INTRODUCTION TO THE DETAILED TECHNICAL PROGRAM

The Detailed Technical Program is a compilation of user needs, the client's requirements and site constraints. It is by no means a prefiguration of the architectural expression and technical solutions.

It constitutes the project owner's commitment, on the basis of which the design team can also commit to the architectural and technical aspects, as well as to costs, phasing and completion deadlines.

Composition of the Detailed Technical Program (DTP):

The Detailed Technical Program for the Ruhengeri referral hospital is made up of 4 Tomes which form a whole whose various elements - surface tables, texts, functional diagrams, feasibility and technical data sheets - must be used jointly and in a complementary manner.

Together, these elements form a complete deliverable that aims to implement the hospital project in line with the recommendations and conclusions of the feasibility study.

The program thus guarantees optimal organization of the planned facility, meeting the health needs of the population while ensuring adequate functionality and operational efficiency.

Tome I: The functional program

The functional program describes in detail the organization and functionality of each space or service within the facility, and also proposes feasibility on the site selected by the MOH, environmental requirements and takes into account the the provision of an *Isange One Stop Center* (IOSC).

Tome II: The technical program

The technical program specifies the detailed technical characteristics and/or expected performances concerning the organization and design of the hospital project, as well as a detailed equipment plan.

Tome III: Detailed sheets by type of premises

Detailed data sheets for each room are included in a separate volume. They are published space by space, with all architectural and technical features, as well as medical equipment and furnishings.

Tome IV: The bioclimatic and environmental program

The bioclimatic and environmental programme specifies the detailed bioclimatic and environmental characteristics and/or expected performances concerning the organisation and design of the hospital project in relation to the requirements of the French High Environmental Quality (HQE) approach.

Annexes from Tome I, II, III and IV

RUHENGERI REFERRAL HOSPITAL

TOME 2

TECHNICAL PROGRAM

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ABBREVIATIONS

AFD	French Development Agency
AHU	Air handling unit
AP-HP	Assistance Publique – Hôpitaux de Paris
API	Application Programming Interface
APSAD	Plenary Meeting of Property & Casualty Insurance Companies (French certification of the fire security system quality)
ASD	Actuated safety devices
ASN	French Nuclear Safety Authority
ATD	Autonomous trigger detector
ATEX	Technical assessment of experiments
BMS	Building management system
CMMS	Computer-aided maintenance management system
CMTI	Centralized management of technical installations
CPI	Permanent insulation controller
CSTB	Scientific and technical building center
CTA-EXT	External Air Handling Unit
CTM	Centralized Technical Management
CUI	Concrete Utilization Index
DAS	Direct Attached storage
DECT	Digital Enhanced Cordless Telecommunications
DHW	Domestic hot water
DTP	Detailed technical program
DTS	Dynamic thermal simulation
DTU	Unified technical document
ETM	Energy Technical Management
EUM	Emergency and maintenance entrance
FSC	Forest Stewardship Council
GE	General electric

GST	General safety table
HACCP	Hazard Analysis Critical Control Point
HDMI	High definition multimedia interface
HDPE	High-density polyethylene
HQE	High Environmental Quality
HV	High voltage
HVAC	Heating, ventilation and air-conditioning
ICPE	Installation classified for environmental protection
IOSC	Isange One Stop Center
LV	Low voltage
LVS	Low-voltage switchboard
MRI	Magnetic resonance imaging
MV	Medium voltage
ODP	Stratospheric ozone depletion
OF	Optical fiber
PEFC	Program for the Endorsement of Forest Certification Schemes
PEX	Cross-linked polyethylene-
PRM	People with reduced mobility
PSSS	Public Safety and Security Study
RBC	Rwanda Biomedical Center
RSEER	Rwanda Seasonal Energy Efficiency Ratio
SDO	Surface dans Œuvre
SDP	Surface de Plancher
SU	Surface Utile
TAN	New Air Treatment
UAE	Operations Support Unit
UGR	Unified glare index
UHD	Ultra high definition
UPEC	Wear, Punching, Water, Chemistry
USB	Universal serial bus

VDI	Voice, data, images
VIP	Very Important Person
VOC	Volatile Organic Compounds
VOC	Volatile Organic Compounds
VRD	Voiries et Réseaux Divers
VVIP	Very Very Important Person

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GENERAL PRINCIPLES

1.3.1. Regulatory and standards context (non-exhaustive list)

The project will adhere to all relevant international regulations or their Rwandan equivalents in effect at the time of its completion, ensuring compliance with the following requirements, among others.

Current regulations:

- The International Health Facility Guidelines – IHFG, Version 6.0, February 6th, 2023,
- The French Environmental code,
- The French Public health code,
- The French labor code,
- The town planning code and community planning regulations,
- The building and housing code,
- Law no. 10/2012 on urban planning and construction in Rwanda;
- Decree-law no. 4-81 on urban planning and territory development;
- Rwanda building control regulations, Ministry of Infrastructure Rwanda Housing Authority, 2nd edition,
- Level 2 Teaching Hospital Standards, February 2022, Ministry of Health, Republic of Rwanda
- Specific Rules to hospital projects,
- Regulations concerning establishments receiving the public (ERP),
- Regulations for fire safety and panic risks,
- Hygiene and sanitation rules,
- Texts and recommendations concerning legionella presence risks,
- Rules regarding accessibility for Persons with Disabilities,
- Rules for asbestos protection,
- Texts concerning noise control,
- Main texts and specific recommendations for technical lots,
- Application of APSAD reference frameworks.
- HQE® High Environmental Quality Health Reference, Cerway (2020),
- To specific rules and standards:
  - ➔ Resuscitation, anesthesia, pharmacy, emergencies,
  - ➔ Legionella control,

➔ Classified installations (ICPE),
➔ Radioprotection (ASN),
➔ Seismic,
➔ Environmental concerns: lead, asbestos, radon...

As well as the following laws:

- Law No. 92-3 of January 3, 1992: Law No. 2006 - 1772 of December 30, 2006 on water and aquatic environments.
- Law No. 96-1236 of December 30, 1996: Law on air and rational energy use.
- Law No. 92-1444 of December 31, 1992, relating to noise control – repealed and codified by Ordinance No. 2000-914 of September 18, 2000.
- Law of February 11, 2005, relating to disabled accessibility.
- Other Rwandan laws and codes, as well as international agreements that Rwanda has ratified.

Technical notices:

- The use and implementation of materials must be subject to a technical opinion compliant with CSTB (Scientific and Technical Center for Building) prescriptions.
- Designs requiring the obtaining of an ATEX (Technical Experimentation Assessment) should be avoided.

However, in the case of a genuine need for an ATEX, it must be justified by a gain in facade performance. The Project Manager must integrate it into the budget and overall project timeline and detail:

- The time required for obtaining it
- Instruction costs
- Potential impacts on the operation

In this case, the Project Manager must commit to obtaining a favorable ATEX assessment.

1.3.2. Obligation to achieve results and completeness

The present DTP describes the architectural, technical, and environmental requirements and characteristics for the design and construction of the future Ruhengeri Referral Hospital.

This large-scale operation will take place within the current Ruhengeri hospital premises. The works will be carried out on-site. The current technical installations will undergo significant refurbishment. All technical requirements, work phasing, and coordination with the hospital must be anticipated by the Prime Contractor to **ensure the hospital's continuous operation 24 hours a day**.

The Prime contractor must conduct all necessary site visits to familiarize themselves with the site and the current hospital environment to establish their architectural concept and principles for connecting to existing networks and buildings.

Upon notification of the Prime contractor's contract is notified, the Contracting authority will provide them with:

- Site knowledge
- DTP elements
- Other transmitted documents

Thus, the Prime contractor will be able to establish the preliminary design during the consultation phase. They must have sufficient knowledge of the project to commit unreservedly to the quality, time, and cost objectives as expressed in the various contract documents.

It is important to remember that the aim here is not to impose solutions on the Prime contractor, but to define the Contracting Authority's technical requirements and needs. These requirements and technical needs will be expressed as an obligation of result and not of means. In fact, the Prime contractor will be responsible for his proposal in compliance with the contractual conditions (cost, deadlines, regulations).

In case of internal contradiction within the DTP or between the DTP and regulatory texts, the designers will prioritize:

- The most stringent regulations between Rwandan and International regulations.
- The most stringent specifications between Rwandan and International specifications.

Any such contradictions must be explained, and the Prime contractors' position explained to the Contracting Authority.

1.3 Actors and principles of flows and circuits

1.3.1. Actors

Hospitals are complex public health establishments, operating 24 hours a day, 7 days a week, where numerous users and users' cross paths. In this context, it is essential to control flows and circuits, and to take into account the following points in its design:

Contracting authority: The Ministry of Health (of which the future Ruhengeri Referral Hospital is a part).

The primarily users consist of personnel employed by the hospital**:**

- Medical staff: doctors, pharmacists, biologists, etc.
- Nursing staff: nurses, orderlies, physiotherapists, etc.
- Medical secretaries
- Hospital workers: building maintenance, stretcher-bearers, logistics, etc.

- Administrative staff
- Technical and biomedical staff
- Fire and security guards

- Personnel involved in hospital operations: ambulance drivers, external service providers (cleaning, operation-maintenance, security, etc.)

The users are the patients attending the medical-technical plateau or consultation (outpatients or inpatients). Also, their companions (visitors and family), as well as family assistance associations.

1.3.2. Flows and circuits

The designer must distinguish the following flows:

- The public and ambulant patients (standing)
- Lying patients
- Logistics: a distinction is made between common circuits, clean and dirty circuits (sterilization/operating rooms) and specific technical circuits.
- Staff: staff have specific access and parking facilities.

The above-mentioned flow must be simple, clear and differentiated. Signage must be efficient and facilitate movement.

Vertical connections must also be taken into account. Indeed, when the project does not allow for single-storey or R+1 architecture (with ramps for stretchers), the designer must integrate:

- Emergency stairs in accordance with current fire regulations.
- Adequate elevators for the projected activity

We will distinguish elevators for the public-visitors, patient lift elevators for inpatients, and freight elevators for logistics.

Redundancy for all types of mentioned elevators must be provided, with a preference for duplex/triplex to ensure service continuity and facilitate operation and maintenance. A "red axis" elevator will provide a connection between emergencies and operating rooms.

Elevators must be sized to accommodate patient stretcher beds and allow for one to two accompanying persons (stretcher-bearers /doctors).

The designer must avoid the following crossing:

- Patient crossings with logistics circuits;
- Crossings between clean and dirty logistics flows.

In order to minimize disruption to patients within the facility, and for reasons of hospital hygiene, it is essential to avoid crossing these flows.

Moreover, it will be important to plan flows so that carts of any type do not obstruct corridors.

In summary, the designer must consider the following principles to rationalize flows:

- Shared common areas (logistics store);
- Differentiated flows (logistics, patients, visitors, staff);
- Accessible care units via vertical connections (elevators, freight elevators);
- Optimize distances based on flow intensity between activities and within activities.

GENERAL TECHNICAL, ARCHITECTURAL AND ENVIRONMENTAL REQUIREMENTS

The construction of a complex structure such as a hospital requires careful integration of the project's various constraints into its environment, taking into account both architectural, technical and environmental aspects.

It is important to consider the following points:

- Develop bioclimatic architecture and ensure the efficiency of technical systems to ensure thermal comfort for users and control energy consumption.
- Choose materials and equipment wisely, particularly with regard to their robustness, maintainability and impact on greenhouse gas emissions.
- Propose an optimal layout for the construction
- Consideration of future hospital operations
- Propose a layout that facilitates maintenance and upkeep during operation
- Assign an annual preventive maintenance plan to each piece of equipment, technical installation and network
- Take into account technical, technological and regulatory developments.

First and foremost, it's essential to make **the right choices when it comes to materials and equipment,** bearing in mind their impact on costs, construction schedules and technical safety. The choice of materials and equipment must also take into account the evolving nature of the hospital. Favoring easy maintenance, enabling spaces to be easily adapted, following the principle ofevolutivity, taking into account fluid distribution... are all important in this approach.

In addition, for most sectors and most types of premises (bedrooms, operating theatres, consulting rooms, offices, meeting rooms, etc.), **we recommend an optimal layout for theconstruction**. The geometry of the premises must not only facilitate the installation of furniture and equipment, but also offer optimum ergonomics.

In addition, right from the programming phase, the project must include a **reflection on the future operation of the hospital,** and must respond to a global cost logic (investment, operation-maintenance and renewal) in compliance with the following criteria:

- Reception and comfort of users,
- User hygiene and safety,
- Environmental objectives,
- To ensure optimum maintenance and operation of the building from the moment it is handed over.
- Provide the future operator with documentation and instructions for use and maintenance, including induction and training of personnel.

In addition, the structure must be designed to **facilitate servicing and maintenance during operation**, while minimizing disruption to occupants during these operations. For example, all technical installations, technical ducts and distribution and evacuation networks for sensitive equipment must be easily accessible for cleaning and regular maintenance.

An annual **preventive maintenance plan** must be drawn up for each piece of equipment, technical installation and network. This plan must include identification of the parts needed, the manpower required, and the cost of any loss of medical activity. Technical solutions must be clearly explained to minimize costs and minimize interruptions to medical activity.

Finally, the Prime contractor must be aware of the delta between the drafting of the design program and the construction of the future Ruhengeri Referral Hospital. Between these stages, technical, technological and regulatory changes may occur. The Prime contractor must therefore **take these developments into account during the project**, to ensure that the Contracting Authority is provided with compliant, modern, high-performance and safe equipment when the hospital goes into operation. This consideration must also make it possible to monitor these developments in the future.

2.1 Personal and property safety

The safety of goods and people involve:

- Protecting structures against the risk of fire,
- Protecting the public from falls and accidents,
- Protecting structures against deliberate damage,
- Protecting people's property against theft,
- Protecting people from malicious acts.

Regulations[1] et applicable texts:

General provisions applicable to all establishments open to the public:

- Decree n°73.1007 of October 31, 1973 (JO of November 4, 1973), Articles R.123.1 to R.123.55 of the Construction and Housing Code;
- Order of June 25, 1980 (JO of August 14, 1980)

[1] As part of the construction of the future Ruhengeri Referral Hospital, it was decided to adopt a demanding regulatory and standards framework. By systematically choosing the most demanding normative framework between International and Rwandan standards, this approach aims to guarantee an optimum level of quality and safety.

- The decree of June 26, 2008 laying down various provisions relating to safety against the risks of fire and panic in establishments open to the public, in particular for safety and security services, the continuity of radio communications with their own means in all parts of the establishments located in infrastructure.
- Order of August 3, 2007 defining technical standards for video surveillance systems
- Circular no. DGS/SD7C/DGUHC/DDSC/2003/114 of March 7, 2003 on prevention and protection of air distribution systems in establishments open to the public against intentional or accidental chemical or biological contamination.

Special provisions:

- The decree of December 10, 2004 approving provisions supplementing and modifying the safety regulations against the risks of fire and panic in establishments open to the public (type "U" care establishments),
- The order of August 1, 2006 laying down the provisions for the application of articles R.111-19 to R.111-19-3 and R.111-19-6 of the French Construction and Housing Code concerning accessibility for the disabled to establishments open to the public and facilities open to the public when they are built or created.
- Any of Rwanda's or international amending decrees, circulars, technical instructions, information notes, and addenda published at the time the project is carried out.

Classification: the planned buildings of the future Ruhengeri referral hospital are classified as type U "health establishments". The buildings will also contain activities:

- Type N (restaurants and drinking establishments),
- Type R (educational establishments)
- Type M (sales outlets, shopping centers)

Dangerous places: Prime contractors are required to ensure that patients and the general public do not unwittingly enter dangerous places or places where the public is not allowed. Appropriate access controls must be provided (doors, barriers, access controls, etc.).

All empty building will be prevented by physical devices, thus preventing defenestration or mutilation. These devices will take the form of: glass screens in stairwells, opening limiters on glazed frames, high railings on interior courtyards, etc.

Routes normally used by ambulant, wheelchair or lying patients must be free of dangerous obstacles, jumps and sharp edges.

Access and surveillance: the site for the future Ruhengeri Referral Hospital is part of the existing hospital.

Access to buildings, control areas, parking lots and emergencies must be provided by the designer only under surveillance and authorization (access control, video surveillance). An emergency exit with access control and video surveillance must also be guaranteed for all buildings. Video surveillance will use IP networks. Intrusion detection systems should be installed in coherent zones: public areas, daytime services, etc.

All the premises of the future Ruhengeri Referral Hospital must be lockable. The key system should enable highly sensitive premises to be fitted with a non-passkey lock, and to be used only by authorized personnel. The premises concerned are :

- Operating rooms,
- Critical care,
- Emergencies,
- Oncology,
- Laboratory,
- Pharmacy,
- Sterilization,
- Mortuary,
- Biomedical service,
- Nursing care station,
- All storage rooms,
- Logistics sector,
- Administration,
- Security and safety, controlled desk,
- Reception and administrative areas (reserved for staff),
- Computer rooms,
- Technical rooms.

2.2 Electricity

Ensuring a reliable power supply is crucial to the smooth running of a hospital. Many medical activities depend on it.

In order to guarantee the continuity of this supply, the minimum installation must include:

- Delivery substations,
- HV/LV distribution substations,
- Power supply to HV/LV distribution substations from delivery substations,
- HV/LV connections
- Centralized Technical Management (CTM) and Energy Technical Management (ETM) connections
- Main general electrical panels,
- All exposed or flush-mounted conduits and trunking required for power distribution,
- High-voltage main and secondary pathways,
- Normal lighting,
- Emergency lighting,
- Exterior lighting,
- Protection against direct and indirect lightning strikes,
- Electromagnetic interference limitation installations,

- Supply, installation and connection of bedhead ducts,
- High-quality sources,
- Small switchgear,
- Earthing of electrical installations and equipotential bonding,
- LV/LV isolation transformers,
- All electrical installations for parking lots and roadways,

The expected rendering for the electrical part includes at least**:**

- Overall power balance by building, sector and power source,
- Network/infrastructure power balance,
- HV/LV synoptic diagram,
- Mimic diagrams for all Low-voltage switchboards,
- Presentation of electrical operating modes (normal, replacement, downgraded, maintenance).

Ventilation and air-conditioning: the ventilation and air-conditioning of premises containing electrical installations must be adapted to ensure continuous operation of the equipment.

Emergency power generators: in the event of a prolonged power cut or failure of the main power supply, emergency power generators must be capable of producing electricity autonomously using diesel or natural gas.

They must be configured to switch on automatically as soon as a power failure is detected. This redundancy guarantees the continuity of essential hospital services (operating theatres, critical medical equipment, emergency lighting).

The minimum composition in terms of low current networks must include**:**

- WIFI terminals
- Patient call, emergency call,
- Telephony
- Access control,
- Intrusion and anti-aggression alarms,
- Video surveillance,
- intercom systems,
- Television,
- Clocks,
- Sound system,
- Videoconferencing and teleconferencing equipment
- Servers,
- PCs and printers,
- Active switching equipment (switch, router),
- Network core equipment,
- Security equipment (firewall, etc.)
- Fire safety system network

2.3 Water

Minimum system components :

- Connections, metering and isolation,
- Water treatment units,
- Domestic hot water production units,
- Safety devices and sub-metering,
- Primary and secondary distribution,
- Terminal appliances and specific accessories,
- Discharge and evacuation collection,
- Effluent treatment,
- Fire columns,
- Rinsing, disinfection and analysis of water distribution networks,

The fundamental safety principles to be implemented are at least:

- Continuity of service and connection,
- Provisions and devices to reduce the risk of development and spread of infections such as legionella or peudomonas, and to treat contaminated systems where necessary,
- Filtration,
- Feed and discharge water quality and control,
- Non-manual control of certain valves,
- In the critical care units, plumbing must have removable spouts[2]

Probable daily consumption must be the subject of an hourly flow simulation by activity**.**

Each starting point includes:

- A suitable safety device (internal network (EA) valve, BA backflow preventer),
- A sub-meter mounted on the BMS (Building Management System) (double pulse meter on DHW -Domestic Hot Water),
- A test sleeve,
- A valve on standby for sampling or disinfectant injection**.**

Network meshing: the main cold water and DHW production networks upstream of the room at the foot of the building must be meshed. Shut-off valves must be placed around each connection to enable work to be carried out on meshed networks without interruption.

2 *DELABI Temporatix © or equivalent*

All equipment used in drinking water and DHW systems must have a Health Conformity Certificate.

2.3.1. Drinking water

A sanitary acceptance procedure for the installation must be put in place:

1) First of all, a sufficiently long period of time must be allowed between commissioning and start-up;

2) Secondly, a cleaning and disinfection procedure must be carried out before commissioning (appropriate physico-chemical and bacteriological potability checks before and after this procedure for each unit);

3) Prior to acceptance, a sanitary water quality check must be carried out at certain relevant points on the circuits, as well as at drawing points to be created upstream of general building inlets.

From each "drinking water" store, the minimum requirements are**:**

- A general cold-water network;
- A general water network for DHW production;
- A technical water network (system filling);
- A dedicated water network to the osmosis water production room for dialysis;
- A network for sterilization and water treatment;
- A network to softened water treatment for DHW;
- A network to areas such as the catering unit;

2.3.2. Production of softened water

Rendondancy catalytic softened water production is to be created:

- By thermal production substation
- In the sterilization area
- In the kitchen area.

2.3.3. Domestic hot water production and distribution

Domestic hot water (DHW) networks: "outward" and "return" loops should be sized to ensure sufficient flow to combat microbiological risks, including Legionella, and avoid dead-ends.

Production: Domestic hot water production and distribution systems must guarantee effective prevention of the risk of Legionnaire's disease.

Domestic hot water production systems must be designed to facilitate maintenance, and each production system must include at least two heat exchangers sized so as to have a back-up exchanger available.

These installations must be equipped with devices for heat treatment and chlorination throughout the network.

Each domestic hot water system must be equipped with a heat metering system, as well as a device for metering the volume of softened cold water used for domestic hot water. These meters must be integrated into the building management system (BMS).

Distribution: hot water distribution must maintain an almost constant temperature, with a maximum permitted deviation of 5°C. The network must be insulated with rock wool shells and a coating to guarantee perfect insulation.

The network must be looped and designed to be decontaminated by thermal shock. The distribution architecture for domestic hot water (DHW) production is identical to that described for cold water, with a multiplication of columns to be limited and the installation of EA valves and non-return valves on terminal connections, etc.

The design of the DHW distribution system enables water to be circulated at 80°C throughout the network without risk to users. However, the network is set to start at 60°C in normal mode, including during peak periods (the distribution temperature is maintained at 60°C).

It is imperative to maintain circulation velocities in the loop piping above 0.2 m/s. This ensures turbulent flow and effectively combats biofilm growth.

Systems must be designed so that they are not too long. The temperature rises of the DHW when tapped at the furthest point must be less than 10 seconds to reach at least 55°C.

Distribution networks should be organized in such a way as to limit the number of loops, and therefore the number of control devices (i.e. encourage loop circulation). Systems must be designed to allow thermal disinfection of networks by counter-current loop, without disrupting the operation of other DHW network tapping points.

Installations should be sectorized to limit disruption in the event of disinfection or network contamination. It is advisable to install a control sleeve and sampling devices on each loop outlet and return.

Any other known technique, resulting from research or recommendations subsequent to the drafting of the present program, must be taken into consideration and submitted to the Contracting Authority for decision.

The DHW temperature must not fall below 55°C at any point in the system.

