DESIGN OF A DATA CENTER FOR THE MUNICIPAL PUBLIC COMPANY OF DRINKING WATER AND SEWERAGE OF IBARRA EMAPA-I, BASED ON ANSI / TIA-912

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Abstract **—** The present work of degree consists of providing a guide of the design of the physical infrastructure of a Data center in the headquarters of the Public Company of Drinking Water and Sewer of Ibarra (EMAPA-I) based on guidelines of the ANSI standard / TIA-942.

In the design of the physical infrastructure of the Data Center, the recommendations of ANSI / TIA-942 and the company were used as a basis to allow the equipment to operate in adequate environmental and physical conditions, according to the necessary requirements of the institution; Recommendations for physical infrastructure, telecommunications, electrical and mechanical, with the purpose of preserving the information of the company and continuity of the computer service to the ibarreña citizenship.

Index og Terms *— ANSI/TIA-942, ANSI/TIA-569, ANSI/TIA-606 A, ANSI-J/STD 607, MDA, HDA, EDA, ZDA, LAN, HVAC, TMGB, TGB, Downtime*

I. Introduction

The data has become the essence for organizations whether large or small, because they handle fragile, confidential, unique and exclusive information of the company. For these characteristics and in view of the great importance it has, its loss represents a great waste of money.

A company having valuable data exposes itself to both internal and external threats. According to a study by Kaspersky Lab and B2B International: "73% of companies have been affected by internal security incidents, with employees being the main cause of the loss of confidential data in 42% of cases. In addition, 21% of companies affected by internal threats lost valuable data that subsequently had an effect on their business. "[1]

EMAPA-I is a public company that provides potable water, sewage and wastewater services for the ibarreña citizens, and handles a large amount of confidential information of great importance, but it does not have a mechanism to keep this information safe. Say does not have a data center that complies with the regulations necessary for the optimal operation of the telecommunications equipment housed in the place. By not having this, it risks the security, integrity and availability of the data, as well as the damage of some server, thus causing the lack of service to internal and external users of the company, which is why the importance of implementation Of a Data Center in the equipment room of the headquarters of EMAPA-I.

II. Theoretical framework

Next, the theoretical basis for the development of the present project is established, starting with the study of ANSI / TIA-942, which aims to provide the necessary parameters for the design of a data center based on the experience acquired by experts in the subject.

A. ANSI/TIA-942 rule.

The telecommunications infrastructure standard for ANSI / TIA-942 Data Centers provides specific

requirements for each level of redundancy in the physical, telecommunications, electrical and mechanical subsystems; The same that is supported by other standards that will allow the complete design of a data center, including: standard of spaces and telecommunications conduits in commercial buildings ANSI / TIA / EIA-569, management standard for telecommunications infrastructure of commercial buildings ANSI / TIA-606 A, connection and grounding requirement standard for commercial building telecommunications systems ANSI / J-STD-607. The ANSI / TIA-942 standard provides basic guidelines for the development of this project, below is the availability according to its classification:

Table 1: Availability of data center according to TIER

Level	Availability	Downtime by year
TIER I (Basic)	99,67 %	28,82 h
TIER II (Redundant components)	99,75 %	22 h
TIER III (Maintenance and simultaneous operation)	99,98 %	1,6 h
TIER IV (Fault tolerant)	99,99 %	0,4 h

Source: ISO. Obtained from: El portal de ISO 27001 en español. http://bit.ly/2g4AHN0

A.1. Telecommunications infrastructure

Composed of the elements of the logical infrastructure of telecommunications that allows to offer the computer service to the company, thus you can see topologies, equipment and telecommunications cabling.

A.1.1 Reduced topology of a Data center

It is possible to consolidate the main and horizontal cross-connection in a single main distribution area, as well as the entry room to this area, for a small data center, as in figure 1:

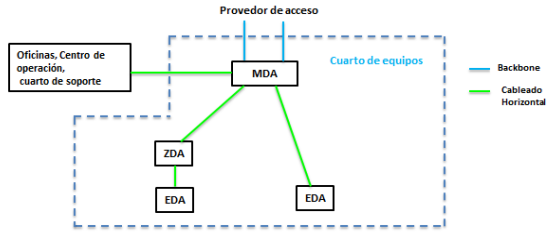


Figure 1. Reduced topology of a Data center
Source: ANSI/TIA-942. Obtained from: Telecommunications Infrastructure Standard for Data centers , 2005, pag 25.

A.1.2 Elements of a Data center

Data center telecommunications spaces include some elements such as: MDA, HDA, ZDA, EDA, equipment room and entry room; The following is the functionality of each of them:

Telecommunications room (TR)

Space that supports the wiring to areas outside the equipment room, if necessary, the MDA and HDA can be combined.

Equipment Room (ER)

Space that provides telecommunications services to the different areas of work of a company.

Main distribution area (MDA)

Space located inside the ER, where the main cross connection for wiring and elements such as: core routers, switchs, LAN, SAN and PBX, and vendor provisioning equipment are located.

Horizontal distribution area (HDA)

It is the distribution point for horizontal wiring, cross connections and active cable distribution equipment in the equipment distribution area, located in ER.

Equipment Distribution área (EDA)

It is where the HC ends in the patch panels, here are connected final equipment; There must be sufficient power panels provided for each rack.

Area distribution of zone (ZDA)

It is optional and can go between HDA and EDA allowing frequent reconfiguration, limited to serving up to 288 coaxial cable or twisted pair connections.

A.2. Physical infrastructure

Physical infrastructure must accommodate large equipment; And not be located in places that limit its functionality.

A.2.1 Access door and ceiling

The door must allow access from the outside, sliding or removable of 1 m wide and 2,13 high as a minimum, allowing access only by authorized personnel; Plus the roof with a height of 2.6 m from the floor to any obstacle.

A.2.2 Lighting

The site must have 500 lux of illimination in the horizontal plane and 200 lux in the vertical and with independent electric power, measured to 1 m of height from the floor in the middle of the corridors.

A.2.3 False floor

False floor and walls must be light colored, well sealed and have anti-static properties; The floor must withstand the distributed load of equipment and wiring of 12 KPa and load suspended to the floor of 2.4 KPa.

