Sudan University of Science & Technology

College of Graduate Studies

College of Graduate Studies

Design of an Infrastructure Standard for Data Center Rooms

تصميم معيار للبنية التحتيه لغرف مراكز البيانات

A Thesis Submitted for the Requirements of MSC Degree in Telecommunications Engineering

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Dedication

This project is dedicated to the Allah and my father and my mother for giving me the grace , courage and strength to complete it .

To my family

To all my friends

To my teachers

You are the light of my live

ACKNOWLEDGEMENTS

At the end of my project thesis I would like to thank all those people who made this project possible and an unforgettable experience for me .
Frist of all I would like to express my deepest sense of gratitude to my supervisor Dr.Ashraf Gasim elseed who offered his continuous advice and encouragement throughout project steps , I thank him for the systematic guidance , way of thinking , and great effort he transferred to me in order to complete the project

Abstract

This standard provides best practices and implementation methods that complement TIA , CENELEC , ISO/IEC , BICSI and other published data center standards and documents . It is primarily a design standard , with installation requirements and guide lines related to implementing a design . The standard includes other installation requirement and guide lines for data centers , where appropriate .

The capacity of a data center is based on the size of the computer room space (floor space available for IT and telecommunications equipment), and the capacity of the power and cooling systems per unit of computer room floor space. High-density data centers have a higher capacity of power and or cooling per unit of computer room floor space.

A balance between space and capacity needs to be determined at the outset when designing a new data center and when modifying an existing data center space. The balance will depend on the type of IT and telecommunications systems the data center is to support and the number/combination of those systems which are to be placed within each cabinet or rack .

If it is perceived that to meet the performance balance will require delivery of both high levels of power and large amounts of cooling to the cabinet or rack, it may be more cost-effective to design and build a more moderate density data center by designing the data center into a space that can accommodate a larger computer room. Resulting space utilization and power / cooling density limitations should be clearly communicated and documented. In this work we studies the standers for infrastructure data center rooms in many big data center rooms in Sudan and compere it with standers and we gat a guide lines to help peoples work to builds this rooms .

الـمـسـتـخـلـص

يهدف هذا المشروع الي وضع معاير قياسية لعمل البيئة التحتية لغرف مراكز المعلوماتية و البيانات حيث تعمل هذه الغرف كحاضنة وتوفر بيئة عمل مثالية تتم فيها تشغيل مخدمات و مقسمات مراكز المعلومات .

تم دراسة اكبر واشهر المعايير العالمية مثل (TIA,CENELEC,ISO&BICSI) وعمل مقارنات بينها حتي يتم ايجاد مجموعة من المقاييس يمكن الاستفادة منها كمرجع لتصميم غرف مراكز المعلوماتية بصوره قياسية تضمن عمل المخدمات بصوره مستمرة دون انقطاع مما يقلل مشاكل انقطاع الخدمات الشبكية .

بعد دراسة المعايير القياسية تم عمل مجموعة من الأسئلة وتم زيارة اكبر الشركات و المؤسسات الحكومية و الغير حكومية التي تعمل في مجال تكنولوجيا الاتصالات و المعلوماتية المحلية داخل السودان وكان الهدف الاساسي دراسة مدي استخدام المعايير القياسية للبنية التحتية لغرف مراكز المعلومات و الاتصالات.

الهدف الاساسي من المشروع هو وضع معايير محلية تتقارب مع المعايير العالمية لغرف مراكز المعلوماتية داخل السودان وذلك للتقليل من مشاكل انقطاع الخدمات الشبكية في المراكز الخدمية الحكومية و الغير حكومية

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Chapter One

Introduction

1.1.Background of study

Data center is a building or portion of a building whose primary function is to house a computer room and it is support areas .

There are four functional requirements of a data center :-

- Location i.e. A place to locate computer storage and networking devices .
- Power i.e. power needed to maintain the devices
- HVAC i.e. Temperature controlled environment within the parameters need .
- Structured cabling i.e. connectivity provided to other devices both inside and out .

Issues facing data centers :-

- Reliability and Availability
- Power
- Rack space
- Site location
- Heat and cooling

1.2. Problem statement

Predominant cause of data center failures are Human error no or poorly executed processes and work instructors (unauthorized access , accidents, and unnoticed alarms) power quality issues poor voltage current frequency regulation and high level of common and normal mode noise and high ground resistance . Electro magnetic fields (EMF) high radiation levels from power cables / UPS / Transformers / PDU / Lighting etc. Environment conditions like temperature / humidity / high levels of contamination .

Data centers are the foundation of any business , and to achieve corporate goals we must having high-performance ICT (Information and communication Technology) resources .

1.3. Purpose

This project provides a reference of common terminology and design practice. It is not intended to be used by architects and engineers as their sole reference or as a step-by-step design guide , but may be used by such persons to determine design requirements in conjunction with the data center owner, occupant, or consultant.

This standard is intended primarily for :-

- Data center owners and operators.
- Telecommunications and information technology (IT) consultants and project managers.
- Telecommunications and IT technology installers.
- Additionally, individuals in the following groups are also served by this standard.

Users within (IT) , telecommunications designers and consultants in conjunction with the appropriate local may use telecommunications infrastructure standard (e.g., BICSI 002 , ANSI/TIA-942, AS/NZS 2834-1995 Computer Accommodation, CENELEC EN 50173 Series, ISO/IEC 24764) to design the telecommunications pathways, spaces, and cabling system for the data center. The telecommunications designer/consultant should work with the data center architects and engineers to develop the IT and telecommunications equipment floor plan using guidelines specified in this standard .

IT and telecommunications management may use telecommunications infrastructure standard as an aid in defining initial data center design requirements based on required levels of security, reliability, and availability. IT and telecommunications should work with information

protection management, the business continuity group, and end user departments to determine the required levels of security, reliability, and availability.

1.4. Objectives

Encourage early participation of telecom designers in data center design process . Fill a void by providing standards for planning of data centers, computer rooms, and similar spaces. The standard encompasses much more than just telecommunications infrastructure .Close to half of the technical content deals with facility specifications. Provide information for a data center owners to understand data center design tradeoffs and to communicate design requirements to engineers and architects . Establish a standard for data center tiers to replace several proprietary standards.

1.5. General objectives

Provide information for a data center owners to understand data center design tradeoffs and to communicate design requirements to engineers and architects and to Establish a standard for data center tiers to the government of Sudan as guideline for engineer how work as data center designers .

A data center that is intelligently designed to accommodate the needs of the equipment and technologies it is meant to house need not be more expensive than one that is not, but it will certainly be more usable.

1.6.Methodology

The method use in this project is studying many standers form bug company around the word and then we tack a questioner from this stander and give this to main four ICT company in Sudan (Zain , Sudatell , MTN , INC) to make a compartment how those companies fallow this standers .

As shown in chick list covered the mane most items found in many stander link BICSI , TIA942 & ITIL (information technology

infrastructure library) like National environment , raised floor , grounding of raised floor , power infrastructure , & cooling infrastructure , and send this chick lists to 12 main companies in Sudan working in IT and telecommunication industry like Sudatell , Zian and MTN .

First get the permeation to inter and study the data center room of this companies and given the IT directors of all companies the chick lists and they were telling have no write to say which chick lists results is belong to any companies but get permeations to visit and to study the data center rooms and if thy designed as in standers or not or if they are nearing to standers , finally I get moor information .

1.7. Scope and Delimitations

This Standard specifies the minimum requirements for telecommunications infrastructure of data centers and computer rooms, including single tenant enterprise data centers and multi-tenant Internet hosting data centers. The topology specified in this document is intended to be applicable to any size data center.

Chapter Two

Theoretical background

2.1The BICSI standers

2.1.1.Site selection

The occupancy classification of data center is dependent on the use of facility and can be required by use or owner. Wind, snow, ice , flood and earthquake requirements are affected by the selection occupancy classification .

2.1.2.National environment

Seismic activity and potential for activity should always be strongly considered before selecting a data center site .and should be avoided whenever possible , if not possible it should have additional requirement and to professional structural engineering to meet the appropriate seismic criteria of data center facility .

- Subsurface stability

Avoid the potential for quick , unstable or expansive soils .Ensure that there are no known subsurface contamination from either on-site hazard waste storage or other adjacent site .

- Groundwater

If the data center is a " slab on grade " on the top of a hill , there should be minor concerns for ground water issues . if the data center is " slab on grade " building in a relative flat topographic area , there may be small concerns for groundwater issues . the risk of groundwater increases if the building has one or more sub grade floors in the same flat topographical area .

- Win

The most desirable location would have no exposure to tornado , hurricane , high wind , or sand storm risks . the ideal area is less than or equal to annual probability of wind in excess of 129 km/hr (80 mph) .

- Air quality

Air quality issues should be considered for the data center fresh air intake as well as any that may be emitted from the site . When data centers must be located in densely populated area or metropolitan area , consider the effects of noise and emissions from the data center exhausts on neighbors and surroundings .

2.1.3.Space planning

- Overall facility capacity

High-density data centers have a higher capacity of power and or cooling per unit of computer room floor space .

A balance between space and capacity depend on the type of IT and telecommunication system the data center is to support and the number/combination of those system which are to be placed within each cabinet or rack

- Overall facility planning :

Design to accommodate a defined load (N) over a defined area .

Consider current and future platforms for server and storage when identifying the design load and area requirement .

Determine percentages for mainframe high-end processing , mid rang processing , small form or blade servers , communication networks , and storage .

Identify potential growth rates not only within business units , but also across platforms .Sufficient clearances shall be provided for safety , access and maintenance for all electrical equipment , and to electrical equipment spaces to remove component or system for maintenance or replacement .

Subsystem of electrical distribution system (e.g. , main switch gear, generator switch gear , UPS and batteries) should be installed in

dedicated electrical rooms or located outside of the data center computer room space separated by a fire – rated wall .

The electrical infrastructure for data center should be isolated and separate from the base building electrical systems if the building is not exclusively dedicated to the data center function .

The space required for the power system will be proportional to the required capacity and level of redundancy/reliability of the electrical system . it is not proportional to the square footage of the computer room alone .

2.1.3.1 Equipment typically installed in dedicated electrical rooms outside the computer area :-

service entrance switchgear (medium or low voltage , metal enclosed , or metal clad) unit substation (medium voltage) ; tie breaker section for dual entrance configuration generators (indoor / outdoors) generator paralleling switches automatic transfer switches (ATS) load banks (permanently installed or portable load banks on trailers requiring connection to electrical system) distribution boards (critical loads , non critical loads , life safety load) transformers uninterruptible power system (UPS – static system or rotary system) UPS battery room .

2.1.3.2 Equipment typically installed in the computer room spaces.

power distribution units (PDU s) remote power panels (RPP s) rake or cabinet mounted panels power strips within each server cabinet that provide power dedicated to the specific cabinet .

PDU equipment may be located outside the computer room for electrical operations and maintenance activities are outside the computer room space

2.1.3.3 Electric utility service feeds

- single entrance single pathway

The distance between electric utility service and switchgear to data center is equally or in close proximity

- singly entrance / dual pathway

The electric and switchgear location to the dual data center space is equally distance

- dual entrance / dual pathway

The electric utility service feed and associated switchgear should be located in dedicated spaces separate from each other .

2.2 Power distribution

Power distribution should have sufficient flexibility and scalability to allow the load to increase or decrease in any rack , or IT equipment zone within acceptable design limits . If the total anticipated data processing gload has a capacity criteria of N, the multipliers for each subsystem within the electrical distribution system (as shown in Table 2.1) will provide sufficient capacity to meet normal equipment layout diversity and scalability, thereby preventing the creation of areas where the power available is insufficient to support the connected load.

Table 2.1: Multipliers For Electrical Distribution System Components

Distribution system component Multiplier	Multiplier (N = IT load design criteria)
UPS and UPS critical distribution	N x 1.25
Remote power panels (RPP)	N x 2.0 to 3.0
Power strips (POU)	NC x 1.25
UPS and UPS critical distribution	N x 1.25

2.2 Electrical Block Diagram

Diagram shows single path electrical system to represent system capacities at various stages in the electrical distribution system as in figure (2.1).

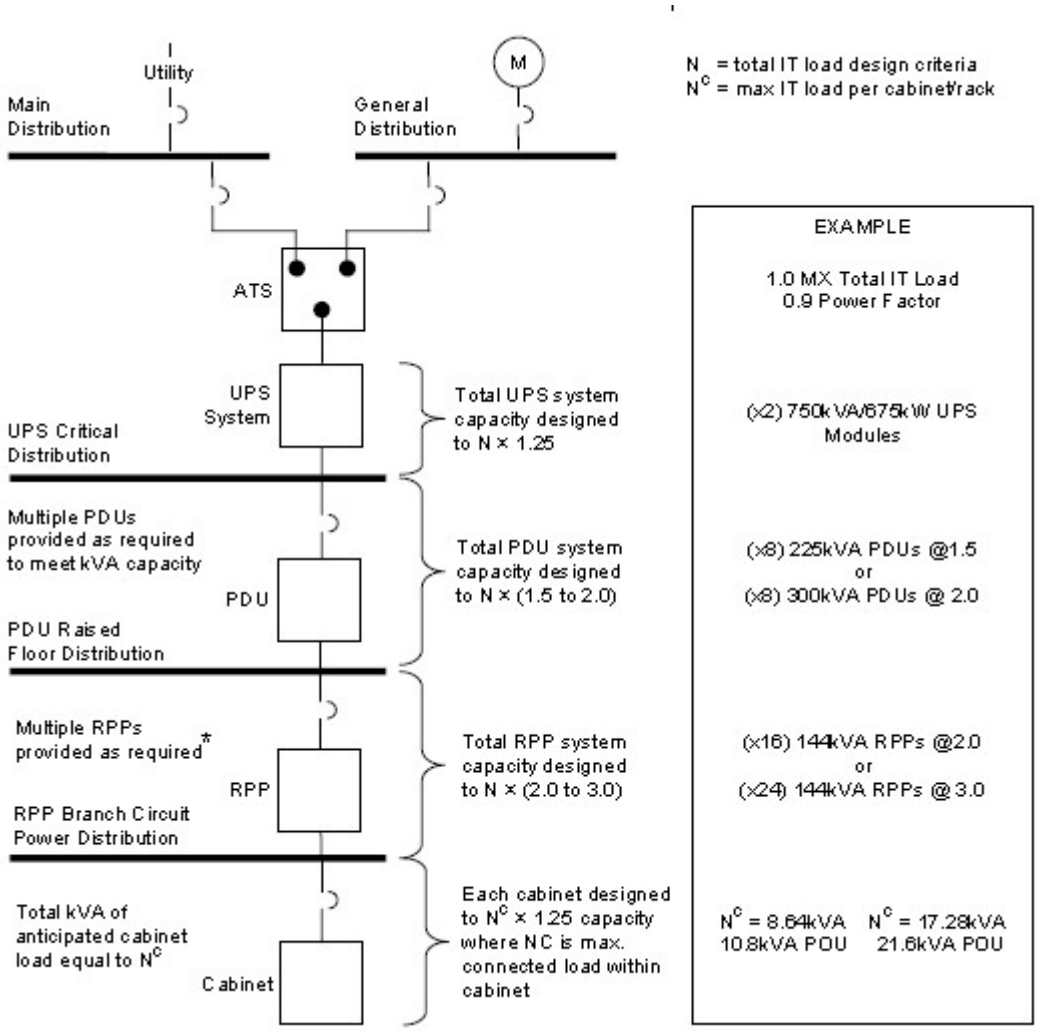


Figure 2.1 Electrical distribution Cooling capacity

The space required to support the cooling systems will vary depending on the type of cooling system selected. Items to consider include

- central air handlers versus CRAC units,
- chilled water versus air-cooled systems,
- liquid-cooled cabinets in the computer processing area,
- cooling tower (chilled water system),
- thermal storage (chilled water system), piping and pumps,

- other required equipment or resources.

The cooling system design capacity should be sufficient to support the electrical distribution system and subsystem cooling requirements within each rack, cabinet or IT equipment zone.