Temperature sensors, linked to the building management system (BMS), must be positioned on the return lines of each loop to monitor Legionella levels in domestic hot water production, storage and distribution systems.

Distribution systems are responsible for the greatest number of cases of Legionnaires' disease. Controlling water temperatures at all points in the system limits, or even eliminates, the need for curative interventions on the networks. The prevention of legionella depends largely on good hydraulic balancing.

The Prime contractor must pay particular attention to balancing the DHW network, which includes:

- Calculate recirculation flow rates,
- Definition and positioning of thermal balancing valves,
- Definition and positioning of hydraulic balancing valves (draw up a hydraulic diagram of the system, clearly identify hydraulic modules, ensure easy access to valves, define balancing valves on DHW loops),
- Definition of the balancing method.

2.3.4. Dialysis water production and distribution

Premises/room:

The dialysis water production room: must be located in the immediate vicinity of the dialysis stations, yet accessible from a corridor outside the department. This room should have a floor drain to prevent water-related problems, and an air extraction system. A cooling system should be installed to keep the ambient temperature below 23°C.

The production room must be covered with high-quality paint on the floor and walls. Lighting must be watertight, in compliance with ISO 8 standard.

The dialysis water production equipment room must be equipped with:

- A normal and an emergency water supply, so that all dialysis operations can continue in the event of cold-water maintenance.
- A normal and emergency electricity supply via a source inverter.

Production and distribution: Production and the network must be handled by a single service provider, guaranteeing the final quality of the water supplied to dialysis machines. Production and network qualification must be unified.

The Prime contractor will have to define and justify the disinfection process planned for the production and distribution of osmosis water, with an automatic system for safe use in care departments. A manual disinfection shut-off mechanism must be provided.

City water undergoes multiple treatments and controls to make it potable. Hemodialysis, however, demands even higher quality. For this reason, the hemodialysis department must have a tap water treatment room comprising:

- A circuit comprising several filters in series.
- A demineralizer.
- An osmosis unit to obtain very pure but not sterile water.

The water circuit dedicated to hemodialysis must be regularly disinfected, and water quality checked frequently.

Dialysis water production must be sized and designed to meet the needs of the user department.

The following is an indicative, but not exhaustive, description of the water treatment chain:

- All production chain components must be isolable and controllable.
- Each component of the production line must be doubled and can be bypassed individually.
- All control valves must be polarized.
- All filter elements must be equipped with upstream and downstream stainless-steel pressure gauges to measure filter pressure drop.
- Double-outlet stainless steel sampling points should be placed before and after each piece of equipment: raw water, softener inlet, softened water, osmosis inlet, osmosis outlet, filter inlet, filter outlet, loop return.
- Thermometers should be distributed throughout the plant for effective monitoring.

Treatment is to be provided by a double reverse osmosis system with filtration at the loop inlet and outlet. In the event of a problem, each of the two osmosis units can be operated individually via an electric control.

If the hot water production unit used for disinfection breaks down, a disinfectant suction dosing pump must be installed to ensure chemical disinfection of both osmosis units and the loop. Production capacities must be adaptable to actual needs. Network temperature must be kept below 22°C to limit organic growth.

Installation, operation and monitoring: the prime contractor's design must comply with and integrate the technical guidelines for the installation, operation and monitoring of a water treatment unit used in hemodialysis. In particular, it must include:

- Recommendations for the installation of a hemodialysis water treatment unit, covering components, water storage, audible and visual alarms, materials in contact with treated water, hydraulic network for water treatment and distribution, discharge pipes for all circuits, choice of equipment.

- Recommendations for operation of the hemodialysis water treatment unit, including monthly monitoring of the bacteriological quality of treated water and dialysate, and monthly chemical monitoring of mains water and treated water,

- The control and monitoring plan for the hemodialysis water treatment unit.

In accordance with environmental regulations, the production of reverse osmosis water will be equipped with a system for recovering, treating and reusing the leftovers from the production of ultrapure water by the osmosis units.

The designer will have to propose the most suitable residue treatment technique (reverse osmosis, nanofiltration, electrodialysis, etc.) according to the various destinations chosen for the water thus recovered, and the normative electrical conductivity values associated with the intended uses (watering of green spaces, reintroduction into the dialysis system, toilet flushing, external uses, etc.).

2.3.5. Cold-water distribution

The minimum velocity of 0.2 m/s required to maintain a turbulent regime must be respected at all points in the system. A flow rate of between 0.2 and 0.5 m/s must be provided for in hot water return pipes (in the absence of extraction).

The Prime contractor will study the possibility of increasing these speeds, while taking into account the limits associated with acoustic discomfort and excessive pressure.

Distribution: Each cold-water network must be distributed at the bottom, with the possibility of being decontaminated by sector. It must also allow closed-circuit injection of a decontamination product and disinfection of the cold-water network by thermal shocks from the nearby hot water network (using shut-off valves on each branch, as well as an injection or sampling valve).

In order to allow the building to evolve, the cold-water supply networks must follow a "horizontal" supply architecture for each service from a main riser coming from the general meshed networks. Particular care must be taken during design to maintain strictly equivalent pressure levels between cold and hot water networks.

Distribution must take place within the ceiling of the department served, with pathways outside the premises and preferably in the corridors.

Each tapping supplying an appliance or group of appliances must be fitted with a shut-off valve, either in the false ceiling or in a technical cabinet, and an EA non-return valve. Technical cabinets must be accessible from the circulation area via access doors.

Control and monitoring: in order to control and detect leaks, as well as take consumption readings, cold water meters need to be installed on each major column, by zone under concessions, as well as in specialized units (sterilization, imaging, etc.). These meters should be integrated into the Building Management System (BMS), enabling consumption curves to be produced to highlight any drifts due to leaks.

2.3.6. Fire water

All fire-fighting systems must be provided, in particular:

- External fire network with fire hydrants
- Dry columns,

2.3.7. Pipes

The materials used must :

- Be compatible with the liquid being conveyed, even if it has been treated,
- Be compatible with each other and with fittings, or use means to make them compatible,
    - Cold water: HDPE (high-density polyethylene), PVC HTA-F[3], copper,
    - Domestic hot water: PVC HTA Copper
    - Chilled water, hot water: black steel
- Large-diameter pipes (>DN [4]65) must be made of 316 L stainless steel for sanitary purposes, or PVC HTA.
- Small-diameter pipes (<60/63) must be made of copper,
- For underground networks, pipes must be made of HDPE.
- Dialysis water distribution networks must be made of PEX - cross-linked polyethylene- (resistant to heat and chemical disinfection).

2.3.8. Drainage systems

The materials used must meet the following criteria:

- They must be compatible with the liquid being conveyed, even after treatment.
- They must be compatible with each other at connection points or means must be provided to make them compatible.
- They must provide the desired soundproofing characteristics, either by their very nature or by the way they are installed.
- After installation, they must retain the characteristics required by current standards and regulations, particularly in terms of fire safety.
- They must be resistant to impact and mechanical stress in passage areas.

[3] Fiberglass-reinforced PVC pipe for use in extreme pressure and temperature conditions
[4] Internal diameter of the tube

Consequently, networks are generally made of SMU+ cast iron for vertical chutes and for all horizontal networks. The elbow and foot-operated valves must also be made of cast iron. For crossings of high-risk premises, such as storage areas, cast-iron networks are mandatory due to mechanical constraints.

Underfloor drains must also be made of SMU+ cast iron. Only individual drains, between fixtures and the general network, may be made of PVC.

Drainage systems must be equipped to guarantee:

- Adequate drainage and ventilation without defusing traps.
- Easy maintenance at every level.
- The presence of inspection plugs on horizontal sections.

2.3.9. Plumbing

The plumbing used must be top-quality and suitable for intensive use in the hospital environment.

Regulations[5] : All plumbing and materials used in sanitary systems must have been certified as compliant with health and safety standards and must be fitted with backflow prevention devices.

Specification: the plumbing used must be manually operated mixing valves with a mechanical stop and temperature limiter. All plumbing is to be fitted with star-shaped jet breakers, Teflon hoses and designed to accept terminal filtration if required.

In areas accessible to the public, such as visitor and consultation areas, washbasin taps must be manually operated.

All showers must be equipped with mixing valves or flow-limiting systems.

Medical equipment must be fitted with elbow-operated valves.

Plumbing must be of the hydro-economy type, including:

- Dual-control water-saving flushes for WCs (4,5[6]-liter tank).

[5] As part of the construction of the future Ruhengeri Referral Hospital, it was decided to adopt a demanding regulatory and standards framework. By systematically choosing the most demanding normative framework between International and Rwandan standards, this approach aims to guarantee an optimum level of quality and safety.

[6] Rwandan Building Code requirement (see § 3.2 environmental requirements)

- Plumbing with cells
- Low-flow showers, with a flow rate of less than 9 liters per minute. In addition, showers must be fitted with flexible hoses and showerheads compatible with filter cartridges. The hose can be easily unclipped and drains automatically when the faucet is closed.

2.3.10. Sanitary device

All installed appliances and equipment must be individually isolated, and therefore fitted with isolation valves or taps, with the exception of bedroom appliances, which must have accessible common shut-off valves and can be isolated from the circulating equipment cupboard.

Every point of use or group of points must be fitted with anti-pollution valves on the cold and hot water pipes, as well as on other equipment. These valves must be easy to maintain, robust and securely attached.

The minimum list of fixtures includes:

- Individual pedestal-free washbasins;
- Synthetic resin washbasins for accommodation rooms;
- Non-hand-operated medical sinks (no plumbing with cell)
- Special sinks for people with reduced mobility (PRM);
- Hand-washing troughs;
- Suspended toilets with built-in cisterns, without showerheads, with floor and ceiling-mounted support frames;
- Sampling toilets;
- Kitchenettes with refrigerator and microwave niche;
- Double sinks;
- Walk-in showers with plastic liners and taps;
- Hospital drains with support frame and concealed tank;
- Deep basins with tall taps;
- Sink taps and floor drains;
- Equipment waits;
- Automatic bedpan washer;
- Disinfection modules;
- Stainless steel floor drains.

All WCs must be suspended, and reinforcements must be provided and fixed to the upper slab. Recessed WC and hospital waste tanks must be directly accessible via a technical shaft with a door opening onto the corridors, or via a generously dimensioned inspection hatch. Access to the technical shaft must allow inspection of the WC connection pipe.

- Surgical troughs must have the following minimum characteristics:

- Be made of thermoformed synthetic material;
- Be easy to clean and disinfect;
- Be fitted with a straight chrome-plated brass spout, femoral control and thermostatic mixer;
- Have a dry siphon;
- Include pressure reducer, pressure gauge, pre-filtration housing, shut-off valve;
- Include a soap dispenser;
- Be equipped with terminal filtration.

2.3.11. Sanitary accessories

Minimum list of accessories :

- A toilet roll dispenser for each WC.
- A paper towel dispenser for washbasins and hand-washing basins, with the exception of bedroom washbasins and washbasins in public washrooms.
- Electric hand dryers in public washrooms, only in the lobby and main public areas. These hand dryers must be forced-air dryers with a drying time of less than 10 seconds. They must also be fitted with high-efficiency filters. Particular attention must be paid to their installation to avoid noise pollution in adjacent areas.
- A mirror opposite each washbasin or basin for patient or public use, or in personal changing rooms.
- One towel rail in each bedroom bathroom (one per bed).
- Two coat-hooks in each public WC, bedroom bathroom (one per bed), personal WC, personal shower, shared bathroom and dressing table.
- One grab bar in each bedroom WC.
- A grab bar for disabled WCs.
- A retractable shower seat for each PRM bedroom bathroom and PRM shower. Shower seats are not required in all bedrooms.
- A shower rail in each shared bathroom.
- A shower bar in each bedroom bathroom, with shower seats in PRM toilet cubicles.
- Liquid soap dispensers.
- Holders for hydro-alcoholic solutions.

2.4 Heating system – Ventilation – Air treatment and air conditioning

The heating, ventilation, air treatment and air conditioning system plays an essential role in a hospital. It ensures:

- Optimal comfort conditions
- Maintains indoor air quality

- An environment conducive to medical care

The system must include at least**:**

- Chilled water production and distribution
- Domestic hot water production
- Primary and secondary fluid distribution
- Air extractions
- Installation of terminal diffusers, air induction accessories, filters, etc.
- Installation of air return, transfer and extraction terminals
- Smoke extraction systems and devices required by safety regulations.
- High-efficiency energy recovery systems
- Means for measuring energy consumption by use
- Performance measurements
- Training of technical staff in charge of operating these installations.

The basic principles to be implemented are at least the following**:**

- Air changes
- Flow logics, special and filtration classes, installation logics.
- Maintaining overpressure or under pressure in certain rooms, depending on the type of room.

2.4.1. Operating room air treatment

The operating rooms of the future Ruhengeri Referral Hospital are organized in modules of 4 rooms:

- Obstetrical theater: 1 emergency room, 1 gynaecological room, 2 caesarean section rooms
- Operating room: 8 rooms in 2 modules of 4 rooms, including 2 endoscopy rooms

Module 2 is reserved for "heavy and elective" operations. 2 operating theatres will be used for the most critical surgical procedures, while the other two operating theatres will be used for elective operations. Module 2 will not be equipped for the firm tranche.

For reasons of operation and future maintenance, it is recommended that each operating room should have its own air handling system, operating independently of the other rooms.

In the context of the project, the air handling levels per room are defined as follows:

A. Obstetrical theater:
   - 1 risk 3 (ISO 7) aseptic "gyneco-obstetric emergency" operating room;
   - 1 risk 3 (ISO 7) aseptic "gynecological" operating room;

- 2 risk 3 (ISO 7) aseptic "caesarean" operating rooms;

A. Operating room:

Module 1:

- 2 risk 3 (ISO 7) aseptic "emergency" operating rooms;
- 2 aseptic risk 3 (ISO 7) "multi-purpose" and endoscopy operating theatres;

Module 2:

- 2 "heavy and elective" aseptic risk 3 (ISO 7) operating rooms;
- 2 "most critical surgical" operating rooms (cardiovascular/aortic, neuro-interventional, orthopedic) hyperaseptic risk 2 (ISO 5)

The positioning of the air intakes must allow:

- Air renewal
- Flow logics, special and filtration classes, installation logics.
- Maintenance of certain rooms in overpressure or underpressure, depending on the type of room.

Supply air return air and extract air pass through appropriate filters.

Return air filters must be replaceable from outside the room.

Operating room access doors must be "airtight", with controlled leakage rates.

A digital display shows the operating room's overpressure, temperature and humidity. These values are transferred to the building management system (BMS). The premises must be capable of aerosol disinfection.

2.4.2. Risk 2 areas: critical care rooms, sterilization

Regulation : ISO standards will have to be taken into account.

Critical care rooms:

- Air handling in rooms with airlocks should be Risk 2, with airlock overpressure in relation to the rooms and corridor, and no gradient inversion system.
- The intensive care unit must be treated with TAN (New Air Treatment) and CTA-EXT (External Air Handling Unit).
- Risk 2 must be fitted with Very High Efficiency terminal filtration.

Sterilization: Risk 2 could be dimensioned with a single TAN air handling unit, equipped with variable/constant flow boxes for each cabin and scrubber drier.

Specific extraction for scrubbers should be made of high-temperature-resistant PVC.

Areas for auto-scrubber exits, packaging, cabin exits, autoclave exits, sterile arsenals and clean corridors should be designated Risk 2.

Classified sterilization areas should be treated to a minimum of 15 vol/h.

The entire Risk 2 zone should be fitted with Very High Efficiency terminal filters, and the return lines with filters.

2.4.3. Pharmacy and pharmacy storage

Regulation : ISO standards will have to be taken into account.

- Minimum fresh air rate 5vol/h.
- Zone air-conditioning at 20°C -/2°C all year round

2.4.4. Waste garbage cans and infectious healthcare waste

Regulation : ISO standards will have to be taken into account.

Rooms maintained at 14°C.

2.4.5. Mortuary

Regulation : ISO standards will have to be taken into account.

- Minimum fresh air rate 6vol/h.
- Zone air-conditioning at 14/17°C all year round, depending on premises.
- Extractions fitted with filters including variable speed drives.

The Prime contractor will take into account all the requirements for refrigerated lockers, preparation tables, specific emptying systems, including the treatment of organic waste and specific extractions.

2.5 Hospital hygiene

In hospital buildings, the notion of hygiene is fundamental, and this requirement must be taken into account right from the design stage to facilitate and guarantee the achievement of objectives throughout the life of the building. In practice, however, it is necessary to characterize premises according to their nature and activity.

A distinction is made between:

- **Strictly aseptic areas**: operating theatres and associated areas, recovery rooms, interventional radiology rooms, intensive care and high-risk patient rooms, etc,
- **Areas requiring rigorous cleanliness**: care preparation areas, sanitary and hygiene areas, food processing areas, linen processing areas, etc.
- **Other areas**: administration, reception, unmarked technical areas, etc.

For areas **requiring rigorous asepsis**, all surfaces should be specially treated:

- Continuous, smooth protective flooring, skirting board or skirting board effect without any right angles,
- Continuous, smooth, easy-to-clean walls,
- Smooth, non-removable ceilings or false ceilings when the treatment area permits, and removable ceilings when there is no other choice, e.g. for access to technical components.
- Air treatment adapted to the activity.
- Use of fluids (medical fluids, osmosis water, etc.) appropriate to the activity,
- Quality of networks and ducts
- Flush-mounted, easy-to-clean terminal equipment.

In rooms with activities **requiring rigorous cleanliness**, certain walls will be specially treated, such as continuous floors and smooth walls. For other areas, the usual hygiene rules apply.

According to the classification of hospital areas, buildings of an essentially medical nature must ensure an excellent level of hygiene. For this reason, the designer will pay particular attention to how best to achieve this objective, with particular emphasis on the following points:

- Control of cross-contamination (tightness of networks, no recycling of contaminated air).
- Easy isolation of premises after cessation of activity for cleaning, disinfection and work.
- Over-pressurization of clean rooms in relation to dirty rooms,
- Sealing of false ceilings, ducts, shafts and ducts to prevent transmission and enable disinfection.

- Use of coverings, sanitary fixtures and building equipment that are easy to clean and contaminate,
- Smooth, cleanable, non-contaminating walls and/or coverings,
- Elimination of nooks and crannies, sharp corners and areas inaccessible to cleaning,
- Study evacuation circuits (linen, waste, carts, etc.) to avoid interference,
- Provide one ventilation network per unit.

Surface treatment: wall, floor and ceiling coverings, as well as sanitary fixtures and fittings, must be accessible for cleaning to enable easy daily maintenance.

The designer should pay particular attention to the following requirements:

- Minimization of horizontal surfaces more than 1.60 m above the floor for easy dust removal;
- General presence of rounded re-entrant corners to avoid the progressive deposit of waste;
- Pipes are recessed in their horizontal path (except for medical fluids);
- External surfaces of glazed frames on façades can be cleaned from the inside;
- Distinction of floor coverings in the operating theatre according to asepsis zones;
- Cleaning of walls and ceilings;
- General cleaning of rooms and care areas;
- Skirting boards for all PVC floors;
- Shower floors will be granular PVC without anti-slip pads;
- Suspended cupboards in bedrooms (all heights and from 30 cm above floor level).

Areas classification: premises must meet certain hygiene and air quality standards, depending on their activity. There are two classifications.

Classification n°1: Hygiene quality of areas (according to the bio-cleaning guide) :

- Zone 1: areas do not receive patients - hygiene requirements are those practiced in the community.
- Zone 2: the area for Non-infectious or non-highly sensitive patients.
- Zone 3: the areas accommodate fragile patients who are carriers of pathogenic micro-organisms - the aim is to prevent the spread of these micro-organisms.
- Zone 4: working techniques and methods used in this zone are designed to achieve "ultra-cleanliness", avoiding the introduction of micro-organisms.

Classification n°2: compliance with standards NFS 90-351 and NF EN ISO 14644-1

- Risk zone 4, very high infectious risk (ISO 5),
- Risk zone 3, high infectious risk (ISO 7),
- Risk zone 2, medium infectious risk (ISO 8),
- Risk zone 1, no infectious risk.

Rooms can be either over-pressurized or under-pressurized in relation to adjacent rooms. Pressure differences between rooms are 15 Pa.

2.6 General principles for durable, upgradeable, easy-to-maintain buildings and controlled operating costs

The difficulty lies in the functional and technical complexity of a hospital such as the future Ruhengeri referral hospital; in the longevity (at least 30 years) of the facility; in its upgradability; and in the cost of upkeep and maintenance in compliance with hospital hygiene rules.

To this end, Prime Contractor is proposing that the future Ruhengeri referral hospital be designed bioclimatically in homogeneous technical and functional block, in compliance with anti-seismic regulations. In this way, each level can be divided into blocks that correspond to the division of protected fire safety zones. It is imperative that these technical blocks overlap vertically and correspond to the functional division.

Networks: fluid distribution networks will be designed so that each block on each level is independent and can be easily isolated. This ensures that other blocks on the same or adjacent levels are not disturbed during maintenance or for safety reasons. All network routes must be easily accessible, removable and replaceable.

The dimensions of the spaces reserved for network passages must allow for a 30% increase in capacity. Network access will be provided either from public areas (e.g. hospitalization) or from unprotected areas in environmentally controlled sectors (e.g. operating theatres, intensive care units, laboratories).

Each network and facility isolation device must be identified, and specific signage must be provided.

As far as possible, Prime contractors should avoid installing control and regulation devices or equipment requiring regular maintenance (fire detection heads, fire alarms, shut-off valves, AHUs -Air handling unit-, etc.) in the plenums, and group them together in more accessible technical spaces.

The water and medical fluid networks must have redundant supply loops, so that the failure of one cannot lead to the failure of the other.

Building envelope: all surfaces of the Ruhengeri referral hospital's envelope should be easily accessible and maintainable, without the need for special access devices: glazing, solar protection (ventelles orientables, blinds, etc.), ceilings, roofs/overroofs, exterior lighting, fences, etc.

Technical rooms: The design and layout of technical rooms must facilitate maintenance, servicing and modifications.

Les locaux techniques courants forts et courants faibles devront être séparés ainsi que le local technique informatique.

Access to HVAC (heating, ventilation and air-conditioning) technical rooms, and in particular AHUs, must be possible without entering functional areas. Equipment on roof terraces (cooling units) must be designed for easy maintenance and fitted with acoustic screens.

The water room must be separate from the other technical rooms and follow the recommendations of the concessionaire. A booster room must be included in the project manager's design.

Heavy technical installations will be installed on pedestals with corner protection.

The logistics platform includes medical fluid installations and must comply with suppliers' specifications, in particular:

- Installation layout (oxygen production unit, tanks, cylinder racks, etc.),
- Access for delivery and removal of equipment and fluids,
- Protection from third parties (walls, distances, etc.),

Electrical technical rooms should preferably be located outside functional areas. Annual checks and preventive maintenance must be carried out on the following items, as they may be a source of downtime:

- HV network (with source inverters)
- GE power station
- LV network (source inverters) / general LV board
- Transformers
- Safety chargers
- Inverters / general LV board/ CPI (permanent insulation controller)
- Management API (Application Programming Interface)

Technical duct: technical ducts are separated according to the type of network:

- High current,
- Low-current with dedicated cable trays for fire safety and VDI (voice, data, images) networks,
- Cold water,
- Hot water,
- chilled water,
- Bacteriologically controlled water,
- Evacuation networks (waste water, black water, clean water)
- Medical fluids,
- Specific networks: liquid nitrogen and CO2 where applicable,
- HVAC,
- Smoke extraction,
- Layout of ducts to allow maintenance work on all networks from corridors or equipment rooms.