A.3. Electrical infrastructure

It plays a crucial role in business continuity, since it depends on the data center being in operation; It is vitally important to have optional systems, we must take into account some elements that are indicated in figure 2:

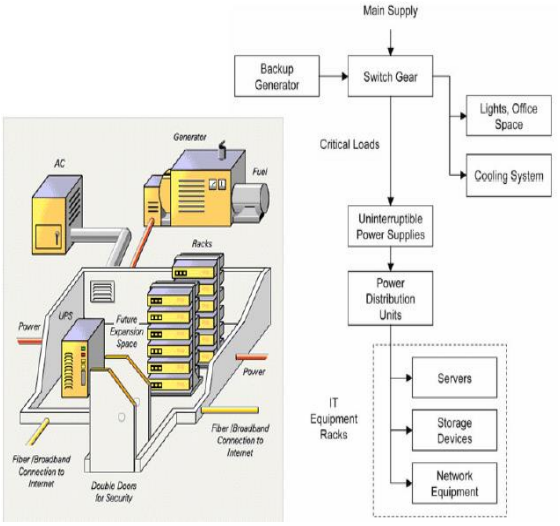


Figure 2. Electrical System Connections
Source: POWER HOST. Obtained from: Conectividad y estructura de red. http://bit.ly/2eG8Faq

A.3.1 Electric board

They are cabinets that serve to receive, control, maneuver, protect and distribute the electrical energy towards the Data center and high capacity loads like air conditioning, motors, transformers; Here are electrical protection devices and is the distribution center of the entire electrical installation. Your location should be easily accessible.

A.3.2 Uninterruptible power supply (UPS)

It is an irreplaceable element in a Data center since it provides a backup of electrical energy in a continuous way, when the commercial electric power service is interrupted, reason why sends a signal to the generator so that it acts, meanwhile it keeps the Data center in operation.

A.3.3 Generator

It is capable of supplying electrical energy to computer and telecommunication equipment in case of failure of the commercial energy supply. They are designed to supply harmonic currents imposed by the UPS system, must be able to provide power to air conditioning systems to prevent thermal overload and equipment outage.

A.3.4 Power distribution units (PDU)

They are electrical connection strips, used to control electrical power in a Data Center, provide electrical outlets for Data Center equipment, have several outlets that distribute electrical energy to computers or network equipment inside the rack.

A.4. Mechanical infrastructure

It will maintain the adequate environmental space, in order to ensure that the equipment works in an adequate environment, thus preserving the useful life of the equipment housed within the data center.

A.4.1 Environmental conditions

HVAC is an air conditioning system that works permanently providing a suitable environment to the place, it must be compatible with the backup generator; The operating parameters of this system are shown in table 2:

Table 2: Operating parameters of the air conditioning system

CHARACTERISTIC	VALUE
Temperature	20 to 25 °C
RH	40 to 55 %

Source: ANSI/TIA-942. Obtained from: Telecommunications Infrastructure Standard for Data centers , 2005, pag 29.

A.4.2 Cold and hot aisle

Cold and hot aisles should be created with the racks / cabinets, placing them facing each other, which will help the best air circulation; Ie circulation from the front to the rear; In addition, a free frontal space of 1 to 1.2 m and a free rear space of 0.6 to 1 m should be considered, the location of these corridors is as follows:

Cold aisle: Located in front of racks / cabinets, access floors with perforated plates,

under them is installed distribution of electric power.

Hot aisle: Located behind racks / cabinets, under the access floor is placed trays of telecommunications cables. Figure 3 shows the distribution of hot and cold aisles:

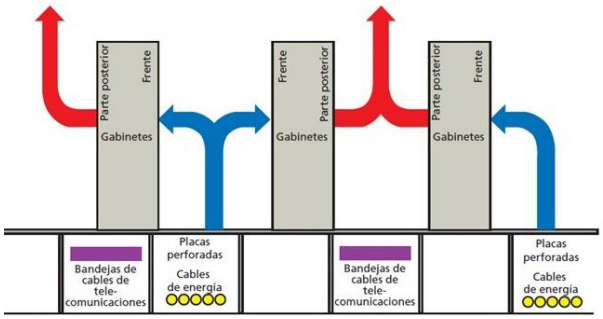


Figure 3. Example of distribution of hot and cold aisles
Source: ADC Telecommunications. Obtained from: TIA-942, Data center standards overview, 2005, pag 6

III. Design of a Data center for EMAPA-I

This design was made under ANSI / TIA-942, taking into account the requirements of the company, the reduced topology of a Data center was used, as well as specifications of a TIER I Data Center.

A. Telecommunications Infrastructure

Currently EMAPA-I has a defined network topology, which is configured and operating at 100%, has an Internet connection of 5 Mbps, has a firewall that maintains the security of company data, Where two kernel switches are connected: one switch serves to connect to the different work areas distributed in the company, and the other to the servers. Since the network is functional, and is operative, the existing equipment, topology and configurations will be maintained; The new systems and network equipment to be implemented in the future should follow the scheme shown in figure 4:

A.1 Elements of telecommunications infrastructure.

The telecommunications infrastructure is composed of the following elements:

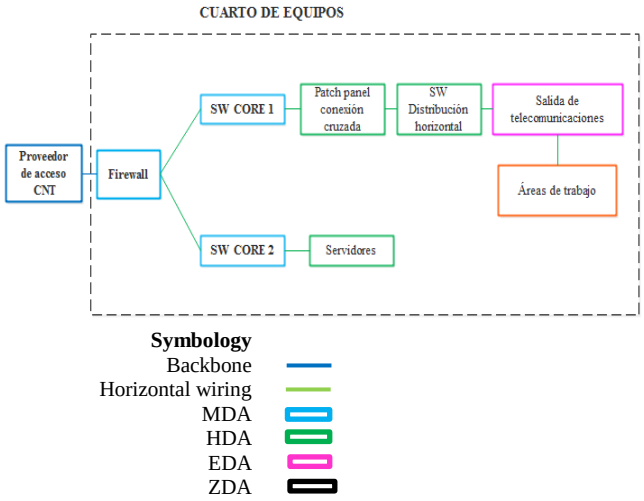


Figure 4. Connection diagram of the telecommunications System
Source: Author

A.1.1 Access provider space

An access route will be provided to the Internet service provider CNT by means of a rigid conduit of at least 4 "PVC, fireproof, insulated and smooth, it must be installed flush with the wall until it reaches the other side of the wall, In addition there will be another conduit for the link with the municipality. [2]

A.1.2 Equipment Room

The equipment room will allow the entry of the CNT provider link, in addition to the link with the municipality of Ibarra, will host horizontal cabling terminations, as well as telecommunications equipment, cable terminations and cross-connects of the company.

A.1.3 Main distribution area (MDA)

This rack should be located in a central point of the equipment room so as not to exceed the maximum lengths of the cables, the two core switches that the company has installed, and the firewall that allows the connection to the internet to the internal network , Securely, safeguarding your information.

A.1.4 Horizontal distribution area (HDA)

This area will be installed in the same rack that contains the MDA, as the standard allows, from HDA will supply the horizontal wiring to the ground floor,

in addition to having the horizontal cross connections, from the patch panel to the respective switch.

A.1.5 Equipment Distribution area (EDA)

This area will allow the mechanical terminations of the horizontal cabling in the patch panels installed in rack 1, allowing the different work areas to obtain the services provided by the Data center.