- Data center supporting spaces

The appropriate adjacencies of spaces can be determined by performing an exercise of required staff and material , as shown in figure (2.2)

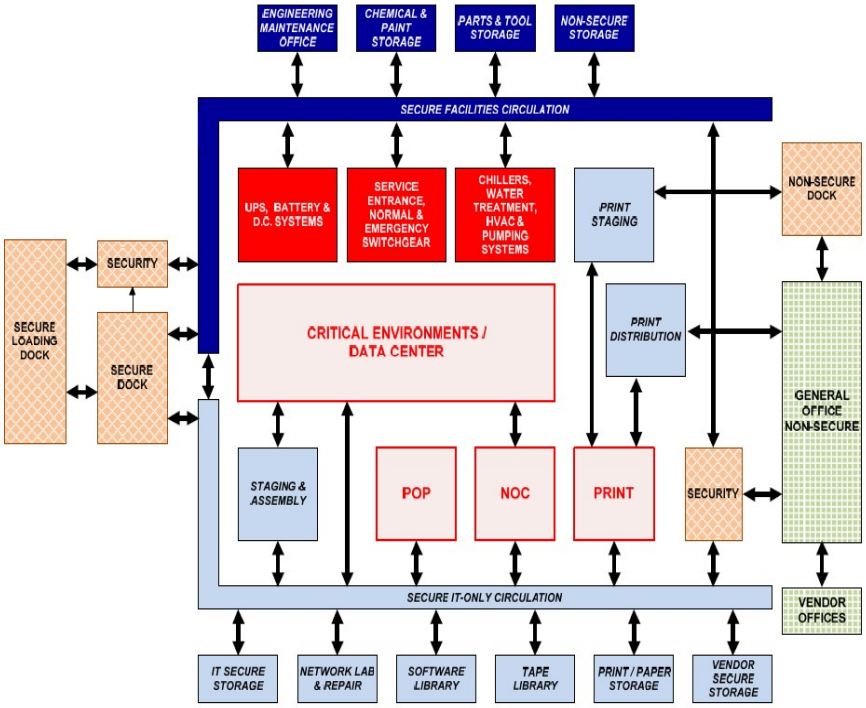


Figure (2.2) Space Adjacencies

2.3.Security

Security should be located or adjacent to the main personnel entrance to facility .Visitor sign-in area should be physically separate from security operation facility, and just including video monitoring and access control system database and front and end user interface .

Space planning items .

- video monitoring space requirements.

- access control system space requirements.
- access control storage requirements.
- unobstructed access to key storage.
- unobstructed access to access-card (temporary and blank) storage.
- fire/smoke alarm monitoring systems.

2.4.Raised Floor

Two types of floors Die formed welded steel construction Die formed welded steel shell with cementations core as shown in figure2.4.1 & 2.4.2.

2.4.1. Raised floor standards

Figure 2.4.1 Die formed welded steel construction

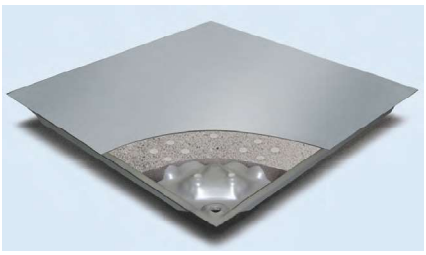


Figure 2.4.2 Die formed welded steel shell

- European standard BS/EN 12825 The raised floor must be capable of withstanding a uniform load of 1,220 kg/m2 or a load of 454 on any 6.5 cm2 , with a maximum deflection of 2.5 mm.
- UK – PSA MOB PF2 standard (Property Services Agency)

light :- 1.5kN over 25 mm2 (PL) , not more than 6.7 kN/m2 (UDL)
Medium:- 3.0 KN over 25 mm2 (PL) , not more than 8.0 KN/m2 (UDL)
Heavy:- 4.5 KN over 25 mm2 (PL) , not more than 12KN/m2 (UDL)
Extra Heavy :- 4.5 KN over 25 mm2 (PL) , not more than 12KN/m2 (UDL)

- US – CISCA (Ceiling and Interior Systems Constructors Association) NFPA 251 , Fire resistant for at least 1 Hour.

2.4.2Grounding of Raised floor

Raised floor needs to be connected to the ground wire ,Signal Reference Grid (SRG) provide an equipotential plane for the equipment contained within computer/server rooms , and provide a low – impedance path for high – frequency noise currents to dissipate before equipment . All racks must be individually bonded to the SRG . serial bonding is not allowed, Ideally created via braided copper wire connected copper wire connected to every other pedestal or surrounding frame. Acceptable via grounded raised floor frames.

The space between raised floor to suspended ceiling should be at least 2.60 meter, more height requirement when using overhead pathways at least 45 cm of clearance below water sprinkler head and nozzles of gas based fire suppression systems is required check cleanliness and cabling regularly.

2.5.Light definition and unit of measure

The light of the work – areas must facilitate an effortless recognition of visual objects it should contribute to the promotion of attentiveness and activation , counteract premature fatigue , and render dangerous situation clearly recognizable .

Lumen : light strength Lux : light strength in an area (Example 1000 Lumen is same as 1000 Lux in 1 square meter) Lux is the most recommended unit of measure .

The most standers advise the following levels :

- Rooms : min 500 Lux , recommend 600 Lux .
- Corridor : min 200 Lux , recommended 300 Lux .
- Service area : min 150 Lux recommended 200 Lux .

Light should be located at regular intervals , in all aisles , back of the rack is typically more important than front of the rack , connect light to the raw supply with backup power supply from the standby generator set , fluorescent light should never be connected to the same UPS which feeds the ICT equipment.

Emergency light Emergency light is required to enable a safe escape of personnel during a power fail in the building .

BS-5588 / 5266 Emergency light stander .

Emergency light to be placed in accordance with local regulations and all critical switch boards , UPS standby generator , cooling equipment.

2.6.Power Infrastructure

ATS Automatic Transfer Switch a device which selects power from one source or the other source , break – before – make principle typically > 50ms.

STS Static transfer Switch a device which selects power from one source or the other source break – before make principle , Electronic therefore fast switching devices <20 ms .

Three phase power cabling three phase power distribution within the building consist out of five wires Live/Phase 1-3 neutral ground three phase to single phase converter done in the distribution boards (PDU/DB)

2.6.1Rack power distribution

single feed power distribution as shown in figure 2.6.1 R =PHASE 1 S = PHASE 2 T = PHASE 3

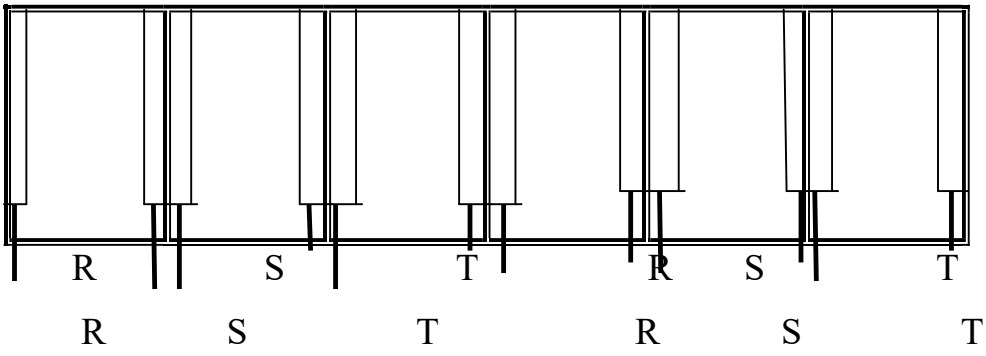
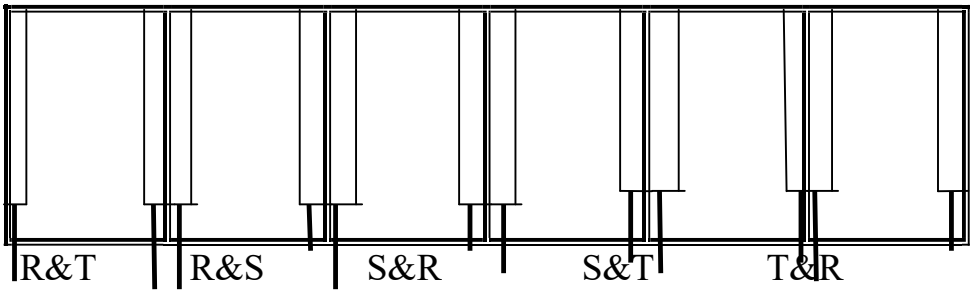


Figure 2.6.1 single feed

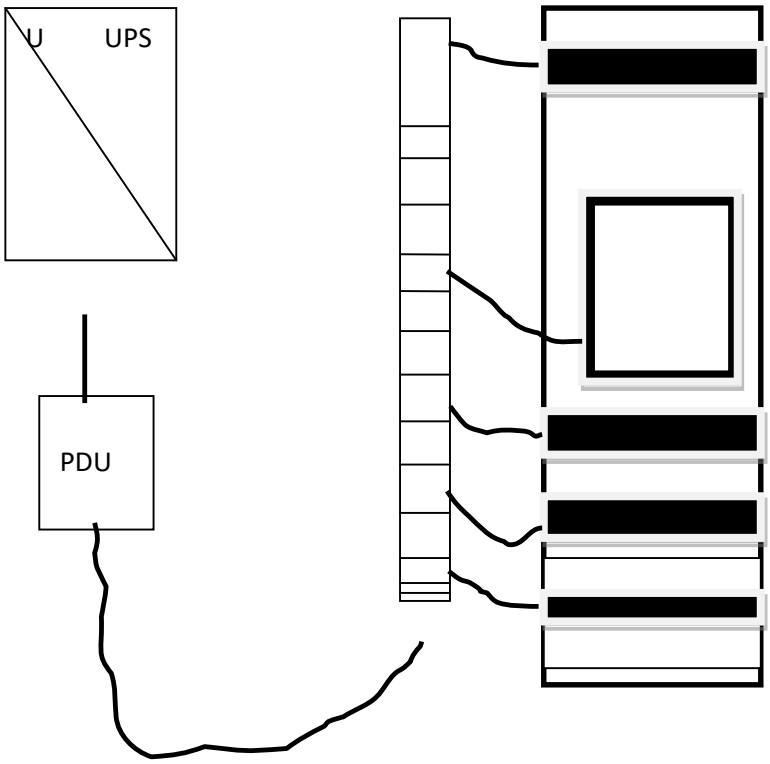
Dual power sources route dual sources to each rack where possible , all conductors to have the same size , each power rail/strip in the rack to have its own breaker . using dual supply equipment where possible (dual core equipment , three/Tri-cord equipment) STATIC SWITCH (STS) for single source equipment .



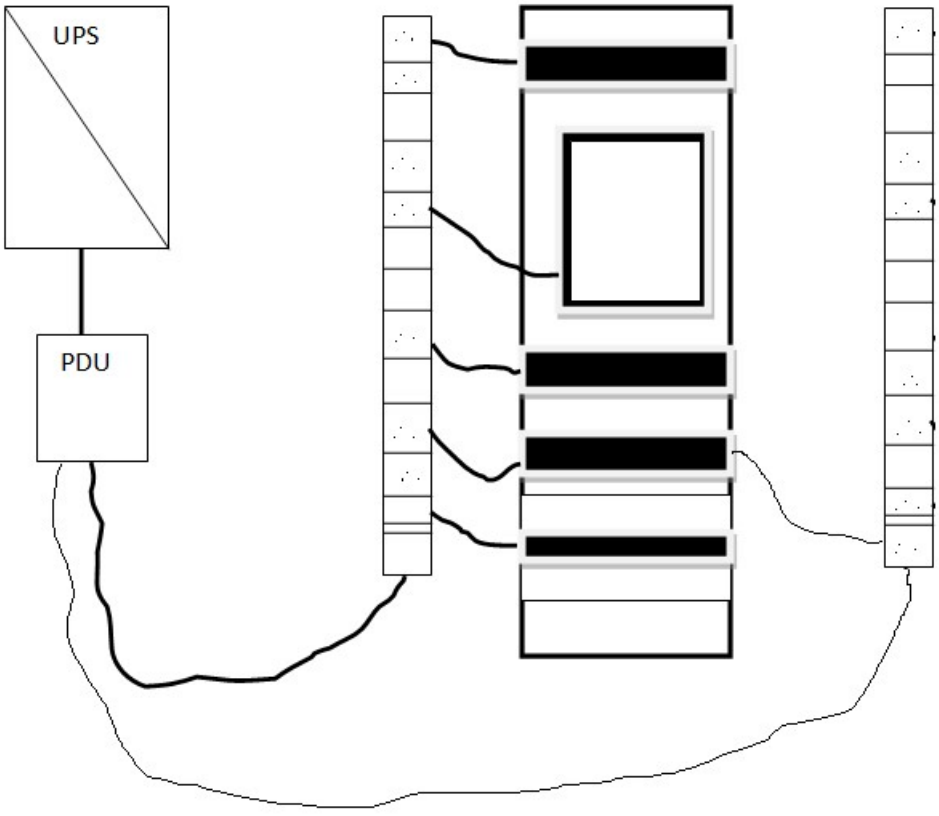
T&S

Figure 2.6.2 Dual power source

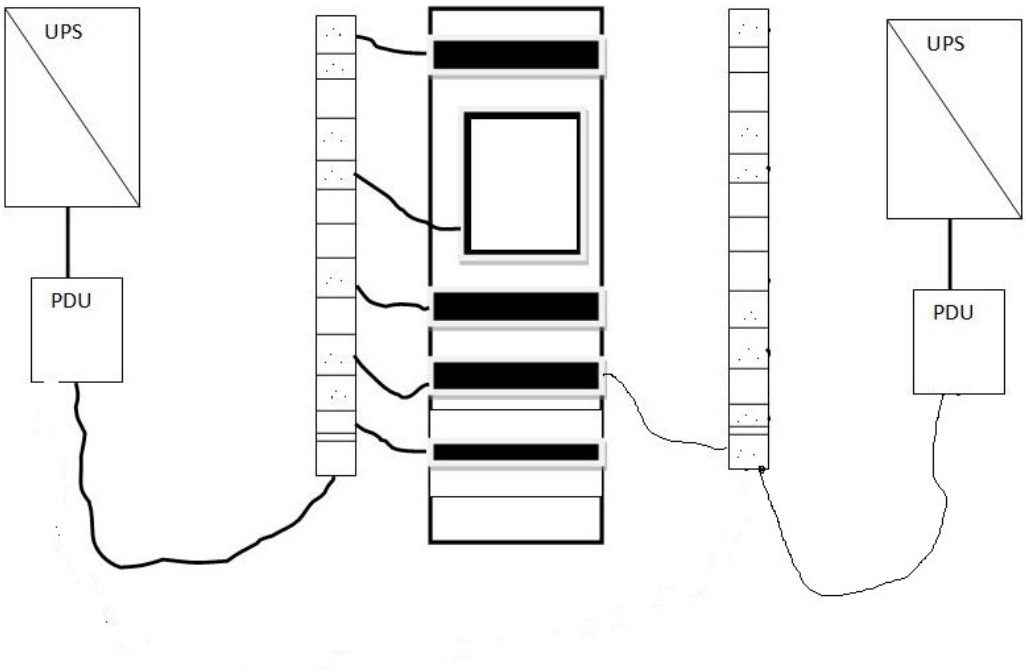
Low availability



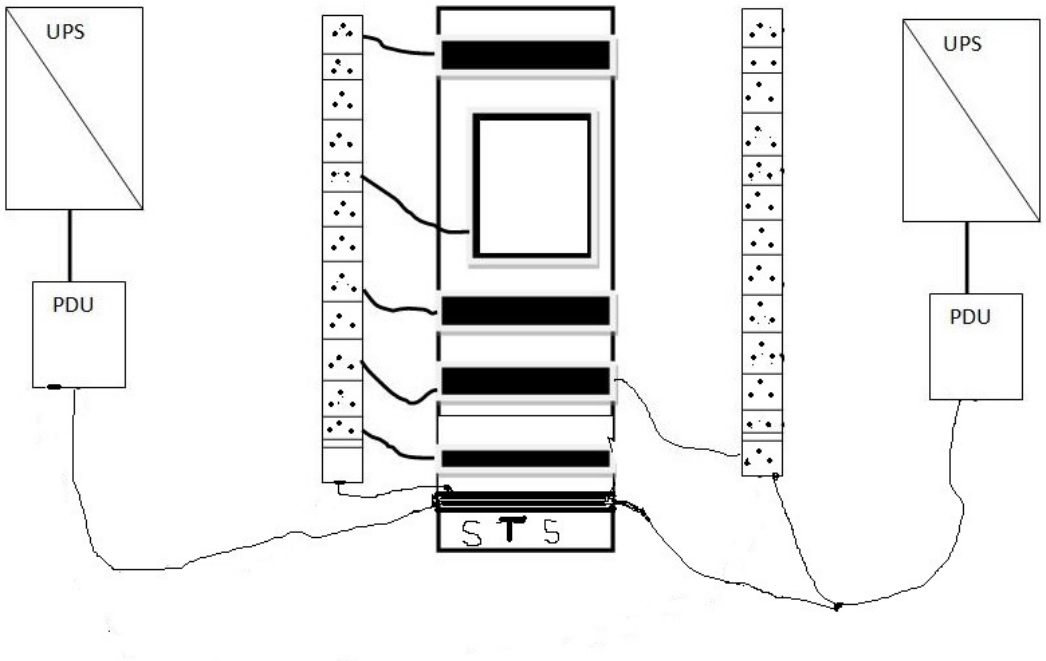
Slightly better availability



Improved availability



Hi – Availability



Common techniques for Power Availability for critical servers use dual- or three/tri-cord equipment and reduce the Single point of failures as

much as possible/required and within budget .Use breakers as much as possible and as close to the load as possible to isolate various loads .

