INTERNSHIP REPORT

ON

FUNDAMENTAL OF POWER SOLUTIONS AND MAINTAINANCE

By

Md. Moin-Ul-Hasan

ID: 2005-1-80-010

Submitted to the

Department of Electrical and Electronic Engineering

Faculty of Science and Engineering

East West University

In partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering

(B.Sc. in EEE)

EAST WEST UNIVERSITY

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Approved By

Academic Advisors

26-01-2011

S.M.Shahriar Rashid

Department Chairperson

Dr. Anisul Haque

Approval Letter

To whom it may concern

This is to certify that Md.Moin-Ul-Hasan having student ID 2005-1-80-010, has successfully completed the project work that was assigned to him as part of the internship program. I, Md.Mahfuzul Hasan Russel, on behalf of Valley Power Solutions Limited, am recommending this work as the fulfillment for the requirement of EEE 499 Industrial Training. I wish his success.

Md.Mahfuzul Hasan Russel

Assistant General Manager,

Valley Power Solutions Limited

Acknowledgment

First of all, I wish to convey my heartfelt thanks and gratitude to almighty Allah to complete the Internship successfully and also those who rendered their cooperation in making this report. Without their assistance we could not have completed my Internship.

I would like to thank and express my gratitude to Md.Mahfuzul Hasan (Assistant Manager, maintenance, sales and marketing, Valley Power Solutions Limited) for giving me opportunity to do Internship at Valley Power Solutions Limited.

I would also like to thank and express my gratitude to Mr. Wahid Hannan Ullash (Asstt. General Manager of Power Solution division looking the Data center solution and support team of Generator and CITEC Precision Air Conditioner for Data Center products. He has also 10 years experience in Power related technical fields and doing job in TVCL & Valley Power Solutions Ltd. for last 10 years. He did technical training on High End SOCOMEC SICON UPS Singapore and Bangkok.)

I would also like to thank Md. Al Mobin (Assistant Manager, Valley Power Solutions Limited) and Mr. Masum Bhuyan (Senior Executive, Support, Valley Power Solutions Limited). I have worked under their supervision. They have guided me with a lot of effort and time.

I would also like to thank Mr. Sahriar Rashid, Research Lecturer, Department of Electrical and Electronic Engineering (EEE) East West University for his generous assistance.

I also would like to thank to all the respected officers and employees of Valley Power Solutions Limited for their continuous inspiration and support.

I am also very grateful to all of my teachers and fellow friends for their encouragement and cooperation throughout my Internship and academic life.

Finally, I am forever grateful to our parents for their patience and love.

Executive Summary

This report is to introduce the fundamental of power solutions and maintenances of a data center. This report actually focuses on different machines, which are being used on Data Center Solution & Service especially on uninterruptible power system. The operations of these machines are illustrated here. The major technical part is the input electrical arrangement of these machines. The electrical arrangement for power systems is also focused in this report. We have discussed the details of uninterruptible power systems which has also been included in this report.

I worked at Valley Power Solutions Limited as intern for 6 weeks. My work was to know about Data Center Power Solution & Service. I knew about some equipment widely used in Power Solutions. I tried acquiring some knowledge about basics on power problems and solution and basics on data center from my own point of view with the help of different websites. These works are attached with this document.

Here I learned about power solution and service networking and network components. This report contains a detail description about some network components. I also learned about uninterruptible power systems. This report also contains a detailed overview of the physical aspects of the data center.

While working with Valley Power Solutions Limited, I have got a lot of opportunities to see and learn how the machines are functioning mechanically with electric power. I have tried my best to share this knowledge that has been included in this report. I would consider my effort to be successful if it has been of use to anyone.

Chronology

Date	Venue	Topic	Instructor
1. 10-06-2010	Valley Power Solutions Ltd.	Introduction	Md. Mahfuzul Hasan
2. 13-06-2010	Valley Power Solutions Ltd.	Company Profile	Md. Mahfuzul Hasan
3. 15-06-2010	Valley Power Solutions Ltd.	Basic on power problems and solutions.	Mr. Wahid Hannan
4. 17-06-2010	Valley Power Solutions Ltd.	Basics on Uninterruptible Power Systems	Mr. Wahid Hannan
5. 20-06-2010	Valley Power Solutions Ltd.	Basics on Uninterruptible Power Systems	Mr. Wahid Hannan
6. 22-06-2010	Valley Power Solutions Ltd.	Effect of power problems on equipments	Mr. Wahid Hannan
7. 24-06-2010	Valley Power Solutions Ltd.	Evaluation parameters	Mr. Wahid Hannan
8. 27-06-2010	Valley Power Solutions Ltd.	Communications and Networks	Mr. Wahid Hannan
9. 29-06-2010	Valley Power Solutions Ltd.	Installation guidelines for medium and large UPS	Mr. Wahid Hannan
10.11-07-2010	Janata Bank Limited	Visit Janata Bank Ltd., Motijheel.	Md. Al Mobin
11.13-07-2010	Janata Bank Limited	Visit Janata Bank Ltd., Motijheel	Mr. Masum Bhuyan
12.16-07-2010	Janata Bank Limited	Equipments Transfer	Mr. Masum Bhuyan
13.17-07-2010	Janata Bank Limited	Interiors design	Md. Al Mobin
14.18-07-2010	Janata Bank Limited	Interiors design	Md. Al Mobin
15.20-07-2010	Janata Bank Limited	Installation	Md. Al Mobin
16.22-07-2010	Janata Bank Limited	Observation and Maintenances	Mr. Wahid Hannan
17.25-07-2010	Valley Power Solutions Ltd.	Conclusion	Md. Mahfuzul Hasan

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Chapter1. Introduction

1-1 An Introduction to company

This chapter is designed to provide an overview of the company details. It describes company profile, history of the company, location, and list of the objective of the internship.

1-1.1 Company profile

Valley Power Solutions Limited concentrated only on Information Technology and specialized itself with more investment, inclusion of new departments to fulfill its mission to be a leader as a System Integrator in Bangladesh. As a result the Company now represents: 3Com, Nortel Networks, AT&T & Lucent Technologies Of USA, Singertel Singapore, Alcatel Of France, Wang Laboratories Inc. of USA, Socomec sicon of France-Italy for UPS, Cylink Security Product, P-Com Wireless modems Of USA, Hyundai Electronics in Bangladesh.

After having their success Valley Power Solutions Limited also concentrated on Data Center Solution & Service, building security, power protection, fire protection, precision air conditioning. Having adequate expertise, this company has the capability to serve the local need with proper support & maintenance services.

To provide their valued customer one stop total IT solution in Bangladesh, this company represents: All IT Products: Generator Set, UPS, Rectifier, Inverter, Stabilizer, Harmonic Equalizer, Surge Protection, Precision Air Conditioning System, Mission Critical Monitoring & Management System, Water Detection & related Accessories, Remote Alert System etc.

Valley Power Solutions Limited is proud to announce that their Company has in its possession the best engineers, programmers and most dynamic sales squad in our country concerning educational background and experience.

1-1.2 History of the company

Valley Power Solutions Limited has been incorporated in February 2005 as the sister concern of Tech Valley Company Limited which started it's operation way back in 1990 with a goal to serve the customer an efficient and reliable system for maximum productivity as well as lowest possible expenditure of maintenance.

1-1.3 Location

Valley Power Solutions Limited

Address: House #6, Road # 5 (1ST & 3RD Floor)
Dhanmondi R/A, Dhaka-1205.
Phone: (+ 880-2) 8616771-2, 9673589.
Fax: + 880-2-9673590.

1-1.4 Services

Valley Power Solutions Limited believe that products, innovations, partnerships and services are the key factors in addressing the information technology needs to enterprise customers today. They make sure to deliver the best of those success factors to their clients to achieve and maintain their objective for partnering with their clients and business partners to build and manage their business effectively and productively, thus assuring them profitability and growth.

Valley Power Solutions Limited also has consulting services where consultants are trained to design solutions which will handle the issues facing your IT department. Once they complete a technology assessment of your current system and build projections for future needs, they will configure possible solutions to meet your IT objectives.

Consulting services:

- Data Center Planning & Virtualization Design /Architecture Services
- Data Center Power & Cooling Systems Analysis

- Data Center Feasibility Studies & Project Cost Budgeting
- Data Center Availability & Risk Assessment
- Technology Master Format Planning
- Data Center Site Selection
- Business Continuity & Disaster Recovery
- Data Center Relocation Evaluation & Planning
- Project Management

1-1.5 Solutions

Valley Power Solutions Limited provides help with the physical aspect of the data center. They have proficiency in expansion and design of the data center build-out process, creating solutions for DR planning and execution

Evolving Solutions provides IT Managers with many Data Center Design solutions to fit their needs. They have the experience and the understanding to consult with businesses of all sizes to determine the best approach for growing the physical aspects of their data center.

Evolving Solutions has Data Center Solutions which can help you fulfill business requirements your IT Management decision making challenges. They offer solutions related to Data center constraints with On Demand architectures and applications which require 24x7 uptime, tightening your security infrastructure with new policies or new technologies.

Valley Power Solutions Limited can assist with

- Data center design
- Power design
- Fire protection design and environmental risk
- Air conditioning System design
- Redundancy
- Physical security

1-2 Objective of the Internship

- To present the overview of Valley Power Solutions Limited.
- To know about some equipments widely used in Power Solutions.
- To acquire some knowledge about uninterruptable power supply.
- To acquire some knowledge about basic data center.
- To present some electrical equipment such as Data Center Power & Cooling Systems Analysis.

1-3 Scope

This report actually provides a complete overview of Data Center Power Solutions Process based on uninterruptable power system. It also contains description of some electrical equipments being used in Data Center.

1-4 Methodology

This report has been written on the basis of information collected from primary sources as well as secondary sources. The primary information has been collected from personal observation, discussion with mentor and technicians. The secondary information has been taken from the company's website and manuals.