A.1.6 Area distribution of zone (ZDA)

ZDA will help connect servers directly to the distribution teams, ie in this area will connect the corresponding servers of the company; In figure 5 a diagram of distribution of the equipment in its corresponding zones is shown:

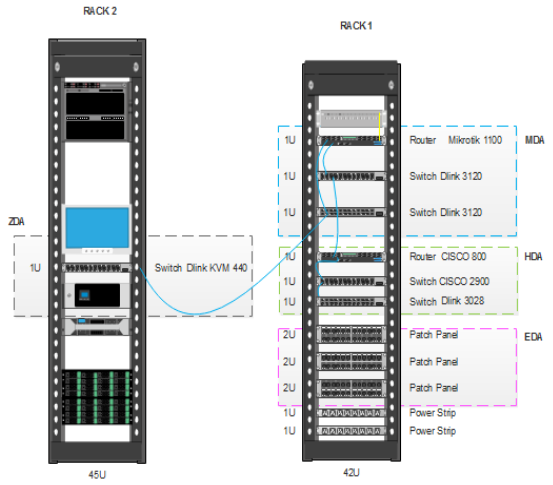


Figure 5. Diagram of distribution of the equipments with their corresponding zones
Source: Author

A.1.7 Work area

Its installation must allow future changes, in addition UTP cable category 6 will be used as a minimum and should not exceed 3 m in length, it is recommended to use patch cord certified or at least checked in a computer that allows the test of them. In each work area must have at least a faceplate of two shots, placed at 0.30 m from the floor and 0.30 m from an electrical outlet. [3]

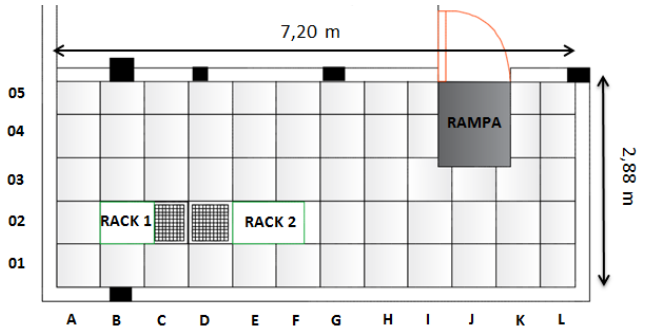
A.2 Structured Cabling Management

The administration of the wiring will be done in the following devices that are housed in the equipment room:

A.2.1 Racks

Actually, two racks are installed in the place, the same ones that allow to accommodate the network elements: servers, routers, switchs, patch panels that connect to the work areas of the company. In case of new racks, they must have the following specifications, which are in accordance with the standard:

a) They must be of 19 "metallic material, with rear and front rails of 42 U duly marked, in addition it must have two lateral panels and independents light and easy to install.
b) Doors, both front and rear must have locks on the handle to allow their safety, in addition to having at least 50% drilling for proper airflow. [4]
c) The maximum height of a rack should be 2.1 m, with a depth of 1 m, to allow easy access of the equipment to the Data Center, in addition to complying with the free space of 0.5 m required from the False ceiling to rack.
d) Placed respecting cold and hot aisles, so that they are aligned to the edge of the tile so that they can be identified, as shown in figure 6:



Equipo	Localización
Rack 1	B02
Rack 2	E02

Figure 61. Identification of racks location
Source: Author

A.2.2 Management of cabling in the rack

For proper cabling management in the rack, good cabling wiring must be done in the rack; The twist of the permitted cable, which may be up to 10 times its diameter, must be minimized to avoid reducing the properties of the transmission medium; In addition it is necessary to take into account to place clamps without tightening the cables, in places where they are necessary, for which will be occupied Velcro ties, in group of 12 cables recommended by the ANSI / TIA-568 C1 standard to protect the cables of damages and Maintain air flow paths to equipment installed in the rack; Horizontal cable organizers will be installed, to have a wiring system in the rack in an orderly manner.

A.2.3 Wiring Labeling

In order to identify the wiring and network elements in the best way, it is very important to keep a label placed on each of these elements, thus complying with ANSI / TIA 606 A, with a class 2 labeling, with labels Self-adhesive and self-adhesive labels for the protection of the label printing, thus the format in table 3 is presented:

Table 3: Network Elements Labeling Format

ELEMENT	DESCRIPTIÓN	LABELING
TELECOMMUNICATION ROOM	Low level	1A
	First floor	2A
	Second floor	3A
PATCH PANEL	Patch panel 1	PA
	Patch panel 2	PB
	Patch panel 3	PC
PORT	Voice	01V
	Data	01D

Source: Author

Once the format of the labeling of some network elements is known, the format to be followed will be shown to label both the wiring and the telecommunications sockets, which are shown in table 4:

Table 2: Label format for network points in work areas

ELEMENT	TR	PATCH PANEL	PORT
DATA NETWORK POINT	1A	PA	01D
VOICE NETWORK POINT	1A	PB	0V

Source: Author

B. Physical infrastructure

The space allocated for this design is located in the area of computer resources, located on the ground floor of the building, so the floor is more stable than in the rest of the building by having a firm base and columns to support the site . [5]

This place is irregular, since there are external tiers that prevent the use of the total area, in addition that is mounted a wall of plaster with the dimensions of 1,42 m of depth and 1,35 m of width, the same that is proposed Remove, since it is not a fixed wall and has openings both in the part that joins with the ceiling, as that which joins the floor.

The standard indicates that the place where the Data center is to be located must be free of vibrations, and the designated place fulfills this requirement, since in areas near to it there is no type of factory work that can produce vibrations Mechanical and affect the operation of the Data center.

B.1 Physical adaptations

There are areas where some physical adjustments must be made: the plasterboard walls that are in place should be removed because it does not allow the room to be sealed and free of dust, in addition the existing toilet must be removed, and sealed Water pipes and drainage, the internal walls will collapse in order to have a wider space.

The windows should be replaced by a construction with solid materials of dimensions 2,88 m long x 2,25 m high, allowing it to be rigid. The existing internal door will also be removed, as well as the removal of plaster walls and the construction of a wall 4,60 m long and 3,25 in height, which allows the area to be occupied For the Data Center is a regular area, thus isolating the site of the stands that prevent the entry of large and heavy equipment, The same one that is presented in the figure 7, indicated with fuchsia color.

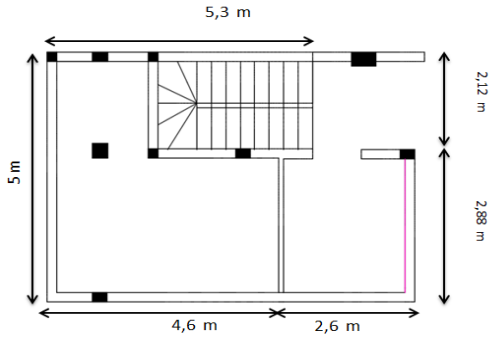


Figure 7. Replacement of exterior windows by a brick construction
Source: Autor

B.1.1 Walls

The walls must be of solid materials that are consolidated to the floor and ceiling, sealing the place, must be rigid and resistant, that allows the support of heavy equipment; For which solid bricks of 8cm wide x 16cm deep x 39cm long will be used, the same ones that will be adhered with a 1: 3 mixture, that is to say a part of cement and three of sand.