Cabling or Busbar –Trunking

Standard Cabling

- less flexible
- Fixed power rating
- Inexpensive

Busbar -trunking

- Allows for flexibility
- 1-phase / 3 – phase
- power rating

2.6.2.Grounding in the data center

In a data center the ground wire has multiple functions.

Establish voltage reference .

Clear electrical faults .

Provide RF/ESD discharge path

Carry lightning currents

Ground resistance should be < 1 Ohm , not to exceed 5 Ohm , current goes through all paths , the lower the resistance the more current carrying the conductor , all metal objects should be bonded to the ground :-

Cabinets

PDUs

Aircon / UPS etc

Raise floor

Common mode noise (CMN) is the voltage between ground and Neutral . Voltage required / desired preference < 1 Volt , Acceptable up to 1% of line phase to neutral voltage .

2.6.3.Generator sets

Generators are critical to the data central and need to there fore be tested regularly free – running : at least monthly .

full load test at least quarterly.

Site of generator – set depend on kVA/kW.

2.6.4.UPS Technology

Tow type of UPS technology are used in data center environments:-

- Static UPS Build up out of electronic components such as rectifier inverter control logic and batteries.
- Dynamic UPS Build up out of mechanical components such as diesel engine , power generators and flywheel .

Static UPS system relative complex power and control electronics , requires a controlled environment , require batteries need to be replaced typically every 3-4 years for 5-year design life and every 7-8 years for 10-year design life available in 500VA-800KVA in single systems.

Dynamic UPS system only available in higher KVA ratings 600kVA – 3000 KVA , heavy (e.g 600KVA could weigh approx 8 Ton) , more noisy , no need for batteries use the flywheel engineer , no need for controlled environment , long live span , and good efficiency .

2.7.Cooling Infrastructure.

Cooling is one if not the most important factors for data center s . cooling capacity is expressed in :-

- Ton
- BTU , 1 TON is 12000 BTU
- Watt , 1 Watt is 3.41 BTU
- Horsepower , 1 Horsepower is 746 Watt

Stick to one unit of measure for all heat / cooling related matters , most design are expressed in watt/Sqmt , RLU i.e Watt per Rack .Difference between comfort and precision cooling .Comfort Air Con Low sensible

heat load capabilities , simple thermostat and temperature control , not aimed at 24 x7 operation , filter sections often not adequate for data centre environment .Precision cooling Precision air conditioners high sensible heat load capabilities , narrow thresholds for temperature and humidity control , contains humidification and dehumidification sections , proper filter sections , aimed at 24x7 operations and therefore more reliable and robust , proper interface for monitoring and control .

SHR – Sensible Heat Ratio . Important measure to understand effectiveness of cooling equipment for ICT environments ,Typical comfort air condition has SHR ratio between 0.6-0.7 , Typical Precision air conditioner has an SHR ratio between 0.9-1.0 More air volume (Cubic feet per Minute (CFM)/ Cubic meter per Hour (CMH)) is required to remove sensible heat from ICT environment when using Comfort air conditioners .

2.7.1.Top Flow or Down Flow

Top flow / throw can be installed with or without raised floor , Limited airflow guidance (need to use ducting) .as shown in figure 2.7.1

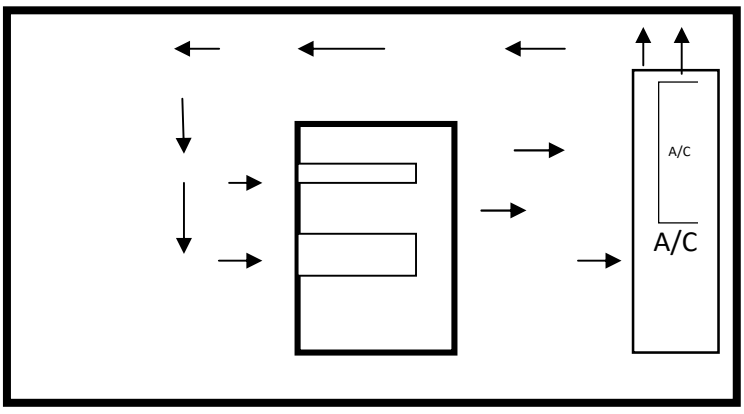


Figure 2.7.1 Top flow

Down flow / throw can only be used with raised floor , allows for air flow guidance through raised floor as shown in figure 2.7.2

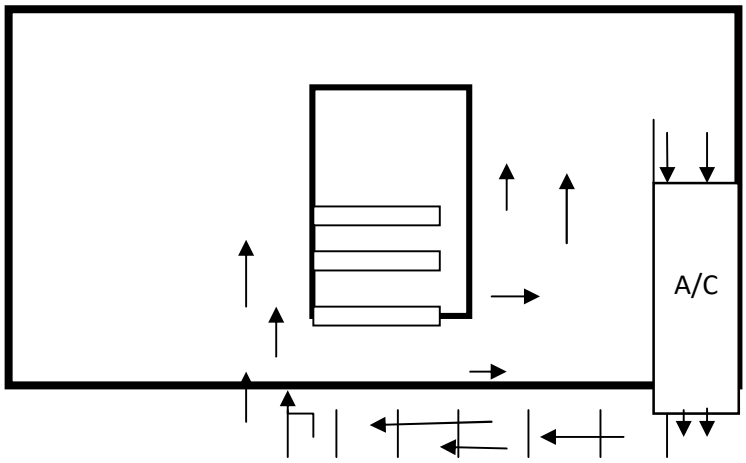


Figure 2.7.2 Down flow

2.8.TIA STANDARD

TIA-942 (TELECOMMUNICATIONS INDUSTRY ASSOCIATION)

TIA Engineering Standards and Publications are designed to serve the public interest through eliminating misunderstandings between manufacturers and purchasers, facilitating interchange ability and improvement of products, and assisting the purchaser in selecting and obtaining with minimum delay the proper product for their particular need. Standards and Publications are adopted by TIA in accordance with the American National Standards Institute (ANSI) patent policy. By such action, TIA does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the Standard or Publication.

2.8.1DATA CENTER TELECOMMUNICATIONS SPACES AND RELATED TOPOLOGIES

The data center requires spaces dedicated to supporting the telecommunications infrastructure. Telecommunications spaces shall be

dedicated to support telecommunications cabling and equipment. Typical spaces found within a data center generally include the entrance room, main distribution area (MDA), horizontal distribution area (HDA), zone distribution area (ZDA) and equipment distribution area (EDA).

2.8.2Data center structure .

The data center telecommunications spaces include the entrance room, main distribution area (MDA), horizontal distribution area (HDA), zone distribution area (ZDA) and equipment distribution area (EDA).

2.8.3Typical data center topology

The typical data center includes a single entrance room, possibly one or more telecommunications rooms, one main distribution area, and several horizontal distribution areas. As shown in figure 2.8.1 the typical data center topology.

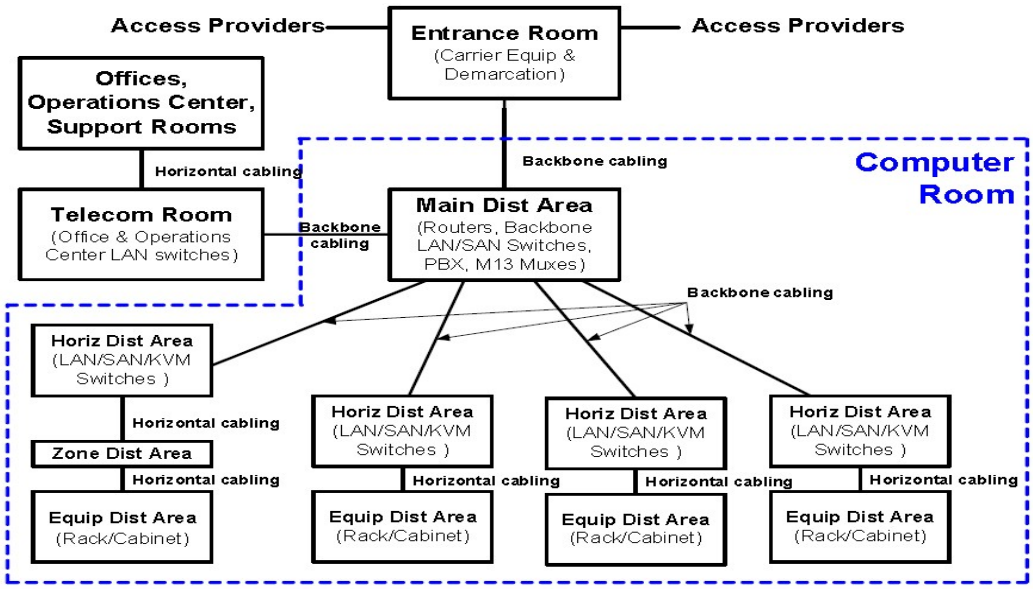


Figure 2.8.1 typical data center topology

Reduced data center topologies Data center designers can consolidate the main cross-connect, and horizontal cross-connect in a single main distribution area, possibly as small as a single cabinet or rack. The telecommunications room for cabling to the support areas and the entrance room may also be consolidated into the main distribution area in

a reduced data center topology. The reduced data center topology for a small data center is as shown in Figure 2.8.2 .

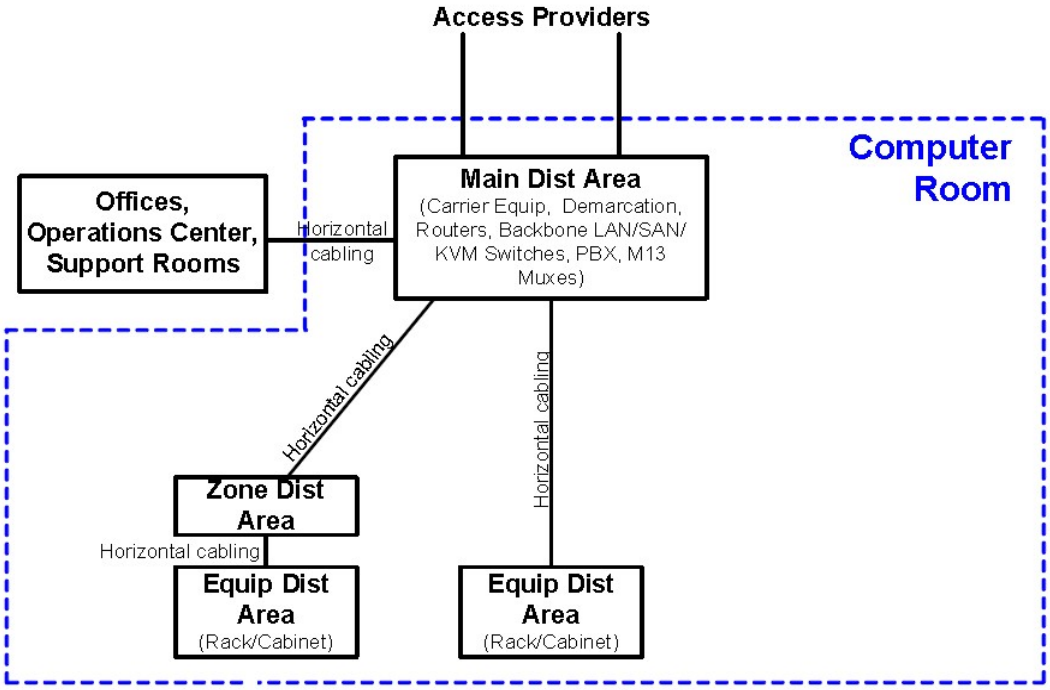


Figure 2.8.2 reduced data center topology for a small data center

2.8.4Computer room requirements

When selecting the computer room site, avoid locations that are restricted by building components that limit expansion such as elevators, core, outside walls, or other fixed building walls. Accessibility for the delivery of large equipment to the equipment room should be provided . The room shall be located away from sources of electromagnetic interference.

The computer room should not have exterior windows, as exterior windows increase heat load and reduce security. Computer room doors should provide access to authorized personnel only.

- Architectural design of computer room Size.

The computer room shall be sized to meet the known requirements of specific equipment including proper clearances; this information can be

obtained from the equipment provider(s). Sizing should include projected future as well as present requirements.

- Guidelines for other equipment

Electrical control equipment, such as power distribution or conditioner systems, and UPS up to 100 kVA shall be permitted in the computer room, with the exception of flooded-cell batteries. UPS larger than 100 kVA and any UPS containing flooded-cell batteries should be located in a separate room except .

Equipment not related to the support of the computer room (e.g., piping, ductwork, pneumatic tubing, etc.) shall not be installed in, pass through, or enter the computer room.

- Ceiling height

The minimum height in the computer room shall be 2.6 m (8.5 ft) from the finished floor to any obstruction such as sprinklers, lighting fixtures, or cameras. Cooling requirements or racks/cabinets taller than 2.13 m (7 ft) may dictate higher ceiling heights. A minimum of 460 mm (18 in) clearance shall be maintained from water sprinkler heads.

- Treatment

Floors, walls, and ceiling shall be sealed, painted, or constructed of a material to minimize dust. Finishes should be light in colour to enhance room lighting. Floors shall have anti-static properties in accordance with IEC 61000-4-2.

- Lighting

Lighting shall be a minimum of 500 lux (50 foot-candles) in the horizontal plane and 200 lux (20 foot-candles) in the vertical plane, measured 1 m (3 ft) above the finished floor in the middle of all aisles between cabinets. Lighting fixtures should not be powered from the same electrical distribution panel as the telecommunications equipment in the computer room.

- Doors

Doors shall be a minimum of 1 m (3 ft) wide and 2.13 m (7 ft) high, without doorsills, hinged to open outward (code permitting) or slide side-to-side, or be removable. Doors shall be fitted with locks and have either no center posts or removable center posts to facilitate access for large equipment.

- Floor loading

Floor loading capacity in the computer room shall be sufficient to bear both the distributed and concentrated load of the installed equipment with associated cabling and media. The minimum distributed floor loading capacity shall be 7.2 kPA (150 lbf/ ft2). The recommended distributed floor loading capacity is 12 kPA (250 lbf/ ft2).

The floor shall also have a minimum of 1.2 kPA (25 lbf/ ft2) hanging capacity for supporting loads that are suspended from the bottom of the floor (for example, cable ladders suspended from the ceiling of the floor below). The recommended hanging capacity of the floor is 2.4 kPA (50 lbf/ ft2). Refer to Telcordia specification GR-63-CORE regarding floor loading capacity measurement and test methods.

2.8.5.Electrical power design

Separate supply circuits serving the computer room shall be provided and terminated in their own electrical panel or panels. The computer room shall have duplex convenience outlets (120V 20A) for power tools, cleaning equipment, and equipment not suitable to plug into equipment cabinet power strips. The convenience outlets should not be on the same power distribution units (PDUs) or electrical panels as the electrical circuits used for the telecommunications and computer equipment in the room. The convenience outlets shall be spaced 3.65 m (12 ft) apart along the computer room walls, or closer if specified by local ordinances, and

reachable by a 4.5m (15 ft) cord (per NEC Articles 210.7(A) and 645.5(B1)).

- Standby power

The computer room electrical panels should be supported by the computer room standby generator system, if one is installed. Any generators used should be rated for electronic loads. Generators of this capability are often referred to as “Computer Grade”. If the computer room does not have a dedicated standby generator system, the computer room electrical panels should be connected to the building standby generator system, if one is installed.

- Bonding and grounding (earthling)

Access shall be made available to the telecommunications grounding system specified by ANSI/TIA/EIA-J-STD-607-A. The computer room should have a common bonding network (CBN) .

2.8.6.Fire protection

The fire protection systems and hand-held fire extinguishers shall comply with NFPA-75. Sprinkler systems in computer rooms should be pre-action systems.

2.8.7.Entrance room requirements

The entrance room is a space, preferably a room, in which access provider-owned facilities interface with the data center cabling system. It typically houses telecommunications access provider equipment and is the location where access providers typically hand off circuits to the customer. This hand-off point is called the demarcation point. It is where the telecommunications access provider’s responsibility for the circuit typically ends and the customer’s responsibility for the circuit begins. The entrance room will house entrance pathways, protector blocks for copper-pair entrance cables, termination equipment for access provider

cables, access provider equipment, and termination equipment for cabling to the computer room.

- Location

The entrance room should be located to ensure that maximum circuit lengths from the access provider demarcation points to the end equipment are not exceeded. The entrance rooms may either be located inside or outside the computer room space. Security concerns may dictate that the entrance rooms are located outside the computer room to avoid the need for access provider technicians to access the computer room.