Details of internship work

At its most basic, the data center is a physical place that houses a computer network's most critical systems, including backup power supplies, air conditioning, and security applications. First we have observed the physical aspect of the data center and studied the operation and the electrical arrangement of the data center. Acquiring basic knowledge about some equipment widely used in Power Solutions especially on uninterruptable power supply.

Chapter2. Basic on power problems and solutions

2-1 Introduction

This chapter is designed to provide an overview of the basic on power problems and solutions. It addresses the current situation, Effect of power problems on equipments, Solutions to power problems, and uses of UPS.

2-2 The current situation

The increasing sophistication of Information Technology Equipment (IT) and automated industrial systems and their increased performance levels e.g. the speed of data processing, the real time interconnection of telecommunications systems, continuous and automated operation, etc. means that they are more and more vulnerable and dependent on their electrical power supply.

This electrical energy is distributed in a waveform making up a single and three phase sinusoidal system characterized by its:

- frequency,
- amplitude,
- shape (wave distortion),
- system symmetry.

Whilst at the power station feeder, the voltage wave is virtually perfect, the same cannot be said by the time it reaches the user, where several different types of disturbances can be observed:

- transients,
- sags/brownouts,
- frequency variations,
- outage – blackouts.

The source of these disturbances which are related to power transmission and distribution and to both the atmospheric (storms, frost, wind, etc.) and the industrial environment (machine anomalies, polluting current consumers, network incidents, etc.).

Therefore, in spite of constant improvements to distribution networks and to the quality of the "electricity product", disturbances remain frequent and indeed it would not be economically viable, or technically feasible to eliminate them completely.

2-3 Effect of power problems on equipments

Here again, very great progress has been made by manufacturers to make equipment less sensitive to all these disturbances (better surge immunity, tolerance to brownouts of up to 10 or 20%, or even to outages of between 5 and 10 ms). As opposed to this however, the increasing sophistication of many computing and industrial applications, the use of high performance plc's and the continuous operation of industrial processes and telecommunications make the consequences of these disturbances increasingly serious.

They can therefore cause production losses, deterioration of product quality, serious risks to people and property and even to the existence of the company, since studies show that one in two companies never recover from a serious IT system failure.

In the IT field a recent survey carried out in UK by the National Computing Centre estimates the average cost of electrical power failures at between £9k -£30K, or in other words more than caused by lightning or theft. For example, any file server and its attached hard disk should be connected to an UPS:

> the file server directory for most network systems is held in RAM for ease of access. A split second power cut can erase it completely.

> the UNIX environment calls for all system files to be permanently opened in RAM. If power is lost, even momentarily, the entire operating system may have to be re-installed, together with application software. Server protection is only the first line of defense; workstations need UPS protection against power cuts too.

Less visible, and therefore all the more harmful, are the effects which can be seen in terms of premature ageing of equipment as well as deterioration of its reliability and dependability.

As I will see, there are several ways in which we can reduced cost maintenance contacts to our customers equipped with UPS systems and protect or desensitize existing equipment.

2-3.1 Solutions to power problems

This document will cover all solutions from the simplest through to the highest performing or most versatile.

2-3.2 Built in protection

Numerous technical solutions exist and the user's choice must be made as a function of several parameters (cost, type of disturbance, characteristics of the equipment to be protected, the electrical distribution on site, criticality of the application to be protected, etc.)

Some equipment includes in-built protection, but this is often reduced to protection against the most frequently encountered types of transients, brownouts or brief outages (using batteries or capacitors).

In addition, the solutions provided in everyday equipment are relatively ineffective and may simply boil down to protection (non destruction) of the device, a "clean" shut-down or the saving of essential data. They rarely enable the continuation of normal use of the sensitive equipment.

Indeed, to be able to continue operation in the event of a failure of the normal supply for more than 10 to 20 ms requires the instant switching in of a replacement supply using the energy stored in an inertia wheel or in a set of batteries.

It should be noted that today these two means remain the only ways of easily storing energy to replace a power source greater than several hundreds of watts. Valley Power Solutions Limited will look at their functions and characteristics in the section dealing with uninterruptible power supply interfaces.

2-3.3 Software methods

These methods are of course used in digital data processing equipment (computers, mainframes, plc's, telecommunication and process control equipment).Their use is mainly limited to reducing or eliminating the consequences of a disturbance on the equipment or the application by using means such as :

> systematic and regular backing up of data to a permanent support that is insensitive to disturbances,

> automatic equipment shut-down and start-up procedures,

> auto supply monitoring by the machine to detect any disturbance which may be detrimental to its operation and warning the operator or restarting an interrupted sequence, or even taking a decision concerning the product currently being produced in a process (reject or restart).

Software methods are limited on machines working in real-time, networked with constant interconnection and data exchange, or for continuous processes for which the stoppage of the equipment during the process could be hazardous (e.g. in the chemical or petrochemical industries), or cause great loss of production or irreversible loss of information.

It should also be noted that these methods require additional programs and memory resources and can still lead to a lengthy stoppage of the application outage can lead to the shut-down (although it would be "clean") of a production unit or a computer for several minutes or even more.

2-4 Filter, Isolating, Transformers, Voltage Regulators

When built-in solutions have not been provided by the manufacturer or prove too costly to be included in each piece of equipment, the solution often involves adding an interface between the power network and the application or group of applications to be protected (centralized protection).

2-4.1 Filters

The filter is the simplest solution. It protects against magnetic or radio electrical interference and atmospheric disturbances (it may be combined with a lightning arrester).

2-4.2 Isolating transformers

An isolating transformer equipped with an electrostatic screen enables the reduction of high frequency interference in common and cross-connected mode. The attenuation level achieved will vary according to the quality of the transformer's design and manufacture. Here again, no protection is provided against other types of disturbances.

However, an isolating transformer enables earth leakage currents to be reduced in an electrical installation by localizing them to the circuits supplied power by the secondary. The use of certain coupling arrangements in three phase transformers also enables certain harmonic currents to be reduced in the primary (3^{rd} harmonic and multiples of 3).

2-4.3 Voltage regulators and network conditioners

A voltage regulator maintains the output voltage constant in spite of variations in its input voltage.

There exist mainly two types:

> Ferro-resonant regulators,
> Electromechanical regulators.

The criteria to be considered when evaluating the performance of regulators are the regulating range, the load variation response and the speed and flexibility of regulation.

Whilst regulators resolve problems of voltage variations, they are often ineffective against noise transients and frequency variations. In response to this problem, the solution involves combing an isolating transformer and a voltage regulator: this is the so-called network or line voltage conditioner.

Two major types of conditioners exist corresponding to the two different voltage regulation technologies described above:

> ferro resonant conditioners and
> static tapping switching conditioners.

Whilst they provide a good solution to major voltage variations and noise transients, conditioners are completely ineffective against outages (> 10ms) and frequency variations which only systems with "back-up" can remedy.

2-4.4 Direct current power supplies

This solution is especially used in security systems, but also in telecommunications equipment and the supply of relays or contactors.

This supply comprises a rectifier and an energy storage unit:

> Capacitors for back-up of less than 1 second,
> Sets of batteries for greater back-up times.

This system is simple and cost effective, but it requires a device with a permanent direct current supply of a voltage of between 12 and 220V. In the case of a centralized back-up solution, it will also require the installation of a separate direct current distribution circuit.

2-4.5 Rotary solutions

There are different variations of rotary uninterruptible power systems, but all of them use motor-generator sets with the generator output going to the critical load.

One version combines a motor and a generator with a highly simplified static inverter. The inverter filters out mains disturbances and regulates only the frequency of its output signal (generally in "square – wave" form) which supplies a regulated motor-generator set. The motor-generator set generates reliable output voltage sine wave taking the inverter output frequency as a reference.

A second version combines a synchronous machine (regulator-generator), an induction coupling and a diesel engine with a free wheeling clutch.

This dynamic solutions are used in large installations (above 300 or 500 kVA) and mainly for applications in an industrial environment.
The arguments often put forward in favors of these "dynamic" solutions are as follows:

>high short-circuit current, galvanic isolation and low internal impedance providing good tolerance to non-linear loads.

But the main disadvantages of the rotary UPS's are the high noise level (70 to 95 dBA), bearing replacement with long downtime, important dimensions and weight.

2-5 Static Uninterruptible Power Systems (or UPS's)

More than 25 years after they first appeared, uninterruptible power systems (UPS) now represent more than 95% of back-up power interfaces sold and over 98% for sensitive IT and electronics applications.
I will briefly recap on how they work, how they are used and the technical possibilities offered to users.

2-5.1 A review of how they work

Acting as an interface between the mains and sensitive applications,

> UPSs supply the load with continuous, high quality electrical power regardless of the status of the mains.
> UPSs deliver a dependable supply voltage free from all mains disturbances, within tolerances compatible with the requirements of sensitive electronic devices.
> UPSs can also provide this dependable voltage independently by means of a power source (battery) which is generally sufficient to ensure the safety of individuals and the installation.

2-5.2 Static power supplies are generally made up of three main sub-assemblies

> A rectifier-charger to transform the alternating current into direct current and charge the battery,

> a set of batteries (generally lead-acid type) enabling energy to be stored and instantly recovered as required over a 5 to 30 minutes period, or even more,

> a static converter to convert this direct voltage into an alternating voltage that is perfectly regulated and filtered in terms of voltage and/or frequency.

These three functions can be supplemented with additional features:

> a bypass in the case of UPS overload or fault, a mechanical maintenance by-pass enabling the UPS to be completely isolated, as well as various options for signaling, maintenance, and even telemaintenance.

2-5.3 Use of UPS's

Over many years, the UPS has become an integral part of high quality power distribution to the customer. Each of their components has been designed by the manufacturer to integrate perfectly with the site layout, whether a 250VA supply for a personal computer in an office or a very complete 2 000kVA installation for a major tertiary sector data centre or for the protection of a production unit.