In addition, the walls must be painted white to contribute to the lighting of the environment, this painting must be fireproof that prevents the spread of fire, antistatic and anti-dust, since the environment must be completely dust-free and well sealed.

The designated area will allow easy entry of large equipment, and an area of 20,74 m2 will be designated, ie it meets the space requirements, since the recommended minimum space for the equipment room is 13, 5 m2 [6], the physical modifications to be made are indicated in figure 8.

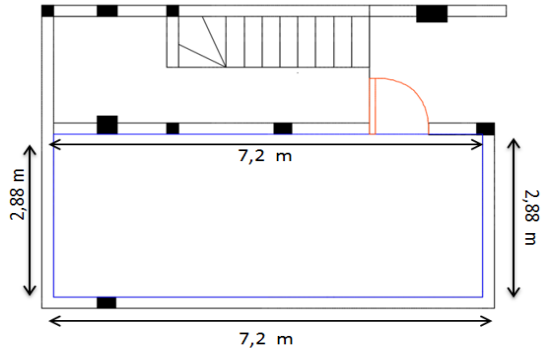


Figure 8. Area designated for the installation of the Data center
Source: Autor

B.1.2 Access door

The established area has a wooden door, which will be replaced by a door with the minimum dimensions proposed by the standard of 0.91 m wide x 2.13 m high, without counting the thresholds [7], So that a wall must be fitted to allow the installation of the door, and must provide only access to authorized personnel and must be placed in a way that allows opening out to allow access for heavy equipment.

B.1.2.1 Material of the access door

The door and its components, such as hinges and frame, must be of steel material, complying with the NFPA-80 standard where it is indicated that the door material must be fire retardant, with a duration of resistance Of RF-180 minutes. [8]

B.1.2.2 Biometric Access Control

A biometric terminal shall be installed on the outside of the door, allowing easy and quick identification of fingerprints by authorized personnel only, to comply with section 5.3.3 of ANSI / TIA-942.

An electromagnetic lock will be installed on the door and its frame, which will have a 300-pound "Fail Safe" clamping force to allow it to remain closed while there is electric current, which is why it must always be connected to the Electric power, or to the generator in case of absence of electrical energy, the connection diagram of the biometric system is shown in figure 9:

Figure 92. Access control System
Source: Partners. Obtained from: Control de acceso biométrico X7. http://bit.ly/2eZiwVc

B.1.2.3 Panic bar

It must be of stainless steel material and placed at an intermediate height of the door and in the inner part of the door, this bar must be associated directly with the electromagnetic lock of the door, so that, if necessary, it allows immediate opening of the door.

B.1.3 CCTV IP system

An IP CCTV system will be installed; Which will be controlled and accessible only to authorized personnel; The monitoring will be done both in the internal and external part of the Data Center, for which IP cameras will be installed inside and outside the site respectively, which will be working 24/7 365 days of the year.

B.1.3.1 Internal camera

Three dome cameras, installed in each cold and hot aisle respectively, will be installed to allow a complete view of the area, must have at least a resolution of at least 640 x 480 pixels, a sensitivity of 0.1 to 1 Lux because they are Color cameras; Install autoiris lens to allow clarity in the image and not create shadows caused by the change of light, signal noise ratio of 46 dB, 90 ° panning and pitch of 60 °, in addition the supports must protect cameras and disarm lenses and Be of opaque materials to light. They will be located alternately to allow the visibility of the whole place. [9]

B.1.3.2 External camera:

An IP Day / Night dome camera with infrared and DC auto-iris lens will be installed, as it is a changing lighting environment, located in front of the Data Center door at a height of 3 m to prevent its manipulation [10]. It must also have an external protective housing, to protect it from adverse environments such as: dust, humidity and risk of vandalism; Must have at least a minimum resolution of 640 x 480 pixels, signal noise ratio of 46 dB, panning of 180 ° and pitch of 60 °, and sensitivity of 0.1 to 1 Lux because they are color cameras. [9]

B.1.3.3 Monitors and NVR server:

An NVR server will be installed that will allow the connection of the VGA output to a PC to allow monitoring of the Data Center, located in the computer analysts office, responsible for this system. [9]

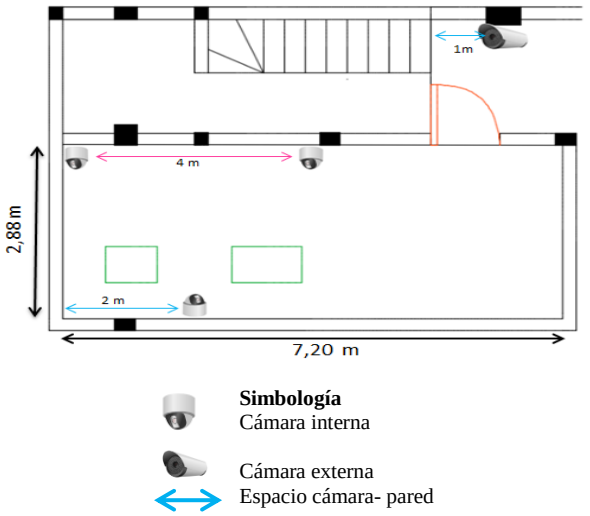


Figure 103. Locating Security Cameras in the Data Center
Source: Author

B.1.4 Lighting

Because the current luminaire does not meet the level of illumination required by the standard, the corresponding calculation will be performed to provide at least 500 lux in the horizontal plane to work properly in the Data Center.

B.1.4.1 Type of luminaire

Environmentally friendly luminaires, LED lamps, will be installed, which have better characteristics compared to traditional lighting such as: saving up to 90% energy, low heat generation, long service life of up to 50000 hours, which reduces costs of Maintenance, and easy adaptation to the Data Center environment. [11]

B.1.4.2 Dimensioning

To obtain the exact number of luminaires to be placed in this place, the light flux was first calculated using the lumens method:

$$\phi_T = \frac{Em * S}{Cu * Cm} \quad (1)$$

Where:
ΦT: Total luminous flux (lumens)
Em: average illumination level (lux)
S: surface to be illuminated (m2)
Cu: coefficient of utilization
Cm: coefficient of maintenance

The same was replaced with the following data: surface with a value of 20,74 m2, average utilization level of 500 lux, as it is dictated by ANSI / TIA-942 in the horizontal plane, a reflection coefficient of 0,30 this value depends on the type of material where the light is affected, whether in walls, ceiling and floor; And a coefficient of maintenance of 0,80 since the lamps will have a clean environment:

$$\boldsymbol{\phi_T} = \frac{500 \text{ lux} * 20{,}74 \text{ m2}}{0{,}30 * 0{,}80} = \frac{10370}{0{,}24} = 43208{,}33 \text{ lm}$$

