# Assessment of the Generator, UPS and Dedicated Power Circuits for the National Credit Regulator

**September 2019**

## Executive Summary

A service provider was appointed by the National Credit Regulator (NCR) to undertake an assessment of the dedicated electrical power supply at its offices located at 127 15th Road Randjesfontein in Midrand.

The NCR through the project desired to achieve the following outcomes:

- Understand whether the emergency generator and un-interrupted power supply equipment could adequately support the needs of the users on the site;
- Assess whether the dedicated power supply circuits are in good working order;

Understand what steps needed to be taken, if any, based on the findings from the assessment to ensure that the dedicated power supply reticulation system is in good working order.

The methodology consisted of a building walk-through, testing of dedicated power outlets, assessment of the Generator and UPS and conducting a short survey of the personnel.

The following key findings were made:

1. The generator is capable of supplying emergency power to all the personnel for their computer use and the UPS for the supply to the servers.
2. The dedicated power outlets and normal power outlets are mixed, and extensions to the electrical circuits by adding additional plug outlets places these circuits to be more likely to trip.
3. There is an extensive use of multi-plug adapters to ensure that normal plugs can be used with the dedicated power circuit.
4. The UPS is able to provide time for a safe shutdown of the servers in the event of a loss of power from both the municipal and generator power supplies.

5. There has been no or limited energy conservation awareness training on the site.
6. The load on the electrical system is imbalanced across the three phases. This could potential increase the maximum demand charges when the site demand increases.

The conclusions drawn and recommendations made are:

a. It is imperative that the integrity of DEDICATED socket outlets be maintained as separate from NORMAL outlets. Apart from just the red colour, they also make use of the shaved earth pins to prevent NORMAL plugs from being inserted here. This standard should be maintained by ensuring the education of all staff in this regard.

b. The labelling should be redone to correctly identify the supply circuit and board on each socket outlet.

c. There are several instances where the wiring is unsafe, with sockets not fixed correctly and skirting covers falling off. These should be corrected to comply with installation safety.

d. The number of socket outlets should ideally be limited to no more than 10 outlets per circuit breaker. The circuit breaker is there to adequately protect the cabling supplying the load and allowance is normally made for inadvertent expansion by users.

e. The server room needs some attention, particularly the power sources and reticulation in the room. There appears to be sufficient outlets, but the mangle of extension cords seems to lead to only a few supply points. A planned outage period should be arranged, with some prior planning, to structure these supply points and cabling.

**Table of Contents**

## 1.0 Introduction

A service provider was appointed by the National Credit Regulator (NCR) to undertake an assessment of the dedicated electrical power supply at its offices located at 127 15th Road Randjesfontein in Midrand.

The NCR through the project desired to achieve the following outcomes:

- Understand whether the emergency generator and un-interrupted power supply equipment could adequately support the needs of the users on the site;
- Assess whether the dedicated power supply circuits are in good working order;
- Understand what steps needed to be taken, if any, based on the findings from the assessment to ensure that the dedicated power supply reticulation system is in good working order.

This report is set out as follows:

- Description of the methodology / approach used for the assessment
- Collation of the findings
- Conclusions drawn from the findings and recommendations based on the findings.

## 2.0 Methodology

The project commenced with a project inception meeting between the service provider and the NCR. The meeting was held on the 13 August 2019. It was agreed at the meeting to revise the project plan to ensure data logging could take place over a period longer than a week. Based on the discussion held at the inception meeting it was also important to provide a perspective on energy management to the NCR.

A building walkthrough was conducted on the same day to have an understanding of the current layout of the building and observe how the personnel access electrical power at their workstations.

This was followed by testing all the dedicated power points to determine each plug sockets functional status. In order to do this test, the normal municipal power was tripped at the main incoming board and the generator was the only source of power via the UPS. As it was difficult to access the various plug socket points it was agreed to re-schedule the assessment to a day on a weekend.

An important component of the assessment was the review of the diesel generator and Un-Interrupted Power Supplies (UPS) capability to provide the required needs for the proposed dedicated power users. In order to assess the capability of these two components of the electrical supply system at the NCR, the municipal power supply was tripped and the diesel generator was disabled. This was to determine which

electrical circuits the UPS supplied and understand its performance characteristics. Thereafter the diesel generator was restarted to determine the extent of the electrical power supply to the dedicated power supply circuits.

The final steps of the assessment were to compile a report. The steps followed in this was for the reviewed by the NCR prior to us engaging the NCR in a dedicated question and answer session. Thereafter the report will be finalized and issued to the NCR in pdf and Word format.

## 3.0 Findings

The key findings from the observations made and tests conducted are presented hereunder.