The Ruhengeri referral hospital has a duty to set an example in terms of sustainable development. It is therefore essential to equip the hospital with appropriate, high-performance maintenance tools to monitor consumption, detect deviations and intervene rapidly in the event of malfunctions.

CMMS / BMS: with a view to optimizing maintenance at the Ruhengeri referral hospital, a computer-aided maintenance management system (CMMS) and a building management system (BMS) are planned to be installed at the start-up phase.

The technical data supplied by the CMMS must be updated on delivery of the buildings.

The BMS will provide, among other functions: metering, supervision, control and command of at least the following main elements:

- Electricity,
- Air conditioning (production),
- Heating (production),
- HVAC,
- Fluid management,
- Access control management,
- Lighting,
- Main heavy biomedical equipment,
- IT infrastructures and VDI networks.
- Transport (express logistics transport)
- Renewable energies (production)
- Solar protection/roller shutter control

Control consumption: in order to optimize the use of fluids and energy in terms of quantity and cost, the designer will focus on organizing the spaces of the future Ruhengeri referral hospital by grouping together rooms with similar needs. Architectural provisions must take into account the physical, seismic and climatic conditions of the site.

It is demanded that the designer implement the following devices to control consumption (non-exhaustive list):

- As far as possible, avoid simultaneous use of heating and cooling, except for process requirements;
- Energy recovery systems;
  - Recovery of the energy released by the operation of refrigeration units to reheat air after dehumidification, and to preheat domestic hot water.
  - Heat recovery from grey water/wastewater, particularly at the end of the sterilization process
- Optimize consumption and efficiency of auxiliary equipment with a view to "overall efficiency": fans, pumps, heat recovery units, etc. ; (see HQE target no. 4)
- Install metering and sub-metering systems; (see HQE target no. 7)
- Install energy consumption regulation and limitation systems;

- Make optimal use of energy-saving tariffs (special tariffs, night-time hours, etc.);
- Limit night lighting to functional areas where necessary;
- Centralized automatic lighting shutdown (per sector);
- Automatically close all peripheral accesses at night (timer), activate alarms, non-stop dedicated elevators;
- Automatically stop or reduce ventilation in areas of intermittent use
- Control ventilation output at night (switch to low-flow mode, stop air-conditioning and restart on schedule from BMS, etc.) Depending on the opening hours of certain sectors (consultations, day hospitals, tertiary areas, etc.);
- Plan to collect all energy consumption data, with generation dashboards and statistics (including predictive ones).

All the above-mentioned devices must be connected to and controlled from the BMS.

The design of the "intelligent" building, which can be "dynamic", will include a system for managing thermal and electrical requirements. An "anonymous" geolocation system for people without identification is proposed, enabling real-time:

- A determination of the number and concentration of people present in the premises used (offices, meeting rooms, etc.);
- Manage lighting with automatic switch-off (corridors, toilets, parking lots, offices, miscellaneous premises, etc.);
- Optimize ventilation requirements for air renewal (volume/hour in premises);
- Manage heating and air-conditioning consumption for unused rooms or rooms used by a non-continuous concentration of people (chambers, meeting rooms, etc.);
- Manage the consumption of unused rooms according to occupancy rates, and of areas or sectors with intermittent operation (day hospital, tertiary sector, logistics, etc.);
- Identify high- and low-use zoning to deduce maintenance locations to be anticipated (preventive maintenance on lighting, etc.);
- Identify premises for cleaning,
- Schedule regulatory and routine building maintenance: painting walls, automatic doors, elevators, fire safety systems, etc;
- Map flows within the hospital: patients/logistics/caregivers/other.

Controlling maintenance costs: the main contractor will have to anticipate maintenance costs in the design of the Ruhengeri hospital, giving preference to a compact project in terms of surface area and volume.

Materials will be chosen for their durability and suitability for use, with preference given to local materials.

The choice of materials for horizontal and vertical walls should be justified by overall cost arguments (construction, maintenance, durability).

All walls in corridors accessible to the public, to patients or in logistical corridors must be systematically protected (hospital-quality vinyl overprotection, handrail, wheel guard, protection of protruding angles, etc.).

The Prime contractor will pay particular attention to:

- Accessibility of the structures to be maintained, including surrounding existing structures, and glazing must be easy to clean. The lower parts of buildings must be treated to prevent soiling and tagging;
- Standardize equipment by function, to avoid a multiplicity of equipment and models when renewing and avoid any "exclusive" or "proprietary" systems.

I. DETAILED TECHNICAL AND ARCHITECTURAL REQUIREMENTS

1. Designer's obligations

When finalizing the architectural and technical studies, the contractor is required to consult, under the supervision of the establishment, the town planning departments concerned by the project.

During the design phase, the contractor must take account of the requirements imposed, in particular for obtaining building permits, and all the formalities required for these permits.

As part of the studies, the prime contractor will be required to submit to the Contracting Authority:

- A Public Safety and Security Study (PSSS) in accordance with Decree no. 2007-1177 of August 03, 2007 and Decree no. 2011-324 of March 24, 2011;
- An energy supply feasibility study for new buildings, in accordance with Decree no. 2013-979 of October 30, 2013 on energy supply feasibility studies for new buildings;
- A traffic study to justify the quantity and number of elevators (public, patient lifts and logistics) required to meet the hospital's needs.
- Other Rwandan laws and codes, as well as international agreements that Rwanda has ratified.

2. Key project priorities

The project to build the new Ruhengeri Referral Hospital is not just a major real estate operation for Rwanda, but also a strategic development project, an organizational and innovative project serving a population in demand. The designer will have to take into account the main priorities of the RRH[7], which will have to be imagined and designed to meet expectations according to the priorities described below, and which will have to develop the attractiveness towards patients/consultants as well as medical and paramedical skills:

- Hospital performance;
- Improved care ;
- Improved working conditions;
- Exemplary energy performance and sustainable development;
- Innovation in communication technologies and IT systems;

[7] See Annex 6 – Master Plan of RRH, Rwanda

- Efficient administrative and logistics functions;
- Scalability and optimize layout of certain areas;

2.1. Hospital performance development

Hospital performance means:

- The construction of a building accessible to all (Law no. 2005-102 of February 11, 2005 for equal rights and opportunities, participation and citizenship of disabled people, or other more stringent international/Rwanda standards) on a human scale, avoiding the construction of "unused/usable spaces";
- Multi-purpose facilities to increase occupancy, such as operating theatres, consultation rooms, bedrooms, etc…;
- The design of hospitalization units with shared areas for staff and patients' families;
- Pooling of logistics platforms shared by several departments;
- optimizing human resources (facilitating the concentration of professionals "in the right places");
- Development of new activities and practices;
- The creation of an ambulatory activity.

All these aspects will enable us to build a high-performance facility in terms of medico-economics, quality and safety of care.

The building will need to be well-sized and adapted to changes in the healthcare offer. It will be designed in such a way as to limit staff movements within a given department, and also between interdependent departments.

This compactness should also limit investment and operating costs (by limiting the amount of floor space required for maintenance).

2.2. Improved reception and accommodation conditions for patients, consultants and their families

The future Ruhengeri referral hospital must be accessible to all, from the moment they enter the building, and every time patients, staff and visitors move around it, with simple, clear and differentiated paths.

The design of the new hospital will have to take into account the separation of route from the moment of entry to the site, as well as from the moment of entry to the building(s). The user circuits to be distinguished are

- Elective patient paths;
- Emergency patients' paths (general and gyneco-obstetric emergencies);
- Outpatients paths: consultations and day care,
- Inpatients paths;
- Visitor paths.

Elective patient paths will be clearly separated from emergency patient paths from the site entrance itself.

The paths for patients treated in outpatient departments (consultations and day-care) should be as short as possible from the main entrance and should avoid disrupting the path for inpatients in conventional departments.

Signage should make it easier for patients and visitors to get around. The use of new technologies should be encouraged to enable individualized, scalable and dynamic signage.

Patient management and administration will be carried out in a centralized area at the main entrance/exit, more commonly known as the admission/fees area.

To improve patient care, the future structure will offer a number of adapted services:

- Development of outpatient activity, with cubicles offering a level of comfort adapted to the type of care required;
- Improved accommodations;
- Provision of a high-performance technical platform to facilitate rapid paths between interdependent departments for the staff

The new hospital will take the staff into account, offering the possibility of using living areas located in the entrance hall and at the entrance to certain departments and/or wards.

The design of the emergency department will ensure that patients are attended to quickly, that they are properly oriented (reception and orientation nurse) and that waiting times are reduced.

More than a regulatory obligation, the accessibility of buildings to people with disabilities (Law no. 2005-102 of February 11, 2005 for equal rights and opportunities, participation and citizenship of people with disabilities), is part of the quality criteria that go into the design of a building.

Health-care facilities designed specifically to accommodate patients/residents with disabilities or reduced mobility impose particular constraints in terms of architectural design and technical provisions.

More generally, spaces must take into account the diversity of the public they cater for (children, the elderly, large families, etc.).

2.3. Improving staff working conditions

Hospital is also a place of work, where a large number of professionals work around the clock. The structure must therefore be designed to provide a pleasant working environment where professionals feel at ease.

The construction of a hospital structure is an opportunity to adapt care practices and organization. In this context, the Contracting authority will want to ensure that all staffs can focus on their work by :

- Automating non-value-added administrative and logistical tasks as far as possible;
- Implementing a high-performance Hospital Information System (HIS), accessible in all care areas through the use of fixed (computer workstations) or mobile systems;
- Implementing logistics solutions, such as "full/empty systems", to directly manage supplies between production units and support services (medical and technical logistics);
- Installing work and relaxation areas in spaces that are adapted both in terms of surface area and layout (adapted furniture and equipment);
- Offering maximum natural light in work and rest areas: rooms must be naturally lit for patients, but also for staff, to optimize working conditions;

All staff room for medical and paramedical, logistics and administrative staff (nursing stations and offices, secretariats, reception desks, consultation rooms, offices, care preparation, etc.), with the exception of specific rooms such as radiology and scanner rooms, radiology interpretation rooms and ultrasound rooms, must have natural daylight.

With regard to the quality of the premises, and more specifically the provision of natural light, it is important to take into account the country's climate. The provision of natural light does not mean that all premises must be glazed. All-glass solutions create air-conditioning and cooling constraints. They not only have a major impact on energy consumption, but also oblige users to install blackout devices such as curtains to combat sunlight, which are inadvisable from a hygiene point of view.

The designer will also propose outdoor spaces for relaxation and conviviality, located in the immediate vicinity of the services. They will be extensively planted with trees and shaded, and partially protected from the rain, to offer staff (and even patients) relaxing settings for poses guided by a feeling of biophilia.

2.4. Innovation in communication technologies and computer systems

Because the hospital of tomorrow will be digital, the new Ruhengeri referral hospital project will have to demonstrate innovation in information and communication technologies, using a unique VDI (voice, data and image) network.

As the HIS is being handled by the contracting authority, and given current technological developments, the project should enable the new hospital to gradually move towards a highly secure, all-IP hospital:

- For internal exchanges (with patients and their families, between healthcare professionals, and for logistical and technical activities);

- Encourage access to multimedia services at the patient's bedside (telephony, Internet access, hotel services, medical examination consultations, etc.), including the use of patients' personal terminals for VIP rooms, for example;
- Cell phone over IP for professionals;
- Computerized patient file interoperable with new information technologies;
- Development of telemedicine;
- Secure messaging;
- Installation of a building management system (BMS) for real-time consumption analysis and facility maintenance management;
- Centralized management of technical installations (CMTI);
- Installation of a CMMS (Computer-aided maintenance management) for technical and bio-medical maintenance to manage the equipment pool;

2.5. Efficiency of administrative and logistics functions

Administrative functions: the aim is to set up a fluid, easily identifiable and sufficiently sized organization to handle patient administration.

To this end, the organization of the admissions office must be in line with patient care modes:

- A reception area dedicated to administrative management (admissions/fees);
- A specific reception area for outpatient hospitalization activities (at unit level);
- A reception area for consultation and medical activities. At the entrance to the consultation area, hospital staff will be responsible for welcoming patients and processing their administrative files in connection with hospital admissions/fees.

Medical secretarial functions will be maintained close to the care units. Secretariats will be created in the back-office of the medical-administrative reception areas and will be shared by hospitalization tray.

Logistics functions: the objectives of the "hotel/logistics" organization to be set up in the new hospital are as follows:

- To help caregivers concentrate on their core activity: care. To this end, the logistics functions must be service providers, at the service of caregivers, who are themselves at the service of patients. The aim is to ensure that health-care staff have access at all times to the logistics products they need to provide quality care.
- Contribute to the continuous improvement of patient care (in terms of reception, hotel services and comfort during the stay);
- Develop a high level of professionalism in hospital "hotel" functions.

To this end, the following actions are to be undertaken:

- Centralize and integrate all logistics, medical and technical functions within the new hospital (pharmacy, warehouses, relay kitchen, relay laundry, waste platform, technical and biomedical services);
- Supply medical and care teams as close as possible to where they work.

Each platform will have local logistics cells to ensure that logistics products are as close as possible to the care teams. These logistics levels bring together shared logistics facilities: dirty linen storage, centralized catering and reheating, cleaning, medical equipment storage, waste storage, clean linen storage.

To limit the volume of local storage and encourage central management, weekly or daily deliveries by logistics agents can be set up, to meet needs adapted to flows, volumes, frequency and product specificities (full/empty principle).

It may also be useful to set up "flying" hotel teams capable of delivering the service right up to the doors of the care department, particularly for VIP rooms. The presence of a hotel and/or logistics agent will facilitate collaboration between care staff and logistics.

2.6. Scalability and optimize layout

The design of hospital buildings is increasingly challenged by advances in medical technology and patient care methods. Rapidly evolving designs and techniques call for permanent flexibility of premises, eliminating fixed locations or assignments.

The choice of structure will therefore be adapted to the following principles: "scalability, flexibility, extensibility and optimize layout".

To meet the requirement for scalability, flexibility and extensibility, the facility will need to have expandable areas to accommodate changes in the local healthcare offer. Services on the periphery of the building, such as the operating rooms, imaging and emergency departments, must be able to be extended outwards. A land reserve must therefore be set aside for the expansion of strategic premises.

In terms of optimizing layout, structures must be adaptable to changes in use and purpose:

- Conventional hospitalization units that can become outpatient units;
- Hospitalization units that can become technical platforms (taking into account floor load and adapted ceiling height, etc.);
- Operating rooms, which can become hybrid rooms;
- Laboratories should be designed as open, fully decompartmentalized trays (with the exception of the microbiology and molecular biology sector), with equipment versatility to adapt the service to future new technologies;
- This laboratory design enables us to manage the flow of analyses as readaptations and prescriptions are made;

- Juxtaposing hospitalization units to limit boundaries between units and facilitate bed scheduling;
- Set up the intensive care unit so as to be able to isolate certain patients, for example in the event of an epidemic. The sector must be equipped with its own reversible AHU to meet the need for negative or positive pressure, depending on the epidemic;
- Provide an internal medicine unit with reversible negative or positive pressure chambers, to deal with infectious patients in the event of a major epidemic.

In future, outpatient activities are likely to grow at the expense of conventional ones. Accommodation units must therefore be capable of being transformed into other functions. They could, for example, become outpatient units. It should therefore be easy to move partitions to shrink rooms into cubicles, or to enlarge spaces into treatment rooms, waiting rooms, etc.

Sectors such as imaging have undergone considerable upheaval in recent years. Healthcare establishments have had to find ways of installing imposing equipment with heavy technical constraints in premises or areas that are often unsuitable. It is therefore advisable to position imaging in a part of the building that can be expanded, and where there are easy access areas to accommodate bulky equipment (e.g. MRI).

The designer is therefore asked to show, right from the proposal stage, the principles for extending the new hospital that could be effective in the more or less near future. The architect should demonstrate how the following services could be extended:

- Inpatient unit: possibility of adding 2 to 3 additional units;
- Consultations: possibility of adding a consultation module;
- Imaging: possibility of adding additional examination rooms (e.g. 1 scanner, 1 MRI and 1 radiology room);
- Emergency: possibility of adding additional cubicles and ancillary rooms;
- Operating rooms: possibility of adding an additional module of 2 to 4 rooms.

3. Structure

The overall stability and strength of the structure depend on several factors, including:

- Geological and geotechnical data,
- Climatic data,
- Safety requirements, such as fire resistance,
- Operating loads,
- Application of structural design rules.

The structure must be designed to allow flexibility in the layout and use of the premises, favoring simplicity with clear and direct routing of loads, whether vertical or horizontal.

It is important to note that the designer must take into account rolling loads of all kinds in order to meet flooring durability requirements. These loads must be standardized by zone, using the most restrictive value. In addition, heavy equipment loads must be taken into account when determining these loads.

The values given in the tables below are general for the sectors mentioned.

Sectors, services, premises	Operating expenses
Conventional hospitalization	
All unit area (rooms, treatment room, circulation, etc.)	2.5 KN/m² floor, ceiling load for patient lift system in rooms
Common areas (room, corridors, etc.)	2.5 KN/m²
Outpatient activities	
All unit areas (rooms, treatment room, circulation, etc.)	2.5 KN/m²
Adult dialysis	2.5 KN/m²
Common areas (room, corridors, etc.)	2.5 KN/m²
Cross-functional activities	
Sectors common to support care	4.0 KN/m²
Tertiary support care zone	4.0 KN/m²
Dental chairs for inpatients	4.0 KN/m²
Interventional and endoscopic sector	
Surgical centers (all areas, operating room, interventional imaging room, etc.)	10.0 KN/m² floor, 2.0 KN/m² ceiling, and loads according to equipment constraints
Obstetrical unit	4.0 KN/m² floor, 2.0 KN/m² ceiling, and loads according to equipment constraints
Centralized endoscope disinfection	4.0 KN/m²
Common sectors	4.0 KN/m²
Critical care	
Resuscitation module	4.0 KN/m² floor, 2.0 KN/m² ceiling, and loads according to equipment constraints
Areas common to all critical care services	4.0 KN/m²
Emergencies	
Emergencies	4.0 KN/m²
Short-term inpatient units	4.0 KN/m²
Common areas to all emergency departments	4.0 KN/m²
Imaging	
Common reception	4.0 KN/m²
Non-interventional imaging (all large-format imaging rooms)	4.0 KN/m² floor, 2.0 KN/m² ceiling, and loads according to equipment constraints
1.5 T MRI room	Stand: 5.5 tons (excluding faraday cage); table: 150 Kg; equipment room: 2.4 tons
Scanner room	Stand: 2 tons; table: 600 Kg
Administrative and medico-administrative logistics	
Main lobby and social areas	4.0 KN/m²

Administration	2.5 KN/m²
Medical services	2.5 KN/m²
Central staff changing room	2.5 KN/m²
Medical logistics	
Pharmacy (excluding storage area)	6.0 KN/m² and loads according to equipment constraints
Pharmacy storage area	10.0 KN/m² and loads depending on storage height
Sterilization (all areas)	6.0 KN/m² and loads according to equipment constraints
Sterilization (Autoclave)	Operating weight: 2.2 tonnes
Wash cabin	Operating weight: 2.7 tonnes
Mortuary chamber (all areas)	4.0 KN/m²
Mortuary chamber (body storage lockers)	6.0 KN/m²
Technical logistics	
Biomedical workstation	4.0 KN/m²
Maintenance workstation	4.0 KN/m² and loads according to equipment constraints
Other facilities	
General circulation, hall, large meeting rooms	4.0 KN/m²
General circulation on the technical platform	4.0 KN/m² and loads according to heavy equipment delivery constraints
Computer rooms	12.0 KN/m²
Technical rooms, technical galleries, logistics transport corridors	4.0 KN/m² and loads according to equipment constraints
Roofs, terraces not accessible to the public, walkways	2.0 KN/m² (excluding planters, large circulations) + moving loads
Tersasses accessible to users	2.5 KN/m² minimum and depending on use

TABLE 1 - VALUES PER SECTOR (NF 06-001)

Vertical and horizontal structures must guarantee fire stability and an appropriate fire-resistance rating.

Operating loads in the corridors must be adapted in line with the study of the routing of the heaviest technical and biomedical equipment in the building. Right from the design stage, a structure must be incorporated to anticipate the replacement of heavy medical equipment (MRI, scanner, etc.), and provide for fusible walls and/or floors to minimize the need to reinforce or demolish the structure.

The Designer will refer to the soil survey, which is his responsibility, to calculate the foundations and structures of the buildings to be constructed.

Calculations will be carried out in accordance with **standard NF P - 06-001**, approved in June 1986 and applicable to both public and private buildings. This norm is based on international standards and is the most updated reference.

Floors will be designed to support the minimum operating loads specified in standard NFP 06001, some of which will be increased to take account of changes in the use of the space.

The operating overloads taken into account will be based on the operating constraints defined in the program and specified in the space sheets. Static and dynamic loads for heavy equipment, particularly biomedical equipment, are also included in the calculations.

The internal organization of the building will inevitably evolve over its lifetime, as will the needs of its users.

Designers are therefore invited to look for a structure and interior layout that allow for occasional changes in distribution and, in the longer term, simple restructuring.

The different grids of facades, partitions and false ceilings should allow for flexibility of layout.

The aim is to use a grid that is as flexible as possible. Load-bearing points will be laid out according to a simple construction grid, with the smallest possible footprint.

- A column/floor/beam structure is preferred to a wall structure, and where appropriate, the pressure caused by the finishing of floor sub-faces (false ceilings) and beam drops (pipe and duct routing) should be reduced as much as possible.

- The chosen structure will also take into account the building's extension requirements. Load-bearing facades or load-bearing walls are cleverly used, i.e. in rooms with no foreseeable changes, or on so-called "blind" walls (stairwells, elevators, emergency exits, unglazed gables, etc.).

The height of the floor will be chosen to allow easy passage of all networks and fluids in the plenum of the false ceilings, and any subsequent modifications.

In addition to improving access to networks for maintenance purposes, generously dimensioned service ducts can also accommodate any increase in the number of new networks.

- Floors with pre-cast slabs (excluding non-prestressed pre-cast slabs) are to be avoided or severely limited, so as to be able to create passageways at a later date without technical complications.

The structure will be designed in such a way that the posts do not penalize the useful surfaces of the spaces.

Vertical and horizontal structures will be designed to ensure the fire stability and fire-resistance required by regulations.

General design: Particular attention will be paid to building insulation and the treatment of thermal bridges. The building will be subject to HQE targets, as required in the terms of reference of the feasibility study by the AFD.

3.1. Covering

The building's roof plays an active part in the bioclimatic architecture desired for the future Ruhengeri referral hospital. As such, the roofing elements (roofing and skylights, materials, etc.) will prevent the transmission of thermal and acoustic pollution to users.

Zenithal lighting systems, whatever their height, should be easy to clean on both sides and provide satisfactory comfort for users.

As with solid facades, the type of roofing (covering or terrace) and the choice of materials will first be determined by the site where it is to be installed, and by current town-planning regulations.

The proposed covering will be energy-efficient, guaranteeing good building insulation. The designer's choices must take into account ease of maintenance (type, frequency, accessibility, etc.) and fire safety requirements.

Where glass roofs are planned, designers are required to take all necessary precautions to avoid overheating of the premises due to the greenhouse effect, and to take all necessary maintenance measures (self-cleaning, etc.).