B.1.4.3 Number of luminaires

Once determined the amount of lumens that the Data center must have, we proceeded to calculate the number of luminaires that are necessary:

$$N_L = \frac{\phi T}{n * \phi L} \quad (2)$$

Where:
NL: Number of luminaires
ΦT: Total luminous flux
N: number of lamps in the luminaire
ΦL: Lamp luminous flux (Ligh Tings Studio Desing, 2016, page 62)

$$\mathbf{N_L} = \frac{43208{,}33 \text{ lm}}{3 * 4950\ lm} = \frac{43208{,}33 \text{ lm}}{14850 \text{ lm}} = 2{,}91 \approx 3 \text{ luminaires}$$

B.1.4.3 Location

Three luminaires with triple flush-mounted LEDs of dimensions: 1,20 m long x 0,60 m wide, each LED tube must provide a luminous flux of 4950 lm, the material of the lamp must be made of rolled steel. They will be installed at ceiling level, embedded in the false sky, the figure shows the location of luminaires:

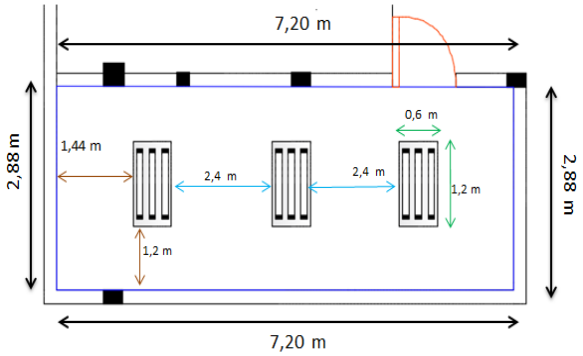


Figure 114. Location of luminaires
Source: Author

B.1.5 False floor

A modular system of at least 0,45 m height [12], which is easily removable, will be placed on a support structure.

B.1.5.1 Pedestals and crosspieces

They must consist of a high quality galvanized steel material and load resistance. It must be ensured that they are at a 90 ° level on the floor to ensure stability. It must withstand a minimum load of 12 KPa and load suspended to the floor of 2,4 KPa.

B.1.5.2 Interchangeable modules

They must be plates with soul of atrianado cement, encapsulated in sheet of galvanized steel and finished with epoxy painting. Each unit should have a size of 0,61 m x 0,61 m and 3,2 cm of thickness.

B.1.5.3 Number of modules required

Being the area to be used for the design of the data center of approximately 20,74 m2, a calculation will be made to know how many plates are necessary to cover the available area, taking into account that each plate has an area of 0,3721 m2; so 56 tiles are required to cover this area.

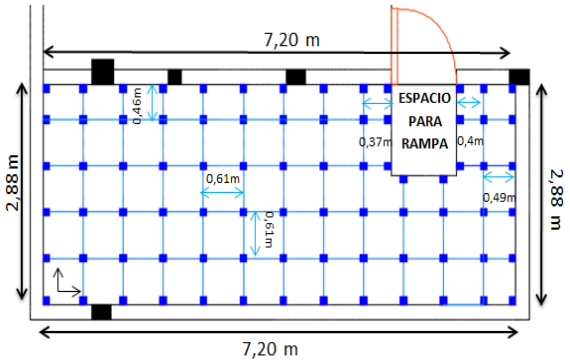


Figure 12. Installation of pedestals and crosspieces
Source: Author

B.1.5.4 Perforated tiles

They must be made of class A1 building materials, with an exposed area of at least 25%, their dimensions must be 0,61 m wide x 0,61 m long, and thickness equal to that of solid tiles. They are placed in cold aisles, and it is not advisable to place false perforated floor tiles near air conditioning, it should be kept 2 m away, so as not to induce hot air into the false floor. [13]

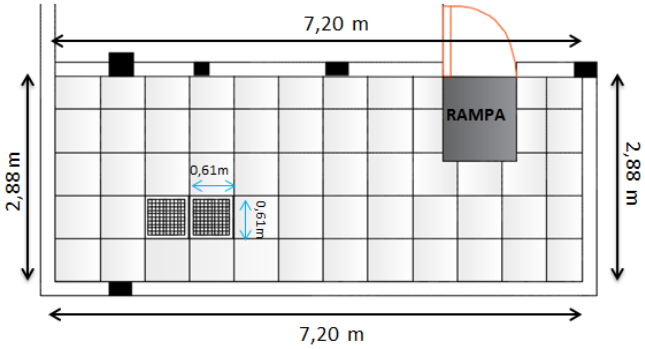


Figure 135. Placement of tiles on transoms
Source: Author

B.1.6 Entrance ramp

An access ramp will be installed to facilitate the entry of heavy equipment, it must be stable, non-slip and made of stainless steel material, covered with a non-slip rubber surface, the dimensions of the ramp will be 1 m wide x 1,42 long , And the angle of elevation of the recommended ramp is 17.6°, complying with a recommendation that the angle be less than or equal to 20 ° of inclination. [14]

C. Electrical infrastructure

In this area all the active devices require connection to the electrical energy for its operation, that is why it must provide sufficient energy to supply the initial and future requirements of the Data center.

C.1 Calculation of the load

In order to determine the electrical capacity required for the operation of the Data Center, firstly, the calculations will be carried out, corresponding to the estimated power in the area, where the following

electric charges are involved, whose data were consulted in datasheets:

Table 5: Electrical Calculation for the Data Center

ÍTEM	DEVICE / POWER	QUANTITY	SUBT [W]
Critical load (1)	Router BOARD 1100 Microtik X2AH / 25 W	2	50 W
	Router CISCO 800 / 20 W	3	60 W
	Swith CISCO serie 2900 (24 puertos) / 170 W	1	170 W
	Switch DLINK 3120 / 40,5 W	2	81 W
	Switch DLINK 3028 / 25 W	1	25 W
	Switch Dlink KVM-440 / 20 W	1	20 W
	Servidor blade HP Proliant DL380P Gen 8/ 550W	2	1100 W
	Servidor HP Proliant ML370G5 / 800 W	2	1600 W
	Central Elastix ELM-3000 / 180 W	1	180 W
	PC /300W	2	600W
	PoE TpLink Pro / 2,3 W	2	4,6 W
SUBTOTAL (1)	Subtotal		3890,60 W
	(1) = Subtotal * 0,67		2606,70 W
Charges not included (2)	Photoelectric Smoke Detector / 12W + Electrical Panel Fire Detector / 96W + Strobe Alarm / 24W	1	132 W
	Electromagnetic lock / 3.6 W + biometric access reader / 60 W	1	63,6 W
	POE for indoor camera / 5W + POE for external camera / 20W + NVR / 30 W	1	55 W
	Emergency light / 6W	3	18 W
SUBTOTAL (2)	Subtotal		268,60W
	(2)= Subtotal * 0,67		179,96 W
Future charges	(1) + (2)		2786,66 W
SUBTOTAL (3)	(3) = ((1) + (2)) * 100%		2786.66 W
Peak Power Consumption (4)	(1) + (2) + (3)		5573,32 W
SUBTOTAL (4)	((1) + (2) + (3)) * 1.05		5851,99 W
Inefficiency of UPS and batteries	(1) + (2) + (3)		5573,32 W
SUBTOTAL (5)	(5) = ((1) + (2) + (3)) * 0,32		1783,46 W
Lighting	20,74 m^2		
SUBTOTAL (6)	(6)= 20,74 m^2 * 21,5		445,91 W
Total electrical power	(4) + (5) + (6)		8081,36 W
SUBTOTAL (7)			8081,36 W
Total cooling power	(7)		8081,36 W
SUBTOTAL (8)	(8) = (7) * 0,7		5656,95 W
Total power	(7) + (8)		13738,31 W
SUBTOTAL (9)			13738,31 W