- Cabling in the entrance rooms should use the same cable distribution (overhead or under floor) as used in the computer room; this will minimize cable lengths as it avoids a transition from overhead cable trays to under floor cable trays.
- Quantity

Large data centers may require multiple entrance rooms to support some circuit types throughout the computer room space and/or to provide additional redundancy.

The additional entrance rooms may have their own entrance pathways for dedicated service feeds from the access providers. Alternatively, the additional entrance rooms may be subsidiaries of the primary entrance room, in which case the access provider service feeds come from the primary entrance room.

2.8.8.Telecommunications room

In data centers, the telecommunications room (TR) is a space that supports cabling to areas outside the computer room. The TR is normally located outside the computer room but, if necessary, it can be combined with the main distribution area or horizontal distribution areas. The data center may support more than one telecommunications room if the areas to be served cannot be supported from a single telecommunications room.

Racks are equipped with side mounting rails to which equipment and hardware are mounted.

Cabinets can be equipped with side mounting rails, side panels, a top, and front and rear doors, and are frequently equipped with locks.

"Hot" and "cold" aisles

Cabinets and racks shall be arranged in an alternating pattern, with fronts of cabinets/racks facing each other in a row to create "hot" and "cold" aisles.

"Cold" aisles are in front of racks and cabinets. If there is an access floor, power distribution

cables should be installed here under the access floor on the slab. "Hot" aisles are behind racks and cabinets. If there is an access floor, cable trays for telecommunications cabling should be located under the access floor in the “hot” aisles.

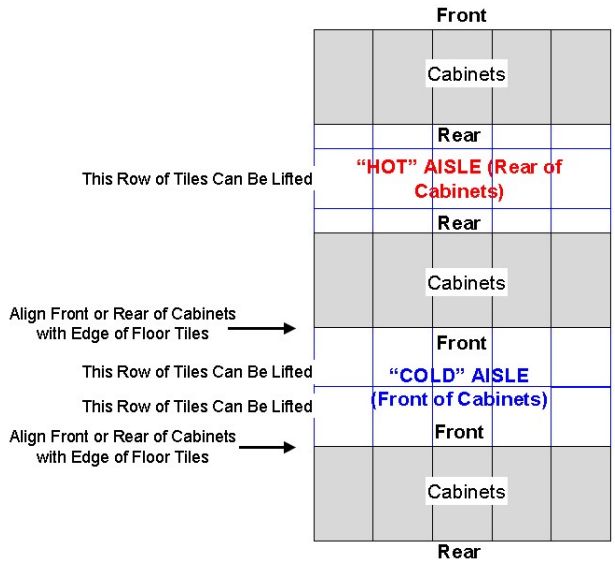


Figure 2.8.3 Example of hot aisles , cold aisles and cabinet placement

2.9.DATA CENTER CABLING SYSTEMS

2.9.1.Horizontal Cabling

The horizontal cabling is the portion of the telecommunications cabling system that extends from the mechanical termination in the equipment

distribution area to either the horizontal cross connect in the horizontal distribution area or the main cross-connect in the main distribution area.

The horizontal cabling includes horizontal cables, mechanical terminations, and patch cords or jumpers, and may include a zone outlet or a consolidation point in the zone distribution area. The following partial listing of common services and systems should be considered when the horizontal cabling is designed.

- voice, modem, and facsimile telecommunications service.
- premises switching equipment.
- computer and telecommunications management connections.
- keyboard/video/mouse (KVM) connections.
- data communications.
- wide area networks (WAN).
- local area networks (LAN).
- storage area networks (SAN).
- other building signalling systems (building automation systems such as fire, security, power, HVAC, EMS, etc.).

In addition to satisfying today's telecommunication requirements, the horizontal cabling as shown in figure 2.9.1 should be planned to reduce ongoing maintenance and relocation. It should also accommodate future equipment and service changes. Consideration should be given to accommodating a diversity of user applications in order to reduce or eliminate the probability of requiring changes to the horizontal cabling as equipment needs evolve. The horizontal cabling can be accessed for reconfiguration under the access floor or overhead on cable tray systems. However, in a properly planned facility, disturbance of the horizontal cabling should only occur during the addition of new cabling.

The horizontal cabling shall be installed in a star topology as shown in figure . Each mechanical termination in the equipment distribution area

shall be connected to a horizontal cross-connect in the horizontal distribution area or main cross-connect in the main distribution area via a horizontal cable.

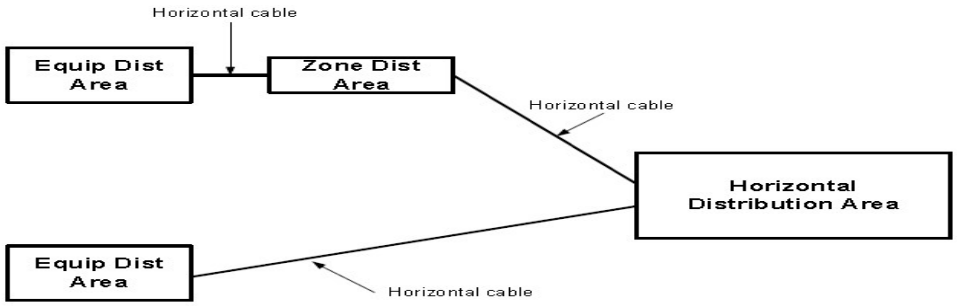


Figure 2.9.1 Typical horizontal cabling using a star topology

2.9.1.1Horizontal cabling distances

The horizontal cabling distance is the cable length from the mechanical termination of the media at the horizontal cross-connect in the horizontal distribution area or the main distribution area to the mechanical termination of the media in the equipment distribution area. The maximum horizontal distance shall be 90 m (295 ft), independent of media type (see figure 7). The maximum channel distance including equipment cords shall be 100 m (328 ft). The maximum cabling distance in a data center not containing a horizontal distribution area shall be 300 m (984 ft) for an optical fiber channel including equipment cords, 90 m (294 ft) for copper cabling excluding equipment cords and 100 m (328 ft) for copper cabling including equipment cords.

2.9.2Maximum lengths for copper cabling

Copper equipment cables used in the context of zone outlets in the zone distribution area, shall meet the requirements of ANSI/TIA/EIA-568-B.2. Based upon insertion loss considerations, the maximum length shall be determined according to:

$C = (102 - H)/(1+D)$ (1)

$Z = C - T \leq 22$ m (72 ft) for 24 AWG UTP/ScTP or ≤ 17 m (56 ft) for 26 AWG ScTP (2)

Where:

C is the maximum combined length (m) of the zone area cable, equipment cable, and patch cord.

H is the length (m) of the horizontal cable ($H + C \leq 100$ m).

D is a de-rating factor for the patch cord type (0.2 for 24 AWG UTP/24 AWG ScTP and 0.5 for 26 AWG ScTP).

Z is the maximum length (m) of the zone area cable.

T is the total length of patch and equipment cords.

Table 2.9.1 shown below applies the above formulae assuming that there is a total of 5 m (16 ft) of 24 AWG UTP/24AWG ScTP or 4 m (13 ft) of 26 AWG ScTP patch cords and equipment cables in the main distribution area, or horizontal distribution area. The zone outlet shall be marked with the maximum allowable zone area cable length. One method to accomplish this is to evaluate cable length markings.

Table 2.9.1 maximum length of horizontal and equipment area cable

Length of horizontal cable H m (ft)	24 AWG UTP/24 AWG ScTP patch cords		26 AWG ScTP patch cords	
	Maximum length of zone area cable Z m (ft)	Maximum combined length of zone area cables, patch cords, and equipment cable C m (ft)	Maximum length of zone area cable Z m (ft)	Maximum combined length of zone area cables, patch cords, and equipment cable C m (ft)
90 (295)	5 (16)	10 (33)	4 (13)	8 (26)
85 (279)	9 (30)	14 (46)	7 (23)	11 (35)
80 (262)	13 (44)	18 (59)	11 (35)	15 (49)
75 (246)	17 (57)	22 (72)	14 (46)	18 (59)
70 (230)	22 (72)	27 (89)	17 (56)	21 (70)

2.9.3Backbone cabling

The function of the backbone cabling is to provide connections between the main distribution area, the horizontal distribution area, and entrance facilities in the data center cabling system.

Backbone cabling consists of the backbone cables, main cross-connects, horizontal cross connects, mechanical terminations, and patch cord or jumpers used for backbone-to-backbone cross-connection.

The backbone cabling shall allow network reconfiguration and future growth without disturbance of the backbone cabling. The backbone cabling should support different connectivity requirements, including both the network and physical console connectivity such as local area networks, wide area networks, storage area networks, computer channels, and equipment console connections.

2.9.4Centralized optical fiber cabling

Centralized cabling provides connections from equipment distribution areas to centralized cross-connects by allowing the use of pull-through cables, an interconnect, or splice in the horizontal distribution area.

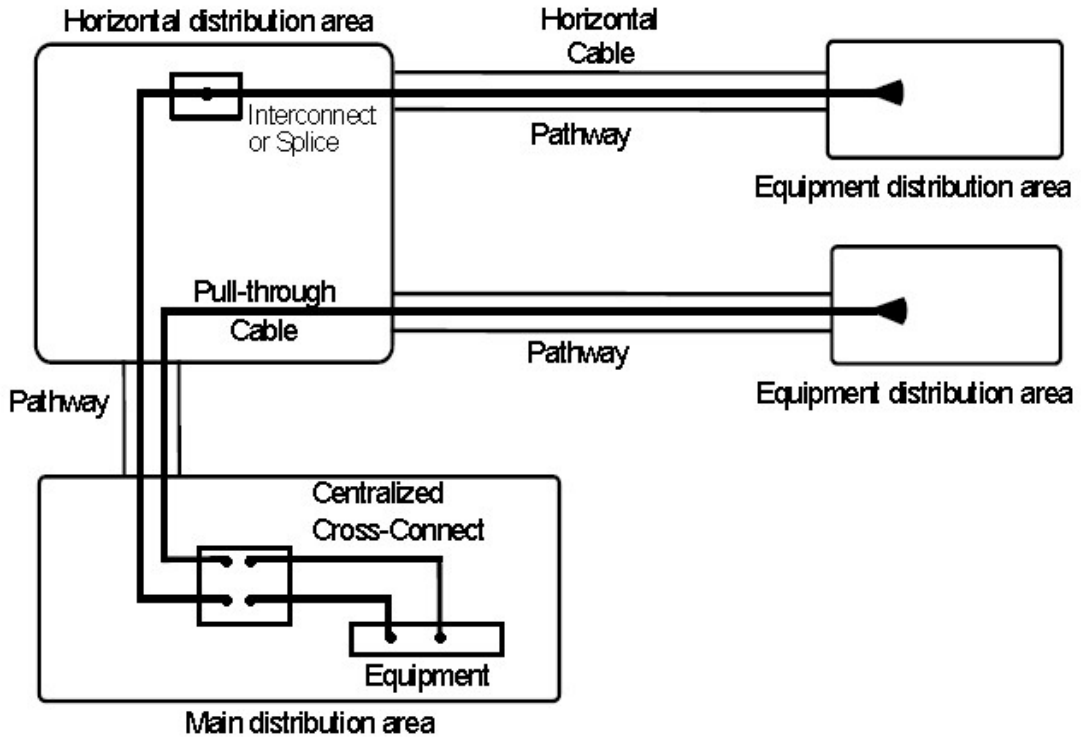


Figure 2.9.4 Centralized optical fiber cabling

Centralized cabling design shall allow for the addition and removal of horizontal and intra building backbone fibers . The layout of the termination hardware should accommodate modular growth in an orderly manner.

The intra building backbone fiber count should be sized to deliver present and future applications to the maximum equipment distribution areas density within the area served by the horizontal distribution area.

Cabling transmission performance and test requirements depends on cable characteristics, connecting hardware, patch cords and cross-connect wiring, the total number of connections, and the care with which they are installed and maintained.

Separation of power and telecommunications cables to minimize longitudinal coupling between power cables and twisted-pair copper cables, the separation distances outlined in this clause shall be provided. This separation is specified to accommodate the wide variety of

equipment that may be present in a data center, but are not found in a typical office environment or telecommunications room. Separation between electrical power and twisted-pair cables The distances in table below shall be maintained between electrical power cables and twisted-pair cables. Electrical codes may require a barrier or greater separation than specified in table below .

Table 2.2 Data center specification between twisted – pair and shielded power cable [3]

Quantity of circuits	Electrical Circuit Type	Separation Distance (mm)	Separation Distance (in)
1 -15	20A 110/240V 1-phase shielded or unshielded	Refer to 569B annex C	Refer to 569B annex C
16 - 30	20A 110/240V 1-phase shielded	50 mm	2 in
31 - 60	20A 110/240V 1-phase shielded	100 mm	4 in
61-90	20A 110/240V 1-phase shielded	150 mm	6 in
91+	20A 110/240V 1-phase shielded	300 mm	12 in
1+	100A 415V 3-phase shielded feeder	300 mm	12 in

If the power cables are unshielded, then the separation distances provided in table above shall be doubled.

The side or the bottom of the metal tray shall separate the power cables from the twisted-pair cables, this separation surface should be solid metal.

2.9.5Separation of fiber and copper cabling.

Fiber and copper cabling in cable trays and other jointly used pathways should be separated so that it improves administration, operation, and minimize damage to smaller diameter fiber cables.

Physical barriers between the two types of cables are not necessary. Where it is not practical to separate fiber and copper cables, fiber cables should be on top of copper cables.

2.9.6.Overhead cable trays.

Overhead cable tray systems may alleviate the need for access floors in data centers that do not employ floor-standing systems that are cabled from below.

Overhead cable trays may be installed in several layers to provide additional capacity. Typical installations include two or three layers of cable trays, one for power cables and one or two for telecommunications cabling.

One of the cable tray layers typically has brackets on one side that hold the data center grounding infrastructure. These overhead cable trays are often supplemented by a duct or tray system for fiber patch cables. The fiber duct or tray may be secured to the same hanging rods used to support the cable trays.

In aisles and other common spaces in internet date centers, co-location facilities, and other shared tenant data centers, overhead cable trays should have solid bottoms or be placed at least 2.7 m (9 ft) above the finished floor to limit accessibility or be protected through alternate means from accidental and/or intentional damage.

The maximum recommended depth of any cable tray is 150 mm (6 in).

Chapter Three

Methodology

3.1 Introduction

3.1.1 Overview

People have come to expect ready to information 24 hours a day , every day . The Internet as well as more traditional enterprises both business and governmental now operate 7 day e week , 24 hours a day . Typical 24/7 operations include banking systems , credit card companies , 999 emergency centers , telecommunication networks , hospital systems , and other international organizations .

The burgeoning demand for mission-critical/data processing facilities (essentially server warehouses) requires fresh thinking given the radical differences in conventional building types. Consider some mission-critical facility norms :

The power supplied to a typical office building is about 110 W/m2 , but between 650 W/m2 and 2200 W/m2 or more in mission-critical facility . Mission-critical power requirements far exceed any conventional building type .

The mechanical/electrical/service space ratio to usable space averages 1:3 or 1:4 in typical buildings and is close to 1:1 in data centers.

The cost of mission-critical facilities can run up to four times the cost of more traditional building types. Power and cooling requirements drive cost and design.

3.1.2 Goals and Objectives

This project is intended to provide a framework for understanding the process for determining facility criticality and aligning project objectives and budgets with appropriate performance levels.

An objective of this project is to put standers or out lines for design a data center room as standers , as we now in Sudan we have many company working in ICT & IT service have many IT data center and many computer servers needs to but it in one good environment to work

24 th hours for 7 days , this environment has standers to keep this servers working but unfortunately many company does not use standers for that , in this project we have many standers as we toking about it and we visit many company in Sudan to study there IT data room infrastructure by putting design of chick lists in standers to compare their designs .

3.2.Methdology

The method use in this project is studying many standers form bug company around the word and then we tack a chick lists from this stander and give this to main 12 ICT company in Sudan (Zain , Sudatell , MTN , INC….ect) to make a compartment how those companies fallow this standers .

3.3. Chick list design

As shown in chick list covered the mane most items found in many stander link BICSI , TIA942 & ITIL (information technology infrastructure library) like National environment , raised floor , grounding of raised floor , power infrastructure , & cooling infrastructure , and send this chick lists to 12 main companies in Sudan working in IT and telecommunication industry like Sudatell , Zian and MTN .

First get the permeation to inter and study the data center room of this companies and given the IT directors of all companies the chick lists and they were telling have no write to say which chick lists results is belong to any companies but get permeations to visit and to study the data center rooms and if thy designed as in standers or not or if they are nearing to standers , finally I get moor information .