If required, roofs can also contribute to the implementation of renewable energy techniques: photovoltaics, DHW, wind power, if these are selected.

To meet different needs, constructions can also be used to collect and recycle rainwater for reuse.

In all cases, the proposed solutions will be studied and justified in terms of overall cost, and provision will be made in the design for devices that facilitate maintenance and operation. The implementation of these techniques must not generate any particular nuisance for the building and its users and must be perfectly integrated architecturally.

The design of roofs must incorporate devices to facilitate access and protect workers during maintenance.

Any work required to install extraction shafts, skylights, etc. must comply with technical regulations and, in particular, avoid any nuisance caused by prevailing winds, for example. The architectural configuration of aediculae must blend in with the overall massing. Ladders should be installed to allow access to roofs and aediculae.

In the case of unplanted terraces, significant slopes are required to eliminate any areas where puddles may form.

3.2. Facade

The prime contractor will design a facade system that enhances the project while complying with town-planning regulations, the projected cost of the work, and the client's wishes in

terms of durability, limiting and facilitating maintenance, and helping to reduce greenhouse gas emissions.

The choice of color and materials is left to the designer.

The proposed construction methods and insulation will respect the environmental objectives expressed in the HQE targets.

The requirements also cover air and water tightness in accordance with Articles 1792 and 2270 of the French Civil Code, air infiltration tightness and thermal and hygrometric behavior.

In terms of airtightness, temperature- and humidity-controlled zones in particular will be subject to strict permeability controls.

The Designer will propose facade solutions that eliminate or limit the need for specific lifting equipment such as gondolas to maintain glazed surfaces, and control overheating in the building.

Facade cladding must be sufficiently weather-resistant to withstand the test of time without needing to be repainted.

Accessible facades, whatever their location, will have T4 impact resistance (reference to the EPEBat association's "reVETIR" classification for exterior insulation systems). Accessible parts of ground-floor facades will be fitted with underpinnings that are resistant to the usual impacts and rubbing and cannot be removed from the outside. Walls must be perfectly watertight and airtight. Insulation materials must be maintained in compliance with humidity regulations.

In the case of facade-mounted equipment such as split-system outdoor units, these must be completely concealed in the facade, and must be invisible or only slightly visible. The same applies to all types of facade installation.

3.3. Exterior joinery

General requirements: the project must be designed and built to ensure that natural light is present in sufficient quantity in all rooms, workplaces, areas with a permanent presence and staff relaxation and catering areas. However, the designer will study the possibility of distributing natural light to as many rooms as possible.

Window and glazing exposure class: the criteria used to classify windows are at least those defined by the DTU (Unified technical document) and compatible with acoustic requirements (mechanical wind resistance: VA2, maximum insensitivity to solar radiation).

Glazing must comply with environmental requirements and the following principles:

- Promotes winter and summer comfort
- Adaptation to acoustic and thermal classification and comfort requirements

- Aesthetic appearance (glass tint) chosen by the designer.
- Laminated glazing to prevent UV transmission.
- Burglar-proof on bales accessible from ground floor (P4 5 Norma P78-406 of April 1994).
- Firestop rating in compliance with regulations for bales exposed to fire risk.

Glazing should be double-glazed or triple-glazed insulating known as low-emissivity, low-solar-factor glazing.

Appropriate measures must be taken to ensure the cleaning of glazed surfaces on elevations and roofs, and of façades if necessary, in compliance with regulations.

For rooms requiring confidentiality, and where glazing gives onto the outside but still lets in daylight, these rooms must be fitted with a film and/or blinds that prevent outsiders from seeing inside. Particular attention will be paid to all treatment or consultation rooms to ensure that they cannot be seen from the outside, even at night when the rooms are lit (patient privacy), either by installing privacy blinds or treated glass.

If interior blinds are used, they should be integrated into the glazing for reasons of hygiene.

Frames: frames should be designed to minimize maintenance requirements, using unalterable materials. Wood should be avoided. Frames must be fitted with safety devices to prevent accidents to persons when opening. In all cases, the maximum opening height should be limited to 11 cm, with secure opening for window cleaning and anti-defenestration systems.

Solar protection - shading: Facades that are particularly exposed to the sun must be fitted with solar protection adapted to the orientation of each opening. This should preferably be a passive sunscreen integrated into the facade, or, where appropriate, roller shutters or blinds. External fabric blinds are not permitted.

Roller shutters (in lacquered aluminium, with adjustable louvers as required) for blackout, or any other device guaranteeing comfort, low noise levels in windy conditions and durability (10-year guarantee), will be installed where necessary.

Roller shutters will be installed in all rooms (blackout) and on the first floor (burglar-proof), with electric controls and boxes accessible from the inside. Firemen's windows will not be fitted with roller shutters.

Light-dependent shutter control systems can be studied as part of the implementation of patient-friendly rooms.

For rooms requiring special airtightness (ISO rooms, etc.), the blackout system should be designed to avoid weakening the room's airtightness (recessed controls, shutter boxes, etc.).

Fittings, hardware and locksmithing: all these elements are simple, robust, corrosion-resistant and adapted to the use of the structures on which they are installed.

The minimum equipment required for:

- Doors in general:
    - Hinges, lever handles, locks, push plates, doorstops, door closers.
- Emergency door:
    - DAS (direct attached storage) device linked to fire detection system with local manual release and audible alarm.
    - Doors for beds, stretchers and carts:
    - Magnetic suction pad controlled by fire detection and held in open position.
- Double-leaf door units:
    - DAS (direct attached storage) controlled by fire detection hold-open.

4. Interior fittings

4.1. Circulation

The dimensions of the circulation systems must ensure that the various flows (patients in bed, practitioners, logistics and the public) are handled satisfactorily.

Circulations must also be designed to allow stretchers or beds to circulate and cross easily within the hospital. The following minimum widths are therefore recommended for:

- Circulation in the accommodation area is 2.20m minimum;
- Circulation in the technical area is at least 2.50 m;

In addition, the intensive use of corridors requires robust materials (floor and wall) and appropriate acoustic treatment. Particular attention should be paid to the treatment of protruding angles (protected by corner protectors), handrails and, wherever possible, recessed protruding elements (fire extinguishers, RIA, etc.).

Wherever possible, the designer will give priority to natural lighting.

Vertical circulation systems (staircases and elevators) must be of sufficient size and quantity to comply with current evacuation regulations and standards.

If the project requires the use of elevators (over R+1), these must be provided in sufficient number to ensure that waiting time does not exceed 30 seconds.

- The leveling system must be compatible with hospital activity.
- The number of elevators must be the subject of a traffic study (distinguishing between public/visitor flows, patients in bed, logistics).
- The public must not have access to goods and patient elevators.

4.2. Partitioning

The prime contractor will comply with the fire resistance requirements of the walls, in accordance with safety regulations. Certain partitions will have to be able to support suspended elements for storage on shelving or suspended basins, etc.

Generally speaking, except for vertical circulation cores (staircases, elevators) and service ducts, partitioning should be independent of the building structure.

Vertical screens should be grouped together to facilitate the flexibility of other zones.

Structures and partitions should therefore allow for future modifications, avoiding heavy concrete wall structures on floors requiring them, in favor of punctual frameworks and light partitions:

- Use materials that are easy to dismantle or break.
- Avoid installing technical terminals that become inaccessible in partitions and linings.
- Install service ducts between two partitions.

Partition materials must obviously be adapted to each type of use. In care areas, partitions should be easy to clean (using washable coatings), and their surfaces should not allow particles or organisms to adhere.

Partitions must also meet the strength and acoustic criteria required for the use of the rooms they enclose. Water-repellent treatment will be provided for sanitary partitions and damp rooms in general.

Partitions between rooms will be full height, from floor to floor.

In terms of room transparency and user comfort, large glazed partitions are to be avoided in favor of smaller, blackout elements or transoms on doors, oculi, etc. Acoustic insulation will be given priority; a proposal will be made by the designer depending on the premises and their activities...the basic partitioning will be mainly plasterboard or composed of: 2BA13 + intermediate profile + 2 BA13 (98/48 or 72/48 in common cases).

At the end of the final project proposal phase, the designer will draw up plans for all terminal, biomedical and furniture equipment (fixed and mobile). The list of this equipment will be attached, determined by the designer according to the needs of the activity handled in the room (space sheets and equipment listing).

These plans will be used to define the partition reinforcements required for suspended equipment, and the routing of networks and ducts in each room.

4.3. Interior joinery

The prime contractor will study all ancillary works such as:

Door blocks, free-standing bay frames, glazed frames, protective rails and handrails, banks, glazed units, counters, dressing tables, miscellaneous panelling, decorative elements, etc. cupboards integrated into the construction of rooms, checkroom fittings, as well as ancillary works (access hatches, safes and covers, panelling, etc.).

General requirements: all wood used must be effectively treated: moisture stabilization, fungicide and insecticide treatment. They will also have to prove that they come from sustainably managed forests, through an FSC (Forest Stewardship Council) or PEFC (Programme for the Endorsement of Forest Certification Schemes) label.

Any wooden door frames or special structures must be made of exotic red wood.

Doors are building components that are subject to heavy use in hospitals (intense traffic) and sometimes severe conditions of use (sometimes brutal maneuvers): particular attention must be paid to their robustness.

Door frames: door frames in main areas will be of the "iso phonique" type, with double rabbet and continuous seal (offices, medical areas, etc.). They should be perfectly smooth, with no hollows (grooves, etc.).

Doorframes are metal, factory-coated with anti-corrosion protection, and grounded as required.

Doors will be solid core, laminated or painted throughout, with 4 edges finely sanded and varnished, with oculus and bottom protection depending on location, and fitted with bumpers and stops (4 welded, oversized hinges over the height).

Door closers should be chosen for their robustness.

Doors must have a PV rating appropriate to their use. Interior doors to consultation offices must be soundproofed to ensure confidentiality.

Door opening direction:

- General case: towards the inside of the room from the traffic (unless otherwise specified for specific safety reasons),
- Small rooms: to the outside of the room.
- Sanitary rooms (WC, washroom, etc.): to the outside of the room.

The cross-traffic doors will comprise:

- 1 metal frame with 3 double-action spring hinges per leaf, to be painted,
- 2 solid-core wooden leaves with laminated or painted finish,
- Fire-tight with thermo-inflating gasket,
- Finger-pinch-resistant, felt-quality joint between sashes,
- 1 oculus on each leaf,
- A closing release system.

- Fire detection system with suction cup.
- Access control on certain doors, linked to the fire security system depending on the building's architecture.

The airlock doors will be interlocked. One door can only be opened when the other is closed. The door between the circulation and the premises (airlock or room) is a French-opening door.

An emergency mushroom key will enable the system to be neutralized and the 2 doors to be opened in an emergency.

Glazed frames: depending on the location, glazed frames will be soft single glazed with clear glass (general case) or partial frosted glass, safety glass or double-glazed with clear glass and air space with blackout blinds (intensive care unit, for example). They must be fitted with blinds. Large glazed and curved windows should be kept to a minimum throughout the hospital.

Protection: the bottoms of doors, walls and protruding corners of partitions, which are subject to numerous impacts from wheelchair footrests and trolleys, will be fitted with protections integrated into the architecture. These protections will also be provided by the handrails. Regulatory heights will be respected, and materials will be durable and aesthetically pleasing.

Projecting corners will be reinforced up to the height of the handrail with sturdy, solution-tinted angle irons.

Hardware: all doors are to be fitted with anti-finger-pinch devices. Hardware must bear a S.N.F.Q. (National Union of Hardware Manufacturers) - NF quality label - 5-year warranty required. Locks must bear the A2P quality stamp followed by the classification index.

Fittings must be fastened to profiles securely and without play. All hardware, such as anchors, brackets and fittings, should be hot dip galvanized.

4.4. Protective coating

The choice of protective coatings will meet the requirements of improved indoor air quality and a low-impact construction strategy, by integrating quality products.

4.4.1. Protective coating of soft floors

The contractor will comply with NF UPEC (Wear, Punching, Water, Chemistry) - Cahier CSTB (building science and technology center) certification relating to the UPEC classification of floor coverings, which is a minimum requirement. Floor coverings, chosen for their quality, resistance and ease of maintenance, are particularly stressed components in a hospital (traffic, punching, chemical aggression, etc.).

Materials must not present any particular risk in the event of fire (toxic gases, smoke). Fire resistance: M3 minimum (i.e. according to Euro code A2fl s2, Bfl s1 or s2, Cfl s1 or s2 depending on premises).

- P3 for floor levelling.
- U4 P3: corridors
- U3 P3: in general for all other rooms

All resilient floor coverings must meet the low VOC (Volatile Organic Compounds) label A or A+ of the French standard, to help improve indoor air quality.

The designer should also refer to Table 6 - Hospital buildings and similar buildings in the UPEC classification notice in the cahiers du. CSTB 2999 - 09/2000.

In wet rooms, skirting boards should be made by raising the floor covering (or other treatment) against the vertical wall over a distance of about ten cm, with a radius of at least 1 cm. Wooden skirting boards should not be used in this type of space.

Floor coverings are generally made of welded strips with skirting (flexible floor coverings with welded tiles are absolutely forbidden, unless justified).

In general, complaints consist of a minimum 10 cm grooved profile upstand with clip stop profile (for all care and accommodation areas and corridors).

A fungistatic and bacteriostatic treatment will be incorporated into the proposed product, as well as an anti-fouling finish.

Carpets and rugs are forbidden in all areas, including the entrance hall.

Certain areas will be fitted with anti-slip coverings in accordance with regulations (imaging, operating theatres, etc.).

Some areas will be fitted with statically conductive floors.

The overall distribution of coverings is as follows:

- Decorative, in reception areas, etc., while preserving the site's specific
- Technical characteristics (ease of cleaning, acoustics, etc.).
- Plastic, adapted to use (electrically conductive, seamless, etc.), in certain medical-technical areas and in patients' washrooms.
- Resins: to be used in (technical) areas where the presence of joints is absolutely forbidden and where a plastic covering cannot be used.

4.4.2. Protective coating of hard floors

The use of tiles will be kept to a minimum in the event that other coverings are unsuitable. It will be permitted in the entrance halls.

Ceramic coverings are preferred for certain areas. They should be thin-jointed, sharp-edged, with a sound-absorbing underlay and a perfect seal. They should belong to group 1 (water absorption E < 3%).

Stair nosing should be slip-resistant, and the appearance and color of the flooring should take into account requirements in terms of disabled access (contrast, etc.).

Threshold bars should be avoided. Particular attention will be paid to the design of floor expansion joints, to avoid tearing and protrusions that could cause shocks when stretchers and carts pass over them.

4.4.3. Protective coating of walls

Exterior paints: exterior paints will be of limited use, in particular:

- For decorative effects, in a very small proportion to solid surfaces.
- To protect corrodible surfaces.

For exterior wood protection, woodstains are preferred to paints.

Interior paints: painted surfaces must satisfy the tests defined in the book of CSTB. As a general rule, paint will be applied to all walls and ceilings (in the absence of suspended ceilings).

The finish will be satin, very high quality, with the exception of technical rooms where a matt finish is tolerated.

Walls in water-sprayed areas should be finished to a high gloss. Rooms where interventions are carried out, and rooms where a high level of asepsis is required, can be covered with PVC panels resistant to most chemical agents.

In corridors, halls and waiting areas, smooth, unpatterned painted canvas or fiberglass should be used. The impact resistance of these areas should be seriously reinforced.

Paints and coatings may be considered for interior fittings. All walls in medical-technical areas, including offices, must be washable. Wallpaper and textile-type coverings are not permitted. All paints and varnishes must be "NF-Environnement" or "Eco-Label" certified, or have a VOC content of <10g/l.

Other floor coverings: U4 P3 antistatic computer flooring for the server room and main distribution frame, sub-distributors.

Industrial floor paint for certain areas such as technical rooms.

Acid-resistant coatings for the inverter room.

4.5. Ceiling and false ceiling

False ceilings should be installed on the smallest possible surface area, in order to limit the accumulation of dust and micro-organisms, and to withstand the successive dismantling required to reach pipes.

They will be systematically installed in rooms over 3.20 m high and in corridors.

They should be avoided in accommodation and care areas. When their use cannot be avoided, they must be as firm as possible, which excludes ceilings made of non-joined boards (impervious to dust and terminal disinfectant vapors).

Ceiling coverings must be solid, flat (non-porous) and resistant to the action of detergents and disinfectants.

Metal false ceilings should generally be avoided for acoustic reasons and because they are difficult to dismantle for maintenance. However, they may be used in certain specific areas.

Removable panels required for access to service ducts should be placed in the corridors.

False ceilings of the watertight type must be installed in areas requiring a high level of asepsis (operating theatres, intensive care rooms, interventional imaging, etc.).

Where technical systems and devices are incorporated into the false ceiling volume, these must be accessible and replaceable during maintenance operations.

In humid areas, false ceilings, if used, must be resistant to humidity. Gypsum board false ceilings are not permitted in these areas.

False ceilings must incorporate lighting fixtures, ventilation and smoke extraction vents, and associated high and low voltage fittings and accessories.

Spaces above suspended ceilings are cut back in height to comply with fire safety regulations and to meet acoustic requirements, particularly in accommodation areas.

Their fire behaviour and harmlessness will comply with current regulations.

Suspended ceilings must accommodate all electrical and ventilation equipment.

Suspended ceilings must be easy to dismantle (no special tools required, no visible damage after dismantling and reassembly). They must comply with current fire safety regulations.

5. Protection against ionizing radiation (radiation protection)

X-ray generators and sealed or unsealed sources are used in specially equipped rooms. To guarantee safety, the prime contractor must take into account the most stringent conditions of normal use. This includes calculating radiation doses and setting up the necessary radiation

protection elements, while monitoring installation areas and areas close to radioactive elements.

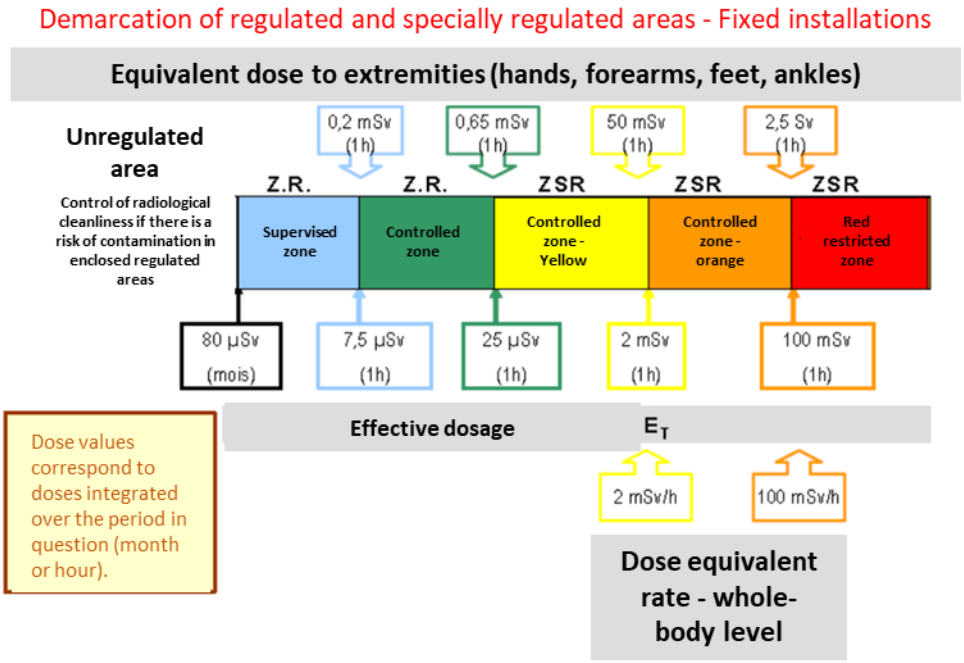

FIGURE 1 - DELIMITATION OF REGULATED AND SPECIALLY REGULATED AREAS

At the same time, it is essential that normal conditions of use also take into account the hazards associated with the circumstances in which ionizing radiation sources are used, including fluctuations that may occur during regular operations. The prime contractor must anticipate these hazards and put in place appropriate safety measures to guarantee the protection of personnel and the public throughout the use of the equipment.

In general, the delimitation of restricted zones must be established on a permanent basis. In addition, these areas, whether restricted or specially regulated, must be visibly signposted, with additional signs at each entrance, together with current access instructions.

Design calculations and implementation of radiation protection provisions are the responsibility of the project manager. Partitions and floors in areas subject to radiation protection requirements must be fitted with lead protectors, as must automatic doors.

6. Signage

Signage must comply with regulations concerning accessibility for all in establishments open to the public.

General requirements:

- The design and form of the signage should be left to the designer's choice, validated by the client. It must be understandable in French and English, and multi-sensory to appeal to everyone, including people with disabilities.
- Exterior signage should include fixed, illuminated "totems" and "signs" at entrances and along lanes to help people and vehicles find their way around. All materials used for exterior signage must be durable and adapted to the climate of the site.
- Interior signage must be consistent with exterior signage.
- Fixed multi-sensory "signs" should be used to indicate general orientation, information panels, the designation of all rooms, fire safety signs, hidden devices in false ceilings, door markings, etc.
- Signage elements must be easily modifiable to adapt to necessary changes, particularly in the event of a change of use of the premises.

Special requirements:

- For technical signage of premises, technical sheaths and equipment, a coding system adapted to CMMS/BMS systems must be installed.
- For fire-safety signage, comply with standards, in particular by affixing labels such as "do not obstruct closing" on DAS doors, "fire-stop" on fire doors, "dead-end" on dead-end doors, and by installing fire-safety signs at emergency exits.
- If the project includes dynamic signage, propose a system based on interactive terminals and dynamic display totems to complement the interior signage.
- For the hearing-impaired, install a magnetic loop in elevators and areas accessible to the public.

7. Fluid

7.1. Plumbing – sanitaries - rescue resources

General: the technical design will comply with standards, decrees and technical specifications relating to hospitals, establishments open to the public and current health, safety and working conditions regulations.

The designer will take account of environmental requirements.

Design bases: the bases for calculating flow rates are defined by regulatory texts.

Probable flow rates will be determined by use and not by schedule, in order to approximate actual consumption.

Sanitary hot water production will be sized in the same way.

The designer is responsible for all calculations relating to network sizing and flow rates.

7.1.1. Drinking water supply

The project will be connected to two separate supply points from different branches of the public network.

The aim is to secure the site's water supply in the event of serious damage to a buried pipe, for example.

The organization in charge of managing, producing and marketing water is ***Water and Sanitation Corporation (WASAC)***.

The water organization and distribution plan for the future hospital must include one or more water towers, depending on the flow rates required, to ensure water delivery during periods of power cuts.

Characteristics of the water tower(s):

- The water tower must be able to supply water for at least 5 days.
- These installations will be filtered upstream of the network to ensure the delivery of drinking water to every point of the hospital.
- This water will be at ambient temperature. For the comfort of patients, independent and mobile solutions for the distribution of fresh water will be provided (bottles, refrigerated fountains, etc.).

These devices will distribute the entire hospital water network. This organizational scheme should ensure a continuous supply to the hospital in all circumstances.

The various disconnection devices will be provided in compliance with regulations:

- Physical separation of sanitary and fire networks
- BA-type [8] backflow preventers including valves and filters (to be provided by the operator)
- Pulse meters (to be provided by the operator)
- Suppressor based on pressures supplied by the operator.
- 3-bar pressure regulator

Buried polyethylene or cast-iron pipes approved for drinking water will serve the service rooms, which will include plumbing equipment (suppressor, softener, outlet manifolds, etc.). The system selected will make it easier to locate any leaks.