Source: Avelar, Víctor. Obtained from: Cálculo del requisito total de potencia para los centros de datos. http://bit.ly/29HmRJR

C.1.1 Electrical service required for the Data center

In this item, the calculation of the amount of current required by the Data Center, which must be supplied in the secondary distribution panel, will be carried out and will allow the electrical network to be operative with its adequate protections; These values are represented in table 6:

Table 63: Values to be met by the electrical service provider

ÍTEM	VALUE REQUIRED	SUBTOTAL [W]
Requirements to comply with NEC	13738,31 W * 1,25	17172,89 W
Three-phase AC voltage supplied at the service entrance	220 V-AC	220 V –AC
Electrical company required electric service in amps	(10)/ ((11) * 1,73)	45,12 A

Source: Avelar, Víctor. Obtained from: Cálculo del requisito total de potencia para los centros de datos. http://bit.ly/29HmRJR

C.1.1.1 Circuit protection

It will be used 50 A thermomagnetic switches for protection of data center internal circuits, either against short circuits or over voltages; Also use 30 mA differential switches that will allow the electrical protection to people. [15]

C.1.1.2 Derived circuits

They will be connected to the differential switch, then the number of circuits required in the Data center will be defined in table 7:

Table 7: Number of Data Center circuits

Detail of electric charge	N° derived circuits	Detail
PDU for racks	2	1 circuit for rack 1 1 circuit for rack 2
Lighting System	2	1 circuit for Main lighting 1 Emergency lighting circuit
Air conditioning System	1	1 Circuit for connection of air conditioning
PDU Access control	1	1 Circuit for connecting the biometric terminal
PDU Fire fighting systems	2	1 Circuit board control 1 Smoke sensor circuit
PDU for PoE CCTV	1	1 Circuit for PoE connection of security cameras

Source: Author

C.1.1.3 Protection switch for each branch circuit

Table 8 shows the maximum capacity of the protection switch for each circuit and the gauge of the cable to be used for connection from the circuit

breaker to the branch circuit, which must not exceed 50 m and must not be connected more Of five equipment in each branch circuit, and at least one independent circuit per rack; For circuits exceeding 20 A a separate circuit must be provided. [16]

Table 84: Definition of switch and gauge to be used in each circuit

Detail of electric charge	N°. of derived circuits	Maximum switch capacity (A)	Maximum consumption capacity (A)	Wire Gauge (AWG)
PDU for racks	2	20 A	16 A	12
Lighting System	2	20 A	16 A	12
Air conditioning system	1	30 A	24 A	10
PDU Access control	1	20 A	16 A	12
PDU Fire Systems	2	20 A	16 A	12
PDU for PoE CCTV	1	20 A	16 A	12

Source: Domínguez, Roni. Obtained from: Diseño de circuitos derivados: clasificación, características y cálculos. http://bit.ly/2a9t19I

C.1.1.4 Electrical conductors for boards

It will be used flexible copper conductors with a thermoplastic insulation material resistant to moisture, heat, fire propagation, low smoke and acid gas, which will allow the security of electrical wiring, telecommunications systems installed in the Data Center and the Staff. The following is the location of the data center electrical boards:

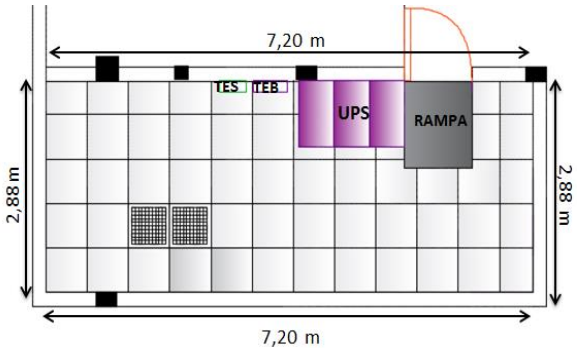


Figure 14. Location of electrical boards and UPS
Source: Author

C.2 Electric Backup Generator

To maintain the critical data center loads fed when the service provider fails, a backup generator will be required, then the calculations corresponding to the sizing of the backup generator will be performed to satisfy the data center loads in table 9:

Table 9: Sizing of the backup generator.

ÍTEM	VALUE REQUIRED	SUBTOTAL [W]
Critical loads requiring generator backup	(7)	8081,36 W
SUBTOTAL (12)	**(1) = (7) * 1,3**	**10505,77 W**
Cooling loads requiring generator backup	(8)	8485,43 W
SUBTOTAL (13)	**(13) = (8) * 1,5**	**5278,46 W**
TOTAL	**(12) + (13)**	**18991,20 W**

Source: Avelar, Víctor. Obtained from: Cálculo del requisito total de potencia para los centros de datos. http://bit.ly/29HmRJR

C.3 Electrical Wiring Channeling

It will be installed a ducting system for electrical wiring under the false floor, using ventilated cable trays of clean aluminum material, using the crossbeams as a support; Must be installed under cold aisles, the maximum depth is 6". [17]

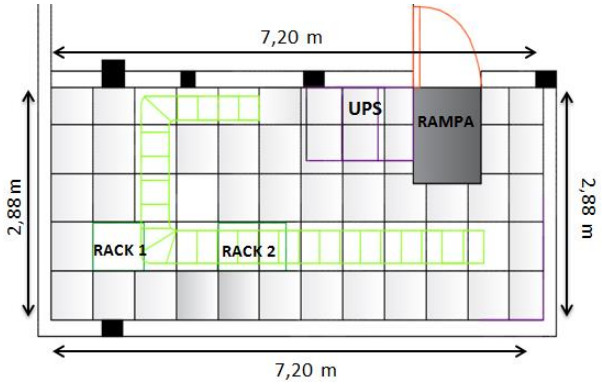


Figure 16. Ladder Location for Electrical Wiring
Source: Author

C.4 Grounding System

The earthing System will help protect company equipment and personnel against parasitic currents and voltages, each of the electrical circuits must be connected to the earthing system, which is why it will be in accordance with the ANS / TIA 607 standard.