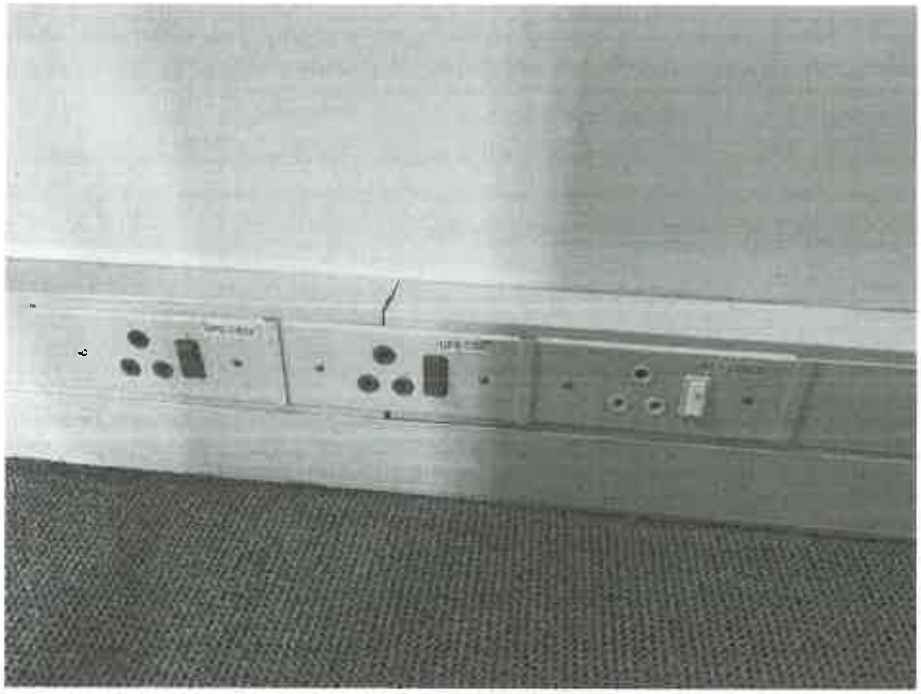
### *3.1* Building Walkthrough

Although the building is more than 30 years old, most of the work areas are serviced with a power skirting. The power skirting generally runs on the longer parallel walls of the specific rooms, with occasion the shorter walls also being serviced.

The following observations were made during the walk-throughs of the different departments:

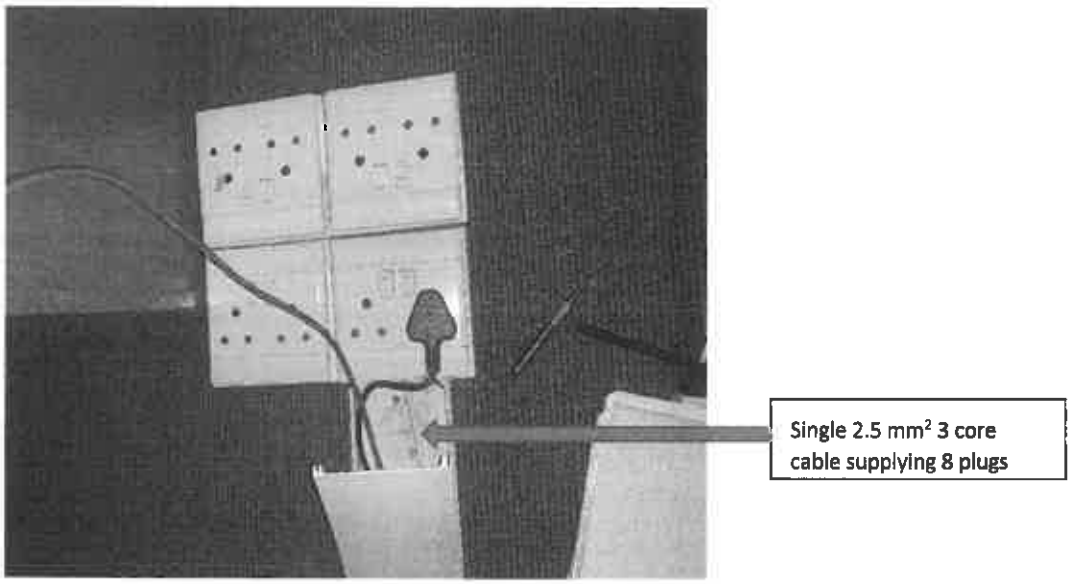
1. Generally, the electrical plug sockets are provided in a sequence combination of 2 dedicated red switched socket outlets with a white normal power plug socket.

*Figure 1: Typical plug configuration on power skirting*



2. In order to increase the availability of power sockets to users, the NCR had in the past commissioned a contractor to extend the dedicated power supply to the desks in the open plan spaces. This configuration has groups of eight power plugs being supplied through a single 2.5mm$^2$ 3 core flat cable.
3. The cable is linked either directly in some places to the dedicated power circuit or through a single plug point on the existing power skirting circuit.