The diagram shows an example of a low voltage electrical installation protected by a UPS. We can notice the inclusion of a generating set, a feature that is often seen as complementary to the static supply.

Indeed, the instance of a very long blackout, it will enable the back-up time provided by the battery to be extended, of course with the battery providing continuity of supply whilst the generator set is starting up and 10 or more minutes of back-up time should it not start up, during which time all the customer application shut-down sequences can be performed.

These technologies are complementary, as might be imagined, and indeed UPS systems manufacturers often work closely with generator set manufacturers during the design of large-scale installations to define together the machine characteristics (powers, operating sequences, etc.)

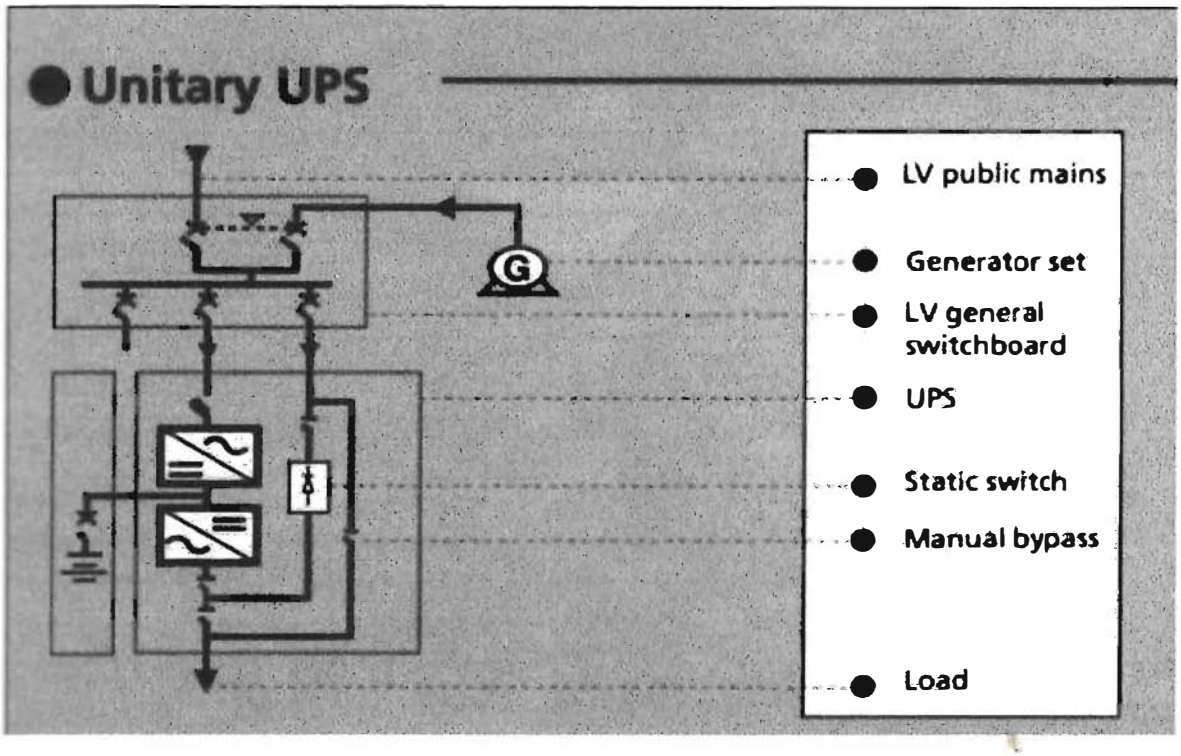

Fig. 1: Example of UPS installation diagram

2-5.4 Parallel connection

In medium and high power installations, it is possible to combine several UPS in parallel:

> to make up a power supply greater than available in the single chain,
> to increase the reliability of the supply by providing one or several redundant chains.

Very sophisticated layouts are possible in order to increase reliability or make the use and maintenance simpler.

2-5.5 User benefits

This section will show some users benefits from the simplest through to the highest performing or most versatile.

2-5.5.1 Improved efficiency

The user is always interested in reducing the cost of operating his equipment. He keeps a close eye on power consumption, and therefore on the losses of the UPSs which are usually always in operation. Moreover, the losses must be paid for twice: kWh's consumed by the UPS plus additional kWh's for air conditioning. This drove manufacturers of UPSs literally into the race against losses in which a few percent are won with every new advance in technology.

2-5.5.2 Good supply of non-linear loads

For years, since the introduction of switch mode power supplies, the majority of electric loads, in particular computers, have been non-linear or "distortion producing". This means that the current waveform is not a sine wave and can have a high harmonic content (order 3,5,7,9, etc.). Such a current is also characterized by a high peak factor (2 to 3.5) and power factor of 0.65 to 0.8.

Manufacturers quickly took all this into account in the design of today's UPSs, in particular by adopting PWM (pulse width modulation) based inverters. The output impedance of different sources as a function of harmonic frequency is revealing that the PWM inverter is the best solution: the output impedance is very low up to high frequencies and the output voltage distortion due to highly non-linear currents is negligible.

It can therefore be said that the problem of non-linear loads has been solved in the new PWM based UPSs and that rerating is no longer necessary.

2-5.5.3 Integration with communication and technical data management Systems

UPS operating parameters, data and alarms are converted to digital data and stored or displayed on the UPS screen. They can easily be transmitted to remote site, i.e. a simple remote indicator unit or a complex centralized Building and Energy Management system (B.E.M). The B.E.M can process both energy management data (MV distribution, LV or engine generator sets) and data concerning the protection of power distribution installations.

The UPS is a key element in high quality electric power installations. The user can receive continuous information on the number of micro-breaks, the power consumed, the number of UPSs in operation and the current drawn per phase. Microprocessors make it possible to establish communication channels between the UPS and the supplied

computer. In addition to the obvious power link between the UPS and the supplied computer system, a data link is increasingly established between the two. With the information sent by the UPS (duration of interruption, load, battery backup time, normal source restoral, etc.), the computer system can initiate automatic procedures (closing files, stopping peripheral devices, restarting), and of course, without operator assistance. Close cooperation was necessary between manufacturers of UPSs and computer systems to arrive at communication software compatible with the numerous standards in use. The UPS is frequently located closer to the computer system than the electrical panel, increasingly right in the office or the computer room next to the system to be protected.

2-5.5.4 Improvements in reliability and maintainability

Equipment reliability has increased considerably over recent years due to better quality and improved performance of power components (transistors, thyristors), integration (integrated circuits, microprocessors, ASICs, etc.) which reduces the amount of components and more elaborate circuit designs. Nevertheless, breakdowns do occur. When a UPS breaks down, an accurate fault diagnosis and quick repairs are of upmost importance. Again, microprocessor-based systems offer major advantages including accurate diagnostics and identification of the faulty subassembly.

- The user receives a clear description of possible remedial action directly or via the telephone,
- Video text or a special diagnostics system running on a micro-computer.
- The remote diagnosis completed, fast repair is necessary. Crucial functions can easily be removed or drawn out and a module can be replaced within minutes.

Chapter3. Basics on Uninterruptible Power Systems configurations

3-1 Introduction

A variety of UPS have been developed to meet the users requirements for continuity and quality of power to different types of loads over a wide range of power few watts to several megawatts. The following classification is part of the European standard ENV50091-3 which defines configurations of UPS by performances.

3-2 Classification Code

There are three main codes defining the most diffused configurations:

VFI:

(Output Voltage and Frequency Independent from mains supply) = where the UPS output is independent of supply (mains) voltage variations and frequency variations are controlled within IEC61000-2-2 or EN61000-2-2° limits. This type can function as a frequency charger.

VFD:

(Output Voltage and Frequency Dependant from mains supply) = where the UPS output is dependent on supply (mains) voltage and frequency variations.

VI:

(Output Voltage Independent from mains supply) = where the UPS output is dependent on supply (mains) frequency variations but supply voltage variations are conditioning by electronic/passive voltage regulating devices within limits of normal operation

*NOTE

IEC 61000-2-2 (or EN61000-2-2) defines normal levels of harmonics and distortion that can be expected from Public Low Voltage supplies at the consumer terminals before connection of a given installation.

The standard ENV50091-3 shows the main working functions of an UPS. UPS basic function is it to supply continuous power to a load and can be carried out with different circuital architectures and relative operating modes. These typologies features are described for example in the following sections.

3-3 UPS double conversion operation

In normal mode of operation, the load is continuously supplied by the converter/inverter combination in a double conversion technique i.e. a.c.-d.c.-d.c.-a.c. When the a.c. input supply is out of UPS preset tolerances, the UPS enters stored energy mode of operation where the battery/inverter combination continues to support the load for the duration of the stored energy time or until the a.c. input returns within UPS design tolerances, whichever is the sooner.