C.4.1 Main ground bar for telecommunications (TMGB)

The EMAPA-I building must have the TMGB bar, in view of the fact that there are racks in the different floors, this bar will be connected to the telecommunication grounding bar located on each floor, with a TBB copper conductor size 6 AWG, and to the building's grounding wire with a 2 AWG copper

conductor that has a green jacket and is led by a green painted PVC tube. [18]

C.4.2 Earth Bar for Telecommunications (TGB)

It will be installed in the telecommunications room of each floor, in addition the connecting conductor between TBB and TGB must be continuous and routed in the shortest path, all TGB of a ER or TR must be connected by means of a 6 AWG copper conductor. [19]

C.4.3 Labeling of Grounding System Elements

In order to identify the grounding elements, a labeling must be maintained placed on each of these elements, complying with ANSI / TIA 606-A, with a class 2 labeling, with self-adhesive and self-adhesive labels of green color for protection of the printing of The label, so the format is presented in table 10:

Table 10: Labeling format of earthing elements

ELEMENT	DESCRIPTIÓN	LABELING
TMGB	Low level	1A- TMGB
TGB	Low level	1A-TGB
	First floor	2A-TGB
	Second floor	3A-TGB

Source: Author

C.4.4 Grounding mesh for racks

To allow the connection of each rack and voltage protectors to the TGB bar, bare copper 6 AWG mesh conductors shall be installed in mesh form under the false floor, taking into account that it should not be pink with the technical floor pedestals, and Each point will be joined by exothermic welding.

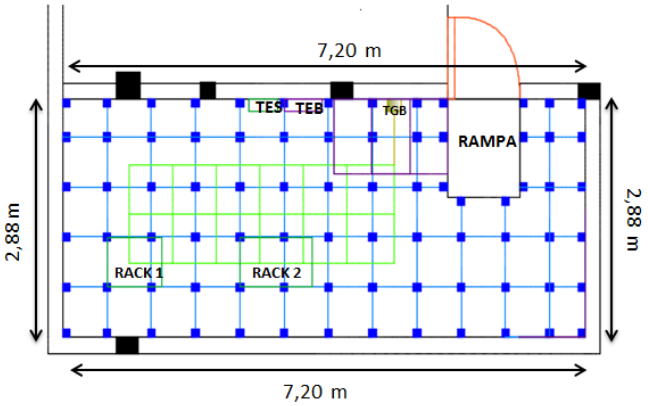


Figure 16. Grounding mesh
Source: Author

C.4.5 Grounding conductors of devices installed in racks

These conductors will serve to connect the different grounding wires connected to each active equipment in the rack; This wire will be bonded to the ground wire by means of a 6 AWG minimum gauge copper wire and joined by an exothermic weld to ensure that eddy currents from these devices housed in the racks are grounded, Will allow greater security to the personnel who manipulate and maintains these equipments.

D. Mechanical infrastructure

The air conditioning system to be installed will provide a temperature between 20° C to 25° C and a relative humidity of between 40% to 55%, and should work 24/7 during 365 days of the year.

D.1 Cold and hot aisles

They help with the distribution of the air flow, so it indicates that there must be a minimum clearance of 0.60 m in the rear of cabinets or cabinets and the front clearance of at least 1.00 m. For the installation of the racks on the technical floor, these values will be taken to provide the adequate space between racks, in addition in cold corridors will install perforated tiles.

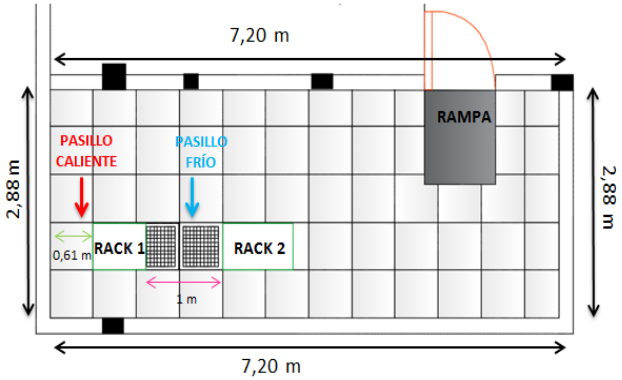


Figure 7. Location of hot and cold corridors in the Data center
Source: Author

D.2 Air conditioner

The air conditioning will help keep the Data Center environment at a suitable temperature, so that the equipment located in the Data Center can work properly.

D.2.1 Sizing calculation

In order to know how many BTU's must provide the air conditioning, first is calculated the amount of

heat generated in the site, taking into account all the elements that generate heat installed in the place, thus have the following variables:

Table 115: Sizing of air conditioning system

ÍTEM	CALCULATION OF HEAT PRODUCTION	SUBTOTAL HEAT GENERATION
IT equipment	8081,36 W	8081,36 W
Electric system	(0,04 * 220 V) + (0,06 * 8081,36 W)	493,68 W
UPS plus batteries	(0,02 * 220 V) + (0,02 * 8081,36 W)	166,03 W
Lighting	21,53 * 20,74 m^2	446,53 W
People	2 x 100	200 W
TOTAL		**9387,60 W**

Source: Neil Rasmussen. Obtained from: Cálculo de los requisitos totales de refrigeración para centros de datos. http://bit.ly/2fWhDgy

To convert the calculated amount to BTU / hour multiply by the factor 3.41; Resulting in 32011.72 BTU / hour; The cool mooving portable air conditioning system installed at the site provides 36,000 BTU / hour, but to meet the needs of hot and cold corridors requires precision air conditioning with false floor injection, which should have the following features:

Controla la humedad en el aire por medio de humidificadores y deshumidificadores.

- Extracts 95% sensible heat percentage.
- Designed to work 365 days a year at peak capacity and on a constant basis.
- Controls moisture in the air by means of humidifiers and dehumidifiers.
- They have air filters that can have a capacity of between 60 and 90%.
- 15-year service life, in the figure, shows the location of the air conditioning in the Data center:

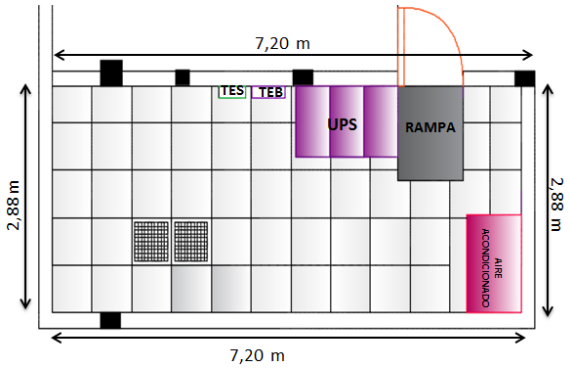


Figure 18. Location of air conditioning
Source: Author

D.3 Fire detection system

For environmental safety, will be installed ECARO-25 clean agent fire suppression system to protect both people and equipment present. This system must be modular to allow for future expansions.