*Figure 2: Incorrect dedicated power plug sockets- normal plugs used*



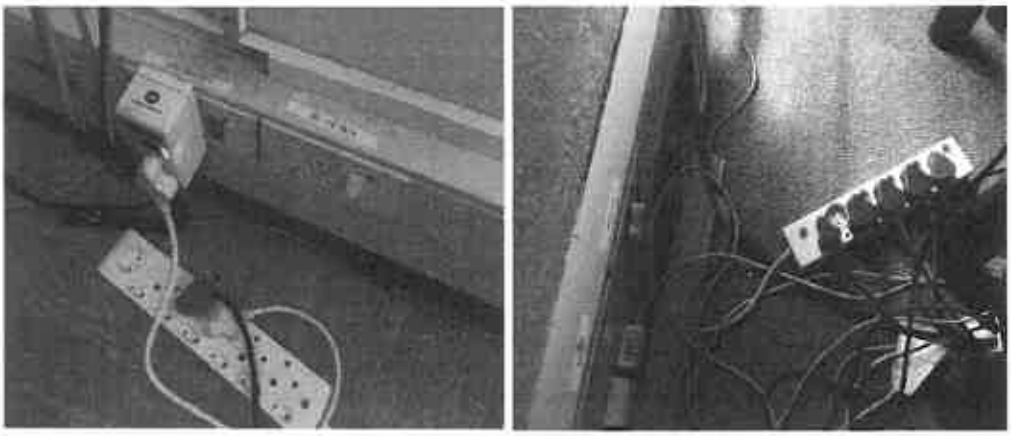

4. The newer extended power circuits do not use dedicated power plug sockets (red, with an earth socket only receiving shaved pins) but rather white colored normal power plug sockets. This allows any device or piece of equipment to be used on dedicated power- possibly compromising the availability of the dedicated power to all users if the load is high.

5. In instances there were additional load placed on the dedicated power circuits with various uses such as charging of mobile phones, heaters, printers, shredders and other devices.

*Figure 3: Incorrect plug sockets provides unfettered access to different uses*

6. There a number of occasions where a range of multiplug extensions are used to provide power to multiple users off the same plug point. Ideally, this should be limited to two additional plugs being used off a specific circuit, for a short duration. This has resulted in the mixing of sources where the dedicated source has been loaded with many normal load sockets via the use of multiplugs and other extensions. One example found was a normal multiplug plug top that has been forced into a dedicated socket outlet.
7. Examples were also found where DEDICATED socket outlets have been supplied off the NORMAL supply circuits. These points have labels indicating (off normal power).

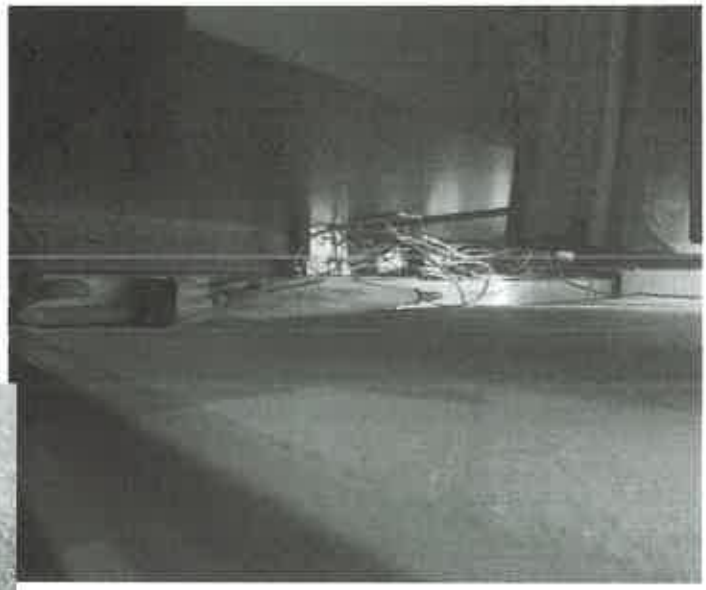
*Figure 4: Normal multi-plug adapters on dedicated power supply sockets*



8. In many cases attempts have been made to identify the circuit breakers of supply to the sockets by means of labels at the outlets. This has revealed that many circuits are overloaded with some supplying over twenty socket outlets. It is also apparent that the labelling is inconsistent, with many socket outlets not labelled at all.

8. The current configuration of the electrical circuits represents both a Health and Safety risk and a compliance issue to building codes.

*Figure 5: Potential risks related to the current configurations of plug sockets*



### *3.2* Testing of the Dedicated Power Circuits

Each plug socket was tested to assess if these were in working order or not, as well as to verify that it is a dedicated supply or normal supply. A summary of the results are as follows:

1. It was found that 6 dedicated plug sockets were not working.
2. Save for the extensions of the dedicated plug sockets which all had been implemented as normal plug sockets, there were 3 white plug sockets that were on dedicated power.
3. There are instances of where the new extensions to the dedicated power plug sockets are linked directly to a plug on the power skirting, using the switch as a means to put the whole extension on or off.

### *3.3* Review of UPS and Generator Capability

This is to check the UPS and Diesel Generator capability to provide the required needs for the proposed dedicated power users. The current configuration of the building electrical reticulation is as follows:

1. Municipal Power is supplied to the Main Distribution Board, located in the Finance and IT Department. This supplies a number of electrical circuits on the southern side of the building, and distribution boards in the server room and the one on the first-floor boardroom.
2. An electrical supply is also provided to the small Distribution Board located at the security office as one enters the gate.
3. Emergency power supply is provided by the John Deere Diesel Generator. This provides power to the Uninterrupted Power Supply (Emerson 30MVA) located in the server room, the dedicated power sockets, the security system and emergency lighting.
4. The UPS only provides power to the servers through a small dedicated distribution board, when the mains and the generator supplies are absent.
5. The tests that were undertaken on the dedicated power supply was to trip the municipal power supply and also disable the generator to ensure that the UPS alone was providing power. This was to establish the following:
    a) Which other circuits were supported by the UPS besides the ones providing power to the servers?
    b) Understand the performance of the UPS in supplying power to current uses it was providing power to during the test (or under normal operations, if the power fails).