7.1.2. Fire water supply

Downstream of the mains water meter, a specific network will be provided for fire-fighting installations (fire hydrants, Armed fire valve).

[8] Protects drinking water networks against the risk of backflow pollution by interrupting the water supply through self-draining and draining the fluid.

Disconnection equipment will be provided in accordance with regulations:

- BA-type backflow preventers including valves and filters (to be provided by the operator)
- Pulse meters (to be provided by the operator)
- Suppressors based on pressures supplied by the operator.

Buried **polyethylene** pipes will serve the technical rooms containing the fire-fighting equipment (suppressor, outgoing manifolds, etc.).

The water flow rates required for fire-fighting equipment will comply with regulations and will be validated by WASAC, particularly with regard to flow rates (dry columns, simultaneous fire hydrants, etc.).

Fire-fighting water reserves will be provided in accordance with the local water tower principle. The designers will pay particular attention to integrating these structures into the landscape.

7.1.3. Domestic hot water production

Domestic hot water (DHW) production will be provided sequentially by the following devices:

- Sun first preheating stage based on recovery of waste energy from refrigeration units, and possibly from sterilization wastewater, using 2 stainless steel plate heat exchangers.
- A second stage consisting of a solar production system sized to provide 100% of additional needs, over and above the previous stage.
- A third and final stage consisting of a direct electrical production system to provide any additional power, thermal shocks at a temperature of 70°C, and total backup for the system.

To limit the risk of legionella development, production will be instantaneous.

The equipment will be installed in a dedicated technical room. The feed water for DHW production will be treated by a softener to a Th of 10°F.

The temperature at the production outlet will be a minimum of 60°C, and the temperature of the various distribution loops will be maintained by looping the networks to ensure a minimum temperature of 55°C at all points.

DHW will be prioritized for the following services:

- Technical platform as a whole
- Logistics services (medical and hotel)
- Treatment rooms and showers in all premises and departments

The sanitary facilities accessible to the public will not be supplied with hot water, nor will all service water point such as washbasins and hand-washing facilities be supplied with hot water. This is to limit the risk of nosocomial infections.

FIGURE 2 - EXAMPLE OF A PLATE HEAT EXCHANGER

7.1.4. Distribution networks

Hot and cold water: the domestic hot and cold water networks will originate in the technical rooms. They will be organized by type of activity or department to facilitate maintenance and monitoring of consumption.

Each outlet will be equipped with :

- An isolation valve
- A meter connected to the Building Management System, installed between two shut-off valves
- A drain valve
- An injection valve
- A temperature sensor (DHW).

Hot water supplies will be looped to maintain temperature. The decrees of 30/11/2005, 01/02/2010 and the circular DGS/SD7A/SD5C-DHOS/E4 n° 2002/243 of April 22, 2002 will be applied:

- Instantaneous DHW production at a production temperature of 60°C
- Distribution temperature of 55°C
- Loop return above 50°C
- Dead legs limited to 5 m maximum
- Water velocity in loop pipes > 0.2 m/s.
- Temperature control for each loop and at the most disadvantaged points.

The networks will include all accessories required for proper operation and maintenance (valves, hoses, expansion sleeves, water hammer arresters, steam traps, etc.). All supplies will be fitted with approved backflow preventers.

Hot water will be mixed as close as possible to the point of use, using taps or thermostatic devices.

Columns will be installed in technical sheaths.

Pipes will be made of copper up to ∅ 54 mm, and stainless steel beyond that. The designer may propose the use of crimped joints.

All concealed piping will be thermally insulated in accordance with regulatory thermal calculations. Insulation thicknesses must not be less than 19 mm for hot water and 9 mm for cold water.

All equipment and accessories must be marked with unalterable markings.

Network decontamination: networks must be designed to withstand thermal and/or chemical shock. Network design will allow for disinfectant injections.

DHW production will enable temperatures to be raised to 70°C. The temperatures of the various DHW loops will be measured and reported to the BMS with alarm thresholds.

7.1.5. Evacuation

Wastewater/floodwater: the networks will be separated inside the building up to the watertight manholes at the foot of the facades.

Pipes must be sized in accordance with DTU standards and fitted with all accessories required for maintenance (expansion, inspection tee, etc.).

Pipe slopes must not be less than 2 cm/m.

Downpipes are to be installed exclusively in technical ducts with inspection hatches. Each chute will include a primary ventilation opening onto the roof. Floor and firewall penetrations will be treated to comply with fire regulations.

The evacuation networks will be designed to meet the acoustic requirements of the premises, including the service ducts.

Specific, aggressive or high-temperature discharge pipes will be adapted to the type of effluent.

Pre-treatment facilities will be provided for the storage of liquids that must not be discharged into the wastewater network (grease separators, hydrocarbon separators, etc.).

The existing hospital has a fairly basic waste water system on the site, which currently treats and disposes of all the hospital's wastewater. This system, which is not very effective from a sanitary point of view, will be replaced prior to the start of the works by a phyto-treatment

system (WWTP) located to the south-west of the plot, between the boundary with the school and the infectious diseases building (outside the scope of this contract).

The designer will have to connect to this system from a central collection point for the building's wastewater, equipped with an automatic bar screen and a tank/booster unit enabling wastewater to be pumped up to the treatment plant in sequence.

Booster pumps will be systematically doubled up and connected to the BMS (operating status, alarms and running times). They will be positioned in a prefabricated pit with a guide bar and footing.

7.1.6. Rainwater

The pathing principle will be equivalent to that of wastewater networks. The networks will be thermally insulated to avoid condensation and acoustically insulated to avoid noise pollution.

The pipes will be fitted with all accessories. At building exits, water will be redirected to the public rainwater collection network, in compliance with local sanitation regulations and recovery devices.

Water containing hydrocarbons will be collected via a separator.

Rainwater recovery will be considered for vehicle cleaning and watering green spaces. Rainwater recovery for the building's sanitary facilities is not permitted.

Rainwater can also be used to supply the fire hydrant network.

The designer must propose the most appropriate solution to meet the environmental requirements of the country and the services responsible for managing this area of activity.

7.1.7. Water treatment (softened - osmosis)

From each "drinking water" room, several outlets will be created, including:

- A dedicated water network to the osmosis water production room;
- A network to the sterilization unit and its water treatments;
- A network to softened water treatment for DHW.

Softened water production: a redundant catalytic softened water production system is to be created for each thermal production sub-station and for the sterilization and kitchen areas.

Humidifiers, if any, will be supplied with water softened to TH=5°F, in accordance with the technical schedule.

The production system must be sized and designed to meet the needs of the user department, under the full responsibility of the company with regard to the needs expressed.

The technical solution chosen for water production must take into account the quality of the feed water and enable water to be produced in compliance with the criteria and circulars already mentioned.

Indicative but not restrictive description of the water treatment chain:

- All production line components must be isolatable and controllable;
- All production line components must be split and capable of being individually bypassed;
- All operating valves must be coded;
- All filtering devices must be fitted with upstream and downstream stainless-steel pressure gauges to determine filter pressure drop.

A stainless-steel double-spouted sampling point will be installed before and after each piece of equipment:

- Raw water
- Softener inlet
- Softened water
- Activated carbon outlet
- Osmosis inlet
- Osmosis outlet
- Filter inlet
- Filter outlet
- Loop return

Thermometers will be installed throughout the plant to enable monitoring.

Pre-treatment will include at least:

- A shut-off valve.
- A backflow preventer.
- A dosing pump, without power supply, to disinfect the pre-treatment.
- An automatically regenerating sand filter.
- A pre-filtration stage comprising at least (the number of housings will depend on the total flow rate of the installation)
- A booster set without buffer tank, comprising 2 pumps with variable-speed motors.
- A filtration stage comprising at least (the number of housings will depend on the total flow rate of the plant)
- A softening system comprising:
- Two softeners whose capacity is to be defined according to consumption, giving priority to a small resin volume, parallel operation without stagnation, volumetric and staggered regeneration, and the possibility of triggering manual regeneration.
- Two salt tanks of a volume suited to the substation's operation.

- A Testomat ECO[9] calcium analyzer to measure residual hardness.
- A Testomat THCI [10] for measuring residual hardness and total chlorine at programmable times.
- A filtration stage for activated carbons, consisting of housings or columns. The number of housings or columns depends on the total flow rate of the plant.

Treatment will be provided by a double reverse osmosis water production unit with loop inlet and outlet filtration. The osmosis unit will be CE class 2B certified.

In the event of a fault, each of the two osmosis units can be operated separately by means of a simple electrical control.

The system can be set up quickly using keys to select Osmoser 1 or 2.

FIGURE 3 - EXAMPLE OF SOFTENED WATER TREATMENT

FIGURE 4 - EXAMPLE OF OSMOSIS WATER TREATMENT

7.2. Rescue resources

Armed fire system: the installation will comply with APSAD rules (APSAD certification is a French certification attesting to the quality of a fire safety system, issued by CNPP- the French national center for prevention and protection) and rescue resources articles of fire regulations. A dedicated suppressor for the Armed fire valve (if required) will be installed in the equipment room.

Galvanized steel pipes will be laid in false ceilings or technical sheaths to supply the various RIA stations.

[9] Automatic determination and monitoring of water hardness
[10] To determine total chlorine content

Diameters and flow rates will be in line with the risks of the premises to be protected. Flexible pipes must be 30m long. The stations will be positioned in accessible and marked "niches". The number of fire extinguishers in the circulation will take into account article MS 15.

Network marking will comply with standard NFX 08-100.

Dry stairwells: enclosed stairwells will be equipped with dry stairwells in compliance with regulations, and accessible to the fire department.

Building-front accesses will be positioned in compliance with regulatory distances.

Each landing will be equipped with an access point. Networks and accessories must be unalterably identified.

All types of fire extinguishers must be provided in sufficient quantity for fire-fighting purposes, in accordance with current standards and the classification of the establishment and premises at particular risk of fire (electrical, etc.).

Extinctor:

Regulation [11]: All fire extinguishers should comply with the CE standard and meet the characteristics required by European Parliament Directive 97/23/EC (or other more stringent international/ Rwanda standards) on this type of equipment, which aims to "guarantee the protection, health and safety of persons and, where appropriate, domestic animals or property". A CE mark must then be affixed to the cylinder to highlight compliance with this standard, which is in force throughout the European Union.

For certain installations representing a localized danger (liquids classified as particularly flammable, first category, as well as low flammability liquids) such as generator rooms, boiler rooms, main LV boards and transformers, additional protection must be provided by :

- ABC [12]or BC powder extinguisher (9kg) ;
- Fire blankets and sandbox with shovel and bucket;
- ABC or BC powder extinguisher on wheels ;
- Water + additive extinguisher on wheels;

Installation**:** Fire extinguishers should be fixed to a post or wall, preferably close to the areas most likely to cause a fire (machinery, workshops, electrical circuits, etc.). They must, of course, be placed in an unobstructed, visible position, and must not interfere with the passage of beds and stretchers in the corridors. For this reason, fire extinguishers should be installed

[11] As part of the construction of the future Ruhengeri Referral Hospital, it was decided to adopt a demanding regulatory and standards framework. By systematically choosing the most demanding normative framework between International and Rwandan standards, this approach aims to guarantee an optimum level of quality and safety.

[12] The main types of powder used are as follows: ABC powder: This is the most commonly used powder, as it can extinguish Class A fires (solids such as wood and paper), Class B fires (flammable liquids) and Class C fires (fires involving flammable gases).

in the main corridors as early as the design phase, and if necessary in "niches" with appropriate signage.

Fire extinguishers must be fixed at a handle height of less than 1.50 m, and must not impede the passage of stretchers/beds in general circulation areas: the designer is therefore invited to integrate the location of fire extinguishers into his preliminary studies.

When several extinguishers are installed, their separation distance must not exceed 15 m. Any extinguishers located outside must be protected from the elements by suitable installations, such as an extinguisher box, while maintaining rapid accessibility, which is essential for emergency intervention.

Evacuation plan and intervention plan: the designer must provide all evacuation plans with fire safety instructions in compliance with current regulations (in particular standard NF X 08-070 of December 2023), as well as the intervention plan.

Evacuation plans should be designed for quick and clear understanding, and should clearly distinguish exit routes, such as corridors, staircases and open spaces, from other spaces.

Plans should be designed to a minimum size of 297 x 420 mm (A3 format), with or without instructions.

Hanging systems and supports for evacuation and intervention plans should be chosen for their durability.

7.3. Medical fluids

The hospital's design must ensure continuity of medical fluids, in particular medical oxygen, compressed air and nitrous oxide, for normal operation of the facility for 15 days, including the associated back-up.

Production and network redundancy will be ensured down to the care units (looping in particular). The distribution principle will be that of double expansion, with primary networks running from the platform to the entrance of each department. The secondary parts following the hospital's needs in medical fluids will be ensured by centralized production as well as medical vacuum (vacuum compressors). Each building will have its own vacuum unit.

The designer will provide for the implementation of a medical fluid platform sized to meet all the project's needs.

The medical fluids distributed on site will be:

- Oxygen,
- Medical air (8 and 4 bars),
- nitrous oxide (cylinders)
- Medical vacuum,

All texts relating to medical fluid installations will be applied, and more specifically:

- Standard NF EN ISO 7396-1 supplemented by reference FD S 90-155.
- Standard NF EN ISO 9170 on medical fluid intakes,
- Articles U of the fire safety regulations for ERP buildings.

The installations and their sizing will have to be validated by the technical controller as well as the site's pharmacist and biomedical engineer.

Source autonomy: in accordance with European standards, storage source capacities will be defined by the hospital, in collaboration with the gas supplier, according to estimated needs and supply frequency.

Sources are sized for peak flow.

The sources are estimated for an autonomy of:

- Source in service + back-up based on 1h/day peak flow over 14 days for N2O,
- Ultimate back-up at 2h peak flow for O_2, Am and N_2O, to be adjusted according to local resupply capacities.

Medical fluids distribution networks: the hospital will be supplied with each fluid from the primary networks of the medical fluid's platform; each medical fluid will be distributed to the hospital via two separate networks. All networks will be looped for all fluids, enabling all care units to be supplied twice.

The network service limit will begin downstream of the EUM (emergency and maintenance entrance) valves installed at the production level.

Each hospital building will be equipped with second expansion regulators on each level, with damming valves to isolate the floor.

Each chamber must be fitted with isolation valves for the 3 fluids (air, vacuum and oxygen) to ensure individual isolation of each chamber, enabling continuity of service and maintenance without disrupting activity.

The pipes will be made of copper, in compliance with standard NF EN 13348, degreased and capped. Assemblies will be silver brazed (40% minimum) under neutral gas flux.

To secure primary gas supplies, primary pipes and valves at the foot of the building will be doubled. The networks will be designed to ensure continuity of supply in the event of fire in zone U 10.

Ventilated technical ducts will be dedicated exclusively to medical fluids.

Secondary networks will be equipped with double pressure regulators and isolation valves.

Medical fluid outlets (with CE marking) will be installed on the surface or in a trucking (housing service duct). Colors and notches will comply with the standard.

Equipment powered by flexible hoses (surgical arms, etc.) must be insulated, and emergency wall-mounted sockets must be provided.

Anesthetic gas emissions will be collected by SEGA outlets and vented to the outside.

For each gas, a general shut-off valve will be installed on the front of the building, in a common glazed and sealed "fire-fighting shut-off" box.

Each care unit will have its own cut-off and pressure-relief unit, with pressure threshold alarms sent to the BMS and local audible and visual alarms.

Distribution of medical fluids inside buildings includes:

- Complete distribution of oxygen, nitrous oxide, medical compressed air and medical vacuum to departments, including outlets and waits;
- Installation of medical gas distribution tubes and outlets in bedhead ducts, multi-fluid ducts/arms, etc... ;
- Installation and supply of anesthetic gas extraction outlets;
- Supply and installation of ultimate rescue devices in critical care hospital departments,
- Supply, installation and connection of analog pressure and vacuum sensors, alarm and signaling boxes required for monitoring primary and secondary networks for all gases distributed, with provision of information;
- Electrical connections;
- Circuit marking (colored adhesive tape, labeling of valves and secondary pressure-reducing assemblies, indicating the premises served).

Medical fluid alarms: medical fluid alarms will be reported to the BMS and will be of 3 types:

- Operation control alarm, including sources.
- Emergency operating control alarm: primary distribution pressures.
- Technical medical emergency alarm, including secondary distribution pressures.

Ultimate local back-up: Finally, an ultimate local back-up is planned, consisting of a compact cabinet for the operating theatres (general and gyneco-obstetrics) and critical care. Each cabinet includes:

- A medicinal oxygen cylinder as main backup.
- A medicinal oxygen cylinder as ultimate backup, to allow replacement of the main backup cylinder.
- One medical air cylinder as primary backup.
- A medical air cylinder as ultimate back-up to allow replacement of the main back-up cylinder.
- Vacuum pump as required.
- Accessories

Figure 5 - Example of a cabinet for local first aid

Medical oxygen: it is important to guarantee the permanent availability of medical oxygen, and to minimize the inevitable loss of liquid oxygen due to temperature and low or no consumption.

Accordingly, the designer is asked to integrate provisions in line with NF EN ISO 7396-1 with three sources to compensate for any oxygen breakdown in the event of failure of the main source:

- A main source consisting of a PSA (Pressure Swing Adsorption) oxygen generator to produce oxygen for the needs of the entire hospital, using Pressure Swing Adsorption technology to concentrate oxygen from ambient air;
- A second source, of lesser capacity than the first, consisting of a PSA-type oxygen generator coupled to the main source (in case of failure or maintenance);
- A third source, consisting of a cylinder rack with an oxygen distribution manifold designed for 48-hour autonomy;

Maintenance of CO2 production and distribution systems must be possible while maintaining 100% production.

Medical air: production will be ensured by a central unit located in an efficiently ventilated technical room, comprising compressors associated with dehumidification and filtration treatment lines; the back-up source will be ensured by cylinder frames on an outdoor FM platform.

A connection point will be provided for additional back-up, mainly in sterilization.

Nitrous oxide: nitrogen supply is provided by 3-cylinder plants (service, standby and emergency):

- A service station (cryogenic storage) for normal operation;
- First aid in the event of increased demand;
- Back-up or ultimate back-up in the event of maintenance on a regulator;

A reversing expansion unit to switch from service or standby mode to emergency mode.

Maintenance of liquid nitrogen production and distribution systems must be possible while maintaining 100% production.

Medical vacuum: production will be provided by two independent networks up to the hospital, with 2 x 100% production provided by a minimum of three independent, controlled compressors. It is located in a technical room with several pumps, including one for back-up.

The 1st back-up will be provided by a cylinder frame (48h), and the 2nd back-up by a 200-bar cylinder frame with 24-hour autonomy.

Vacuum production must be connected to the secure electrical network.

8. Heating - ventilation – air conditioning – smoke extraction

8.1. Air conditioning, cooling

The technical design will comply with standards, decrees and technical specifications relating to hospitals, establishments open to the public and health, safety and working conditions regulations in force at the time of submission of the permit and construction.

The designer will take into account environmental requirements, in particular the objectives to be achieved in terms of renewable energy and energy autonomy of the project.

Chilled water production: chilled water production will be dedicated to:

- Cooling of category 1 hospital premises and rooms (VVIP).
- Air-conditioning of technical facilities
- Biomedical equipment needs

Basic: chilled water production will be provided by a minimum of 4 air-cooled screw compressor chillers. The choice of refrigerant will be based on machine efficiency, ozone depletion potential (zero ODP) and global warming potential (GWP < 50).

The performance of the refrigeration production units will be based on the Rwanda Seasonal Energy Efficiency Ratio (RSEER), developed using ISO CSPF with an outdoor temperature distribution in Rwanda. It should reach a minimum value of RSEER = 4.

In this respect, the designers will indicate the procedures used to detect refrigerant leaks.

Over-powering according to requirements will be 20%. The choice of temperature regime for the chilled water loop will favor production yields without being lower than 7/12°C.

The production equipment will be PLC-controlled, enabling cascade operation with balancing of operating times.

Energy production will be backed up by a generator for the following uses:

- Air conditioning of certain technical rooms (server room)
- Cooling biomedical equipment (MRI)
- Air conditioning of technical facilities (operating theatres, intensive care units, etc.).

The choice of location for technical equipment will limit noise and visual pollution.

Variant: in the interests of long-term maintenance efficiency, and to ensure that the project's financial objectives remain stable, the designer will propose a variant for the chilled water production principle (magnetic bearing units, refrigeration storage, etc.). This variant will be costed in order to assess the comparative elements in relation to the basic solution described above. The designer must provide the same technical and regulatory quality as the solutions proposed in the basic solution.

The alternative solution will be oriented towards chilled water production for the technical platform only. The number and sizing of the chillers must be calculated by the designer, who must provide a detailed, well-argued comparative study enabling the client to make the right choice in any event.

The installation will comprise:

- Redundancy, backed-up chillers
- Cold distribution for MRI cooling

For rooms and other premises, split-system installations will be used for cooling. Interior modules will be ceiling-mounted rather than wall-mounted. Access hatches will be provided for maintenance purposes.

This equipment is widely available on the market, ensuring that it is easy to maintain.

8.2. Ventilation air treatment

General: all air-conditioned rooms in the technical center will be equipped with double-flow mechanical ventilation. Regulatory flow rates will be complied with (departmental health regulations and labor code).

The positions of fresh air intakes and stale air extraction grilles will be defined taking into account potential pollution risks (parking lot, kitchen extraction, main roads, etc.), as well as prevailing winds to avoid any untimely recycling of stale air. Nanosense" type sensors (air quality) will be installed on the exhaust of each air handling system, and reported to the BMS.

The designers will carry out an aeraulic study, the results of which will influence:

- The location of ventilation outlets in the premises
- Air flow rates selected to ensure hygienic air renewal.
- The cross-sections of air distribution terminals to ensure low residual velocities.

Other premises, such as hospital wards, consultation rooms and other medical premises, can be naturally ventilated by means of facade grilles or other means. All wet rooms will be connected to a single-flow CMV.

Aseptic rooms: the particulate environment in these rooms is controlled and under control. Other corresponding characteristics must be respected: bacteriological class of the area to be protected, bio-decontamination kinetics class, minimum and maximum temperature, relative humidity, maximum acoustic pressure, air flow regime and air renewal rate (mixing rate).

Extract from standard NF S 90-351. Guide value for performance at rest.

Risk zone	Particulate cleanliness class	Particle removal kinetics	Microbiological cleanliness class	Positive or negative differential pressure	Temperature	Flow regime of the area to be protected	Other specifications
4	ISO 5	CP 5	M1	15 Pa (plus or minus 5 PA)	19°C - 26°C	Unidirectional flow	Air velocity from 0.25m/s to 0.35m/s Renewal rate 6 air volume/hour
3	ISO 7	CP 10	M10	15 Pa (plus or minus 5 PA)	19°C - 26°C	Unidirectional or directional flow	Renewal rate 15 air volume/hour
2	ISO 8	CP 20	M100	15 Pa (plus or minus 5 PA)	19°C - 26°C	Unidirectional or directional flow	Renewal rate 10 air volume/hour

TABLE 2 - EXTRACT FROM STANDARD NF S 90-351

Supply air, return air and fresh air are passed through appropriate filters to ensure the following performance levels:

- Particulate dust classes {NF.EN.ISO. 14644-1 and 2)
- Bacteriological classes (NFS 90351)

Particulate air cleanliness class:

Classification number	Maximum permissible concentration (particles/m3 of air) of particles equal to or larger than those given below.					
Particle size	0.1µm	0.2 µm	0.3 µm	0.5 µm	1 µm	5 µm
ISO 1	10	2				
ISO 2	100	24	10	4		
ISO 3	1000	237	102	35	8	
ISO 4	10000	2370	1020	352	83	
ISO 5	100000	23700	10200	3520	832	29
ISO 6	1000000	237000	102000	35200	8320	293
ISO 7				352000	83200	2930
ISO 8				3520000	832000	29300
ISO 9				35200000	8320000	293000

TABLE 3 - PARTICULATE AIR CLEANLINESS CLASS

Some hospital areas or departments require specific air treatment to suit their activities and/or biomedical equipment.