D.3.1 Clean agent cylinder ECARO 25

Must be installed

An Ecaro-25 clean agent cylinder, horizontally, the valve should point upwards; This agent is friendly with the environment, also presents better characteristics to absorb the fire, provides protection to people and equipment; Works with a Fike valve, which will control the pressure inside the cylinder and discharge efficiency of the system.

D.3.1.1 Calculating the required agent

It is necessary to define some aspects before making the calculation corresponding to the quantity of agent required, the maximum design of concentration is defined to allow to have spaces occupied by authorized personnel of the company, with a maximum time of exposure of 5 minutes, in the table 12, the value for the variable C is indicated:

Table 12: Design values of maximum clean agent concentration

Type of space	Maximum concentration of design
Occupied	11,5 %
Not Bussy	There is no limit

Source: Santos, Miguel. Obtained from: Manual ECARO 25. http://bit.ly/29OtnjY

After knowing these values necessary to perform the calculation, the following formula will be used to know the amount of required ECARO-25 clean agent, presented in the ECARO-25 Manual:

$$W = \frac{V}{S} \times \frac{C}{100-C} \qquad (3)$$

Where:
W = Clean agent weight (kg)
V = Volume of risk (m3)
C = Design concentration,% volume, (11.5% maximum, for occupa - ble areas)
S = Protected net volume (m3 / kg)

Where:
S = k1 + k2 = 0.1832
K1 = 0.1825
K2= 0.0007

The values of k1 and k2 were obtained from the ECARO-25 manual [20]. The calculation was then made to know the amount of clean agent that the fire extinguisher tank should contain, as follows:

$$\mathbf{W} = \frac{V}{S} \text{ x } \frac{11,5}{100-11,5} = \frac{67,392\ m3}{0,1832} \text{ x } \frac{11,5}{88,5}$$

$$=367,86 \text{ x } 0,129 = 47,45 \text{ kg } \approx 48 \text{ kg.}$$

The clean agent container shall be 48 kg, but according to the data specifications of the container shall be 60 pounds and with a 1 "Fike valve.

D.3.1.2 Wall mounting bracket

It must be installed horizontally and with the valve facing upwards. Failure to comply with this requirement will result in an incomplete discharge.

D.3.1.3 Suppression pipe

It should be a steel tube of 1/2 "diameter, and installed flush with the ceiling with its proper supports, on which the discharge nozzles of the clean agent will be installed. It should also be modular to allow future expansions. [20]

D.3.1.4 Discharge nozzle

The discharge nozzles shall be 1/2 ", 6 holes, covering 360 °, ie a coverage radius of not less than 0,30 m and not more than 4,9 m; Will be placed every 0.30 m distance between them, to be able to cover the area to be protected in its entirety.

D.3.1.5 Photoelectric smoke sensor

It will be installed on the ceiling a photoelectric smoke sensor, since they present better characteristics than the ionic ones; 9 m of space between sensors is recommended, but given the limited space available, a single smoke sensor will be installed in the center of the room, and it should be placed 30 cm from any obstacle to avoid false alarms. [21]

D.3.1.6 Humidity sensor

It will be installed a humidity sensor in the cold aisle row created, located in the front of a rack in the center of the row, on a crossbar that supports the false floor, which will allow the control of the relative humidity between 40% and 55% as indicated by ANSI / TIA-942. [22]

D.3.1.7 Temperature or heat sensor

It will be installed two temperature sensors in each rack at a height of 1.40 m from the floor to control the air entering the equipment, and another sensor should be installed on the back of the second rack that corresponds to the row to control the air Which leaves the teams at the height of 1.40 m. In addition, six sensors, each 1.5 m, will be installed along the electric tray installed under the false floor. [23]

D.3.1.8 Control Panel

It will integrate the aforementioned elements, assist with the monitoring of the photoelectric smoke sensor, and activate the valve for the discharge of the clean agent, in addition to triggering the corresponding alarms in case of a fire, supervise the manual station and the station. Blocking, must always be provided with energy, either with the contracted public electric network or with batteries that allow its operation.

D.3.1.9 Fire alarm

It will be installed a visual / audible strobe alarm that will alert people close to the Data Center that a fire is occurring and can be safe. They should be placed in a high place so that they can be visible. The figure shows the location of the different elements mentioned:

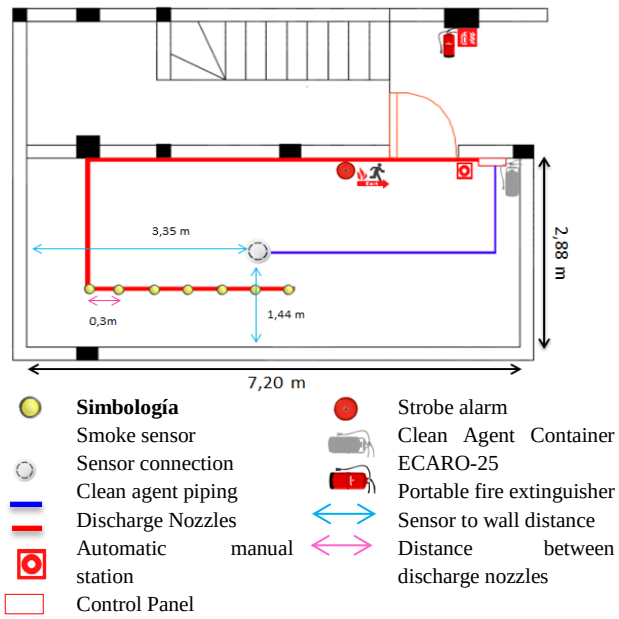


Figure 19. Schematic of the fire detection system
Source: Author

IV. Conclusions

- With this project, the EMAPA-I headquarters has a guide for the future implementation of a data center in its dependencies according to the analyzes carried out in each phase of the design, meeting the needs of the company.
- ANSI / TIA-942 is the best standard for this project, as it does not require any additional costs for certification.
- The study of the ANSI / TIA-942 standard determined the basic parameters that were later taken into account in the evaluation phase of the current situation of the EMAPA-I equipment room and data center design.
- Through the dialogue established with the EMAPA-I computer analysts and periodic visits to the site, it was possible to obtain the current state of the physical and logical infrastructure of the site where the data center will be implemented.
- With the present design, it was possible to solve the existing shortcomings analyzed in the current situation, achieving the provision of computer services on a continuous basis to the personnel working in the company and the citizens of ibarreña.
- The economic analysis concludes that the implementation of the data center in the head office of EMAPA-I is viable, and that the benefits generated by this project are much higher than the expenses, with the largest beneficiary being 48666 families from ibarreñas.

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VI. AUTHOR'S REFERENCES

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