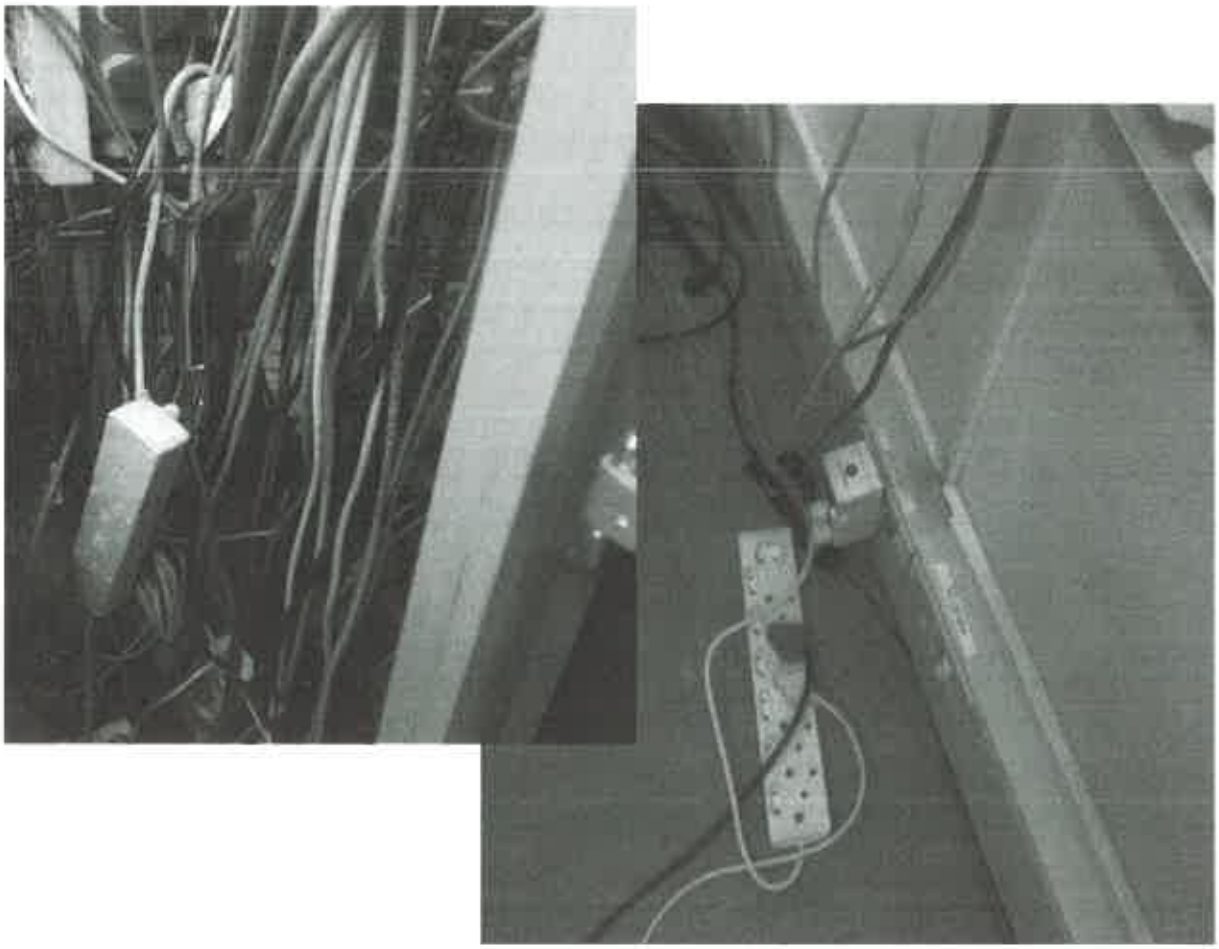
### 3.3.1 UPS

The following was observed during the test:

1. A constant alarm is raised by the UPS. This alarm is specifically pointing to a problem with the batteries contained in the UPS enclosure. These batteries have been installed for many years (it appears since 2003) and are affected by the number of cycles and the temperatures they are subjected to.
2. On switching off the power from both the municipal supply and the generator, the UPS continued to supply power to the servers only.
3. There were no emergency lights working in the server room. It was observed that certain cameras and DVR's were not powered during the test. The question also relates to the Alarm Systems, Surveillance Systems, Biometric Scanners, Fire Monitoring & Control Systems, Telecoms. It was observed that the Biometric scanners had their own battery backup supplies and also that the electronic door locks disabled during power outages.
4. The air-conditioners in the server room were not working. It is important to note that the absence of the air conditioners leads to a rapid increase in temperature in the server room and that the servers are sensitive to these increased temperatures.
5. Three servers indicated faults as they were connected to the power skirting in the server room, which also had dedicated power supply. Notably, there was also an extension cord plugged into the circuit, which is a normal 10-amp cable, which was running warm to the touch. This

indicated an overload on that extension cable large power use, likely for the cable to have a fault when the air-conditioners tripped on no power supply.