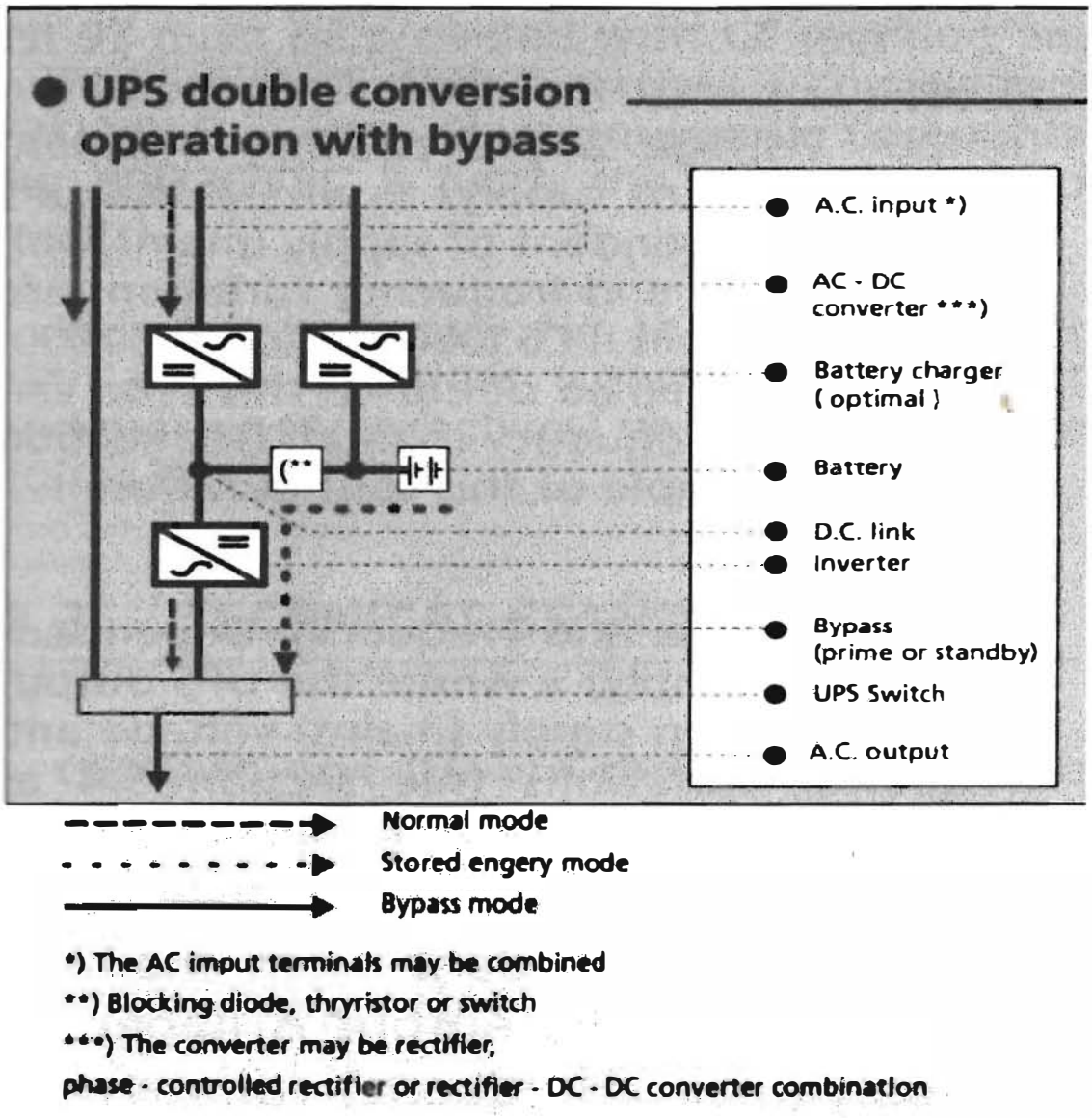

Fig. 2: UPS double conversion operation with automatic static switch

* NOTE

This type is often referred to as an "On-line UPS" meaning the load is always supplied by the inverter irrespective of the condition of the a.c. input supply. The term "On-Line" also means "On-the-Mains". To prevent confusion in definition, this term should be avoided and the above term used.

3-4 UPS double conversion operation with Bypass

By the addition of a bypass, the continuity of load power can be improved by activation of the bypass by means of a transfer switch in case of:

a) UPS failure
b) Load current transients (inrush currents or fault clearing currents)
c) Peak load

3-5 UPS line interactive operation

In normal mode of operation, the load is supplied with conditioned power via a parallel connection of the a.c. input and the UPS inverter. The inverter is operational to provide output voltage conditioning and/or battery charging. The output frequency is dependent upon the a.c. input frequency.

When the a.c. input supply voltage is out of UPS preset tolerances, the inverter and battery maintain continuity of load power in stored energy mode of operation and the switch disconnects the a.c. input supply to prevent back feed from the inverter.

The units run in stored energy mode for the duration of time permitted by the charge of battery or until the a.c. input supply returns within UPS design tolerances, whichever is the sooner.