3.3.1.National environment

asking about the seismic activity and potential if it considered before selecting a data center sit , all 12 companies said no and they were saying that there are no activity of seismic in general in Sudan , it is very beg errors in standers .

And for subsurface contamination all they said No , and for area less than or equal to annual probability of win in excess of 129 km/hr the answer is No .

3.3.2.Rais floor

Two types of floors Die formed welded steel construction Die formed welded steel shell with cementations core , raised Floor all of those companies chose Die formed welded steel as it in standers .

3.3.3.grounding of raised floor and racks

Raised floor needs to be connected to the ground wire ,Signal Reference Grid (SRG) provide an equipotential plane for the equipment contained within computer/server rooms , and provide a low – impedance path for high – frequency noise currents to dissipate before equipment .

3.3.4.power infrastructure

Type of power distribution in racks one company chose single feed and tow anthers chose dual feed , dual feed is stander for stability and continually.

3.3.5.Type of UPS system

Tow type of UPS technology are used in data center environments:-

- Static UPS Build up out of electronic components such as rectifier inverter control logic and batteries.
- Dynamic UPS Build up out of mechanical components such as diesel engine , power generators and flywheel .

3.3.6.Cooling

Cooling is one if not the most important factors for data center. Important measure to understand effectiveness of cooling equipment for ICT environments ,Typical comfort air condition has SHR ratio between 0.6-0.7 , Typical Precision air conditioner has an SHR ratio between 0.9-1.0 More air volume (Cubic feet per Minute (CFM)/ Cubic meter per Hour

(CMH)) is required to remove sensible heat from ICT environment when using Comfort air conditioners .

3.3.7.Electric Utility service

Single entrance single pathway The distance between electric utility service and switchgear to data center is equally or in close proximity.

Singly entrance / dual pathway The electric and switchgear location to the dual data center space is equally distance.

3.2 Sample selection

send this chick list to 12 main companies in Sudan working in ICT and telecommunication industry like Sudatell , Zian and MTN as sample selection to study there data center room and how much they neer to standers .

Chapter Four

Results and Discussion

4.1.Study of chick list

As shown in chick list covered the most items found in many standards like BICSI, TIA942 & ITIL (information technology infrastructure library) like National environment , raised floor , grounding of raised floor , power infrastructure , & cooling infrastructure , and did send this chick list to 12 big companies in Sudan working in IT and telecommunication industry like Sudatell Zian and MTN .

First did get the permission to study the data center room of this companies and given the chick list to IT directors of all companies , and they did tell have no right to say which chick list is belong to any companies but did get permissions to visit and to study the data center rooms and if they did design as in standards or not or if they are nearing to standards, finally did get moor information.

4.2. National environment.

Asking about the seismic activity and potential if it considered before selecting the site of data center , all three companies said no and they did say that there are no activity of seismic in Sudan is not as standards. And for subsurface contamination all they said No, and for area less than or equal to annual probability of win in excess of 129 km/hr the answer is No.

4.3. Raised Floor.

All of those companies chose Die formed welded steel as it in standers.

4.4. Grounding the raised floor and racks.

All said yes as standards , as we know grounding very important to avoid any electrical signal coming from any body or devices .

4.5.Power infrastructure.

Type of power distribution in racks one company chose single feed and tow anthers chose dual feed , dual feed is stander for stability and

continually . For grounding testing the most company are not make quarters testing which it is not stander.

4.6.Generators test.

They did test generators one time in year with no load which it is not standards , as in standards they have to test it in full load every quarterly , and in free load every month that for making maintenance and the generators be ready for any time wont to be used , and to save time for starting up the generators not more then 5 minutes.

4.7. Type of UPS system.

The type of UPS system is dynamic UPS and it is stander.

4.8.Cooling infrastructure.

They are standers using comfort air cooling and top or down flow / throw as in standers .

4.9- Electric Utility service feed.

All companies chose dual entrance / dual pathway.

Then I get all three questionnaires back as shown in (A) and the final result is those companies are following the standers by %70

Chapter Five

Conclusion and Recommendation

5.1 Conclusion

The industry and investments of informatics centers are considered one of the leading industries in the world due to the importance of the continuity of informatics services, as international companies compete in developing standards and standards to design a suitable environment for the continuation of the servers 'work around the clock. Design and build a standard infrastructure for data server rooms that helps in the continuity of information services and reduces interruptions that cause large financial losses.

This project is a summary of my practical experience over 15 years in designing, building and implementing projects for data center rooms and servers. It is also a summary of several standards from international companies in setting standards for the design of server rooms, from determining the appropriate location and environment of server rooms, from providing main and backup electricity, air conditioning that works around the clock, adequate lighting, distribution of the equipment inside the room, feeding the trucks with energy and the distribution of air conditioning ratios And monitor the temperature.

The project studies international standards and the extent of their application in Sudan. The server rooms for the three main telecommunications companies inside Sudan and information centers for the ministries were chosen.

The extent of deviation in the environment of the data server rooms of these companies and the server rooms of the ministries has been studied from the international standards applicable to the design of the rooms of the server centers.

The method of the chick lists was chosen in the project to collect information after the approval of the target authorities, and the loan is to

develop work in the server rooms and correct mistakes with the selection being put in place for the confidentiality of these companies.

The chick lists based on a set of questions in the way of designing the infrastructure of central rooms for servers, which are answered by the managers of these rooms.

This information was collected through chick lists distributed to all the target parties, which were analyzed and studied, and to determine the extent to which the data center rooms of these entities matched the international standard values.

5.2. Discuss the results

As shown in the table 5.1 any question is numbering to macking the discussing very easy and to change it to graphics

questoins name	questoins name
National environment -Should seismic activity and potential be considered before selecting a data center site ?	1-1.
National environment-Are there no known subsurface contamination from either on – site hazard waste storage or other adjacent site ?	1-2.
National environment-For groundwater issues concerns , if the data center is slab on grade on the top of a hill ?	1-3.
National environment-Is the area less than or equal to annual probability of win in excess of 129 km/hr (80 mph) ?	1-4.
What types of the raised floor ? Die formed welded steel construction	2-1.
What types of the raised floor ?Die form elded steel shell with cementations core	2-2.
What types of the raised floor ?Other	2-3.
Grounding of Raised floor Are All racks and raised floor individually bonded to the SRG ?	3-1.
Power Infrastructure type of power distribution in racks Single feed	4-1-1.
Power Infrastructure type of power distribution in racks Dual feed	4-1-2.
Power Infrastructure Testing the ground resistance-1 ohm < Rg< 5 ohm	4-2-1.
Power Infrastructure Testing the ground resistance-Rg > 5 ohm	4-2-2.
Power Infrastructure Testing the ground resistance-No test	4-2-3.
Power Infrastructure-At free load every month	4-3-1.
Power Infrastructure-At full load every quarterly	4-3-2.
Power Infrastructure-No testing in year	4-3-3.
Power Infrastructure-The type of UPS-Static UPS system	4-4-1.
Power Infrastructure-The type of UPS-Dynamic UPS	4-4-2.
Cooling infrastructure-cooling comfort Air con	5-1.
Cooling infrastructure-precision cooling	5-2.
Cooling flow come from-Top flow / throw	6-1.
Cooling flow come from-Down flow / throw	6-2.
Electric Utility Service feeds-Single entrance single pathway	7-1.
Electric Utility Service feeds-Single entrance / dual pathway	7-2.
Electric Utility Service feeds Dual entrance / dual pathway	7-3.

Table 5.1 numbering the questions

So any numbers her for examples 1-1 it means National environment - Should seismic activity and potential be considered before selecting a data center site 5-1 means Cooling infrastructure-cooling comfort Air con.

There are 12 company given those chick lists and in table 5.2 see a total of saying yes and no for any question and the percentage of yes and no as shown for example a question number 2-1(What types of the raised floor ? Die formed welded steel construction) there are 6 company saying yes

which it is the standers and 6 saying no and the percentage of the company following the standers is 50%

questions number	Total Yes	Total No	YES %	NO %
1-1.	7.00	5.00	58.33	41.67
1-2.	6.00	6.00	50.00	50.00
1-3.	4.00	8.00	33.33	66.67
1-4.	5.00	7.00	41.67	58.33
2-1.	6.00	6.00	50.00	50.00
2-2.	4.00	8.00	33.33	66.67
2-3.	2.00	10.00	16.67	83.33
3-1.	10.00	2.00	83.33	16.67
4-1-1.	9.00	3.00	75.00	25.00
4-1-2.	3.00	9.00	25.00	75.00
4-2-1.	2.00	8.00	16.67	66.67
4-2-2.	5.00	7.00	41.67	58.33
4-2-3.	3.00	9.00	25.00	75.00
4-3-1.	3.00	9.00	25.00	75.00
4-3-2.	7.00	5.00	58.33	41.67
4-3-3.	2.00	10.00	16.67	83.33
4-4-1.	8.00	4.00	66.67	33.33
4-4-2.	4.00	8.00	33.33	66.67
5-1.	5.00	7.00	41.67	58.33
5-2.	7.00	5.00	58.33	41.67
6-1.	5.00	7.00	41.67	58.33
6-2.	6.00	6.00	50.00	50.00
7-1.	2.00	10.00	16.67	83.33
7-2.	1.00	11.00	8.33	91.67
7-3.	4.00	8.00	33.33	66.67

Table 5.2 total of yes & no

Those results can given as a figure to see which of those questions follows the stander as shown in figure 5.1 the question number 4-1-1 (Power Infrastructure type of power distribution in racks Single feed) most company follows the standers but in question 7-1 (**Electric Utility Service feeds-Single entrance single pathway**) litter company follows the stander

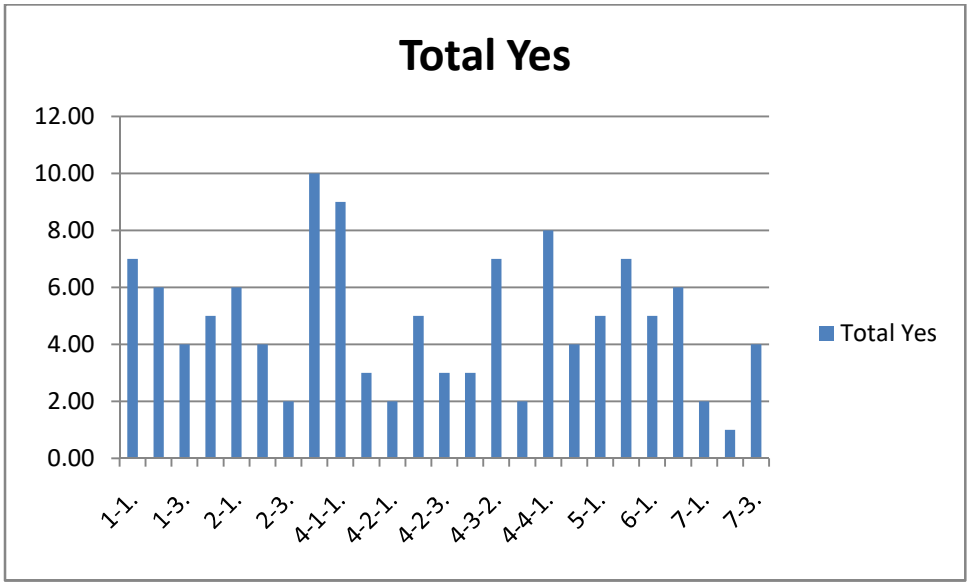


Figure 5.1 total yes in which company follows the standers

5.2.1. discuss any question alone

To discuss this chick list in details any question need to find how may company saying yes so it follow the standers :-

5.2.1.1. National environment company list chick number follow standers

As showns in figure 5.5 the total yes of company following the standers in the this question is 66% , Figure 5.4 national environment company follow standers and it is about 66.67% which it is good .

TOTAL YES	TOTAL NO	YES %
0	3	0.00
2	1	66.67
2	1	66.67
2	1	66.67
2	1	66.67
2	1	66.67
1	2	33.33
0	3	0.00
2	1	66.67
0	3	0.00
1	2	33.33
1	2	33.33

Figure 5.5

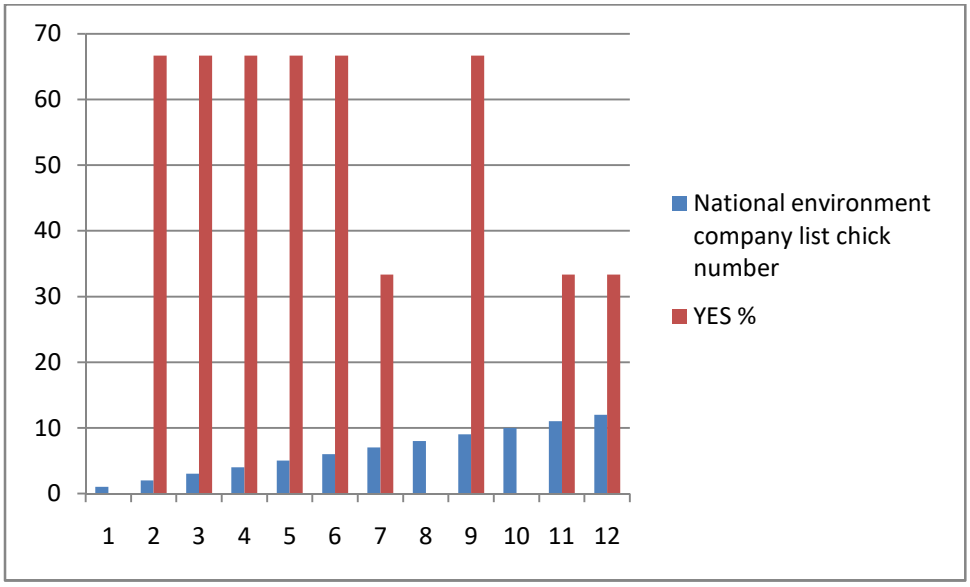


Figure 5.4 national environment company follow standers

5.2.1.2. Raised Floor company list chick number

For this question as shown in table 5.6 there are three type of raised floor and the stander is to use Die form elded steel shell with cementations core and there are jest 4 company chose this type but die formed welded steel construction is ok some time as see the are 6 company chose it , jest there are tow company not follow the standers , in table 5.7 shown the percentage of company follows the standers and it is about 33.33% as shone in figure 5.5

Raised Floor company list chick number	Die form elded steel shell with cementations core	Other	Die formed welded steel construction	choice of company
1	NO	NO	YES	Die formed welded steel construction
2	NO	NO	YES	Die formed welded steel construction
3	NO	NO	YES	Die formed welded steel construction
4	NO	NO	YES	Die formed welded steel construction
5	NO	NO	YES	Die formed welded steel construction
6	YES	NO	NO	Die form elded steel shell with cementations core
7	YES	NO	NO	Die form elded steel shell with cementations core
8	NO	NO	YES	Die formed welded steel construction
9	YES	NO	NO	other
10	NO	YES	NO	other
11	NO	YES	NO	other
12	YES	NO	NO	Die form elded steel shell with cementations core

Table 5.6 Raised Floor company list chick number

question	how many company choice	%
Die form elded steel shell with cementations core	4	33.33
Die formed welded steel construction	6	50.00
other	2	16.66

Table 5.7 how many company choice

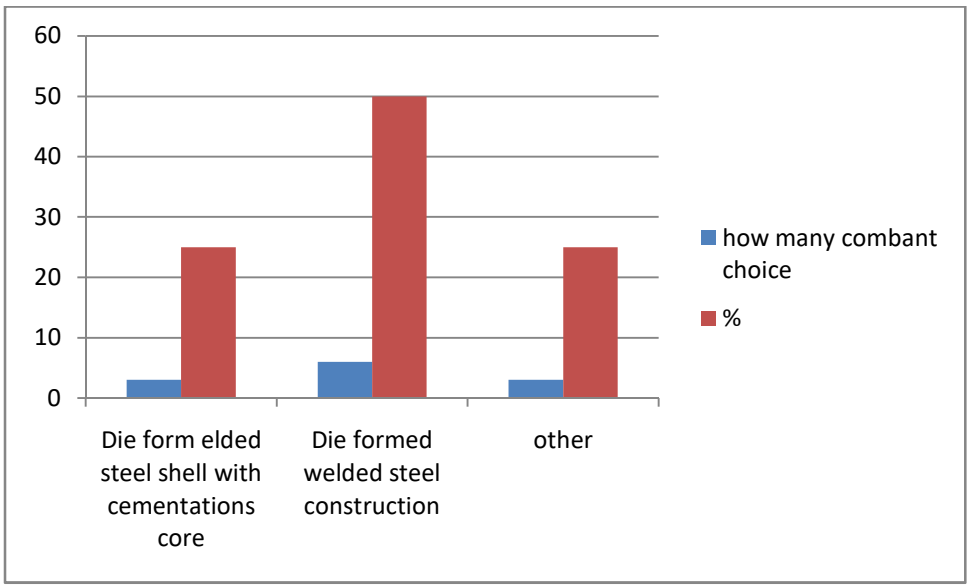


Figure 5.5 Raised Floor company list chick number

5.2.1.3. Raised floor needs to be connected to the ground

As in table 5.8 there are 10 company connect raised floor to ground which give 83.33% of company following the standers and 16.67% not follows , and as in figure 5.6 see it is very good because grounding the raised floor to ground in very important to avoid any electrical choke or problems