*Figure 6: Extension plug providing power to servers from power skirting*



6. The decay pattern of the UPS was as follows during the test: The UPS gives some measure of the available power remaining in the batteries whilst it is the sole supply to the servers. The decay on the batteries was not really representative as some of the servers tripped prematurely, reducing the load on the batteries.

### 3.3.2 Generator

The diesel generator starts within 5-10 seconds of the municipal power tripping. The generator starts supplying power to the circuits within 30-45 seconds of start-up.

The diesel generator is able to supply approximately 100 kVA of power. This is supplied to the emergency lights, the air-conditioners in the server room, the dedicated power circuits and the security system of the facility and the UPS, which in turns supplies the servers.

The capacity of the generator is adequate to supply the various users listed above. No significant frequency changes are encountered whilst the generator is on load. The generator appears to be in a healthy state and performed as expected during the tests. Note should be taken of the weekly testing regime.

Measurement of the load on the various supply systems indicate the load to be imbalanced between the 3 phases: RED, WHITE & BLUE. This imbalance indicates that the maximum demand could potentially be reduced if the load is balanced. This is also a requirement of the municipality.

### *3.4* Survey Results

The number of respondents to the survey were 53 employees across all the departments. The key findings from the survey are:

1. Personnel are unclear of whether they use dedicated power or not. At least 19 users indicated that they use normal power, i.e. the power is interrupted when the municipal power is off.
2. Of the 53 respondents, 23 indicated they access power through a multi-plug adapter. This shows that are large proportion of the users dependent on multi-plug adapters. This poses a challenge for the number of appliances or pieces of equipment that can be safely supplied by one circuit breaker.
3. Most users required dedicated power for the printers that they use as 29 indicated yes to printer on dedicated power and 23 indicated no.
4. The majority of the respondents (75%) did not have any electrical power challenges to their workstations in the last 6 months. The ones which did have anywhere related to load-shedding, indicating that they were on normal power supply.
5. Only 1 of the 53 respondents indicated that they had had awareness training on energy conservation within the last 2 years.
6. The key energy conservation measures listed by respondents are:
    a. Switch off computers at the end of the day;
    b. Switch off lights and air-conditioners when not in use;
    c. Make use of solar water geysers for hot water;
    d. Use energy saving lights.

## *3.5* Data Logging Results

There are four main distribution boards which are configured as follows:

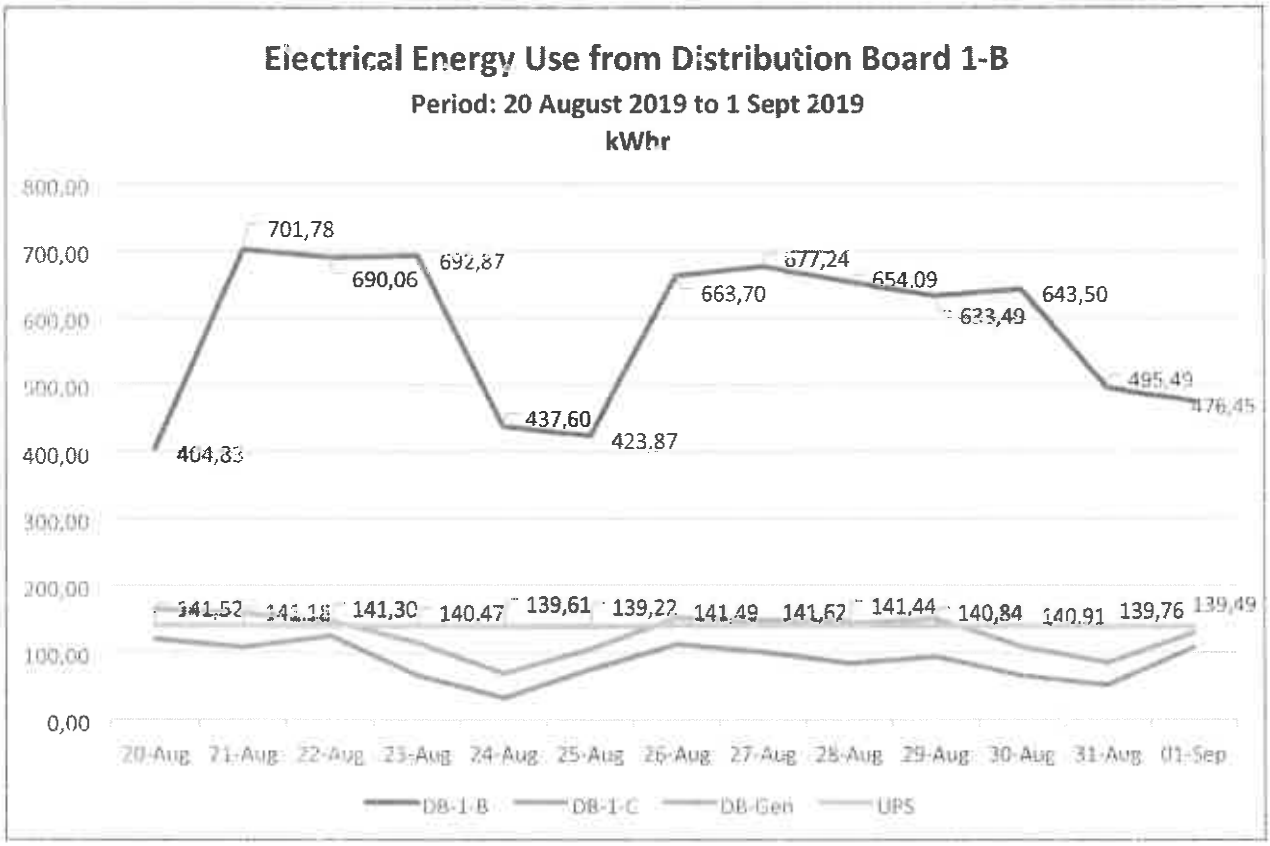
1. Distribution Board 1 A (the main incoming board, located in the Finance Department) which feeds Distribution Board 1 B and the small distribution board located at security office found at the gate.
2. Distribution Board 1 B (located in the electrical enclosure in the server room), which feeds Distribution Board 1 C, the Generator Distribution (also fed from Generator) and the UPS Distribution Board via the UPS (also fed from the Generator).