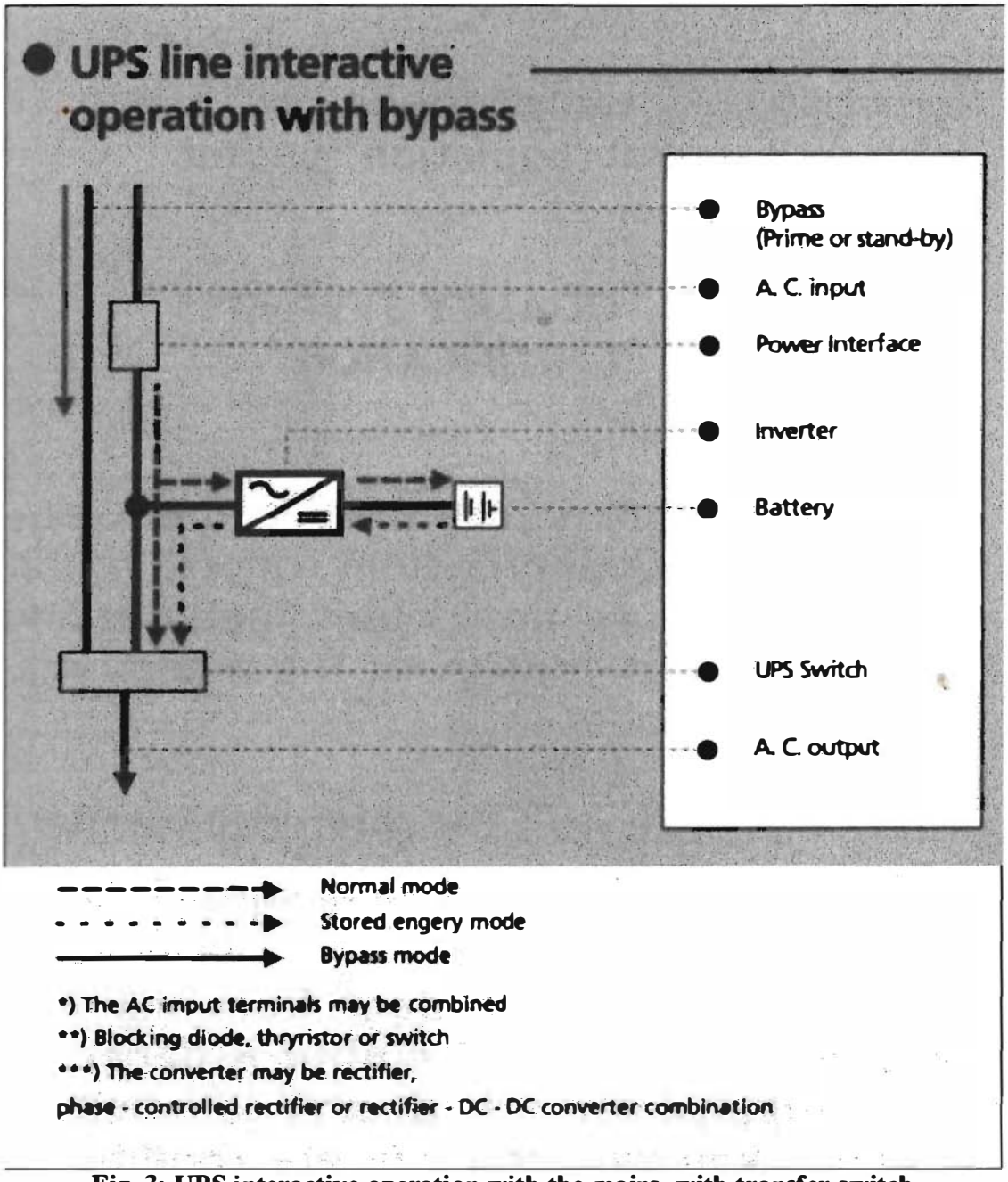

Fig. 3: UPS interactive operation with the mains, with transfer switch

3-6 UPS passive Stand-By operation

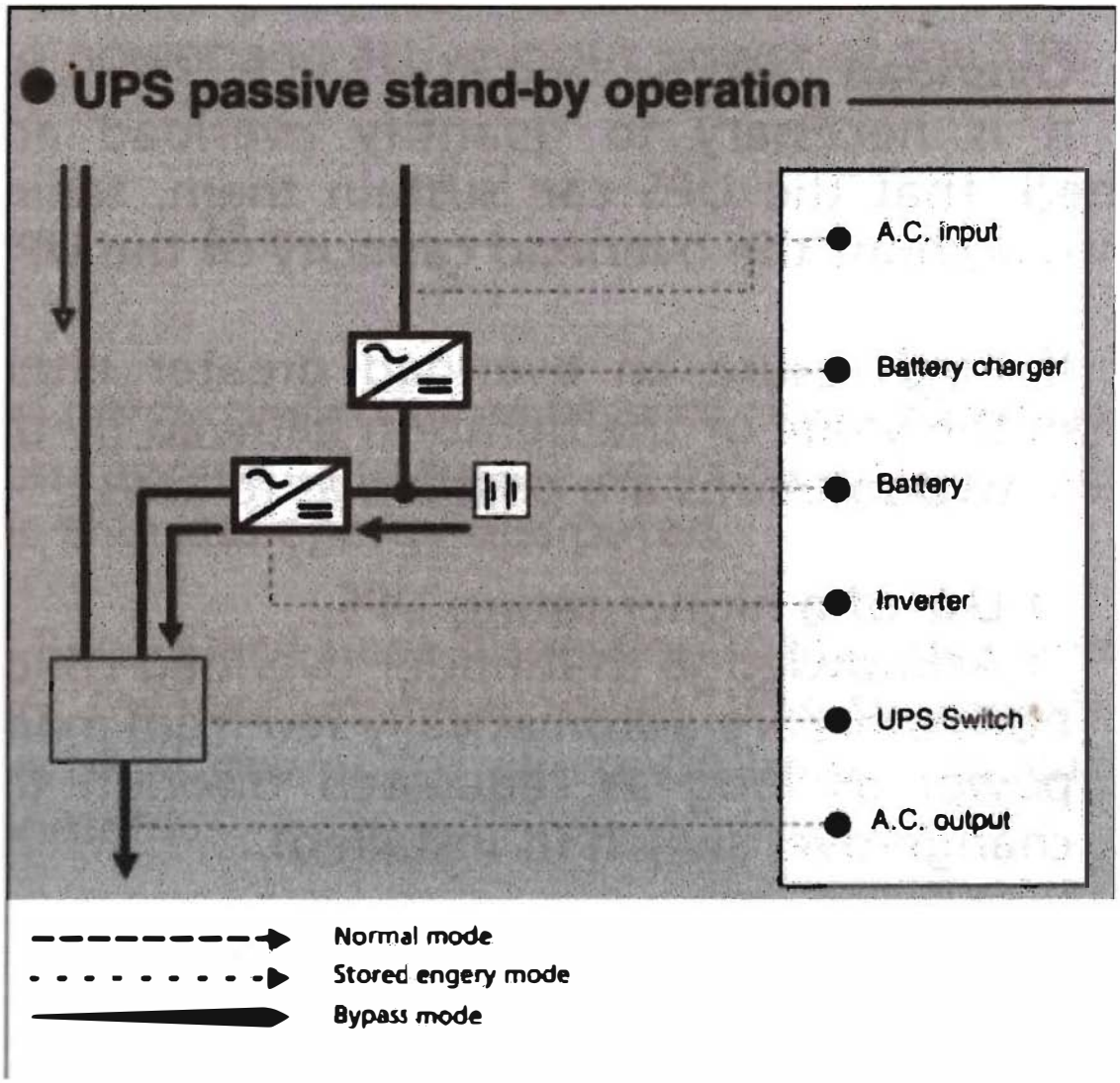

Fig. 4: UPS in stand-by operating conditions

In normal mode of operation, the load is supplied by the a.c. input primary power via the UPS switch. Additional devices may be incorporated to provide power conditioning, e.g. ferro resonant transformer or automatic tap changing transformers. The output frequency being dependent upon the a.c. input frequency.

When the a.c. input supply voltage is out of UPS preset tolerances, the UPS enters stored energy mode of operation, when the inverter is activated and the load transferred to the inverter directly or via the UPS switch (which may be electronic or electromechanically).

The battery/inverter combination maintains continuity of load power for the duration of the stored energy time or until the a.c. input supply voltage returns within UPS preset tolerances and the load is transferred back, whichever is the sooner.

*NOTE

This type is often referred to as an "Off-Line UPS" meaning electronic conditioned power is fed to the load only when the a.c. input supply is out of tolerance. The term "Off-Line" also means "Not-On-the-Mains" when in fact the load is primarily fed from the mains in normal mode of operation. To prevent confusion in definition, this term should be avoided and the above term used.

Chapter4. Evaluation parameters

4-1 Introduction

This chapter is designed to provide an overview of the basic on evaluation parameters for power problems and solution. It addresses some formula to calculation for select the parameters.

4-2 UPS Electrical sizing

Knowledge of the following parameters has a key role in determining the UPS size.

4-2.1 Apparent power (VA OR KVA)

It is defined as:

S = U x I for single-phase load
S = (UL1 x IL1) + (UL2 x IL2) + (UL3 + IL3)
(For three-phase load)

Where,

U is voltage
I is the current absorbed by the load under normal load conditions (EN50091-1-X)

This information is normally indicated on documents and/or load nameplates, though it may be shown as an oversized value.

The permanent Apparent Power of a UPS is specified in VA or kVA with the PF (power factor) specified under sine-wave condition.

4-2.2 Active power (W OR KW)

It is defined as:

P = S x PF

Where,

PF is the power factor.

The P or the PF value of loads are generally not indicated, therefore a correct UPS sizing requires measurements of the P absorbed by loads. Experience shows that typical loads of computer equipment have a PF between 0.65 and 0.8.

4-3 Crest factor

A linear load absorbs a sine-wave current which shows an effective value (IRMS usually measured and declared) and a peak value (Ipk).
The Crest Factor is defined as:

$$CF = I_{PK} \div I_{RMS}$$

The normal value for a linear is CF = 1, 41.

Most loads applied to UPSs are non-linear loads: they absorb distorted currents with CF value greater than 1, 41 and require therefore higher peak currents thus resulting in an increased distortion of the output voltage than equivalent linear loads. The value of the Crest Factor (CF) is practically never indicated and it may be necessary to measure it specifically. Standard EN50991-1-X, enclosure M15, indicates a typical non-linear load as CF = 3, used for UPS testing. This value may be used in the absence of other data from the purchaser.

4-4 Overload

Overloads are temporary requested from load equipment when exceeding the normal steady state value and are caused when one or more user's equipment are switched on.

4-5 Operating parameters

In determining the size of a UPS, the following operating parameter conditions must be fulfilled:

ST:
The nominal Apparent Power of a UPS must be equal to or greater than the total S of loads.

PT:
The nominal Active Power of a UPS must be equal to or greater than the total P of loads.

*WARNING
Don't rely on computer power, similar definitions!

CF:
It is necessary to verify that the UPS is sized fir feeding non-linear loads with CF equal to or greater than the CF of loads as a whole and that the relevant output voltage distortion is compatible with the loads to be fed.

4-5.1 Overloads

It is necessary to quantify overload and check that the UPS can sustain them, taking into account the overload capacity of the UPS. If loads cause an overload greater either than the value or the duration allowed by the UPS, two solutions are possible as follows :

Use of a higher rating UPS,

Acknowledge that under overload conditions users are automatically fed from mains power as long as requested through the change-over switch (if installed).

*NOTE
A problem may arise if the mains power supply is missing or is out of tolerance: in this case the load may loose its supply. Where possible, switch on the load progressively, to avoid overload.

4-6 Operating temperature

If the temperature in the room is higher than the one declared by the manufacturer, the power of the UPS must be rerated according to the indication of the manufacturer.

*WARNING
Power rating is defined when comparing operating temperatures and different products.

4-7 Future expansion

Once the UPS size has been established, it is recommended to add some extra power as allowance for future expansion. Generally an extra power allowance of not less than 30% is regarded as adequate.

4-8 Efficiency

Efficiency (M) is the ratio between active output power and active input power of the UPS.

$M = P_U \div P_I$

Energy dispersed as heat during UPS operation represents naturally an extra cost given by the thermal energy dissipated.

Because of heat dispersion it may be necessary, for medium-high power UPSs, to use extra electrical power for air-conditioning the environment.

On a yearly basis, the cost of lost electrical power for a given load is given by:

Energy Cost = PU x (1M – 1) x T x c

Where,

Pu is the active output power (kW) supplied to loads,

M is the UPS efficiency for that loads level and therefore not necessarily the nominal UPS efficiency,

T is the time taken, in hours of operation, in one year, at that load level,

C is the unit cost of electricity per kWh.

If air conditioning has to be taken into account, the result obtained may be possible multiplied by a factor of 1.3.

4-9 Input current harmonics

According to technology, UPS may generate a distorted containing harmonics that are multiples of the reference 50 Hz frequency. The options paragraph may be referred to for available procedures to reduce the input current harmonics.

4-9.1 Noise

The presence of a UPS in the environment must be implemented in a way that will not alter living conditions. One must not forget that the average noise level, measured in accordance to ISO 3746 standard, is equal to:

≥ 52 dBA in an office
≥ 60 dBA in a computer room,
≥ 65/75dBA in an electrical equipment room.

4-10 Dimensions and ease of maintenance

Compact size means:

>reduced space required for installation, a factor that is important depending on cost per square meter of the area needed,

≥easier and cheaper conveyance and installation of the UPS. Adequate engineering may guarantee adequate maintainability even for small UPS size.

4-11 Degree of protection

This means the safeguards laid out in the EN 60529 standard "Degrees of protection provided by enclosures (IP Code)" against access to hazardous parts and against foreign objects (first characteristic numeral and optional additional letter) and against ingress of water (second characteristic numeral and optional supplementary letter).

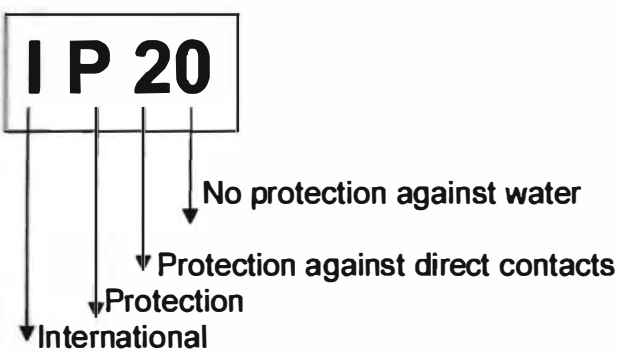

Fig. 5: Example of IP

4-12 Reliability parameters

4-12.1 MTBF

MTBF (Mean Time Before Failures) is a parameter for evaluating UPS reliability. It represents the time estimate of satisfactory UPS operation between failures. MTBF depends on various conditions like weather conditions to which the equipment is subject, altitude, reliability of components used and their rate of use, on design features and, when applicable, redundant operation (systems in parallel).

4-12.2 MTTR

MTTR (Mean Time to Repair) is a parameter for evaluating easy repairing of UPS and therefore of the time it will be out of service for repairs. MTTR represents in fact the estimated repair average time and is largely affected by UPS design (easy replacement of parts and modules) and by on-board diagnostic equipment (easily troubleshooting). Note that the MTTR factor is dependent too on availability of spares on site when repairs are needed.

It must be noted that MTBF and MTTR values are informative only, as the range of these parameters may be quite large since it is subject to many associate factors.