ISO classifications and air renewal rates are to be specified by the manufacturer in the data sheets for each room:

- Endoscopy suite
- Imaging department
- Intensive care unit
- Laboratories
- Sterilization department.

Pressure management in relation to adjacent premises: a pressure hierarchy will be set up to protect the premises. This is the relative pressure level, in relation to atmospheric pressure measured in Pa. The values obtained should be entered in the data sheets for each room.

Risk 2, 3 and 4 premises:

These are pressure levels relative to atmospheric pressure, measured in Pa, in conditioned or air-conditioned premises. Levels will be measured and checked during performance tests. The pressure probes will act directly and automatically on motorized dampers or frequency inverters (fans).

Other hospital premises will be subject to either:

- An overpressure with respect to neighbouring area, the rate of which results from the difference between the supply and extract air flow rates, {S alone = +15 Pa).
- A negative pressure with respect to neighbouring area, the rate of which results from the difference between the supply and extract air flows, (D alone = -l5Pa).
- E : a balance between the said supply and extract airflows.

Air Handling Units: the designer must provide for the installation of a sufficient number of AHUs, depending on the services and activities to be handled. The number of AHUs should also be multiplied by type of room in the operating theatres, to limit the risk of total isolation of the operating theatres in the event of a breakdown.

They should be self-supporting and comply with European standard EN 13053. Air handling units (AHUs) should preferably be installed in equipment rooms. They should be selected with an airflow speed of 2.5 m/s or less. They will all be equipped with electronic variable speed drives.

All panels will be double-skinned, insulated with MO rock wool. Surfaces should be perfectly smooth inside and out, to facilitate cleaning.

Panels must be perfectly sealed to prevent defibration of the insulation. Floor and roof panels should cover the entire width of the plant, with no intermediate connections.

Interior and exterior sheet metal will be galvanized and then protected with polyester paint. The floor of each box will be in stainless steel.

The panels will be mounted on an aluminum frame with thermal bridge break. The doors will be of the same design as the panels. They will be mounted on aluminum hinges to ensure excellent rigidity.

They will open outwards. Hygienic gaskets will be placed on the opening and not on the frame.

The filters used should be of the standard EU 7 type minimum.

If air handling units are to be installed outdoors, they should be mounted on insulated bases, to match the dimensions of the air handling unit. The bases will be installed flush with the structure and will allow for peripheral waterproofing with flap.

The designer will provide one AHU for each type of use (departments, or a group of rooms with the same use) and for each ISO-classified room (one AHU per intensive care unit, one AHU per operating theatre, etc.).

The energy efficiency of AHUs will be assessed using the SFPv indicator. For each type of premises, and according to the various dust and bacteriological classes required, this indicator will have to be justified, and will in no case exceed 1.2.

The weighted average flow rate for the entire project must be less than 1.

Distribution networks: ventilation networks should be designed for easy integration into the premises. Sizing will limit pressure losses to reduce the energy consumed by fans. Tightness tests are mandatory.

The sheaths will be made with assemblies that guarantee the watertightness of the networks.

Air must not come into contact with the building structure (concrete, masonry, plaster, etc.).

Particular attention will be paid to the following maintenance and design aspects:

- Presence of accessible control dampers
- Cleaning hatches
- Watertight dampers for ISO-rated premises
- Thermal insulation (with mechanical protection of accessible sections at ground level)
- Removable fire damper with accessible reset

Fire dampers (with valid PV) will be installed to comply with cross-connections and fire regulations. They will be connected to the Fire safety system and feature motorized reset and position contacts.

Ventilation terminals: ventilation diffusers and grilles will be made of painted aluminum with plenum connections. Controlled mechanical ventilation vents will be made of painted metal.

Terminals will be equipped with adjustment and connection registers, using aluminium flexible hoses of limited length (maximum 2m). Terminal dimensions and positions must comply with the following requirements:

- Residual circulation speed between 0.15 and 0.25 m/s in occupied areas.
- Positioning of ventilation grids to ensure correct sweeping of volumes.
- Extraction at pollution points
- Noise levels in line with regulations and use of premises

ISO rooms with turbulent flow (not unidirectional) :

- Ceiling supply with filter holder diffuser including pressure taps
- H10 or H14 filter depending on ISO class required, including integrity tests.
- Air intake in room corners, at top and bottom, with filters integrated into grilles.

Unidirectional flow ISO rooms:

- H14 filter ceiling with air velocity between 0.25 m/s and 0.35 m/s, including filter integrity tests.
- Diffusion surface adapted to the operating field
- Air intake in the corners of the rooms, at the top and bottom, with filters integrated into the grilles.

8.3. Smoke control

The design will comply with fire safety regulations, in particular Technical Instruction 246 and Type U articles.

Circulation areas will be mechanically smoke-extinguished. Premises larger than the regulatory surface area will be naturally or mechanically smoke exhausted.

The equipment used will comply strictly with current legislation and will have been validated by CSTB and CNPP.

Smoke extraction ducts will be 4-sided fire-stop ducts with fire resistance corresponding to the transverse walls.

Description of CE-certified smoke extraction dampers:

- Types with leaves, tunnel controlled by the fire control system
- Dampers with motorized rearming, current sensing. Voltage depending on SSI
- Position contacts
- CR1 cable connection

Smoke extraction extractors must be CE-certified, with validated PV, and be of the turret or box type. Relay box with safety position and control equipment.

9. High current electricity (CFO)

9.1. High-current electricity

Regulations: in most countries, electrical installations must comply with a set of national regulations, or those laid down by approved private bodies.

It is essential to take these local constraints into account before starting to design the installation.

Technical specifications must comply with standards, decrees and technical specifications relating to hospitals, establishments open to the public (ERP) and health, safety and working conditions rules in force at the time of the work.

The organization in charge of the management, production and delivery of electricity by ***Rwanda Energy Group (REG),*** the energy concessionaire serving the Ruhengeri referral hospital.

The electricity supply and delivery plan for the future hospital must include:

- **Duplication of the "primary" supply cable from two separate power plants, to ensure continuity of power supply under all circumstances, and to enable maintenance without impacting on hospital operations.**

  It should therefore be assumed that there will be two redundant high-voltage feeders. The concessionaire must confirm the possibility of supplying the hospital with two cables from the existing delivery substation (in the Musanze district).

- In particular, they will comply with standard NFC 15-211 which is based on international standards.

The prime contractor must also ensure that the HV/LV distribution system is as unified as possible, to enable easy maintenance.

Features and selection criteria:

Criteria	Category
Type of site activity	Healthcare building
Site configuration	Multi-storey building
Positioning latitude	Weak
Public network availability	Reinforced
Maintainability	Standard
Scalability of the instalation	Scalability
Total power of installed loads	2400 kW
Uniform load installation	Localized expenses
Circuit sensitivity to power failure	High sensitivity: operating rooms
Disruptive power	Non-disruptive
Other constraints	Specific regulations for hospitals, double-attached loads

TABLE 4 - FEATURES AND SELECTION CRITERIA

Selection criteria for adapting the principle to the project:

Criteria	Category
Construction time	Preferred
Environmental impact	Minimal
Preventive maintenance costs	Reinforced
Power supply availability	Level IV for operating rooms

TABLE 5 - SELECTION CRITERIA FOR ADAPTING THE PRINCIPLE TO THE PROJECT

Distribution principle:

Criteria	Category
Connection to the distributor's network	Sensitivity to cuts
MV circuits	Double-attached loads
Number of transformers	Redondancy
Number and distribution of positions	Building surface area
MV generator	Site activity

TABLE 6 - DISTRIBUTION PRINCIPLE

HV/LV architecture: from the two delivery substations, a high-voltage distribution loop with automatic reconfiguration will be created. It will link all the site's transformer substations.

It should be sized to allow for a 30% increase in installed power (30% compared with the power of the installed transformers) and will be controlled from a Hyper Vision. The configuration of the loop in real time must be displayed on the Hyper Vision.

Each transformer station must have at least two redundant transformers of equivalent power, capable of handling all the low-voltage installations they supply. Transformers and low-voltage distribution boards must be designed to allow transformers to be connected in parallel.

Transformers must be of the high-efficiency type, with a minimum reserve power of 30%.

The project manager will have to position the transformer substations judiciously, right from the sketch stage, to enable pooling, to distribute power on the HV loop, and to separate critical installations (blocks, imaging) on the loop.

The position of the transformer substations must allow for natural ventilation of the premises (under no circumstances should it be mechanical).

Neutral system: TN-C - TN-S. IT system prohibited except for medical IT.

9.2. Backup sources - Generators

All site installations will be backed up by low-voltage safety generators. Each main LV board on the site must be backed up by one of the generators.

The generators should start up in a **maximum of 10 seconds**, with load shedding followed by gradual reloading of non-priority equipment. They will be sized with a **power reserve of 30%.**

As a matter of priority, the site's back-up system will be able to re-supply the activities listed in NF C15-211 (criticality levels 1 to 3).

The number of generators will have to be reduced. To achieve this, the designer will have to locate them judiciously in order to limit distances and numbers, although they will have to be redundant.

Provision must also be made for connecting a mobile generator in the event of failure or maintenance of the fixed generators. For this purpose, the GE premises must have direct access to the outside.

The installation will include two underground fuel tanks, with easy access for delivery.

9.3. Backup sources - Inverters

A corrugated network will be set up to support:

- The computer server room
- Certain medical equipment

These networks will need to be robust and highly available, both for the medical network and for the IT network containing all the sensitive equipment.

These networks will be based on 2 redundant (parallel) inverters, each taking 100% of the load of the installations backed up by this network (under normal circumstances, this load is shared between the two inverters). They will be equipped with isolation transformers, by-passes integrated into the equipment and maintenance by-passes external to the inverters, which can "shunt" each system for maintenance purposes.

To reduce maintenance costs, the number of inverters must be kept to a minimum.

The inverters will be calibrated to allow a **reserve of 20%** of the equipment installed, and an **autonomy of 30 minutes**. They will be of the rackable type and can be upgraded by adding additional modules.

Medical electrical backup systems must be designed to meet the requirements of standard C15-211. Electrical distribution must be organized in such a way as to supply equipment with a high level of criticality via dedicated switchboards, backed up by appropriate means, i.e.:

- Criticality 1: High Quality Medical and IT networks + generator backup
- Criticality 2: generator back-up in less than 15 seconds
- Criticality 3: generator backup between 15 seconds and 30 minutes.

Sockets on the corrugated network will be differentiated from sockets on other networks. Socket covers will be red.

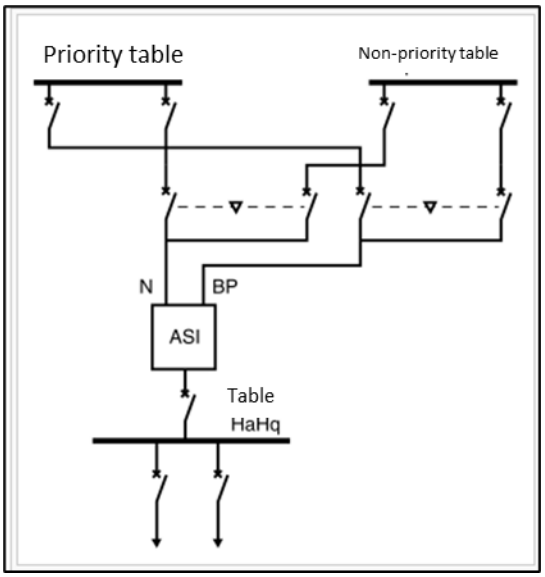

FIGURE 6 - ONE-LINE DIAGRAM: INVERTER CONNECTION

9.4. Distribution

The main distribution system should use U1000 R2V cables laid on cable trays in false ceilings or technical sheaths, etc.

Threaded rod-type mounting brackets should be avoided. Only support elements such as uprights, brackets, gussets, clamps and other spacers are authorized.

Certain cabinet power supplies may be wired with CRI cables, in order to comply with Article U10.

Terminal circuits will be wired with U500 V conductors laid in sheaths.

Three types of cable tray will be used:

- High current
- Low current
- Fire security system security

They must be easily differentiated (either by labeling or by material difference).

All cable trays will have a capacity to increase the quantity of cables by at least 30% and will be adapted to their environment.

9.5. General and divisional tables

9.5.1. Low-voltage switchboards (LVS)

LVS supplied from transformer substations must be fitted with automatic source inverters, enabling them to be supplied from the generator.

Each main LVS will be divided into two parts, installed in separate fireproof rooms. Each of these half-LVS can be powered from one of the transformers or from the generator. They can be connected to each other by means of a manual switch.

Low-voltage switchboards and all switchboard components will be of the same make and will be standard parts referenced to enable the operator to carry out subsequent maintenance, repairs, extensions and modifications.

In order to allow for any future modifications, the enclosures will allow for a minimum extension of 30% of the equipment per cell, in a single volume. In each LVS (or half LVS), the busbars will be left available for future expansion of the switchboards.

In particular, space will be provided on either side of the switchboards for such an extension (2 cells minimum).

The main switchboards will be designed to allow additions and modifications to be made without cutting them off.

They will have the following characteristics:

- Form: 4B
- IS: 333 for all protections

The architecture of the main distribution system will comply with NF C 15 211, ensuring a secure power supply and continuity of service.

Each half-panel must be equipped with a central measuring unit with remote transmission (to Centralized technical management). This unit will measure all general electrical parameters and the consumption of the main feeders.

The project manager will study the possibility of using fuse-type technology for the LVSs.

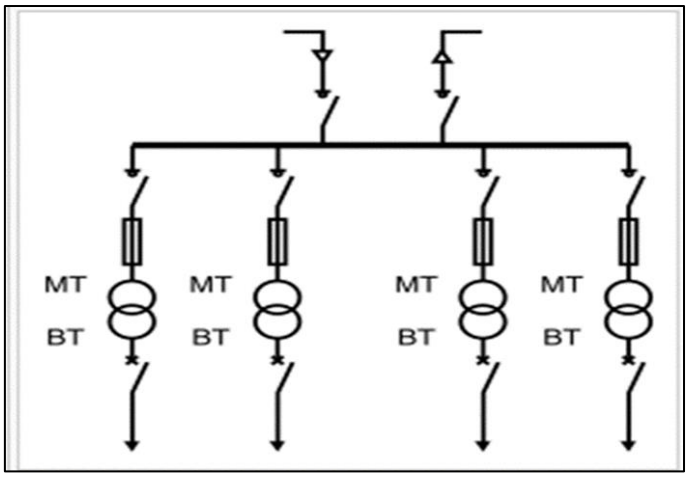

FIGURE 7 - SINGLE-LINE DISTRIBUTION DIAGRAM

Adaptation of the layout principle:

Choice	Overriding criterion	Solution
Topological layout	Barycentre	LVS: in the center of the building or in the basement
	Atmosphere	Generator: outdoor station
Centralized or decentralized distribution	Scalability, uniformity	Centralized distribution
Presence of emergency generator	Acceptable outage time	Generators: 3 x 1000 kVA
Presence of UPS: Inverter	Critical loads	UPS: 3 x 160 kVA
LV circuit configuration	Need for redundancy	Delightful: HVAC Double attachment: priority LVS HaHq medical + IT panel

TABLE 7 - ADAPTATION OF THE LAYOUT PRINCIPLE

Choice of technological solutions:

Choice	Overriding criterion	Solution
MV/LV substation	Service index	Prefabricated indoor substation
Table MTV	Availability by country	SM6 - medium-voltage cells
Transformers	Atmosphere	Trihal 800 kVA
LV panels	Service index	Okken(Example)
Primary energy coefficient	/	/
Inverters	Power, redundancy	Galaxy 5005 'example, 160 kVA
Reactive energy compensation	Country availability, power	Fixed: 2 x 400 kvar

TABLE 8 - CHOICE OF TECHNOLOGICAL SOLUTIONS

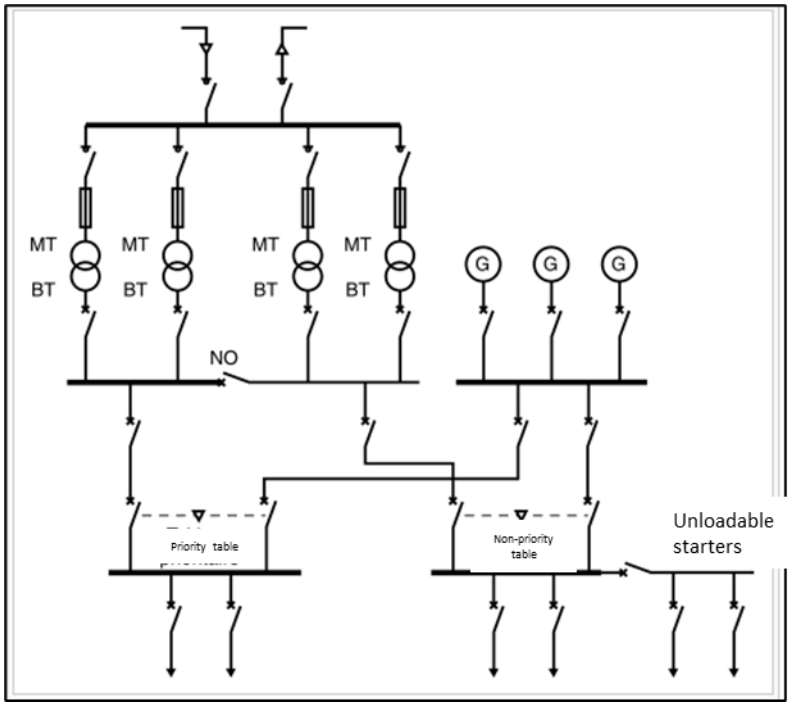

FIGURE 8 - DETAILED UPSTREAM SINGLE-LINE DIAGRAM

9.5.2. General safety table (GST)

The General Safety Panel will have the same characteristics as the LVS:

- Form: 48
- IS: 333 for all protections.

They will be systematically powered from the two half-LVS'. The GST will supply the building's security installations.

9.5.3. Divisional table (DT)

The distribution boards will be fed in organ sets from the half-LVSs. The building will be equipped with one distribution board per protected zone and per floor.

These will be installed in technical cabinets in each unit.

TDs will be 2b form, with an IS 112 service index and FFF connections on all these protections.

CTs with a power rating of less than 100 kVA should be installed in the form of frames fixed to the walls.

Those above 100 kVA will be installed on a raised base. A general safety switchboard will be installed to supply the smoke extraction towers.

9.5.4. Metering

A set of meters will be installed in the various electrical switchboards (LVS, DT etc.) to provide a coherent metering plan. In particular, the following consumption items will be identified:

- Centralized refrigeration production
- Individual air-conditioning units,
- Domestic hot water,
- Interior lighting,
- Exterior lighting,
- Lifting equipment,
- Heavy biomedical equipment (sterilization, MRI, scanner, radiology, etc.)

All electrical meters will be connected to the BMS.

9.6. Lighting

9.6.1. Interior lighting

The minimum requirements of European lighting standard EN 12464-1 must be met. To limit electricity consumption, LEDs will be used throughout the facility.

The color temperatures to be used will be higher than 3300K in bedrooms and at least 4000 K in work areas and passageways, except when regulations require a higher value.

In all rooms, the color rendering index should be such that CRI ≥ 85.

LED luminaires will have a depreciation factor of 85% for 50,000 hours. The LED driver will have a minimum efficiency of 85%.

To facilitate maintenance, the variety of luminaires will be limited.

Indirect lighting should be limited (bedrooms, patient corridors) and glare-free direct lighting (UGR<176) should be favored.

In rooms where indirect lighting is necessary, such as bedrooms, reflective surfaces (walls and furniture) and dark colors should be avoided.

Lighting will be controlled mainly by local or centralized intelligent controls (CTM management, presence, brightness and dimming detectors), particularly in offices, care management, consultations, etc.

Dimmable lighting systems will be installed in bedrooms, and possibly in other areas as proposed by the designer. Lighting in circulation areas (hall, corridors, etc.) will be controlled in 1/3 - 2/3 via the BMS and presence detectors.

In accommodation areas or areas where lighting is used at night, 1/3 of luminaires should be switched on at all times.

9.6.2. Safety lighting

The luminaires will use LED technology. Exterior lighting will be provided for pedestrian and vehicle pathways, as well as for parking lots. Decorative lighting will be provided for the façade(s), controlled by a twilight sensor.

Emergency lighting will be provided by independent self-testing battery-powered emergency lighting units.

These units will comply with the EC standard (EC7 EC15) and the regulatory safety pictograms. According to regulations, lighting units will have maximum autonomy.

Ambient and evacuation lighting units will use LED technology and very low power consumption. They will be on standby during operation and activated in the event of a fault.

They will be present in the premises covered by the regulations and will indicate changes of direction leading to emergency exits, while allowing recognition of obstacles.

9.6.3. Exterior lighting

The luminaires will use LED technology. Exterior lighting will be provided for pedestrian and vehicle pathways, as well as for parking lots. Decorative lighting will be provided for the facade(s).

Energy requirements and the wishes of the client have led the designer to opt for photovoltaic solutions.

Installations must be on a self-sufficient and easily maintainable network.

High-rise installations are outlawed, as the proposed solutions must allow for maintenance without the need for elevating equipment or great heights.

9.6.4. Protection against the effects of lightning (direct and indirect)

Adequate protection against the direct and indirect effects of lightning must be provided, in accordance with the study carried out by the designer.

All LV and low-current installations on site will be protected against the indirect effects of lightning (e.g.: external camera cables protected at building penetration level, links between buildings or from outside the site passing through slices, etc.)

10. Low-voltage electricity

10.1. Fire safety system

The fire safety system will comply with standards, decrees, fire regulations and technical specifications relating to establishments open to the public and hospitals.

In accordance with regulations, the facility will be equipped with a Category A fire safety system and Type 1 alarm equipment.

The installation must be designed to set up an alarm zone for each entity to be defined, or for each sector of activity.

Fire detection systems must be installed on the premises in compliance with current regulations.

Action indicators will be installed for all premises. These should be installed in the horizontal circulation serving them.

Evacuation plans and instructions must be drawn up and posted.

Operating repeater panels will be provided for all care management systems, with at least one per level.

The fire safety control panel will be installed in the building's security station. In all cases, a UAE and graphic supervision will be provided.

Central equipment and remote modules must have at least 30% of their space left unequipped. A technical passageway must be provided behind the central installations for maintenance purposes.

Smoke extraction relay boxes must be installed in dedicated rooms.

Emergency doors must be fitted with panic bars.

Doors in high-traffic areas (e.g. laundry, storerooms, etc.) will be fitted with an electromagnetic comfort suction pad, controlled by the fire security system, to keep them open. Automatic door closing can be programmed via the BMS.