Raised floor needs to be connected to the ground wire company chick list	Are All racks and raised floor individually bonded to the SRG ?	YES %	NO %
1	YES	83.33	16.67
2	YES		
3	YES		
4	YES		
5	YES		
6	YES		
7	NO		
8	NO		
9	YES		
10	YES		
11	YES		
12	YES		

Table 5.8 Raised floor needs to be connected to the ground wire company chick list

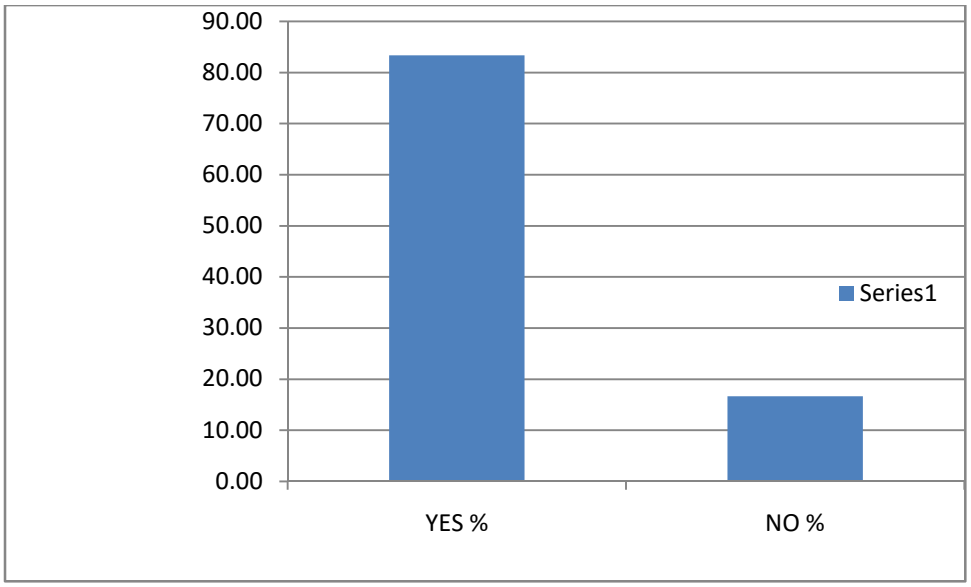


Figure 5.6 Raised floor needs to be connected to the ground yes & no percentage

5.2.1.4. Power Infrastructure company chick list

Power distribution is tow type it is single feed and dual feed which it is the standers as shown in table 5.9there are 3 company chose dual feed as stander , as shown in figure 5.7 company following standers is jest 3% and may be that is the reason for downtime and breaking in the network and the continuous of the service

	company not follow standers	company follow standers
Power Infrastructure company chick list	What type of power distribution in racks-SINGLE FEED	What type of power distribution in racks-DUAL FEED
1	YES	NO
2	YES	NO
3	YES	NO
4	YES	NO
5	YES	NO
6	YES	NO
7	YES	NO
8	YES	NO
9	NO	YES
10	NO	YES
11	YES	NO
12	NO	YES

Table 5.9 Power Infrastructure company chick list

company follow standers %	**9**
company not follow standers %	**75**
company follow standers	**3**
company follow standers	**25**

Table 5.10 Power Infrastructure company follow standers chick list

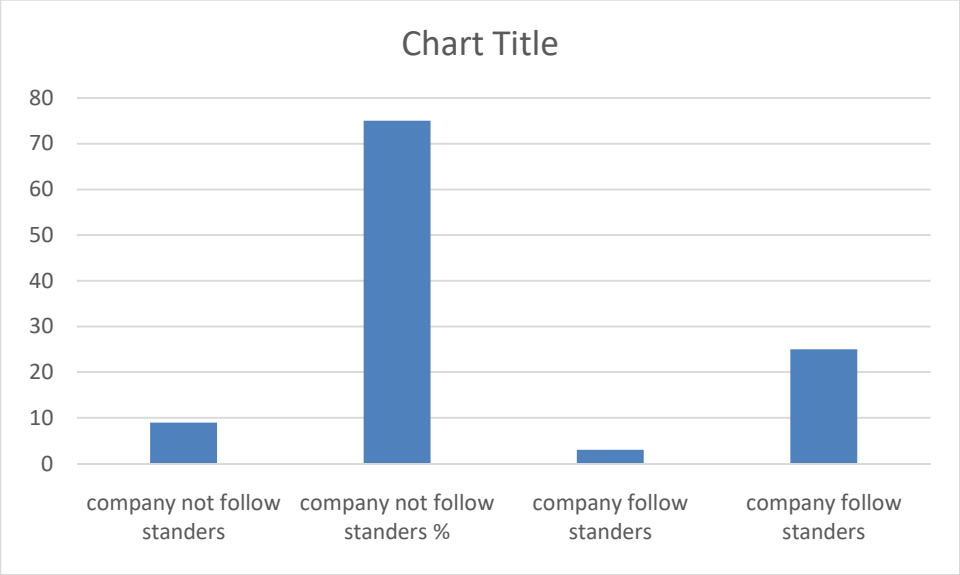


Figure 5.7 Power Infrastructure company chick list

5.2.1.5. Testing the ground resistance

As in table 5.11 shone jest 5 company do this test to avoid electric problems and this give a 41.67% as in table 5.12 .

Testing the ground resistance Rg > 5 ohm	Testing the ground resistance No test
NO	YES
NO	NO
NO	NO
YES	NO
NO	NO
YES	NO
NO	NO
YES	NO
YES	NO
YES	NO
NO	YES
NO	YES

Table 5.11 Testing the ground resistance

number of company follow stander	company standers %
4.00	**33.33**
number of company follow bad stander	**very bad standers %**
5.00	**41.67**
3.00	**25.00**

Table 5.12 number of company follow stander

5.2.1.6. Generators sets company chick list

Any company have to make chick for backup power as shone in table 5.12 at free load there are 3 follows standers and at full load jest 7 company but there are no one do this test full load and free load in same time which is very bad to continuing IT service , figure 5.8 shown a bade percentage for following the standers

Generators sets company chick list	At free – load every month	At full- load every quarterly	No testing in year
1	NO	NO	YES
2	NO	YES	NO
3	NO	YES	NO
4	YES	NO	NO
5	YES	NO	NO
6	YES	NO	NO
7	NO	YES	NO
8	NO	YES	NO
9	NO	YES	NO
10	NO	YES	NO
11	NO	YES	NO
12	NO	NO	YES

Table 5.12 Generators sets company chick list

At free – load every month	3.00	25.00
At full- load every quarterly	7.00	58.33
No testing in year	2.00	16.67

Table 5.13 total of percentage for generators

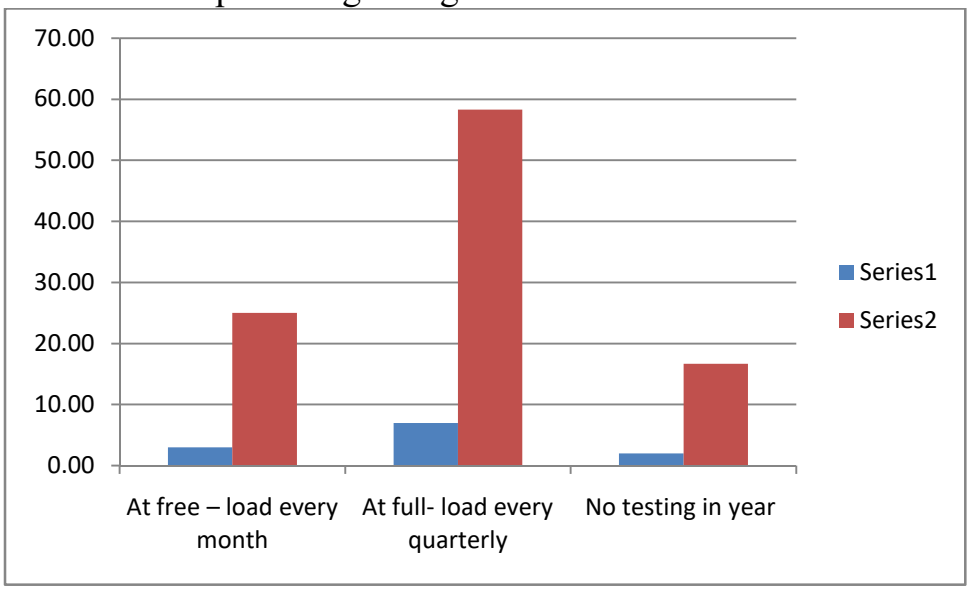


Figure 5.8 Generators sets company chick list

5.2.1.7. The type of UPS company chick list

There are tow type of USP static system and dynamic system as shown in table 5.14 there are 8 company use static system which no follow the standers may be it is very cheep and figure 5.9 show that the company follows standers jest 33.33%

The type of UPS company chick list	Static UPS system	Dynamic UPS
1	YES	NO
2	NO	YES
3	YES	NO
4	YES	NO
5	YES	NO
6	YES	NO
7	YES	NO
8	NO	YES
9	YES	NO
10	NO	YES
11	YES	NO
12	NO	YES

Table 5.14 The type of UPS company chick list

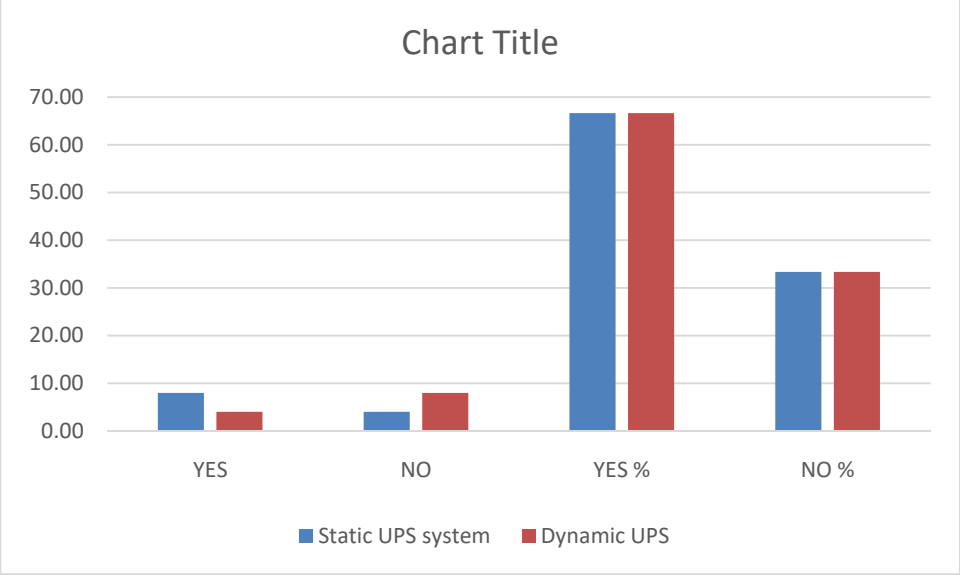


Figure 5.9 The type of UPS company chick list

5.3 Recommendation

Through this project, we are trying to set global standards for the manufacture and construction of rooms for information servers at the level of Sudan, based on international standards, to ensure the continuity of network and information services.

I strongly recommend that the project be adopted as a reference or as standards for all contractors working in the field of building rooms for information centers, so that the principle of continuity of information services is achieved.

I also recommend government institutions to match these standards with server rooms, in order to reduce the problems of network outages and information services.

I strongly recommend the Ministry of Technology and Information and the Sudanese Communications Supervision Authority to study this project and set it as a standard for designing server room centers for all companies and governmental and private institutions that rely on electronic and information services in order to end the suffering that is represented by network disruption in government institutions in particular and companies General .

In the end, I would like to thank Prof. Ashraf, my supervisor in this project, for his assistance in the work of the supplementary project to obtain a master's degree in telecommunications engineering.

References

1. Data Center Telecom Cabling Standards (JonathanJew Jonathan Jew J&M Consultants, Inc. Vice-chairTIATR-42.6TelecomAdministration Vicechair TIA TR42.6 Telecom Administration Editor ISO/IEC TR 14763-2-1 Telecom Identifiers Co-editor TIA-942-A Data Centers Telecom Infrastructure CochairBICSIDataCenterSubcommittee)
2. Voltage Disturbances Standard EN 50160 Voltage Characteristics in Public Distribution Systems (Henryk Markiewicz & Antoni Klajn Wroclaw University of Technology July 2004)
3. A D M I N IS T R AT IO N S TA N DARD FOR T E L E C O M M U N IC AT IO N S I N F R A S T R U C T U R E (For more information, please go to www.imap.textron.com)
4. BICSI International Standards (8610 Hidden River Parkway Tampa, FL 33637-1000 USA)
5. ANSI/TIA/EIA-606 (Administration Standard for the Telecommunications Infrastructure of Commercial Buildings) Head Office 7/131 Thai Ha – Dong Da – Hanoi – Vietnam Tel: +84.4.5376480 Fax: +84.4.5376481 Email: info@nds.com.vn Web: www.nds.com.vn

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Results tables

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National environment-Are there no known subsurface contamination from either on – site hazard waste storage or other adjacent site ?	1-2.
National environment-For groundwater issues concerns , if the data center is slab on grade on the top of a hill ?	1-3.
National environment-Is the area less than or equal to annual probability of win in excess of 129 km/hr (80 mph) ?	1-4.
What types of the raised floor ? Die formed welded steel construction	2-1.
What types of the raised floor ?Die form elded steel shell with cementations core	2-2.
What types of the raised floor ?Other	2-3.
Grounding of Raised floor Are All racks and raised floor individually bonded to the SRG ?	3-1.
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Power Infrastructure Testing the ground resistance-1 ohm < Rg< 5 ohm	4-2-1.
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Electric Utility Service feeds Dual entrance / dual pathway	7-3.