4-13 Batteries technology

Batteries are normally supplied with the UPS and may be installed in the same cabinet: in this case, the supplier guarantees the UPS runtime specified for the apparent power of load and the power factor designed for.

Batteries are generally valve regulated lead-acid batteries (VRLA), usually called sealed batteries, with no electrolyte top-up, very low gas emission and therefore suitable for installation in offices and public places with no need for special precautions. These batteries are usually placed in the UPS cabinet or in electrical cabinets; how long they will last depends on conditions of use (e.g. ambient temperature non exceeding 25°C) as well as on their design and quality. In some case, for installations requiring high power and extended runtime, stationary open-cell batteries may be used. They require installation in a suitable room and regular maintenance for electrolyte top-up. Nickel-Cadmium Batteries too may be used and are suitable for use in particular severe environment: temperature from –30° to 60°C, and high mechanical and electrical stress.

Their expected life is 15 to 20 years, but their cost is 5 times higher than for the equivalent VRLA batteries.

TECHNOLOGY	ELECTROLYTE	DESIGN LIFE IN YEARS AT 20°C	MOST COMMON APPLICATIONS	ADVANTAGES	DISADVANTAGES
ERMETICAL VALVE REGULATED	Absorbed in microporous fiberglass separator (AGM)	3-5 (Flat Plate)	• Consumer application • Toys • Alarm systems • UPS	• No specific room requirements • Easy installation • No topping up operations • High energy density • Extremely low gas emission • Less involved maintenance	• More sensitive to high temperatures, especially AGM type • Require good voltage stabilisation chargers • No possibility to check or to see internally the cell
		5-8 (Flat Plate)	• General use where safety and performance requirement is not severe • Emergency lighting • UPS • Alarm systems		
		>10 (Flat Plate)	• Telecommunication, Nuclear and Conventional Power Plants • UPS systems • Application where highest security is required		
	Fixed in a gel structure	3-12 (Flat Plate)	• Consumer and general use where safety and performance requirement is not severe	• Available in large quantities and in a variety of sizes and design	• Limited storage period
OPEN VENT	Free liquid	12 (Flat Plate)	• Large UPS systems	• Long life • Easy to determine the state of a cell due to transparent container • Long storage periods are possible for dry charge cells	• Installation in dedicated rooms • Maintenance operations required • Need of filling • Limited energy density • Gas emission
		15 (Tubular Plate)	• Telecommunication back up • Renewable energy • Emergency lighting • Power generation		
		>20 (Planté Plate)			

Table.1 Batteries technology

4-14 General considerations on the misleading concepts of computer power

In the definition of the UPS rated power, the parametrical values, defined as "computer power", "switching power", "actual power", power at particular temperature values, etc..., are sometimes indicated. Such arbitrary parametrical values have no relation with apparent power and active power; they cannot be neither quantified nor defined and therefore must not be used for the correct sizing of the UPS.

4-15 Module for offer requirement

The following module (tab.3) can be adopted to require the offer for a UPS.

INPUT

>Input voltage
380-400-415V

>Input frequency:
50-60 Hz

LOAD

(Nameplate ratings if available)

>Load voltage:
380-400-415V

>Load frequency:
50-60 Hz

Brief description of the load

> Information technology (computers, printers…), lighting, telecommunication equipment, electro medical equipment….,
>Future expansion of power (%) _____

Battery

>Back Up Time (min.):_____
>Battery type: sealed, open vent, NiCd
>Life (years) NL (Normal Life) 3-5
LL (Long Life) 8-10
Other (specify): _____

Environment

>Operating temperature
>UPS room
>Battery room

Chapter5. Communications

5-1 Introduction

The UPS is becoming more frequently a part of a system of intercommunicating devices. Within such an environment, the UPS must become a peripheral of a system that can send information based on user needs. This must occur efficiently and in a secure manner, and often through microprocessor control. The communication can be divided into two types:

> local communication and
> remote communication.

5-2 Local Communication

This section will cover local communication which is performing or most versatile.

5-2.1 Illuminated Indicators

The simple lighting warning on the front panel of the device supplies the immediate acknowledge of the UPS condition and are normally sufficient for small UPS ratings.

5-2.2 Alphanumeric Display

For specific information about the UPS operating condition and its electrical parameters, it may be useful to equip the UPS with an alphanumeric display to ensure that the information supplied is clear. In addition, it is possible to implement special functions related to the use and diagnostics of the UPS. This solution is suitable for the UPS with higher ratings.

5-3 Remote Communication

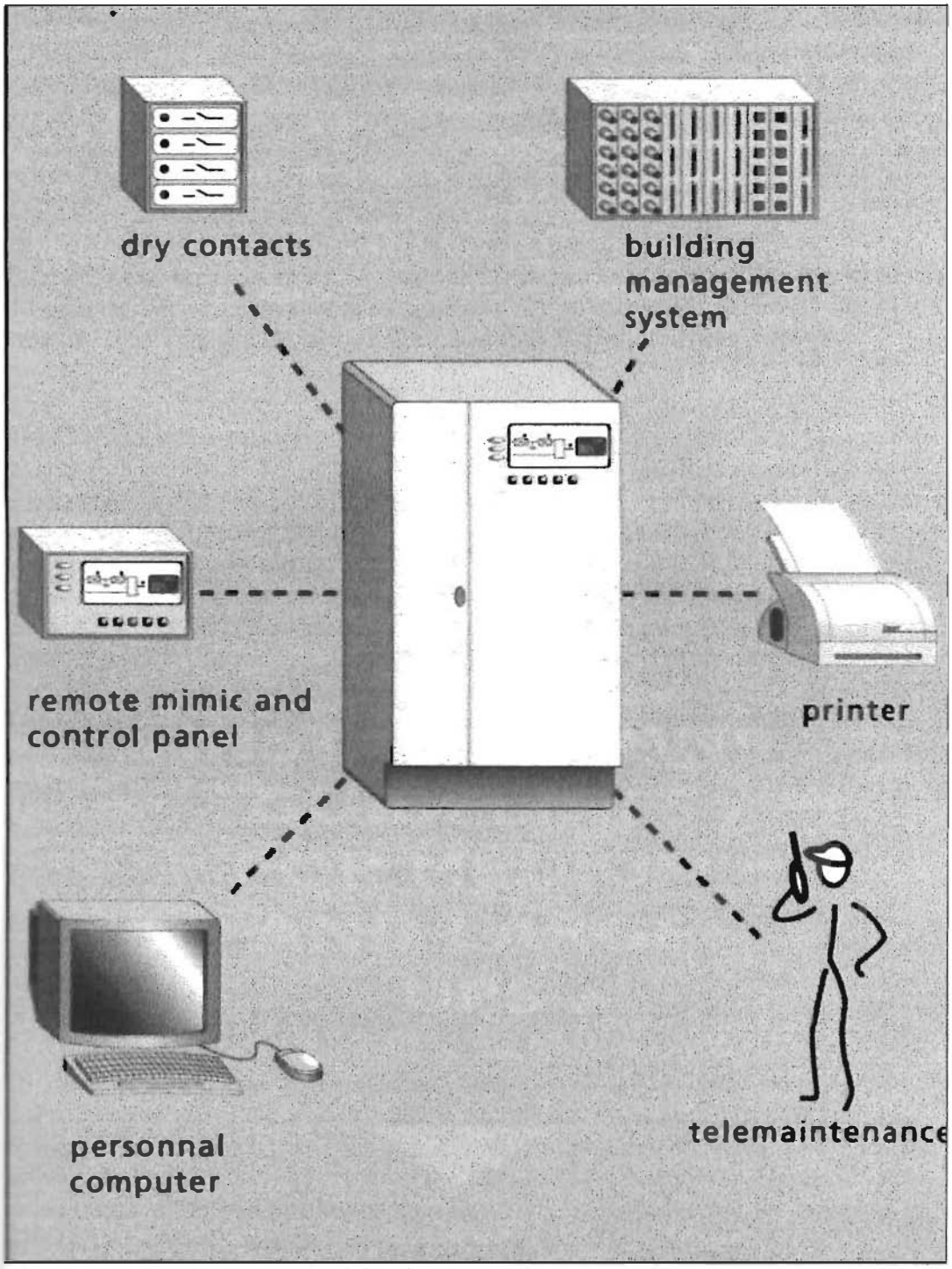

Fig. 6: Different remote communication

5-3.1 Remote Report Though No-Voltage Contacts

If operator does not have easy access to the UPS, it can be equipped with a remote signal for remote diagnostics of the main operating functions (at least "general alarm" and "battery operation"). This signal ca be transmitted to information systems fed by the UPS, to a Customer's signal panel or to a signal synoptic panel supplied together with the UPS.

5-4 UPS/User Communication

By using clean contacts or a serial communication line, the UPS can be interfaced with the protected information user to ensure that system files are automatically shut down in case of a black-out and to transmit information about UPS status to operators.

5-5 Serial Communication

For a more detailed remote diagnosis of the UPS, the information can be reported on an alphanumeric panel or directly on a Personal Computer. In these cases, the communication occurs through a standard serial line RS232, RS422 or RS485 guaranteeing a complete transmission of information through a simple twin pair connection. The serial interface can also be used to report on a PC a much greater quantity of information than what is available locally and without any distance limits.

The installer is free to use each communication device that is compatible with these standards: telephone modem, optical fibres or whatever else is necessary to reach faraway plants.

In some cases, it is more efficient to connect a UPS to a supervision system, using existing information networks (SNMP – Simple Network Management Protocol).

5-6 Communication between UPS and assistance center

UPS remote control can be extended and processed until it becomes a complement of the technical assistance service. It is possible to create a connection, using the normal telephone line, between the installed UPS and the assistance centre for an immediate alarm signal and a preventive control to ensure correct management of the UPS. The detail degree of the information on the single UPS can even include the recording of significant parameters for particular events.