Areas concerned: waste, laundry, storage rooms for care premises and, in general, logistics premises. Fire dampers must be motorized and controlled.

Cables running outdoors must be fitted with suitable UV protection.

Variant: in the interests of long-term maintenance efficiency, and to ensure the stability of the project's financial objectives, the designer will propose a variant on the smoke extraction principle. This variant will be costed in order to assess the comparative elements in relation to the basic solution described above. The designer must provide the same technical quality as the basic solution.

The technical solution proposed for the servo-control of the doors could be based on an "autonomous trigger detector" (ATD) system, rather than on "actuated safety devices" (ASD).

It must offer:

- A class 1 ATD unit with power supply.

- An associated optical detector

- A manual control unit

- Architecture adapted to this solution

- Detection in all premises except bathrooms, with audible alarm.

As a result, the Fire safety control panel and UAE (Operations Support Unit) will be simplified.

10.2. VDI pre-wiring

General: the site must be eligible for fiber optic installation in line with current government policy. ***Le concessionnaire est BroadBand System Corporation (BSC).*** This requirement is the basis for efficient IT functionality.

The pre-wiring must be flexible to allow quick and easy adaptation to the various changes of use of the premises during the life of the hospital.

The VDI network will drain all the building's communications (video, data, voice, etc.). It will also provide power for certain equipment.

The type of pre-cabling will be the best available at the time of consultation (Category 7 or 8, fiber optics, etc.). In all cases, if a copper solution is chosen, the cabling must be shielded: S/FTP or F/FTP at least).

It should be noted that a highly elaborate IT master plan will form the basis for defining IT policy within the future hospital.

This document defines a working basis, which should be taken into account during studies with the IT department.

General architecture: two main distribution frames will be installed. Each will have a connection to the public network (copper and optical fiber) taken from a different distribution center.

They must be installed in two different wings, and their connections to the public network must never run in the same place or cross.

The sub-distribution frames will be connected in a star and loop configuration to the two main distribution frames. For complete link redundancy, the two main distribution frames will also be connected to each other.

Loop and star cables must be routed on different supports and pass through different technical sheaths and premises. Under no circumstances should these two types of networks intersect.

Fiber optic links will be multi-mode OM4 and single-mode 052. OF (optical fiber) links between distribution frames will be 10Gb/s. Copper links will also be distributed to enable the connection of specific equipment.

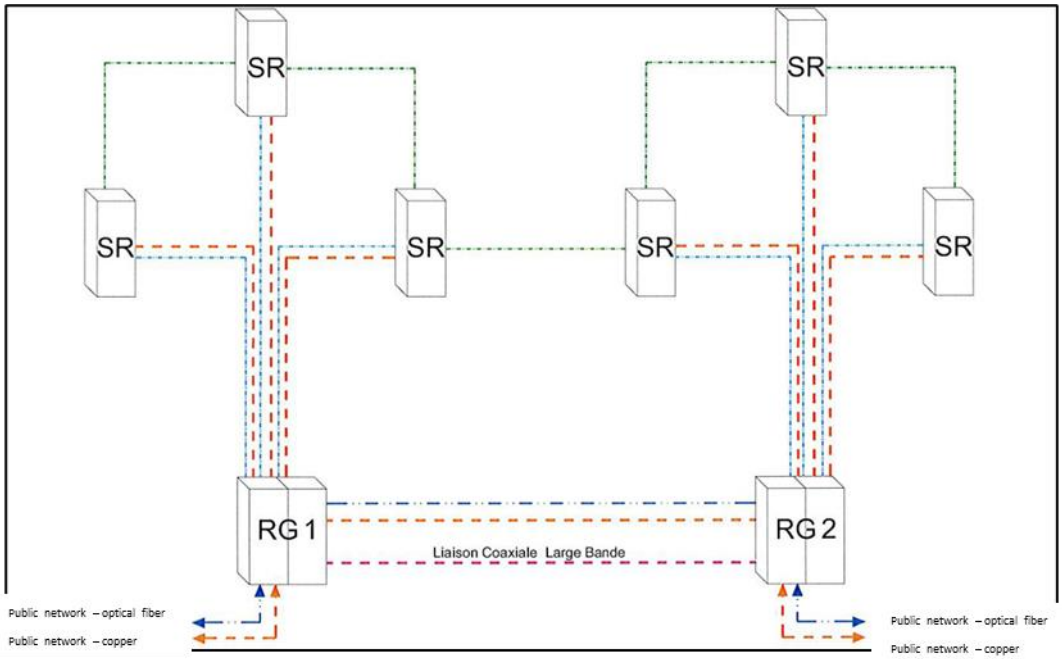

FIGURE 9 - EXAMPLE OF A DISTRIBUTION FRAME CONNECTION DIAGRAM

Power supply and air conditioning

General distribution:

- Power supply: each bay must have a double corrugated power supply and double distribution within the bay.
- Air-conditioning: racks must be cooled directly by injection at the bottom and suction at the top.

Sub-distributors:

- Power supply: each bay must have a double corrugated power supply and double distribution in the bay.
- Air-conditioning: the room must be air-conditioned.

Grounding network: a specific grounding network must be installed for IT and telephone equipment directly from the main busbars.

Workstation distribution: workstation distribution will be carried out using optical fiber, either with a local micro-switch or directly with optical fiber at the workstation if the technology is mature. Failing this, the designer will propose the existing solutions, copper network and RJ 45. In all cases, the distribution method must be flexible and high-performance.

Active equipment: active equipment (switches, servers, routers, etc.) will be supplied and installed by the designer.

WIFI network: a WIFI-type wireless distribution network will be installed. This must be a low-power network with a tight, secure mesh.

It should enable patients to connect to the local network.

All buildings and outdoor areas must be covered.

Telephony: connection to the telephony network will be achieved by laying two fiber optic links supplied by the concessionaire.

These links will enter the site from two different points and must be routed to the main distribution frames via two completely different paths. Under no circumstances should the two networks cross.

A switchboard with billing capability will be provided, as well as all fixed and mobile telephones.

A DECT (Digital Enhanced Cordless Telecommunications) network is to be installed throughout the facility (inside and outside). The system will enable:

- Technical alarm reporting on certain phones
- Staff alarm reporting: emergency call or intervention request

11. Security of goods and personnel, access control

The aim of access control is to create a facility with security levels adapted to requirements.

Three levels of criticality will be created to determine the level of access control to be installed.

- Level 0 will identify premises that do not require locking devices.
- Level 1 will be set up for premises requiring traceability and real-time rights management. In this case, access will be controlled by card readers or badges.
- Level 2 covers premises requiring a high level of security.

Determination of zones and premises (non-exhaustive list, to be completed by the client).

Level 0	Level 1	Level 2
Public toilets, rooms	Dirty utility room Cleaning room Waste room Staff toilets and staff changing rooms	Personal parking Storage facilities Operating room Offices Technical room Central and local pharmacy Care management Laboratory

Card readers will comply with ISO 4443 A, B and B' standards, with encrypted keys. The cards will be multifunctional and multi-protocol. In addition to access control, they will enable access to restaurants, parking lots, etc.

The aim is for the card to identify the bearer for all hospital applications and services.

Rights will be managed in real time by Hypervision. The database will be derived from the hospital's human resources department database. This database will therefore be unique.

It will be possible to:

- Assign or remove rights in real time,
- Create visitor badges,
- Consult the history of each reader remotely.

The system must have a degraded mode and process events in compliance with the rules, even in the event of network loss or a power cut lasting a minimum of 12 hours.

11.1. Intercom connection

A system will be installed to enable voice communication between certain areas (operating room, intensive care unit, etc.). The system will be based on IP technology. It will enable hands-free communication.

In hygiene-controlled areas, the stations must be watertight, bio-cleanable and recessed. As a general rule, it is preferable for units to be flush-mounted.

11.2. Video intercom access control

Access control will be by videophone.

Access to offices in the administrative zone, particularly in the management offices. Access will be reported directly to a control screen near the workstation.

And other sensitive services access to critical care, theatres, etc.

Video intercoms must comply with PRM standards, be IP-connected, recessed and vandal-proof for those placed outside. Cameras and screens must be HD quality.

11.3. Emergency calls

In all operating room and recovery room, an emergency call system will be installed, enabling a discriminating signal to be sent to certain personnel in the event of a critical medical problem.

In the rooms concerned, the system will comprise a call button, an acknowledgement button and visual and audible signals.

11.4. Nurse call (also known as "sick call")

The nurse call system must be installed in all rooms, patient washrooms in the care area, and dressing rooms, according to local specifications. The installation will be decentralized (by department), based on IP technology.

- The system will track attendance and acknowledgements via a wall-mounted unit.
- The patient, by pressing the button, the call button or the bathroom pull cord, will trigger:
- The call window in the corridor lights up;
- The three-color visual and audible display of the call on the department's displays;

The call button on the right-hand side of the bed must be physical (not on a touch screen, for example).

Care staff going to the room will stop all call signals.

Displays will be placed in the "nursing care station", "care preparation" areas.

An information display can also be installed in the corridors if required (depending on the needs of the department concerned or the configuration of the premises).

All equipment must be watertight, disinfectable and cleanable. The system will be backed up via the corrugated network.

11.5. Anti-intrusion systems

An anti-intrusion system will be installed in the following sensitive areas:

- Pharmacy,
- Warehouse,
- Computer rooms,
- Sensitive Medical Devices
- Day sectors - Day hospitalization
- Laboratories
- Mortuary chamber

Perimeter surveillance using detectors and sensors will be installed for services or areas used only during the day (day-care unit), and can be activated and deactivated by clock, keypad or card.

The control unit will be addressable, and the number of zones will correspond to the number of sensitive zones, with the possibility of changing the number and type of zones. Intruder alarm information will be reported to the PCS and visible in hyper vision to enable precise localization.

When an alarm is activated:

- Siren if necessary,
- Timed lighting,
- Report to control desk security,
- Display of the zone concerned on the Hyper Vision.

11.6. Video surveillance

New-generation IP cameras will be needed, capable of combining functions and adapted to the scene, so that only useful areas can be viewed. They should automatically manage backlighting.

Video surveillance will meet three needs, depending on the areas to be monitored:

- Identification: identification of an individual without any possible doubt. Cameras must be of sufficient quality to have at least 5 pixels per centimeter.

- Recognition: to determine whether or not an indicated individual is the same as the one seen previously. At least 1 pixel per centimeter is required.
- Person detection: determine whether or not a person is present in the field of vision. Detection requires a minimum of 0.2 pixels per centimeter.

Cameras should have a flux of 25 to 30 images per second.

Determination of areas to be monitored:

Exterior :

- Gates and site entrances (identification with license plate recognition)
- Parking lots and roadways (recognition)
- Emergency exits (Identification),
- Entrances (Identification)
- Other outdoor areas - Motorized cameras (people detection with manual zoom recognition)
- Firemen's lanes
- Sensitive technical areas (HV premises, medical fluids platform)

Interior :

- Major communication hubs
- Entrance halls
- Circulation in logistics zone
- Unloading dock

Cameras

A number of day/night cameras will be installed outside the building to monitor the following areas:

- Exterior surroundings
- Parking lots

11.7. The security stations

All cameras and alerts will be reported to the security station. A viewing wall must be installed.

At least two 42" monitors per 80 cameras (or equivalent) are required. They should be of Full-HD quality.

Joysticks will enable the motorized cameras to be controlled quickly and fluidly.

Navigating between monitors will be easy thanks to keyboards.

Digital color recording: The necessary number of recorders will be installed to store images from all video surveillance cameras for a minimum of 96 hours. These recorders will be located on the control desk security in the manager's office.

Recording can be triggered manually, permanently, by alarm contact, motion detection or calendar. The recorder will enable motion detection for a sufficient number of zones. Recording speed will be a minimum of 480 images per second.

The quality of the outputs to the monitors will be adapted to the quality of the cameras.

12. Multimedia

12.1. Room television

The need for TV sockets will be considerable. Each room will be equipped with one. The broadcast medium will be the VDI network.

The system must allow :

- Broadcasting of the main national and satellite channels...
- Management of the service charge system
- Hospital information display.

➔ Category 1 rooms will be equipped with a 50" UHD 4K TV with remote control on the wall visible from the patient's bed, and an associated sound system.

12.2. Video projection

Conference rooms, meeting rooms and General Director office will be equipped with a 50" UHD 4K TV (with remote control) on the wall or white screen provided for this purpose, as well as an associated sound system.

The TV will be fixed to the ceiling, and the video projector's connections (HDMI, USB, etc.) will be used, to enable users to connect easily.

13. Publics roads and miscellaneous networks

General requirements: Exterior design must take into account environmental constraints and required exterior treatments. All outdoor spaces must be designed to take into account the risks associated with precipitation, wind and noise.

Materials used for exterior landscaping must be of proven quality and in common use.

Roadways, circulation paths, service yards, maneuvering areas and walkways must be sized according to the width and height of passage, as well as the radii of curvature required to accommodate the type of vehicle planned, in compliance with current regulations. Run-off water from these surfaces must be treated according to its nature, notably by screening, the use of hydrocarbon separators and filtration on materials such as gravel and sand.

Networks (electrical, water, etc.) must be designed in compliance with the specific regulations laid down by the relevant planning authorities and concessionaires.

13.1. Buried networks

No water pipe will be smaller than 200 mm in diameter, to avoid the risk of clogging, and minimum slopes will be respected to allow self-cleaning. Rainwater pipes will be designed to evacuate rainfall of ten-year intensity.

All network trenches will be included in the design. These networks include

- Drinking water supply,
- Fire-fighting with hydrants, water reservoirs,
- Wastewater and industrial water networks,
- Rainwater networks,
- Energy networks (high and low voltage, lighting, etc.),
- Irrigation network, water recycling

As well as the associated miscellaneous structures, in particular: gullies, culverts, access ladders, valves, taps, hydrants.... They will be placed in sufficient numbers and in strategic positions (elbows, bends, etc.) to facilitate subsequent maintenance work.

Accessibility will be ensured by designing suitable structures (manholes, inspection chambers, etc.).

The designer will take into account the state of the ground. Wastewater / clean water roof / EP parking networks must be separate.

All technical devices will be provided on the structures: manholes, buffers, hydrocarbon separators where necessary.

To avoid interference between networks and facilitate maintenance, the designer must comply with the positioning rules set out in standard NF P 98-331.

13.2. Publics roads

The design of the roadways will include internal site services (heavy and light vehicles, 2-wheelers, etc.), footpaths to link buildings, roadworks and grading, and any service structures required for the project.

Internal traffic flows, from the site entrances to the building entrances, will be designed to differentiate the flows feeding the new hospital:

- Light vehicles for patients, consultants, staff and visitors;
- Light vehicles for minute drop-off (light medical vehicle) at specific entrances (consultations);
- Emergency vehicles (EMS, fire brigade);
- Delivery vehicles (light and heavy goods vehicles) to the logistics yard;
- Technical maintenance vehicles to technical supply and production areas.

These flows are made from 3 entrances envisaged in the program:

- An entrance/exit << people >> serving the circuits
- An entrance/exit << emergencies >> serving the emergencies
- An entrance/exit << materials >> for logistics access

The designer will define a model of its various flows to judge the relevance of the organization of circuits.

Access and maneuvering areas will enable supply and emergency trucks to circulate: turning radius must be integrated.

Pedestrians and people with reduced mobility must be able to access and circulate easily on the site without having to use car traffic lanes.

With this in mind, pedestrian paths and soft modes of transport in general will be given priority and strongly individualized. All pedestrian/vehicle intersections must be designed to ensure the safety and comfort of pedestrians, cyclists, etc.

13.3. Logistic dock

The dock will be adapted to the new European regulations and will comply with INRS ED94 recommendations.

Loading and unloading dock heights will be adapted to the types of vehicles used by the hospital.

It will be equipped with:

- Hermetically sealed sectional doors, with central oculi measuring at least 2 m2, with automatic "push-button" opening and manual back-up.

- Tailgate pits for platforms at 1.10 m,
- Weather protection devices (canopies, dock caps, dock bellows, etc.), joined to the vehicle bodies to ensure a good seal against draughts and bad weather,
- At least 2 bumpers per dock (minimum size 500 x 250 by 155 mm thick),
- Water run-off collection grids, parallel to the building, set at 3.50 m from the edge of the dock with a minimum slope of 2%. The slope from the gutter to the outside edge of the roadway will be adapted to the length of the truck, allowing the truck to be positioned horizontally for loading and unloading.

Note: Take into account the constraints of international standards (gauge, etc.). A clearance of at least 18 meters must be provided between the dock and the wall. Access and maneuvering must be possible for a 38T vehicle.

The slope of the dock access ramp (if any) must not exceed 12%.

Dock lighting must be automatic when the presence of people or vehicles is detected.

Trucks resting against platforms must be horizontal. Handrails and handrails must be made of galvanized steel, protected and finished by thermo-lacquering.

13.4. Fences and gates

Certain areas of the site will be fenced off in accordance with the safety requirements of certain activities as expressed in the functional program.

Staff parking areas and service vehicles will be clearly separated by a fence and gate.

Walls and gates must be high enough to prevent unauthorized access. Depending on the level of security required for the area concerned, the type and materials of fencing will be designed to resist vandalism and intrusion (rigid, non-removable metal fencing, etc. where necessary).

Entrances and exits to staff parking lots, etc. will be controlled by barriers, while certain areas will be closed by automatic or manual gates.

13.5. Parking

Parking spaces are not part of the program. However, as part of the design studies for the external layout, the designer must propose a parking area for the public/visitors, for emergency vehicles (ambulances, fire brigade, police, army, etc.) and for staff in sufficient quantity for the hospital's capacity.

Parking facilities must be designed with the following requirements in mind:

- They must be integrated into the composition of the master plan, with an overall circulation plan specifying access arrangements for the various users of the car park, in particular visitors, patients and staff;

- They must be designed to integrate harmoniously with the rest of the project, creating logical links with the other parts of the building;
- They must include a sufficient number of 2-wheel parking spaces, as well as spaces for PRM;
- They must include a parking area reserved for clean vehicles (particularly electric vehicles), representing at least 10% of parking spaces, equipped with devices to encourage their use (electric charging stations), or with precautionary measures to enable them to be fitted at a later date (waiting ducts, reservations in electrical panels, etc.).
- They must include a secure, rain-protected parking area for staff bicycles,
- They must meet a range of safety requirements, particularly in terms of fire and personal safety. This includes effluent management;
- They must be adequately lit to prevent users from feeling unsafe;
- Access and pedestrian walkways must be designed to ensure pedestrian safety and avoid unnecessary crossings with motorized vehicles on the site.

Minimum technical requirements:

- Vehicle accesses must be equipped with controlled automatic barriers and intercom systems to enable rapid intervention. Remote controls must be accessible from the main access gatehouse. The project manager must carry out a study to determine the number of barriers required at parking lot entrances, based on traffic volume and time distribution, with particular emphasis on the fluidity of staff movements.
- All parking areas must be equipped with surveillance cameras.

14. Dimensional constraints

The overall design of the Ruhengeri referral hospital will have to comply with regulatory requirements as well as the usual dimensioning elements for the proper operation of a healthcare facility.

The main contractor must respect the following dimensions to enable the design and operation of a scalable reference hospital:

Window sill to ensure patient privacy	0.90 m
Solid spandrel for glass partitions and laboratory windows Lab bench backsplash	1.20 m
Minimum false ceiling height in laboratories and critical care rooms	2.80 m
Minimum height required under suspended ceilings in operating theatres and imaging rooms	3.50 m
Minimum height under ceiling luminaires.	2.50 m

Minimum suspended ceiling height for corridors, including walkways and connecting galleries, and small rooms. Minimum height under false ceiling in hospital rooms, offices, consultations. Minimum clear height for all premises not mentioned elsewhere.	
Minimum height under beam and all obstacles: sick bay, mortuary courtyard, emergency courtyard. Minimum height under false ceiling in the pharmacy (drug storage and preparation areas). Minimum height under footbridge (unless otherwise constrained by Rwandan town-planning regulations)	3.80 m
Minimum distance between bed and side wall	0.90 m
Space required between two beds (in rooms with 2 or more beds).	1.20 m
Space between footboard and wall (in rooms with 2 or more beds)	1.20 à 1.30 m
Minimum space for crossing 2 inpatient beds	2.20 m
Minimum space for crossing 2 beds in the technical platform corridors	2.50 m
Adult bed, equipped (2 mobile wheels).	2.20 x 1.10 m
Adult resuscitation bed with serum holder rod	2.20 x 1.30 x H=2.08 m
Worktop, lab bench, medical bathtub	0.90 m
Minimum clear height in technical gallery. Minimum clear height in trafficable area of crawl space.	2.20 m
Minimum clear height in main technical rooms housing bulky installations (LVS, etc.).	3.40 m
Minimum height under beam and any obstacle: central warehouse, logistics yard (5.80m for lifting waste skips), laundry. Minimum height in generator room.	4.00 m
Minimum height under beam and any obstacle: circulation and parking of heavy goods vehicles such as trucks with tractor + trailer	4.50 m
Hatches and passageways for maintenance personnel.	0.50 x 1.80 m

TABLE 9 - DIMENSIONAL CONSTRAINTS

Passageways leading to heavy medical equipment (imaging) must be dimensioned (width, height and strength of floors) to allow for subsequent renewal of the equipment. The prime

contractor will propose a simulation of the routing of this equipment from the external delivery areas to the installation sites (medical imaging, operating theatres, etc.). If the supplier is not known at the time of the study, it will be necessary to take into account the strongest constraints of the market.

15. Accessibility

Regulation[13]:

- Decree no. 2006-555 of May 17, 2006 on the accessibility of establishments open to the public, installations open to the public and residential buildings, and amending the construction and housing code,
- Circular no. DGUHC 2007-53 of November 30, 2007 on the accessibility of establishments open to the public, installations open to the public and residential buildings.
- "Facilities for disabled people in public buildings" published by RHA in November 2011, and reiterated in the RWANDA GREEN BUILDING MINIMUM COMPLIANCE SYSTEM - indicator 5.2 Universally accessible building.

The architectural and technical design of the planned structure should enable people with disabilities to access all areas of the future Ruhengeri referral hospital building.

Disabled-accessible public toilets will be provided in accordance with regulations, i.e. at least one per level, per sector or protected area (if not specified).

At the very least, sanitary facilities in hospital rooms must be accessible to people with reduced mobility. The design and equipment of these facilities must comply with accessibility regulations for establishments open to the public.

Sanitary facilities and rooms with 2 to 8 beds do not comply with standards for people with reduced mobility (PRM).

The large single rooms (categories 1 & 2) and their sanitary facilities comply with PMR standards for the accommodation of one patient per room. There is no requirement to accommodate 2 PRM patients simultaneously in the room. They must, however, be able to accommodate 1 PRM patient.

In all public areas (reception, elevators, cafeteria, etc.) whose function is to welcome all persons, equipment must be at a height that allows access for people with reduced mobility, in particular:

[13] Il est rappelé que dans le cadre de la réalisation du futur Hôpital de référence de Ruhengeri, il a été décidé d'adopter un cadre réglementaire et normatif exigeant. En choisissant systématiquement le cadre normatif le plus exigeant entre les normes françaises et rwandaises, cette approche vise à garantir un niveau de qualité et de sécurité optimal.

- Counters and reception desks
- Elevator controls

Essential controls must be easy to locate and operate for the visually impaired, hearing impaired and physically handicapped.

Elevators: Elevators will be electric. It should be noted that the designer must consider that elevators can be prioritized for PRM and reduced mobility, on the assumption that the circulation of ambulant people and stretchers can take place via access ramps.