Table 5.1 numbering the questions

Table 5.2 total of yes & no

questoins number	Total Yes	Total No	YES %	NO %
1-1.	7.00	5.00	58.33	41.67
1-2.	6.00	6.00	50.00	50.00
1-3.	4.00	8.00	33.33	66.67
1-4.	5.00	7.00	41.67	58.33
2-1.	6.00	6.00	50.00	50.00
2-2.	4.00	8.00	33.33	66.67
2-3.	2.00	10.00	16.67	83.33
3-1.	10.00	2.00	83.33	16.67
4-1-1.	9.00	3.00	75.00	25.00
4-1-2.	3.00	9.00	25.00	75.00
4-2-1.	2.00	8.00	16.67	66.67

4-2-2.	5.00	7.00	41.67	58.33
4-2-3.	3.00	9.00	25.00	75.00
4-3-1.	3.00	9.00	25.00	75.00
4-3-2.	7.00	5.00	58.33	41.67
4-3-3.	2.00	10.00	16.67	83.33
4-4-1.	8.00	4.00	66.67	33.33
4-4-2.	4.00	8.00	33.33	66.67
5-1.	5.00	7.00	41.67	58.33
5-2.	7.00	5.00	58.33	41.67
6-1.	5.00	7.00	41.67	58.33
6-2.	6.00	6.00	50.00	50.00
7-1.	2.00	10.00	16.67	83.33
7-2.	1.00	11.00	8.33	91.67
7-3.	4.00	8.00	33.33	66.67

Table 5.3 percentage of yes

questoins number	Total Yes	YES %
1-1.	7.00	58.33
1-2.	6.00	50.00
1-3.	4.00	33.33
1-4.	5.00	41.67
2-1.	6.00	50.00
2-2.	4.00	33.33
2-3.	2.00	16.67
3-1.	10.00	83.33
4-1-1.	9.00	75.00
4-1-2.	3.00	25.00
4-2-1.	2.00	16.67
4-2-2.	5.00	41.67
4-2-3.	3.00	25.00
4-3-1.	3.00	25.00
4-3-2.	7.00	58.33
4-3-3.	2.00	16.67
4-4-1.	8.00	66.67
4-4-2.	4.00	33.33
5-1.	5.00	41.67
5-2.	7.00	58.33
6-1.	5.00	41.67
6-2.	6.00	50.00
7-1.	2.00	16.67
7-2.	1.00	8.33
7-3.	4.00	33.33

Table 5.4 percentage of No

questions number	Total No	N0 %
1-1.	5.00	41.67
1-2.	6.00	50.00
1-3.	8.00	66.67
1-4.	7.00	58.33
2-1.	6.00	50.00
2-2.	8.00	66.67
2-3.	10.00	83.33
3-1.	2.00	16.67
4-1-1.	3.00	25.00
4-1-2.	9.00	75.00
4-2-1.	8.00	66.67
4-2-2.	7.00	58.33
4-2-3.	9.00	75.00
4-3-1.	9.00	75.00
4-3-2.	5.00	41.67
4-3-3.	10.00	83.33
4-4-1.	4.00	33.33
4-4-2.	8.00	66.67
5-1.	7.00	58.33
5-2.	5.00	41.67
6-1.	7.00	58.33
6-2.	6.00	50.00
7-1.	10.00	83.33
7-2.	11.00	91.67
7-3.	8.00	66.67

Table 5.5 National environment company list chick number follow standers

TOTAL YES	TOTAL NO	YES %
0	3	0.00
2	1	66.67
2	1	66.67
2	1	66.67
2	1	66.67
2	1	66.67
1	2	33.33
0	3	0.00
2	1	66.67
0	3	0.00
1	2	33.33
1	2	33.33

Table 5.6 Raised Floor company list chick number

Raised Floor company list chick number	Die form elded steel shell with cementations core	Other	Die formed welded steel construction	choice of company
1	NO	NO	YES	Die formed welded steel construction
2	NO	NO	YES	Die formed welded steel construction
3	NO	NO	YES	Die formed welded steel construction
4	NO	NO	YES	Die formed welded steel construction
5	NO	NO	YES	Die formed welded steel construction
6	YES	NO	NO	Die form elded steel shell with cementations core
7	YES	NO	NO	Die form elded steel shell with cementations core
8	NO	NO	YES	Die formed welded steel construction
9	YES	NO	NO	other
10	NO	YES	NO	other
11	NO	YES	NO	other
12	YES	NO	NO	Die form elded steel shell with cementations core

Table 5.7 how many company choice

question	how many compant choice	%
Die form elded steel shell with cementations core	4	33.33
Die formed welded steel construction	6	50.00
other	2	16.66

Table 5.8 Raised floor needs to be connected to the ground wire company chick list

Raised floor needs to be connected to the ground wire combany chick list	Are All racks and raised floor individually bonded to the SRG ?	**YES %**	**NO %**
1	YES	**83.33**	**16.67**
2	YES		
3	YES		
4	YES		
5	YES		
6	YES		
7	NO		
8	NO		
9	YES		
10	YES		
11	YES		
12	YES		

Table 5.9 Power Infrastructure company chick list

	company not follow standers	company follow standers
Power Infrastructure company chick list	What type of power distribution in racks-SINGLE FEED	What type of power distribution in racks-DUAL FEED
1	YES	NO
2	YES	NO
3	YES	NO
4	YES	NO
5	YES	NO
6	YES	NO
7	YES	NO
8	YES	NO
9	NO	YES
10	NO	YES
11	YES	NO
12	NO	YES

Table 5.10 Power Infrastructure company follow standers chick list

company not follow standers	**9**
company not follow standers %	**75**
company follow standers	**3**
company follow standers	**25**

Table 5.11 Testing the ground resistance

Testing the ground resistance Rg > 5 ohm	Testing the ground resistance No test
NO	YES
NO	NO
NO	NO
YES	NO
NO	NO
YES	NO
NO	NO
YES	NO
YES	NO
YES	NO
NO	YES
NO	YES

Table 5.12 number of company follow stander

number of company follow stander	company standers %
4.00	33.33
number of company follow bad stander	very bad standers %
5.00	41.67
3.00	25.00

Table 5.12 Generators sets company chick list

Generators sets company chick list	At free – load every month	At full- load every quarterly	No testing in year
1	NO	NO	YES
2	NO	YES	NO
3	NO	YES	NO
4	YES	NO	NO
5	YES	NO	NO
6	YES	NO	NO
7	NO	YES	NO
8	NO	YES	NO
9	NO	YES	NO
10	NO	YES	NO
11	NO	YES	NO
12	NO	NO	YES

Table 5.13 total of percentage for generators

At free – load every month	3.00	25.00
At full- load every quarterly	7.00	58.33
No testing in year	2.00	16.67

Table 5.14 The type of UPS company chick list

The type of UPS company chick list	Static UPS system	Dynamic UPS
1	YES	NO
2	NO	YES
3	YES	NO
4	YES	NO
5	YES	NO
6	YES	NO
7	YES	NO
8	NO	YES
9	YES	NO
10	NO	YES
11	YES	NO
12	NO	YES

Table 5.15 company chick list

company chick list	YES	NO	YES %	NO %
Static UPS system	8.00	4.00	66.67	33.33
Dynamic UPS	4.00	8.00	66.67	33.33

Table 5.16 Cooling flow come from company chick list

Cooling flow come from company chick list	Top flow / throw	Down flow / throw
1	YES	NO
2	YES	NO
3	NO	YES
4	NO	YES
5	YES	NO
6	NO	YES
7	YES	NO
8	NO	YES
9	NO	YES
10	NO	YES
11	YES	NO
12	NO	YES

Table 5.17 Cooling flow come from company chick list percentage

Cooling flow come from company chick list	Top flow / throw	Down flow / throw
YES	5.00	7.00
NO	7.00	5.00
percentage %	41.67	58.33

Table 5.18 Electric Utility Service feeds company chick list

Electric Utility Service feeds company chick list	Single entrance single pathway	Dual entrance / dual pathway
1	YES	NO
2	YES	NO
3	NO	NO
4	YES	NO
5	NO	NO
6	YES	NO
7	YES	NO
8	NO	NO
9	NO	NO
10	NO	NO
11	NO	NO
12	NO	YES

Table 5.19 Electric Utility Service feeds company percentage

YES/NO	Single entrance single pathway	Dual entrance / dual pathway
YES	**5.00**	**1.00**
NO	**7.00**	**11.00**
PERCENTAGE	**41.67**	**8.33**