Chapter6. Options

6-1 Introduction

This section contains general technical information of different option for customer support and fulfill their request. It is possible to improve the UPS standard version by adding options in order to respond to specific customer requests.

6-2 Galvanic isolation transformer

The UPS can be used without galvanic separation transformer, thus keeping unchanged the neutral between input and output. However, in case of need, an isolation transformer can be installed.

6-2.1 Additional autotransformer

When the mains voltage or the voltage required by the load has a different value in respect to the UPS standard value, an autotransformer for the voltage adjustment can be added.

6-3 Solutions for input harmonic current reduction

- Twelve pulses rectifier: the rectifier is doubled and supplied by a transformer with double output; combining the currents on the primary winding, the cancellation of the more dangerous harmonics is obtained,
- Rectifier with PFC (Power factor Control) the current is absorbed from the mains with low harmonic content. This feature is normally available for low power range only,
- Resonance filters: they are installed in the UPS input and through a local circulation of the harmonics it is avoided the circulation of the harmonics in the mains,
- Other options are available and can be agreed with the UPS manufacturer in order to optimize the installation.

Chapter7. Installation guidelines for medium and large UPS

7-1 Introduction

This section contains general technical information for the guidance of qualified personnel when installing UPS of the permanently connected type. The manufacturer's installation instructions and national wiring rules should be adhered to, when they conflict with following information.

7-2 Power systems

Most UPS are designed primarily for use on single phase/three phase power systems with an earthed neutral. For use on other power systems, i.e. impudent neutral or for single phase UPS for line to line operation, refer to the manufacturer or supplier for guidance on power system compatibility. Isolating transformer options are generally available to enable conversion from these other power systems to earthed neutral operation. In some cases, you may be required to fit additional protective devices or switches in your supply installation.

7-3 Circuit protection devices

When using circuit breakers as protective devices a delayed action type should be used to prevent erroneous tripping due to the following.

7-3.1 UPS Inrush Current

On switch-on a UPS may draw an inrush current up to 8 times normal full load current for a mains cycle. This may also occur if the UPS load is powered up in bypass operation.

7-3.2 Earth Leakage Currents

Due to the presence of EMC filters, at power-one, the instantaneous currents flowing to earth may not be balanced in all power lines and may cause differential type earth leakage detectors to operate.

7-4 Branch circuit protection and discrimination

When designing branch circuit protection for either the input or output wiring of the UPS, the guidance of the manufacturer/supplier should be sought, if proper circuit fault co-ordination is a requirement and details are not specified in the technical data sheets or installation instructions.

7-5 UPS output current limiting

Dependent on the UPS technology, overload protection may be provided by internal electronic current limit circuits. It is a safety requirement, that when the output voltage falls below 50% of nominal rated output voltage that the UPS shut down within 5.0 seconds. (EN 50091-1-X clause 2.7.1d)

7-6 Neutral cable sizing

If your load consists of single phase power supply loads, connected to the output of a three phase UPS between phases and neutral, then it is likely that the neutral conductor will have to carry third harmonic currents, which are additive, for all the loads connected.

In this situation, the output neutral conductor should be increased in size in accordance with national wiring rules or IEC 364-524-02-01 (HD 384). This may also apply to the supply neutral in some circumstances, such as in maintenance bypass operation.

7-7 Isolation of neutral

Many UPS types use the input supply neutral to reference the output neutral. When providing a means of supply isolation or input supply change-over circuits to the UPS, care needs to be taken to ensure that the input supply neutral reference is not disconnected whilst the UPS is in service.

This also applies to installations where the bypass supply is separate from the normal input supply to the UPS and only one supply neutral is connected to the UPS for both supplies.

7-8 Stand-by generators

Stand-by generators, are alternative supplies to the mains. Specify to the supplier of the generator that its load is likely to be electronic equipment to ensure that the generator regulation circuits can respond to and synchronize with waveforms having harmonic distortion and of the non-linear type.

7-9 Battery installations

Ambient temperature-Lead-acid battery design life is reduced by half for every 10 degrees rise above the design reference temperature of 20/25 degrees centigrade. Whenever practicable, install in temperature controlled environments if optimum service life is required. Batteries installed remote from the UPS itself should be provided with protective devices suitably rated for operation on D.C. as close to the terminals as possible. A means of isolation should also be fitted to enable maintenance of the battery if the battery consists of more than one battery string in parallel, then each battery string should have a means of isolation. This will allow one battery string to be worked on whilst the other string is still in service.

Battery installations should comply with national rules if the supplier provides no other information. Any requirements specified by the manufacturer for compliance with EMC regulations must be complied with. Cabling from external batteries to the UPS should be sized to not exceed the maximum recommended volt drop requirements specified by the manufacturer/supplier.

7-10 UPS remote shut down

UPS that are permanently connected to the mains supply, have provision for the connection of an external device to permit the remote shut-down of the load, and at the same time, prevent the UPS from continuing to operate in any operational mode, if an emergency situation, such as fire, occurs in the building.

This is a requirement of safety standard EN50091-1-X and may also be a national requirement for protection of computer room installations. When using this option, additional contacts on this same device should also cause the interruption of the mains supply to the UPS to prevent operation of any automatic bypass circuits.

Alternative methods may be applied by using external devices when so permitted by local fire regulations.

7-11 UPS communication ports

Terminals and plug/socket connections on UPS intended to be connected directly to external Information Technology Equipment (I.T.E) are termed "Safety Extra-Low Voltage" (S.E.L.V) circuits in accordance with the S.E.L.V definition of IEC950/ (EN60950).

An I.T.E S.E.L.V circuit is defined as a secondary circuit which is so designed and protected, that under normal and single fault conditions, the voltage between any two parts, or any one part and earth, does not exceed 42,4 V peak, or 60 VDC except transiently.

This differs from the S.E.L.V definition of IEC364 which has different voltage limits and circuit requirements. All site wiring from the UPS to the external I.T.E equipment must be kept segregated from all other S.E.L.V and non-S.E.L.V wiring by at least 25 mm to maintain the integrity of the UPS S.E.L.V circuits and meet EMC mitigation requirements.

7-12 Non-linear loads

Typical non-linear loads usually found in the UPS industry, are those that consist of a rectifier and storage capacitor as normally found in any power supply. Power is only drawn from the mains or UPS when the supply voltage exceeds the d.c. voltage level on the storage capacitor.

The resultant current waveform does not follow the voltage waveform but occurs for up to 3.0 ms around the peak of the waveform. Its peak level can be between 2.2 and 5.0 times the r.m.s. value dependant on the supply source impedance and its waveform is rich in harmonic currents.

This type of current waveform can only be measured accurately with true r.m.s meters. If the conventional average reading meters, corrected to read the normal r.m.s a.c factors are used, it will result in a lower recorded value than the real r.m.s value.

With this type of load, the r.m.s current drawn and its peak value is dependent upon the supply source impedance as this limits the rate at which energy can be stored on the power supply capacitor each half cycle. Therefore it is not unusual to find that the value of the r.m.s load current may be different in each of the UPS mode of operation if the output impedance differs. The UPS design normally takes this into account when the power rating is defined.

Equally, the voltage waveform may show signs of flattening at the peaks due to voltage drop across the supply source impedance, if the peak current value exceeds the normal

sinusoidal square root of 2 peaks to r.m.s value. When sizing distribution cabling it may be necessary to increase the cable size to allow for the higher voltage drop caused by high peak voltage to r.m.s load current to avoid this loss of peak voltage and consequently a lower mean D.C. in the load power supply, unless the power supply has a wide operational voltage tolerance. This applies especially in areas where the nominal mains voltage is often at the lower tolerance level for long periods due to peak demands on the supply network in your location.

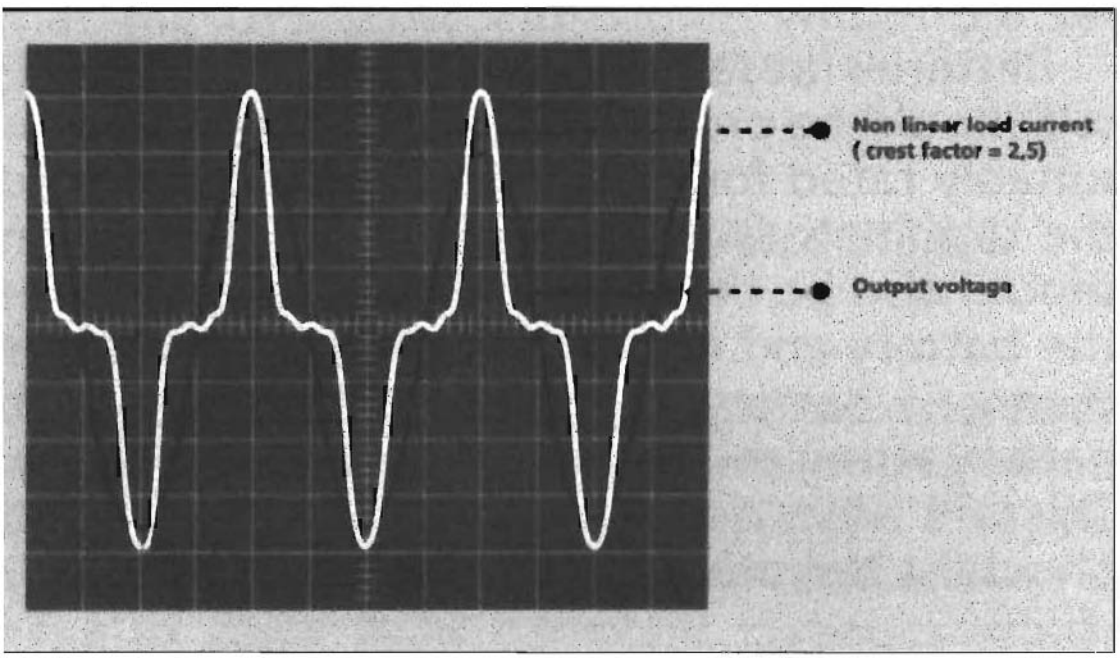

Fig. 7: No-linear load current and voltage

Chapter8. Maintenance and services

8-1 Introduction

When it comes to choosing a UPS one of the most critical factors is the technical support which the manufacturer provides for current and future customers. Here are some of the services which should be considered when installing a UPS:

> pre-sales support,
> installation and initial start-up,
> maintenance contracts,
> after-sales support,
> remote supervision,
> training.