The number of lifts, their capacity and their allocation will be the subject of a traffic study, in which the flows (public, staff, goods elevators, patient lifts, logistics, etc.) will be specified. Depending on the proposed architecture, if the facility is to include them, the elevators and patient lifts will be sized to accommodate a heavily equipped bed with two attendants.

Acceleration and deceleration will be designed to limit inconvenience to patients.

Cleaning and disinfection must be facilitated.

Depending on the location of the elevators, the interior of the cabins will be treated in such a way as to prevent damage and vandalism to wall coverings, control units, reinforced lighting, etc.).

Certain landings and/or cabins will be equipped with controls enabling priority to be given to certain categories of personnel. This priority will be managed by the key system.

The height of the passageway will be a maximum of 2m10. Its width will be 0m90 minimum. The precision of the cabin stop will be +/- 5 mm to limit shocks to patients and biomedical equipment. The layout and operating characteristics of the equipment will take account of the particular features of the buildings and functional areas, with particular attention to be paid to the layout of the machinery in relation to the noise nuisance generated.

Elevators must be sized to provide sufficient space for the patient's bed/ stretcher and allow for the presence of one or two attendants (stretcher-bearers/doctors).

The designer will consider the cost of the maintenance contract. In this case, this point will be included in the overall cost study requested as part of the competition and updated at the various stages of the study.

16. Warranty

The warranty period will begin on the date of complete and unconditional acceptance of the works. For a period of two years, the service provider will provide full maintenance of the installations (parts and labor) from the date of unconditional acceptance of the equipment.

It undertakes to replace any faulty equipment whose malfunction is not due to improper use of the equipment. The warranty also includes:

- Updating of settings and programming required to improve results,
- Travel expenses (transport, accommodation, meals) and staff intervention,
- Provision of an on-call telephone number from Monday to Saturday, 8am to 7pm.

16.1. Maintenance contract proposal

For a period of two years, the purchaser will provide full maintenance of the installations (parts and labor) from the time the equipment is accepted without reservation as being in good working order.

The contractor undertakes to replace all faulty equipment whose malfunction is not due to misuse of the equipment, and to manufacture or have manufactured, the materials and components used in its installation for a minimum period of 10 years after acceptance.

The contract will include:

- The service provider must intervene and troubleshoot the installation within a maximum of 4 hours.
- The intervention will take place after the internal technical structure set up by Treichville University Hospital has attempted to troubleshoot, and when it is unable to do so.
- Travel costs (transport, accommodation, meals) and staff intervention costs.
- Provision of an on-call telephone number from Monday to Saturday, 8 a.m. to 7 p.m.

The manufacturer's offer will therefore include a maintenance package covering all aspects of the technical installations.

This offer must be attached to the file:

- Name and location of the company carrying out the maintenance work,
- Human resources (workforce - staff qualifications) and equipment (vehicles - tools - diagnostic and communication resources, etc.),
- Simple contract with details of the number of operations per year, indicating their frequency and giving details of each schedule,
- Presence or absence of an on-call service,
- Average response time from message to actual arrival on site,
- Stock levels of consumables and spare parts

16.2. Equipment management

The management of healthcare quality and technology is essential to the safe and efficient delivery of these services.

In order to achieve this objective of controlling the stock of equipment, which is essential to the overall response to the needs of public health, prevention and clinical care (including examination, diagnosis, treatment and management, follow-up and rehabilitation), the first step is to determine which items (in terms of number and quality) need to be managed, and to create a reliable inventory of medical equipment. This inventory must be centralized with the Ministry of Health.

Secondly, it is important to identify deficient equipment according to three criteria:

- Adequacy of the volume of equipment in relation to patient needs (comparative analysis of hospital equipment quotas),
- The availability and practical accessibility of equipment (with the establishment of obsolescence rates for equipment which, depending on its age, no longer meets requirements in terms of performance and standards).
- This inventory will become the basis for all developments in health technology management and will help guarantee the safety and efficiency of medical equipment.

Recommendations: Carry out an analytical study of the equipment pool to identify medical devices (MDs) at the end of their life cycle, with recurring breakdowns, embolizing care and potentially having serious repercussions on patient care and health (with implementation of a priority scale);

Acquire statistical and traceability tools for equipment to better organize and plan maintenance operations.

Keep imaging, medical biology and operating rooms up to date (bring them into line with regulatory changes).

Draw up multi-year equipment plans over 3 years, with the aim of replacing obsolete medical devices and identifying the need for additional equipment in line with the facility's project.

Combine the equipment plan with a maintenance plan (preventive and curative) and a quality control plan (internal and external) for radiology equipment and all sensitive medical devices, to reduce the probability of failure and operational degradation.

II. EQUIPMENT PLAN BY DEPARTMENT

1. Scope of the medical equipment plan

The medical equipment and furnishings plan for the Ruhengeri referral hospital was drawn up on the basis of the medical project validated by the project owner, and on the basis of arbitration on the breakdown of floor space.

It aims to identify the equipment required for the smooth running of the various hospital departments, and to provide an indicative list of equipment requirements outside the biomedical field, which should be consolidated in the APS by the contractor according to the customer's needs. These include:

- IT package (computer workstation, printer, etc.),
- Plumbing-sanitary package (pedal-operated sanitary garbage can, paper towel dispenser, mirror, etc.),
- Architectural or joinery package (joinery bank, etc.).

Note:

In view of the decision by the owner to take charge of the HIS, it will be important to consider the specific nature of the equipment to be acquired by the hospital, integrating from the outset the interfacing and interoperability requirements between the equipment and the HIS.

2. Equipment plan by division

2.1. Equipment list by room type

HOSPITALIZATION

VVIP room

- Hospital bed, electric
- Wall-mounted medical rail
- Sanitary pedal garbage can
- Visitor chair – bedroom
- Bed table with castors
- Bedroom wardrobe
- Bedside table
- Bedside table
- VIP Canape
- Paper towel dispenser
- Liquid soap dispenser
- Mirror
- Pre-equipment for future TV set
- Toilet paper dispenser
- Washbasin
- WC

VIP room

- Wall-mounted medical rail
- Hospital bed on wheels
- Sanitary pedal garbage can
- Visitor chair - room
- Bed table with castors
- Bedroom wardrobe
- Bedside table
- Paper towel dispenser
- Liquid soap dispenser
- Mirror
- Pre-equipment for future TV set
- Toilet paper dispenser
- Washbasin
- WC

Rooms with 2 or more beds

- Wall-mounted medical rail
- Hospital bed on wheels
- Sanitary pedal garbage can
- Visitor chair - room
- Bed table with castors
- Bedroom wardrobe
- Separation curtain (rail-mounted)
- Bedside table
- Paper towel dispenser
- Liquid soap dispenser
- Mirror
- Pre-equipment for future TV set
- Toilet paper dispenser
- Washbasin
- WC

Mother & Child « Kangaroo » Room

- Wall-mounted medical rail
- Hospital bed on wheels
- Sanitary pedal garbage can
- Visitor chair - room
- Bed table with castors
- Bedroom wardrobe
- Separation curtain (rail-mounted)
- Bedside table
- Cradle
- Paper towel dispenser
- Liquid soap dispenser
- Mirror
- Pre-equipment for future TV set
- Toilet paper dispenser
- Washbasin
- WC

OPERATING ROOM

Incubator box

- Bottle warmer
- 3-bag waste collection cart
- Dry bench
- Incubator
- Ambulatory chair
- Paper towel dispenser
- Liquid soap dispenser

- Standard medical washbasin

Emergency room

- Emergency ventilator
- Automatic ph/blood gas analyzer
- ECG - 12/16 Tracks/Downrigger
- Cardio-respiratory monitor
- Surgical ceiling light 1 dome (small)
- Emergency cart + defibrillator
- Mobile V.C. aspirator
- Syringe holder
- Infusion / transfusion heater
- 1-channel syringe pump
- 3-bag waste collection cart
- Dry bench
- Wet bench 2 bins
- H.V. practitioner stool
- Air generator - Heated mattress/blanket
- Transparent radio cart
- Care trolley
- Medical device storage cabinet
- Negatoscope 4 ranges
- Stainless steel medical trolley 2 trays
- Serum holder on wheels
- Paper towel dispenser
- Liquid soap dispenser
- Support rail & accessories
- Washbasin
- Computer workstation

Emergency box

- Blood glucose meter
- Portable ultrasound
- Multiparameter monitor
- Otoscope
- 1-channel syringe pump
- 3-bag waste collection cart
- Step stool
- H.V. practitioner stool
- Care trolley
- Electric examination couch
- Mobile focusable medical lamp
- Personal scale

- Negatoscope 2 ranges
- Stainless steel medical table, 2 trays
- Paper towel dispenser
- Liquid soap dispenser
- Support rail & accessories
- Standard medical washbasin
- Computer workstation

Rescusitation room

- Intensive care bed + mattress
- Multiparameter monitor
- Support - Syringe pump
- 1-channel syringe pump
- Suspended ceiling column with double segment infusion arm
- 3-bag waste collection cart
- Wet bench 1 tray
- H.V. practitioner's stool
- Articulated lamp on column
- Space for dialysis generator
- Paper towel dispenser
- Liquid soap dispenser
- Space for ultrasound scanner
- Computer workstation

Delivery room

- Obstetric suction cup
- Multiparametric monitor
- 2-dome overhead operating light
- 1-channel syringe pump
- Delivery table
- Wall-mounted medical rail
- 3-bag waste collection trolley
- Step stool
- Nursing trolley
- Instrument trolley
- Lockable medicine cabinet
- Emergency and resuscitation trolley
- Paper towel dispenser
- Liquid soap dispenser
- Multifunction laser printer

- Standard medical washbasin
- Computer workstation

C-section room

- Complete anesthesia station
- Obstetric suction cup
- Curarization monitor
- Newborn scale
- Transport box
- 1-dome ceiling-mounted operating light (Small)
- Surgical ceiling light 2 domes
- Operating table accessories
- Mobile operating table
- Mobile self-contained surgical aspirator
- Defibrillator + scope on cart
- Frontal cold-light helmet
- Ultrasound scalpel
- Mono bipolar & thermo fusion scalpel
- Pneumatic tourniquet for surgery
- Stainless steel wheeled tub
- Infusion pump
- 1-channel syringe pump-Anesthesia
- Support - Syringe pump
- Surgical arm
- Single anesthesia arm
- 3-bag waste collection trolley
- Decontamination cart + bins
- Footboard
- Podium
- Anesthetist stool
- H.V. surgeon stool
- Instrument table 1 tray - Mayo
- Stainless steel instrument table, 2 trays
- Modular drawer trolley
- Air generator - Heated mattress/blanket
- Dressing trolley
- Emergency trolley
- Negatoscope 4 ranges
- Stainless steel medical trolley 2 trays
- Serum holder on wheels
- Space for mobile image intensifier
- Space for ultrasound scanner
- Computer workstation

ISO 7 Operating room

- Complete anesthesia station
- Portable ultrasound
- Curarization monitor
- 1-dome ceiling-mounted operating light (Small)
- 2-dome ceiling-mounted operating light
- Operating table accessories
- Mobile operating table
- Mobile self-contained surgical aspirator
- Defibrillator + scope on trolley
- Frontal cold-light helmet
- Ultrasound scalpel
- Mono bipolar & thermo fusion scalpel
- Pneumatic tourniquet for surgery
- Surgical motor
- Stainless steel wheeled tub
- Infusion pump
- 1 way syringe pump-Anesthesia
- Support - Syringe pump
- Surgical arm
- Single anesthesia arm
- 3-bag waste collection trolley
- Decontamination trolley + bins
- Footboard
- Stage
- Anesthetist stool - Backrest
- H.V. surgeon stool
- Instrument table 1 tray - Mayo
- Stainless steel instrument table, 2 platform
- Modular drawer trolley
- Air generator - Heated mattress/blanket
- Dressing trolley
- Emergency trolley
- Negatoscope 4 ranges
- Stainless steel medical trolley 2 platform
- Serum holder on wheels
- Space for mobile image intensifier
- Computer workstation

Endoscopy equipment and endoscope storage and disinfection room

- Complete endoscopy vacuum column

- Bronchoscope
- Cardio-respiratory monitor
- 1-dome ceiling-mounted operating light (small)
- Mobile table for radiolucent endoscopy
- Transparent X-ray stretcher trolley
- Endoscope washing & sterilizing machine
- Air gun
- Waste collection cart 3 bags
- 6-tray endoscope washing bench
- Dry bench
- H.V. practitioner stool
- Transport cart for dirty endoscopes
- Clean endoscope transport trolley
- Transport and decontamination trolley + bins - endoscope
- Multifunction laser printer
- Liquid soap dispenser
- Paper towel dispenser
- Washbasin
- Computer workstation

Radiology room

- Boitier de commande - Injector
- X-ray control panel
- Conventional X-ray table
- X-ray room equipment room
- 3-bag waste collection trolley
- H.V. practitioner stool
- Treatment trolly
- Mobile focusable medical lamp
- Medical device storage cabinet
- X-ray apron
- Mobile lead apron holder
- Stainless steel medical table with 2 platform
- Serum holder on wheels
- Paper towel dispenser
- Liquid soap dispenser
- Standard medical washbasin

Ultrasound room

- Printer - Med-Echo Imaging
- Multifunction ultrasound scanner
- 3-bag waste collection trolley

- Step stool
- H.V. practitioner stool
- Ultrasound examination couch
- Medical device storage cabinet
- Hand towel dispenser
- Liquid soap dispenser
- Telephone station
- Standard medical washbasin
- Computer station

Consultation box

- Auto Tensiometer
- Blood glucose meter
- Somatometer (TOISE)
- Pulse oximeter
- Stethoscope
- Pediatric scale with toise
- 3-bag waste collection trolley
- Visitor chair
- Doctor's / pharmacist's desk
- Ergonomic swivel chair
- Step stool
- H.V. practitioner stool
- Examination couch
- Mobile focusable medical lamp
- Medical device storage cabinet
- Personal scale
- Negatoscope 2 ranges
- Stainless steel medical table 2 platform
- Liquid soap dispenser
- Multifunction laser printer
- Toilet paper dispenser
- Hand wash basin
- Computer workstation

Mammography room

- Fixed lead shield
- Mammography unit
- Mammograph control station
- 3-bag waste collection trolley
- H.V. practitioner stool
- Medical device storage cabinet

- X-ray apron
- Mobile lead apron holder
- Stainless steel medical trolley 2 platforms
- Paper towel dispenser
- Liquid soap dispenser
- Multifunction laser printer
- Standard medical washbasin
- Computer workstation

Audiometry room

- Impedance meter
- Audiometer
- Audiometry booth
- 3-bag waste collection trolley
- Dry bench
- H.V. practitioner stool
- Paper towel dispenser
- Liquid soap dispenser
- Multifunction laser printer
- Standard medical sink
- Computer workstation

ENT consultation box

- Halogen headphones
- ENT examination chair
- ENT mirror
- ENT mirror heater
- ENT consultation unit
- 3-bag waste collection trolley
- Visitor chair
- Doctor's / pharmacist's desk
- Ergonomic swivel chair Step stool
- H.V. practitioner stool
- Mobile focusable medical lamp
- Medical device storage cabinet
- Bathroom scale
- Stainless steel medical trolley 2 platforms
- Liquid soap dispenser
- Multifunction laser printer
- Toilet paper dispenser
- Hand-washing basin
- Computer workstation

Ophthalmology consultation box :

- Ophthalmic testing projector
- Ophthalmic examination chair
- Ophthalmoscope
- ISHIHARA test album
- Slit lamp
- Frontofocometer
- Set of trial lenses
- Near reading test
- Worth test - distance vision
- Headset - Indirect ophthalmoscope
- Spotlight, Wall-mounted
- 3-bag waste collection trolley
- Visitor chair
- Translation table - 3 instruments
- Dry bench
- H.V. practitioner stool
- Modular drawer trolley
- Mobile focusable medical lamp
- Medical device storage cabinet
- Liquid soap dispenser
- Multifunction laser printer
- Toilet paper dispenser
- Hand wash basin
- Computer workstation

Dental consultation box

- Intraoral radiogenic block
- Dental amalgamator
- Complete dental unit & chair
- Stomatological examination cabinet
- 3-bag waste collection trolley
- Visitor chair
- Wet bench 1 platform
- H.V. practitioner stool
- Mobile focusable medical lamp
- Medical device storage cabinet
- Negatoscope 3 ranges
- Stainless steel medical table, 2 platforms
- Liquid soap dispenser

- Multifunction laser printer
- Toilet paper dispenser
- Hand wash basin
- Computer workstation

Dental panoramic room

- Fixed leaded protective screen
- 2D dental panoramic
- Dental panoramic control panel
- Technical room Dental panoramic
- 3-bag waste collection trolley
- Dry bench
- H.V. practitioner stool
- Treatment trolley
- Anti-X apron
- Paper towel dispenser
- Liquid soap dispenser
- Multifunction laser printer
- Standard medical washbasin
- Computer workstation

Cytotoxic preparation (isolator) / control

- Laboratory refrigerator
- Vertical laminar flow hood
- 3-bag waste collection trolley
- Wet bench 1 bin
- Dry bench
- Safety cabinet for cytotoxic products
- Laboratory stool with backrest
- Medical device storage cabinet

Lab / blood bank

- Precision scale
- Hot plate
- Laboratory refrigerator
- Chemical hood
- Refrigerated cabinet - Blood bank
- 3-bag waste collection trolley
- Dry bench
- Lockable medicine cabinet
- Safety shower + eye wash

Director's / manager's office

- Visitor chair
- Storage cabinet
- Single desk
- Ergonomic swivel chair
- Multifunction laser printer
- Computer workstation

2.2. Detailed table of equipment by department

See the Annex 4 - the equipment list for the RUHENGERI referral hospital's firm tranche.

See the Annex 5 - the equipment list for the conditional tranche of the RUHENGERI referral hospital.

2.3. Specificity of certain equipment

In the preliminary project phase, it is essential to consolidate the hospital's equipment plan by drawing up specifications that meet user requirements.

However, this chapter will detail the specific requirements for certain equipment and furnishings (real estate by destination) included in the interior design or architectural package:

Wet lab bench:

- Bench tops should be prefabricated and designed to suit their intended use and the dimensions of the space in which they will be installed.
- Water connections and drains should be made using PVC pipes. The recommended material for tanks and drip trays is synthetic resin.
- Depending on their intended use, benches should be fitted with fittings for cold water, hot water and draining.
- Tanks should be both deep and wide, allowing for total immersion of fragile or bulky materials.
- For intensive use, height adjustment is recommended. They should have no overflow and drain through transparent siphons that can be removed without tools. Bungs should be offset from the water inlet to prevent splashing, and they can be plugged at a distance to prevent accidents with sharp objects.
- Faucets should be designed so that they can be operated from the elbow, thus ensuring greater hygiene.

Dry lab bench:

- Worktops should be prefabricated and designed with dimensions appropriate to their use and to the dimensions of the space in which they will be installed.
- The recommended material is post-formed high-density laminate.

Bank - Reception desks - Cash desk:

- The dimensions of banks, reception desks and work desks should be adapted to their use and to the dimensions of the space in which they will be installed. The materials used should be chosen according to their compatibility with their use.
- Each reception area should be designed to accommodate people with reduced mobility as well as seated people.
- Banks and reception areas potentially exposed to violence from the public should be equipped with alarm buttons linked to the security control station.
- Securely fastened rings should be put in place to allow computer terminals such as CPUs and monitors to be firmly attached by cable, in order to prevent computer theft.
- Such furniture should be designed in such a way that computer equipment, such as screens and CPUs, can be integrated in a recessed position. In general, banks and reception desks should be equipped with electric shutters to secure these areas outside opening hours.

Fixed bedroom closet:

Cupboard dimensions should be adapted to the installation room. The cabinet should be pedestal-mounted and include for each patient:

- A full-width, transom-mounted section with an easily removable hatch for access to medical fluid networks, if required.
- A closet section with a clothes rail and non-removable clothes-hanger eyelets.
- A storage area with a set of shelves.
- Door with lock and individual key.

The closet door should be laminated, with natural ventilation and a secure locking system.

2.4. Specific equipment for operating rooms

Electrical cabinets

These include transformers to adapt the power supply, rectifier chargers to recharge the emergency batteries, batteries with a minimum autonomy of 2 hours for operating lights in the event of a power failure, and a control cabinet for the room lighting system. In rooms without battery backup, a manual lighting control unit must be provided.

Medical arms

Anesthetists' and surgeons' arms should be ceiling-mounted and equipped with electrical outlets and medical fluids. These arms can be either compact or suspended gondolas.

All installation constraints must be provided for by the designer as part of the project (overloads in particular).

Switching devices should be provided at the entrance to each room.

Technical panel

The technical panel, to be flush-mounted in stainless steel on invisible hinges (supplemented by a fixed panel up to the ceiling for access to networks), groups together several functions and controls essential to operating rooms, including:

- Alarm signalling for medical fluids.
- Air-conditioning control, including on/off functions, speed, temperature and humidity settings.
- Room lighting controls.
- Alarm indicators, indicating any problems with the electrical cabinet, the operating status of the mains supply, and the use of the back-up battery.
- An intercom for communication.
- A clock and stopwatch to keep track of intervention time.

Automatically opening doors

Power-operated doors should be installed for most OR doors. These doors should be clad in stainless steel or stove-enamelled metal, smooth and easy to decontaminate.

Automatic opening should be by full translation, activated by a proximity control (photocell).

A remote manual control should be provided outside the operating room, enabling the door to be stopped in the fully open, partially open or closed position. When closed, these doors create an airtight barrier (with a leakage rate controlled according to the quality of the air treatment) to protect the operating room.

Computer workstation:

We recommend dedicating an operating room nurse computer workstation (PC on wall-mounted articulated arm + disinfectable keyboard and mouse + barcode reader) and an nurse anesthetist computer workstation (PC on wall-mounted articulated arm + disinfectable keyboard and mouse + barcode reader) in each operating room.

Light box:

We recommend that operating rooms be equipped with built-in digital light boxes. These scopes should be linked to PACS to facilitate the exchange of X-ray images.

2.5. Specific equipment for critical care rooms and life-saving emergency boxes

Fluid inlet arms

Fluid supply arms should be recessed in the ceiling, be double, of fixed height, capable of supporting heavy loads, and equipped with electrical outlets and connections for medical fluids. The design of these arms can be column or pod.

All installation constraints must be taken into account by the designer as part of the project, particularly additional loads.

Arms should be equipped with the material supports required for medical activity, such as trays, drawers and infusion racks, and they must be recognized for their reliability, robustness and ease of use.

Fluid supply column

Fluid supply columns should be ceiling-mounted and equipped with electrical outlets and connections for medical fluids, in addition to the material supports required for medical activity, such as trays, drawers and infusion racks.

All installation constraints, especially overloads, must be anticipated by the designer as part of the project.

Columns and supports must be recognized for their reliability and robustness.

ANNEXES TOME II

- Annex 4 – Equipment for firm tranche of RHH Rwanda
- Annex 5 – Equipment for conditional tranche of RHH, Rwanda
- Annex 6 – Master Plan of RHH, Rwanda
- Annex 7 – Financial estimate for medical equipment plan of first tranche
- Annex 8 - Financial estimate for medical equipment plan of conditional tranche
- Annex 9 - Rwanda-Green-Building-Minimum-Compliance-System-REVISED
- Annex 10 – Topographical map