Electrical power data loggers were installed on the electrical supply boards to understand the electrical energy use for a period of a week. The intent of the data logging was not to have a complete electrical audit but rather to provide a high-level understanding of usage patterns and typically how much electrical power is consumed by the NCR.

The information discussed hereafter will be for Distribution Board 1-B and the ancillary boards. The loggers on Distribution Board 1-A (the main distribution board) had tripped whilst collecting data and the logger on the Security Distribution stopped recording within 5 hours of being installed. The reason for it stopping is unknown.

Despite this, the information from Distribution Board 1-B, DB 1-C, the Generator DB and the UPS DB provide an adequate history to infer some salient findings on usage patterns that can utilized in possible energy management interventions. The daily usage for the period from 20 August 2019 to 1 September 2019 is illustrated below.

*Figure 7: Electrical Power Use from Distribution Board 1-C*




The above figure indicates the following:

1. Typical usage per day during the week is in the order of 600-700 kWhr per day for the areas supplied by DB 1-B. The usage during weekends (when there is limited staff on site) is approximately 400-475 kWhr.
2. The constant use from the Servers is indicated to be approximately 140 kWhr per day. The usage from other uses during the week account for approximately 460-560 kWhr per day and 260-335 kWhr per day on weekends.

3. From this can be inferred that there is still significant amount of energy being utilized per day even during weekends during times when the majority of the staff are not on site. Typical utility uses that can be accounted for would be lighting at night, server room air-conditioners and power to security features. This is estimated to be approximately not more than 150 kWhr per day, thus the

other uses can be assumed to come from computers and other equipment remaining powered on whilst not in use.