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Result figures

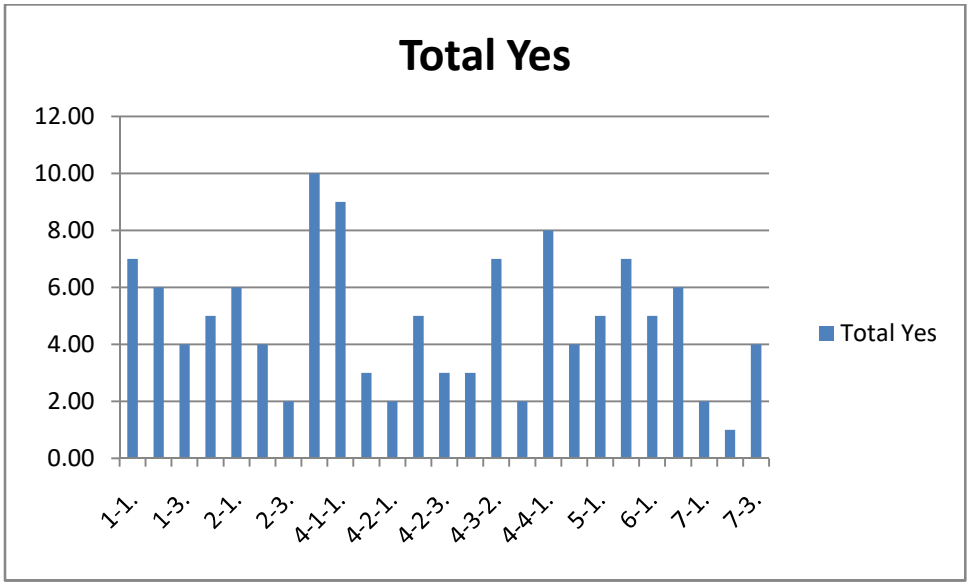

Figure 5.1 total yes

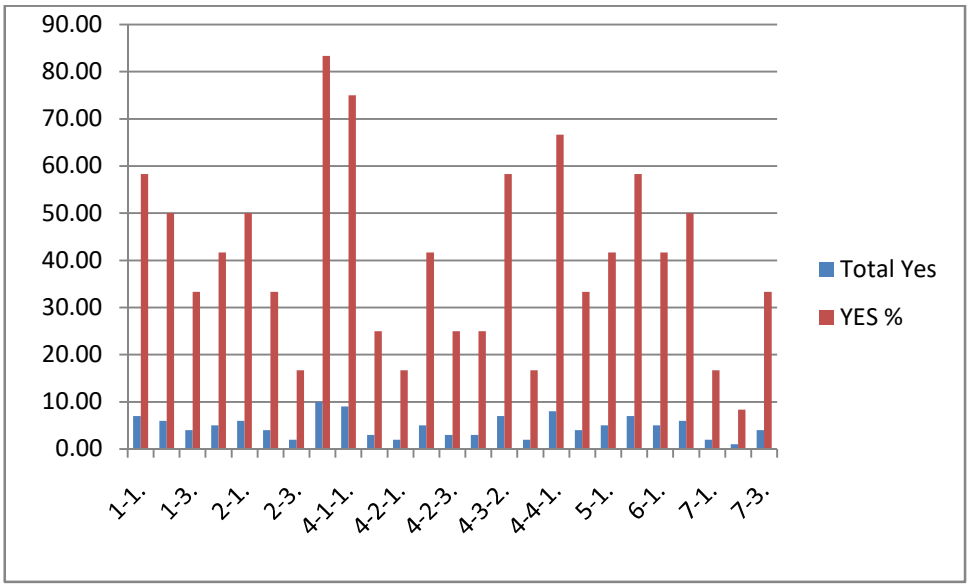

Figure 5.2 total yes percentage

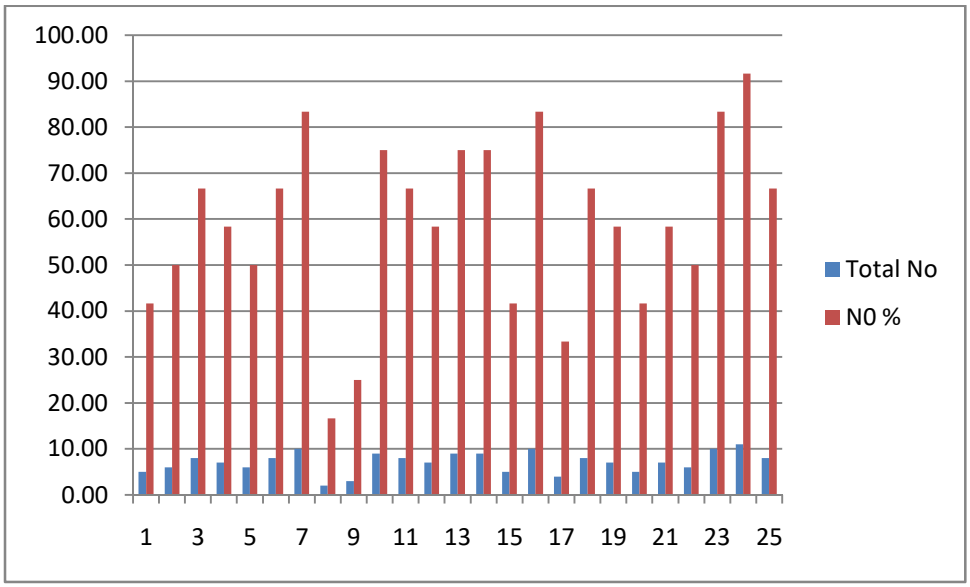

Figure 5.3 total No percentage

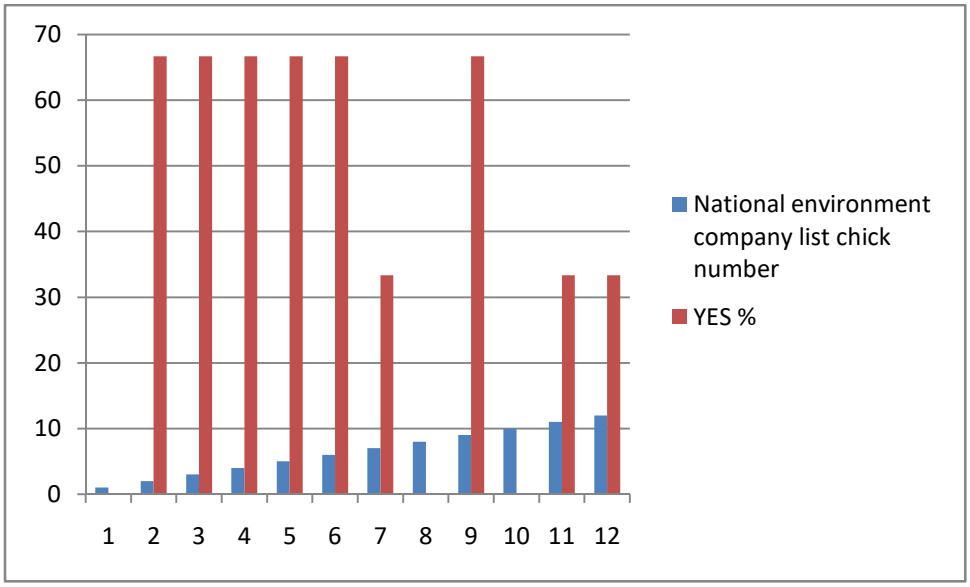

Figure 5.4 national environment company follow standers

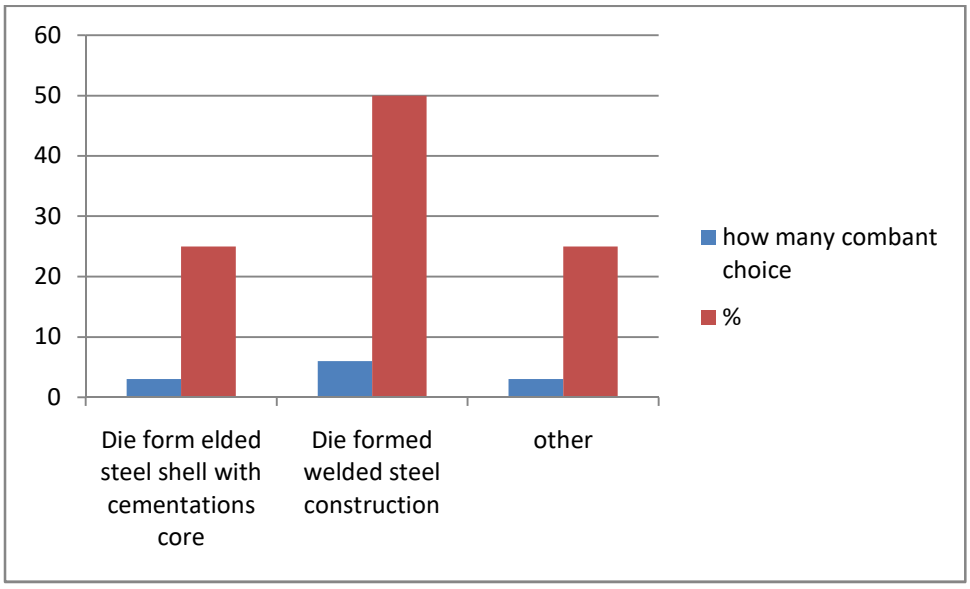

Figure 5.5 Raised Floor company list chick number

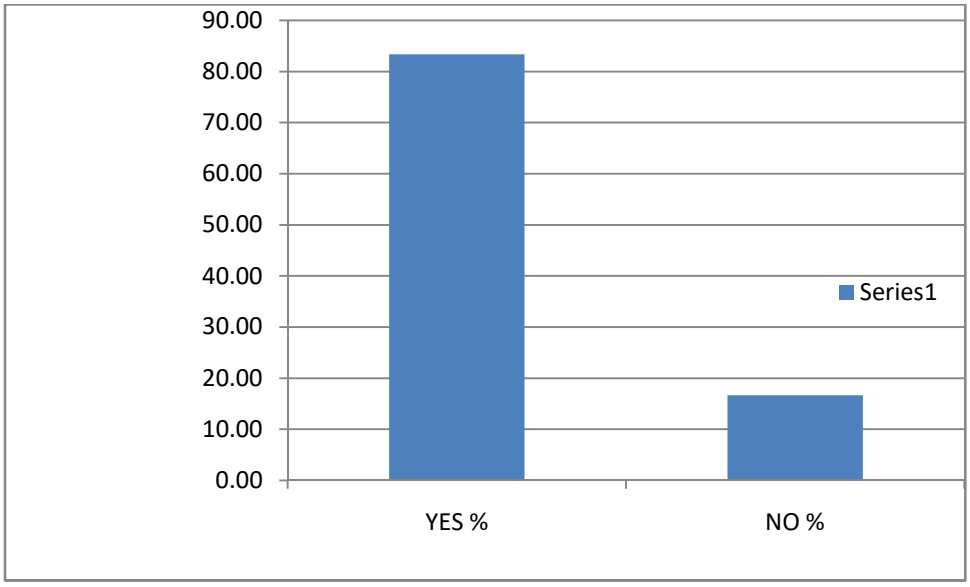

Figure 5.6 Raised floor needs to be connected to the ground yes & no percentage

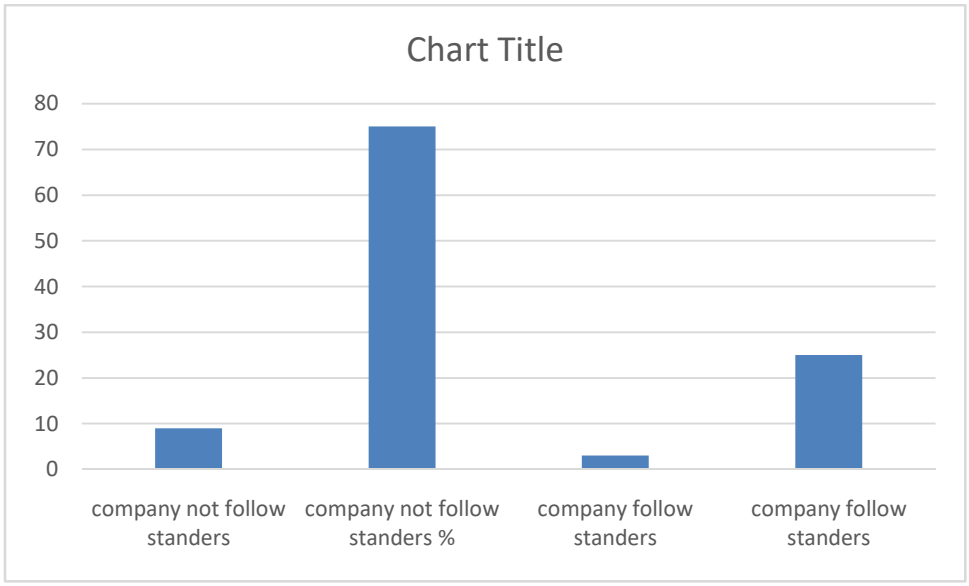

Figure 5.7 Power Infrastructure company chick list

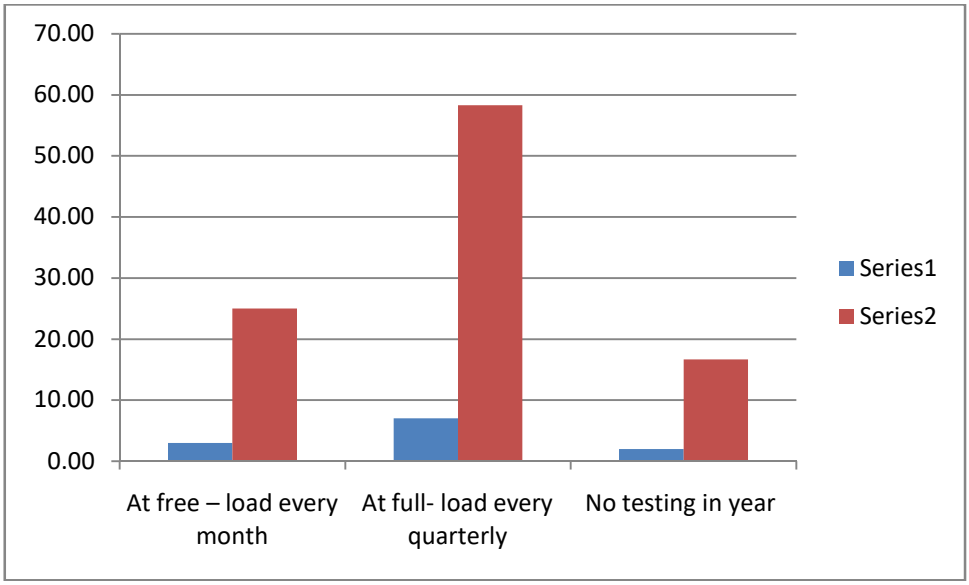

Figure 5.8 Generators sets company chick list

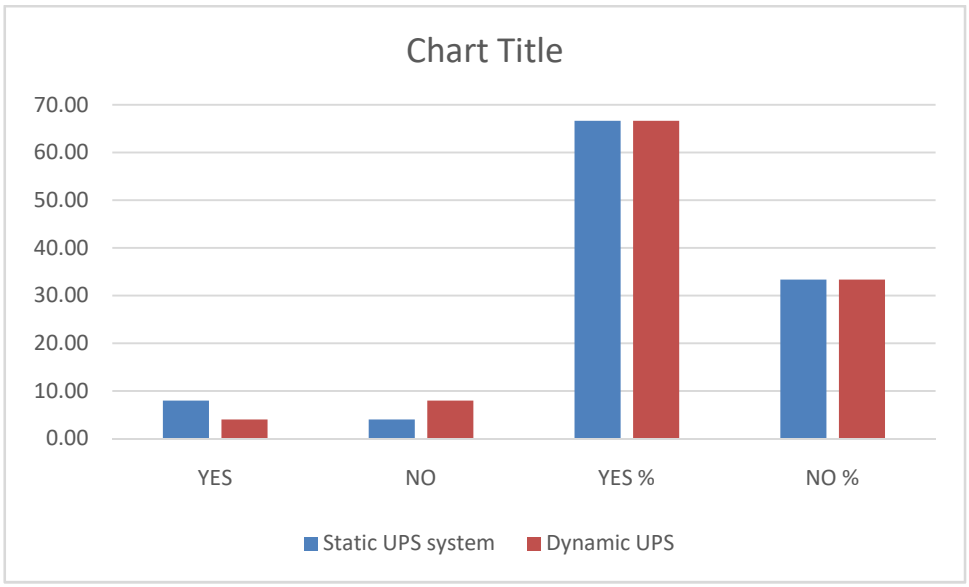

Figure 5.9 The type of UPS company chick list

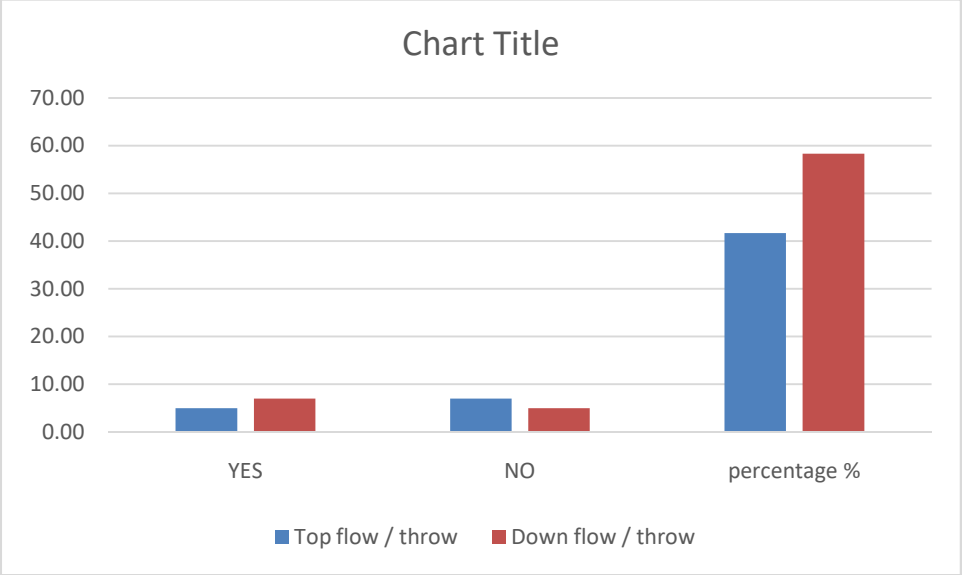

Figure 5.10 Cooling flow come from company chick list

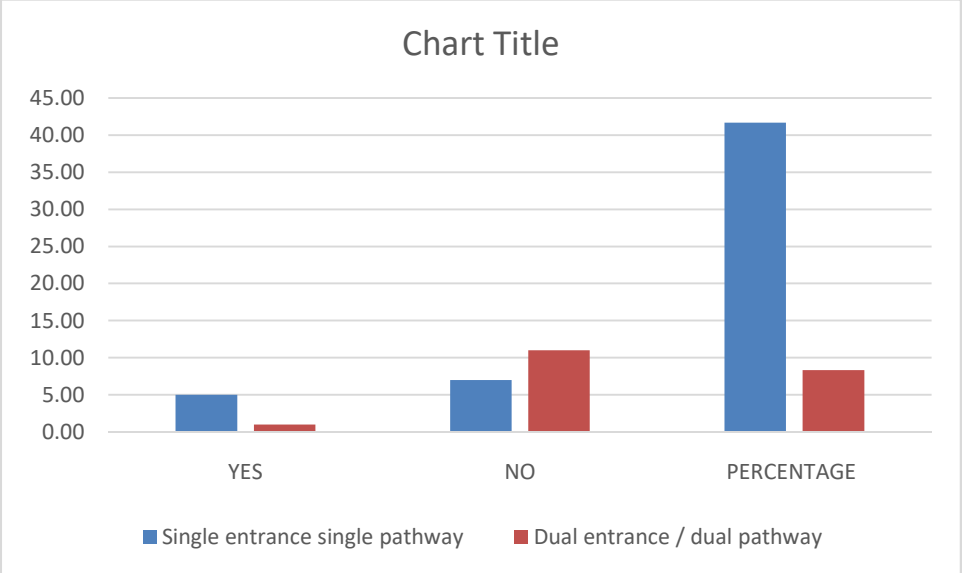

Figure 5.11 Electric Utility Service feeds company chick list

Open index C

Chick list

Questionnaire

1 - National environment

Should seismic activity and potential be considered before selecting a data center site ?

☐ YES NO ☑

Are there no known subsurface contamination from either on – site hazard waste storage or other adjacent site ?

☐ YES NO ☑

For groundwater issues concerns , if the data center is slab on grade on the top of a hill ?

☐ YES NO ☑

Is the area less than or equal to annual probability of win in excess of 129 km/hr (80 mph) ? NO

2 - Raised Floor

What types of the raised floor ?

☑ Die formed welded steel construction ☐ Die form elded steel shell with cementations core

☐ Other (_____)

3 - Grounding of Raised floor

Raised floor needs to be connected to the ground wire

Are All racks and raised floor individually bonded to the SRG ?

☑ YES ☐ NO

4- Power Infrastructure

1- Distribution

What type of power distribution in racks

☑ Single feed ☐ Dual feed

2 - Grounding in data center

Testing the ground resistance

☐ 1 ohm < Rg< 5 ohm ☐ Rg > 5 ohm ☑ No test

3 - Generators sets

Testing generators

☐ At free – load every month

☐ At full- load every quarterly

☑ No testing in year

4 - The type of UPS

☑ Static UPS system

☐ Dynamic UPS

5 - Cooling infrastructure

Is the cooling comfort Air con ☐ or precision cooling ☑

6 - Cooling flow come from

☑ Top flow / throw ☐ Down flow / throw

7 - Electric Utility Service feeds

There are three type of electric utility service what type is used ?

☑ Single entrance single pathway

☐ Single entrance / dual pathway

☐ Dual entrance / dual pathway

2

Questionnaire

1 - National environment

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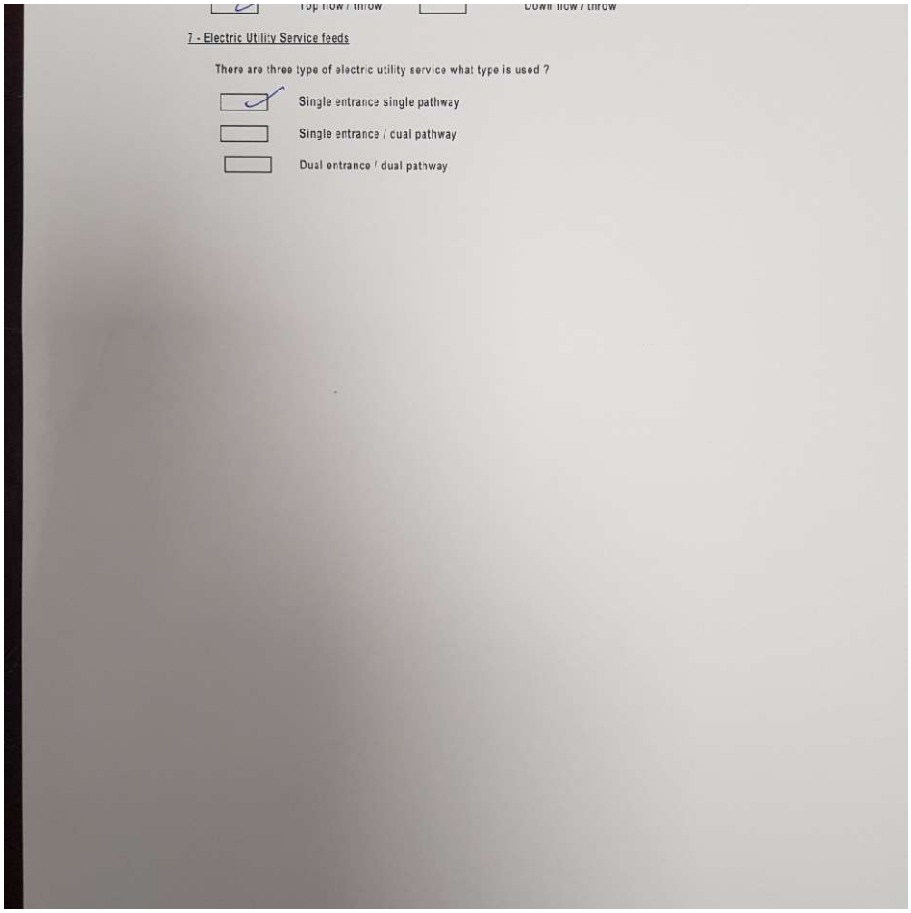
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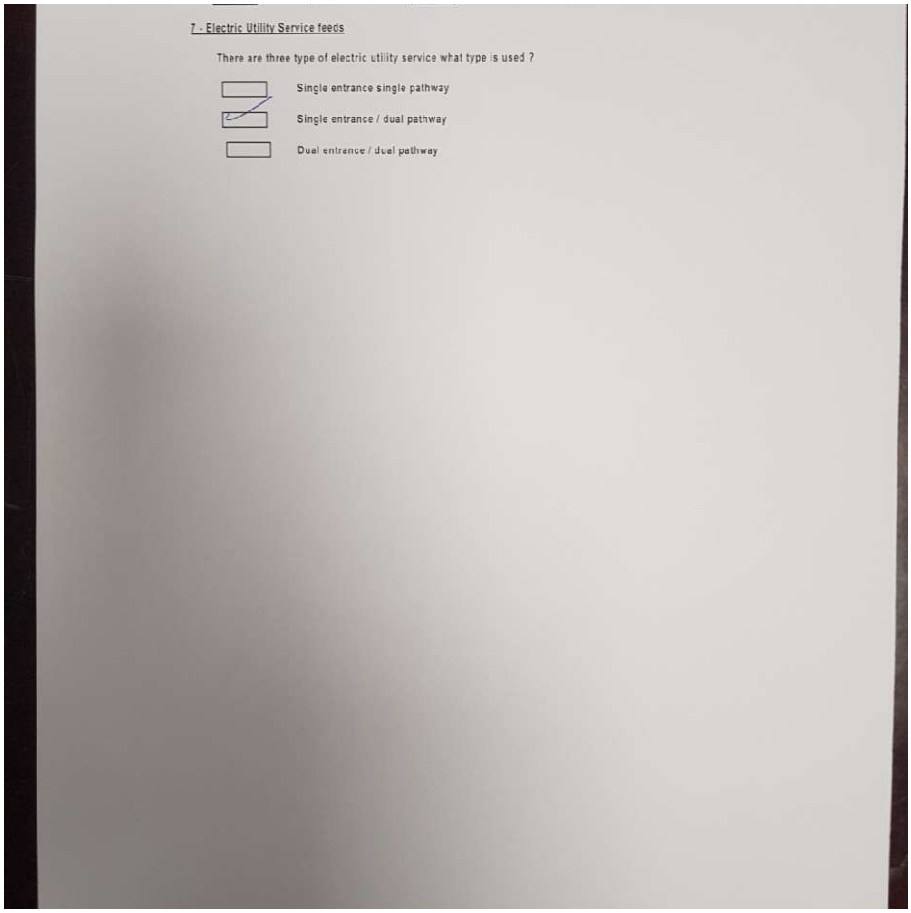

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- [x] Single entrance / dual pathway
- [ ] Dual entrence / dual pathway

4

Questionnaire

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