8-2 Why is service essential?

In answer to their needs, systems no longer expect just a product. They require a solution. The solution is a combination of services and product. The services include pre-sales guidance, site assessment, maintenance of the UPS and its environment and so on.

8-3 Pre-sales support

There is some pre-sales support which helps customer for choosing UPS.

8-3.1 Load analysis

Before choosing a UPS, the load to be protected must be clearly defined. The presence of peak or start-up inrush currents may have a significant effect on specifications. The service technicians, equipped with harmonic analyzers and storage oscilloscopes help customers to establish the required output and avoid costly, over-sized specifications.

8-3.2 Electrical environment analysis

The service technicians help customers in the following ways:

>They determine which protective circuit-breakers be placed on the various connections, n line with the current rating and short circuit current at the point of installation,

>They assess the cross section for the connection cables, as a function of heating and the permissible voltage drop,

>They meet the requirements set by international standards with regard to neutral systems and the protection of persons.

8-4 Installation

The service technicians assist in reviewing all the key installation tasks.
Key tasks are as follows:

> access possibilities,
> equipment unloading,
> upstream mains connection,
> distribution switchboard connection,
> battery connection,
>air conditioning/ventilation.

8-5 Initial start-up

In order to ensure compliance with standards and accepted practice the UPS manufacturer recommend that initial start-up be carried out by its own after-sales service for the medium and large size UPS.

The following operations are carried out by the engineers:

> validation of the measurements made during production testing,
> on load test,
> battery discharge test,
> training for site personnel,
> full job report.

The following key points should be checked with the customer:

> in the event of it being necessary to stop data processing for initial UPS start-up, when should this be done? In the evening, on weekends, etc...,
> if loads are not available, who will provide the test loads?
> who will be responsible for coordinating the various suppliers and/or contractors involved.

8-6 Maintenance contracts

Keep this risk as low as possible
Regular battery checks

The justification for a UPS installation is that it supplies "clean", uninterrupted current. To purchase this type of installation is to recognize that protected application is vitally important. It is therefore essential to consider the complete cost of an eventual UPS failure, however unlikely.

To do this, it is necessary to take account of the cost of repairing the equipment, but also expenses related to down time, during which the critical application is not protected, or perhaps not even supplied at all.

The aim of the maintenance contract is to keep the risk as low as possible.

Thanks to regular battery checks (for site contracts) it also implements preventive maintenance and extends the working life of the battery investment. The manufacturers have developed a wide range of maintenance contracts, which are designed to suit all types of individual requirements.

Contract vary, from an entry range contract including routine visits, but excluding parts and labour, to all inclusive contracts with a guaranteed response time.

The range, which is completely adaptable, enables customers to get the most out of their maintenance budget, in line with specific requirements, both in terms of response time and preventive maintenance.

8-7 After-sales support

'A warranty that the manufacturer alone may supply.'

Although the manufacturers recommend maintenance contracts as the best way of keeping an installation in perfect working order, it also provides high quality, on-site trouble-shooting services:

> requests for service received by phone,
> short response time thanks to large number of after-sales centers,
> rapid repair thanks to modern technology used in the equipment and the high professional standards of the after-sales technicians.

8-10 Data center

A data center is a computer system's most important and vulnerable component. We're talking a large amount of data here, stored in a large number of computers.

A typical example of a company that almost certainly has a data center is a bank or other kind of financial institution. A bank's data center will have a mainframe or other kind of computer network, on which customers' account information and other data are stored. A university will also have a data center, which includes not only personal information about the university's employees and students, but also information on the university's buildings, construction projects, and physical and intellectual history.

These kinds of data centers contain information that is critical to the continued operation of the bank, university, or other business. Therefore, that data cannot be lost. Security measures surrounding such data centers are usually very strong, as are systems of climate control that keep the data center's computer systems from malfunctioning. Data centers will also almost certainly contain backup computers or mirror drives that protect against massive data loss. Such backup computers or mirror drives are routinely dependent not only on electronic power but also on battery power, so that they can continue to function in the case of an interruption of electronic power.

Other kinds of data centers can be found in government institutions; companies that have multiple headquarters; and providers of electronic services such as television, mobile phones, and the like. A data center can also be a single computer, storing and accessing one company's or one person's critical data. Smaller data centers usually have less complicated forms of data protection. No matter the size, all data centers serve the same function: to compile and protect the data of a person or company.

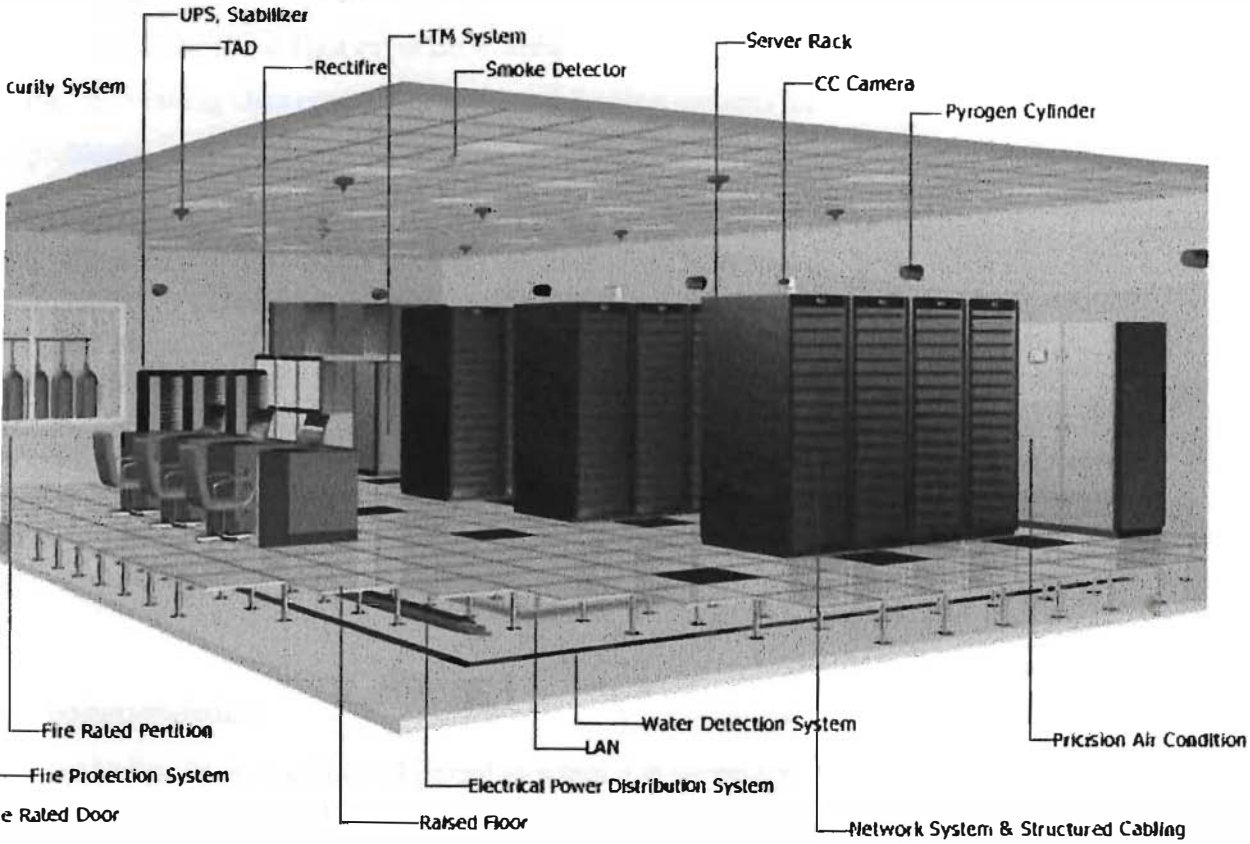

Fig. 8: Sample of a Data Center turnkey solution

Chapter9. Case Study and Recommendation

9-1 Case Study

The case study shows how I got experience some of the following problems when installing and running Data center. Refer to the following sections for common solutions to the problems:

i) The installation of a raised floor system took long time. Structural problems, such as rocking panels and gaps between panels, caused the thermal behavior of the building by reducing the interaction between the heat gains and the thermally massive concrete slab. The raised floor did not serve as a separation between the room and the slab. Regular inspections for the structural integrity of a raised floor system were identified problems.

ii) Strategic planning for data centers disaster recovery (DR) were a significant part of the equation and overall decision making. A place that did not immediately come to mind as an ideal location to use as a disaster recovery.

9-2 Recommendation

To work at Valley Power Solutions Limited as intern it is necessary to apply and contact with the human resource department of Valley Power Solutions Limited.
Currently, there are no more prerequisite certifications to complete to learn the Data Center Storage Support certification. The CCNA certification is simply a recommended training now due to fact that the information having been found to be sufficient for the said certificate.

Chapter10. Conclusion

In this report our main objective is to appraise the practical knowledge, information and understandings that we have acquired from exploring several electrical equipments and machines, discussing with knowledgeable engineers and technicians. Here we have tried to share a simple overview of the knowledge how electrical equipments protect a data center. We have also talked abut electrical protections of some equipments. Here we have also provided a simple overview of the making process of the uninterruptible power systems.

Reference:

[1] http://ewubd.edu/ewu/showDocument.php?documentid=100

[2] http://www.valleypowerbd.com/company.html

[3] http://www.tvclcps.com/