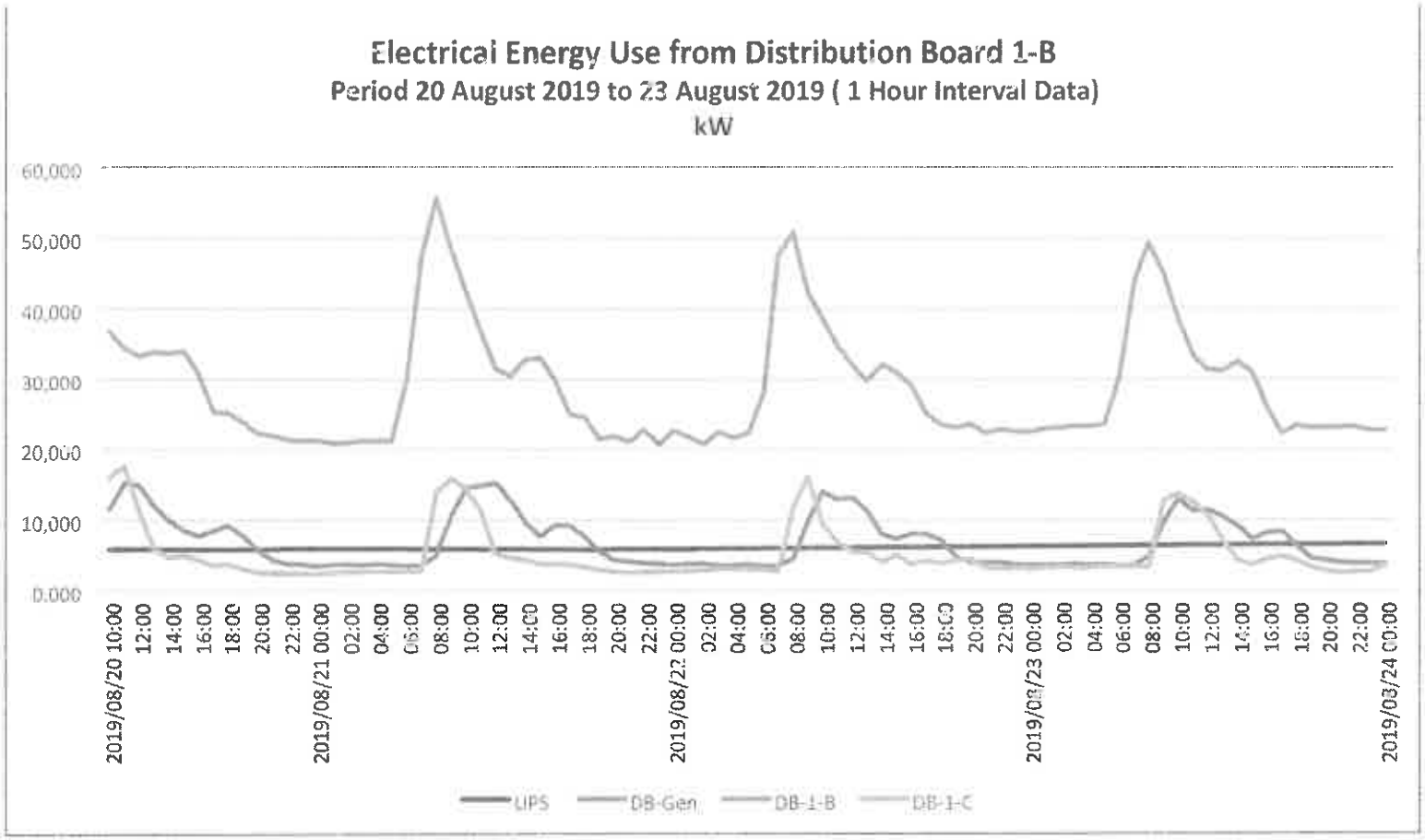
4. Typically, an order of magnitude estimate of such cost when extrapolated say over 48 working weekends of the year is estimated to be:

| | | |
|---|---|---|
| a. | Extra energy used per day: | 200 kWhr |
| b. | Number of days: | 96 days |
| c. | Energy cost per kWhr | R0.70 /kWhr |
| d. | Total cost | a x b x c |
| | | 150 kWhr x 96 days x R0.70 /kWhr |
| | R 13 440.00 | |

A more detailed picture is provided when considering hourly intervals of electrical energy use. For this purpose, the hourly intervals for the period from 10:00, 20 August 2019 to 00:00 24 August 2019 are graphically illustrated in the accompanying figure.

DITIROPELE, 100% COMMITTED TO SERVING CLIENTS

*Figure 8: Electrical Power Use from Distribution Board 1-B*



From the graph the following trends can be seen:

1. Morning start each day draws peak demands between 06:00 and 09:00. A decline in energy usage occurs from thereon until after lunch when there is typically a small peak and then a decline to close of day.
2. Typical nighttime use approximately 20-22 kW per hour. The servers draw approximately 6 kW of this power.
3. The startup use per day could be typically attributed to air-conditioner use.
4. Opportunity exists to smoothen the peak demands in the morning by possibly sequenced start of air-conditionings.

## 4.0 Conclusions

Based on the findings, the following conclusions are drawn:

1. The diesel generator can supply approximately 100kVA and is able to adequately supply power to the dedicated electrical power circuits.

2. The UPS operated as designed during the total blackout situation. UPS is the biggest cause of concern, as it is also the more critical piece of equipment in the whole scheme. It also appears that there is a need for some education on the role and operation of the UPS. The Original Equipment Manufacturer may be called upon for opinion here. It may not be necessary to replace more than the batteries. It will also be a good idea to utilize the feature of automatically shutting down servers through the UPS, as this software capability does exist.

3. The load across the three phases is imbalanced. This could lead to an unnecessary cost through increased payments for maximum demand charges.

4. The configuration of the electrical circuits by extending the plug sockets per circuit presents a safety risk. This is above the generally acceptable configuration of 10 plug outlets per circuit there is the likelihood of a circuit breaker tripping.

5. The use of normal plugs (white plug sockets without the earth pin-hole not being shaped) for dedicated plug sockets allows for non-dedicated equipment to be used on dedicated circuits, thus increasing the strain on the electrical system during an emergency situation.

6. The practice of using multi-plug adapters as permanent fixtures to the electrical circuits increases the likelihood of overloading specific circuits.

7. All the servers in the server room where not plugged into UPS power. This was evident when 3 servers tripped when the diesel generator was switched off. These servers were being served by an extension cable that is limited to approximately 10 amps.

8. There is no emergency light in the server room if the generator is not operational during a municipal power outage.

9. The security system of the building only operates on power from the diesel generator and is not linked to the UPS. The system has a fail-safe mechanism which ensures that the doors are open in a blackout situation.

10. The UPS, when its batteries are fully charged, currently can support the server operations for maximum time of about 54 minutes prior to being safely shut down.

11. Most of the users in the building are on dedicated supply, with isolated users not having dedicated supply. Save for the group in procurement, the rest could access dedicated supply by adaption of the plugs they use for their PCs or laptops.

12. A positive observation made was that there was adequate provision made for emergency lighting throughout the building, whilst running off the generator supply. This does not include the Server Room, however.

13. The server room needs some attention, particularly the power sources and reticulation in the room. There appears to be sufficient outlets, but the mangle of extension cords seems to lead to only a few supply points. A planned outage period should be arranged, with some prior planning, to structure these supply points and cabling.

14. Data logging at the DB boards indicated the energy consumption by the different departments. The pattern indicated a typical demand pattern. The use of energy by Air conditioners are excessive, VRV's are often suitable for reduction of energy consumption. Extensive work has been conducted to ensure that NCR is Energy efficient.

## 5.0 Recommendations

The following recommendations are made based on the conclusions drawn to provide a productive and safe working environment in the current facility:

a. It is imperative that the integrity of DEDICATED socket outlets be maintained as separate from NORMAL outlets. Apart from just the red colour, they also make use of the shaved earth pins to prevent NORMAL plugs from being inserted here. This standard should be maintained by ensuring the following:

    a. Providing all staff, the requisite number of plugs for safe operation. The current plug outlets should be re-configured to ensure approximately 2 dedicated plug outlets per 1 normal plug outlet is maintained at all work areas.
    b. Education of all staff on the use of the various power outlet sockets.
    c. At least a monthly inspection by the Department Head to ensure compliance. This should be followed up by either half yearly audits by Facilities Management and at least quarterly inspections.

b. The distribution boards should be re-labelled as well as all the plug outlet sockets. On each distribution board each circuit needs, be labelled; each main breaker incoming and outgoing and new legends should be created for each board.

c. The circuits in the distribution boards should be re-wired to ensure that the load across the three phases of supply are balanced.

d. For the plug outlet sockets, the labelling should be done to correctly identify the distribution board and supply circuit on each plug socket outlet.

e. All unsafe wiring must be rectified, plug outlet socket need to be fixed correctly and properly to the power skirting. All power skirting covers should be installed properly.

f. The number of socket outlets should ideally be limited to no more than 10 outlets per circuit breaker. The circuit breaker is there to adequately protect the cabling supplying the load and allowance is normally made for in-advertent expansion by users.

g. A planned outage period should be arranged to structure the supply points and cabling in the server room. The reticulation in the server room must be re-organized neatly to ensure that the

various points of demand are properly serviced by the supply points in the room. Where needed, additional supply points should be implemented.

h. The UPS test checklist needs to be translated and verified to ensure that it is aligned to the Original Equipment Manufacturers recommendations. All data and check-sheets should be provided completed in a duplicate. A copy should be provided to the NCR for their records.

i. A procedure for the priority shutting down of the servers must be implemented. Training should be provided to key IT personnel. The capability of the UPS to automatically shut-down the servers sequentially should be implemented.

j. The emergency lights should be re-configured to ensure use during total blackout situations. The LED lights should either be supplied off the current UPS (or another UPS) or battery.

k. The emergency light in the server room should be on the UPS circuit to ensure light in the server room when the municipal and generator power fails.

l. A Certificate of Compliance for all the electrical reticulation should be obtained. This is important to comply with Occupational Health and Safety requirements, General Building Standards and for insurance purposes. An updated electrical reticulation plan should be obtained for the as built installation.

m. General energy conservation awareness training should be scheduled for all staff. This can be integrated to the periodic departmental and organizational staff meetings with specific dedicated training events.

n. Solar power might be a good alternative for the reduction of the energy consumption; however, the Landlord would have to approve the installation. NCR must consider being part of National Business Imitative where various solutions on Energy an operational efficiency are shared with companies.

## 6.0 Appendices

### *6.1 Scope* of Works

The following scope of works has been derived from the assessment undertaken on the generator, UPS and dedicated electrical power circuits utilized by the NCR.

The Contractor is required to undertake a range of remedial actions related to the above electrical circuits and equipment. The NCR makes use of both normal and dedicated electrical power circuits on the site. The NCR has been desirous to ensure that the all the core work activities utilize dedicated power. Currently the following deficiencies exist on the electrical power circuits:

**Plug Outlet Points**

1. Plug outlets and wiring in the power skirting are loose in a number of places;
2. Normal plug outlets are connected to the dedicated electrical power circuit, thus not restricting use to dedicated users alone;
3. Dedicated plug circuit outlets have been extended so that the number of plug point outlets on some circuits are exceeding the accepted best practice and safe working loads per circuit;
4. The labelling on the plug outlets need to be corrected.

**Distribution Boards**

1. Each distribution board should have the requisite number of circuit breakers to support the number of lights and plug point outlets per circuit;
2. The boards are not labelled correctly and there does not exist an updated legend for each board.

**Lighting**

1. No emergency light in the server room;
2. Emergency lights are not available in a total blackout situation.

**Server Room and UPS**

1. The cabling in the server room is not neat and properly truncated; 2. The UPS batteries' have reduced life.

A bill of quantities has been drawn up, setting out a summary of the scope of works.

| Item | Description | Quantity | Cost |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |