Report Name : CTCT Substations Conditional Assessment

Project Number :

Document Number :

DOCUMENTATION DISTRIBUTION, REVISION AND APPROVAL HISTORY

Executive Summary

Introduction

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Transnet Port Terminals Engineering team has been tasked to undertake a conditional assessment of substations in the Port of Cape Town. The idea is to ensure a safe and reliable electrical infrastructure. The current infrastructure is now old with limited available spares which poses a risk of power supply to operations. It is a requirement by law to entirely make a substation compliant to at least the minimum enforced regulations once you attempt to undertake upgrades of plant such as switchgear. It is for this reason that a thorough conditional assessment was conducted. This document is a resultant assessment report to recommend the required upgrades especially for compliance to regulations.

Scope Overview

Only five substations were assessed mainly against the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993) (OHS Act). The assessment was mainly a visual inspection exercise and excluded fault finding, sample testing and routine testing. The focus of the inspection and the report is specifically on the no compliance so less is highlighted about a lot of good practice that was observed.

Literature Review

This section seeks to summarise the bases for the identified findings and proposals. Substation buildings shall be of size suitable for design and working space requirements. MV and LV switchgear shall be separated with a barrier. Oil distribution transformers shall have an oil containment to avoid spillage to the environment and the substation building area.

Medium voltage switchgear shall ensure operator safety through the application of SANS 62271 arc flash requirements. VCBs are the preferred technology for MV circuit breakers mainly because they are environmentally friendly. LV switchgear fuse and circuit breaker technologies have contesting properties over each other, but circuit breakers have been proven and accepted to be more beneficial than fuses.

Site Assessment

The Container Admin Substation has space constrains and requires an additional room to house transformers so that adequate working space can be allowed for in the existing substation building.

There is redundant plant in the Road Rail and Refrigeration Substations because of the decommissioned loads. The redundant plant will be re-evaluated for compliance when needed to resume supply to operations. All the transformer bays shall be bunded as a minimum requirement for oil containment. The MV switch gear is now old and of oil technology. The design, supply and installation of new VCB MV switchgear is require. LV switchgear is also old across all the substations and shall be upgraded with new modern switchboards. All the proposed upgrades shall be compatible with SANS 61850 for substations automation.

Conclusion

It is recommended that the business supports the recommendations of this report and approve funding as detailed in the resultant cost estimate.

Table of Contents

Definitions/Abbreviations

TPT	Transnet Port Terminals
NMD	Notified Maximum Demand
N+1	A network state where one critical component of the electrical supply system is out of service, e.g. a source transformer or supply cable. Under N+1 conditions, electrical networks are typically operated using a contingency plan where load shedding may be necessary.
PLP	Project Life Plan
MVA	Mega Volt Amperes
kV	Kilo-Volts
Plant	Includes fixtures, fittings, implements, equipment, tools and appliances, and anything which is used for any purpose in connection with such plant.
Dead	Means at or about zero potential and isolated from any live system
Earthed	Means connected to the general mass of earth in such a manner as will ensure at all times an immediate safe discharge of electrical energy.
SANS	South African National Standard
ANSI	American National Standards Institute
IEC	International Electro Technical Commission
IEEE	Institute of Electrical abd Electronics Engineers
FM200	Heptafluoropropane
HVAC	Heating, Ventilation and Air Conditioning
ISO	International Organization for Standardization
ORS	Owner Requirement Specification
CAD	Computer Aided Design
PFC	Power Correction Factor
UPS	Uninterrupted Power Supply
kVA	kilo Volt Amperes
kA	kilo Amps
kW	kilo Watts
CT	Current Transformer
VT	Voltage Transformer
SCADA	Supervisory control and data acquisition

1.1 Container Admin Substation

1.1.1 General Layout

The substation is located at the ground floor of the admin building. It consists of five medium voltage panels, two low voltage panels and two 1250kVA, 11.66kV/400V transformers all installed in the same room. See figure 2 to for the switching diagram. Covered Trenches are used as the primary cable management system and supplemented with the cable ladder system. Access to the substation building is through a single door facing out of the substation room and a wooden double door opening to the reception area of the ground floor of the building.

The LV panel is backed up by a generator set through a separate panel which supplies only critical loads. The substation room also houses a UPS system that supplies ICT systems in the building.

The substation is fed from feeders L12 and R12 at the Harbour Main Substation and is in a ring between the CAE and Carrier Substations with 2x 150mm² XLPE insulated 3core copper cable.

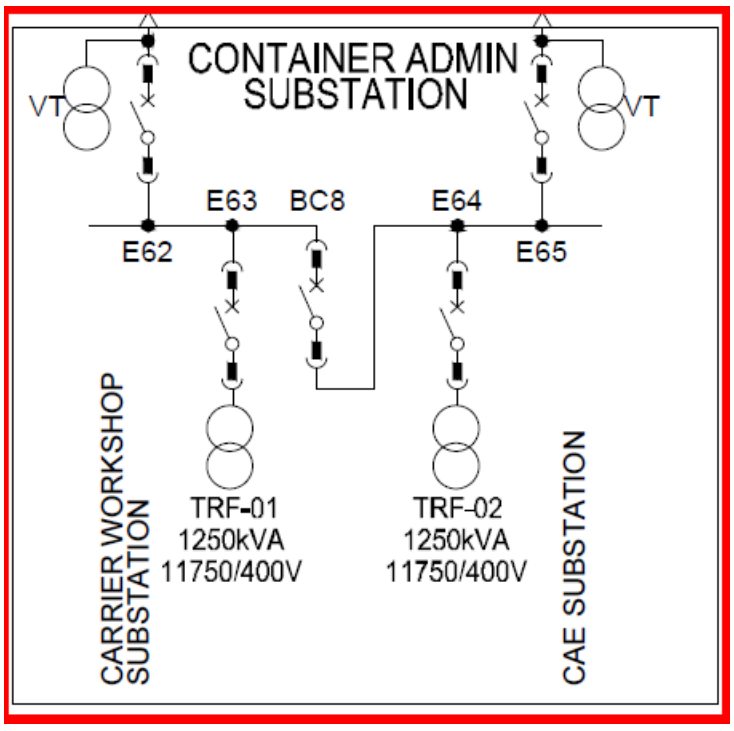


Figure 1: Admin Substation Switching diagram.

1.1.2 Findings

1.1.2.1 Room layout

1.1.2.1.1 There is not enough working space as informed by the NEC recommendations discussed in section 4.1. See figure 3. It can also be seen from figure 3 that there is no barrier between the MV and LV switch gear. This is in violation of the buildings and enclosures clause of SANS 10142-2.

Figure 2: Racking space in front of the MV panel is less than 1200mm. MV switch gear is not separated by any form of barrier from the LV switchgear.

1.1.2.1.2 The substation has two doors which is acceptable but the positioning of the door leading to the admin is not suitable as a fire escape route. See figure 4. If an operator was to be next to the existing LV panel and the fire happened along the existing MV panel position, the operator would be trapped without an accessible escape route.

1.1.2.1.3 The substation door leading to the admin station is a safety finding because of the posed risk to unauthorised entry. There is also a risk to personnel occupying the admin area may a fault occur in the MV panel. A typical short circuit fault in MV switchgear on this type may generate enough energy to blast through the door and cause serious injury and possible death.

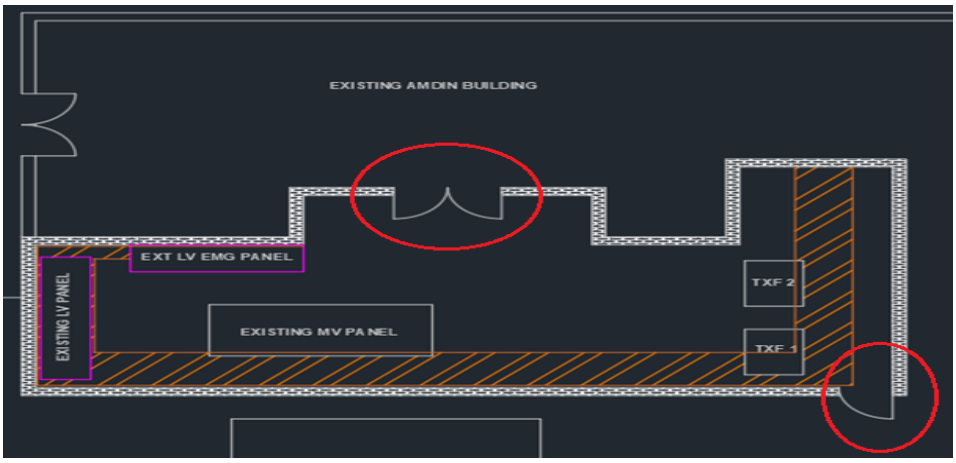


Figure 3: Admin Substation Layout.

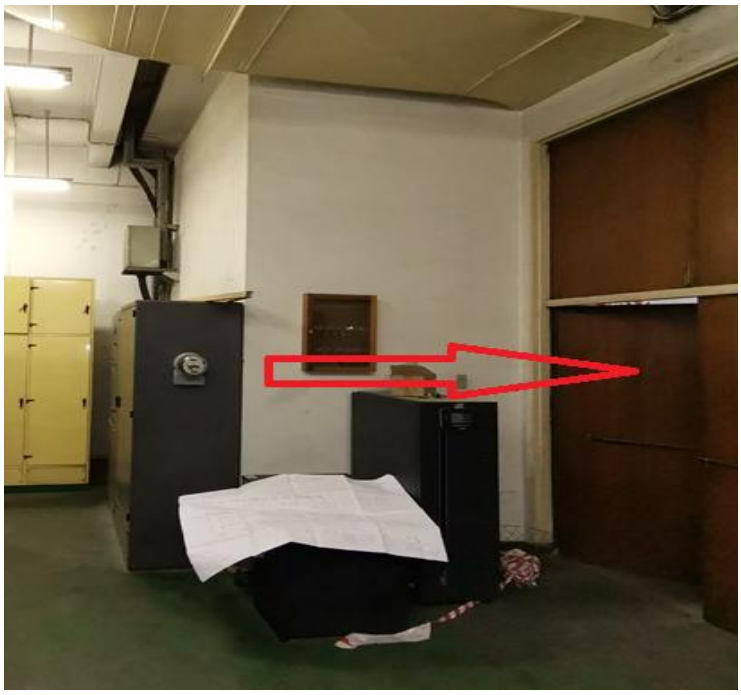


Figure 4: Substation door leading to the admin station.

1.1.2.2 Design compliance

1.1.2.2.1 The battery terminal unit is not sufficient for the intended uses. The breaker closing and opening function is supplemented by the voltage transformers. See figure 6.

Figure 5: BTU with only three batteries.

1.1.2.2.2 For installations with oil Filled transformers, SANS 10142-2 requires that adequate provision shall be made for containing oil in case of leakages of spillages. Figure 7 shows an installation without an oil containment with some evidence of experienced leakages. The spill oil can also gain access to cable trenches which is in addition not acceptable.

Figure 6: Distribution transformer with no oil containment provision.

1.1.2.3 Technology concerns

1.1.2.3.1 The Container admin substation is fitted with old oil MV circuit breaker technology. See figure 6. The detail of the racking system shows that the breaker is racked at the bottom compartment and with bent old rails. A smooth rail is required to make a firm contact with the bus bars to avoid hotspots. The bottom compartment is not favourable for service conditions. This technology is with findings discussed in section 4.3.1 of this report.

1.1.2.3.2 The switchgear is fitted with old relay technology that is of the disc type.

Figure 7: Old oil circuit breaker MV switchgear

1.1.2.3.3 The LV switchgear makes use of circuit breakers which is recommended than the fuse technology. The switchgear shown in figure 9 is now old and is an old design that is not compact. See figure 9.

1.1.2.3.4 Next to the main LV switchgear that is fed from the transformers, there's a Generator LV panel that is also fitted with circuit breakers. See figure 9,2. This panel is also old strictly dedicated to supply the lifts, UPS *(in the same room for the third floor)* and the third floor which is a control room. The installation is not simple to follow, with some unnamed breakers, but can be made simpler in the proposed upgrades.

Figure 8: Old LV switchgear.

1.1.3 Recommendations

1.1.3.1 Room layout

1.1.3.1.1 Addressing the space constrain:

The room is congested with all plant in one room, the solution making the substation complaint to working space requirements is to relocate the transformers to a proposed new room outside the substation. The proposed positions for the room are highlighted in red as shown in figure 10. Position 1 is a parking space behind the wall that is adjacent to the existing LV switchgear, position 2 is the roof space of the generator room and position three is also a special parking position as show in figure 11.

1.1.3.1.2 The proposed transformer room shall be designed and constructed with ventilation and oil containment requirements in accordance with SANS 10142-1&2 and the fire design requirements.

1.1.3.1.3 A door that is suitable for an escape route is required. The position indicated with a yellow squire in figure 10 is ideal for this proposal.

1.1.3.1.4 The room shall be re-arranged to only house the MV and LV plant. A barrier shall be fitted to separate the MV and LV plant. See section 4.1.2. The rearrangement shall be such that a minimal disruption to the reticulation system is achieved to help avoid cable joints. New tranches might be required because of the rearrangement.

1.1.3.1.5 The door leading to the admin area shall be sealed with brickwork or replaced with a sufficiently fire rated door *(to be informed by the mechanical engineering conditional assessment report)*. The risk to personnel from a possible blast will be reduce further because of the proposed MV switchgear technology with arc flash protection.

1.1.3.1.6 The substation shall be shall be equipped with a wooden ladder.

1.1.3.1.7 Updated LV and MV single line drawings shall be displayed.

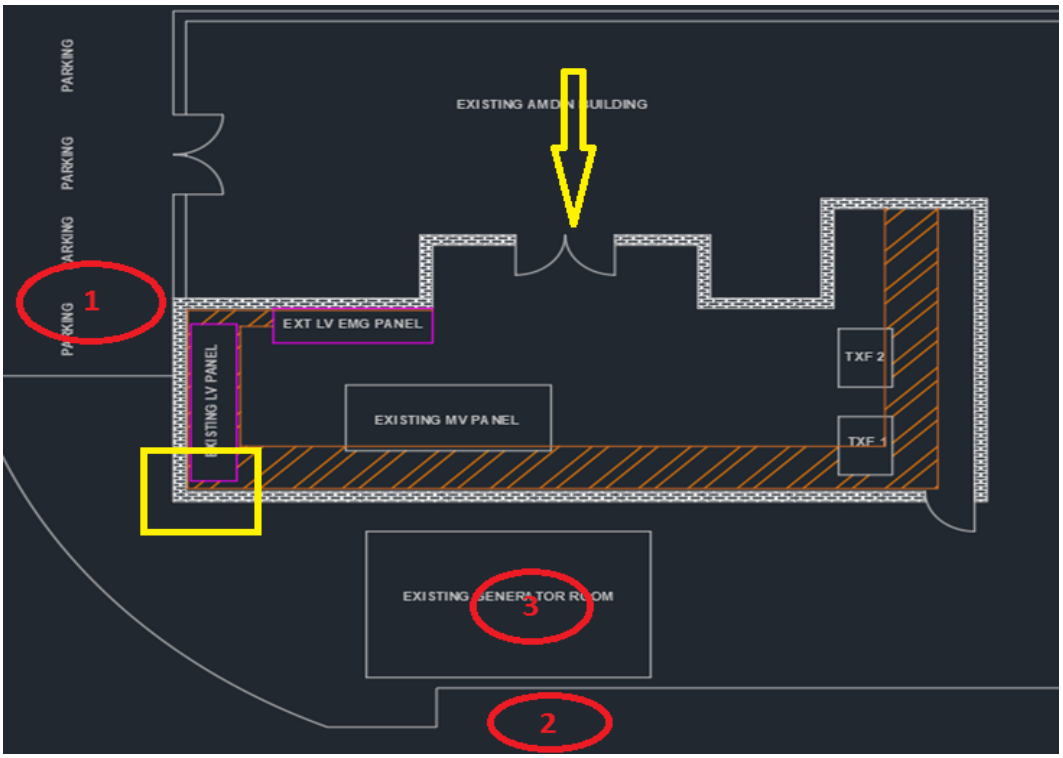


Figure 9: Container admin Building layout and surrounding arrangement:

Figure 10: Positions for the proposed transformer room

1.1.3.2 Design and Technology

1.1.3.2.1 Design, supply and install a new substation reticulation system to complement the rearrangement of the substation plant.

1.1.3.2.2 Design, supply and install new MV switchgear complete instrument transformers and morden electronic relays compatible with SANS 61850. The switchgear shall meet the requirements of section 4.3.3 of this report.

1.1.3.2.3 Design, supply and install a new DC power supply for the MV switchgear.

1.1.3.2.4 Design, supply and install new LV switchgear with automation functionality.

1.1.3.2.5 Design supply and install new lighting in accordance with the OHS Act Environmental regulations. The proposed lighting shall make use of energy efficient LED fittings.

1.1.3.2.6 There was no recommended action for the TRF1 oil from the 2019 oil test report [].

1.1.3.2.7 TRF 2 test results indicated local overheating and elevated methane (sparking), the recommendation in 2019 was to monitor the transformer closely to determine the production rates []. No information was provided if the action was carried out as advised. Routine tests are advised by the investigation team.

1.2 Road-Rail Substation

1.2.1 General Layout

The substation consists of a medium voltage switchboard that is a single bus arrangement with eight medium panels. The panels comprises of two incomers, a bus-sec, and five feeders as shown in figure 12. The switchgear room also houses two low voltage panels *(400V and 550V)* fed from four transformers. The transformers are housed in a separate room of the same substation building. Covered Trenches are used as the primary cable management system.

The substation is ring fed by 2x150mm^2 XLPE cables from feeders L13 of the Harbour main substation and through E51 of the Harbour Signal Substation back to the Harbour Main Substation. See annexure A for the overall Port Electrical Reticulation single line diagram.

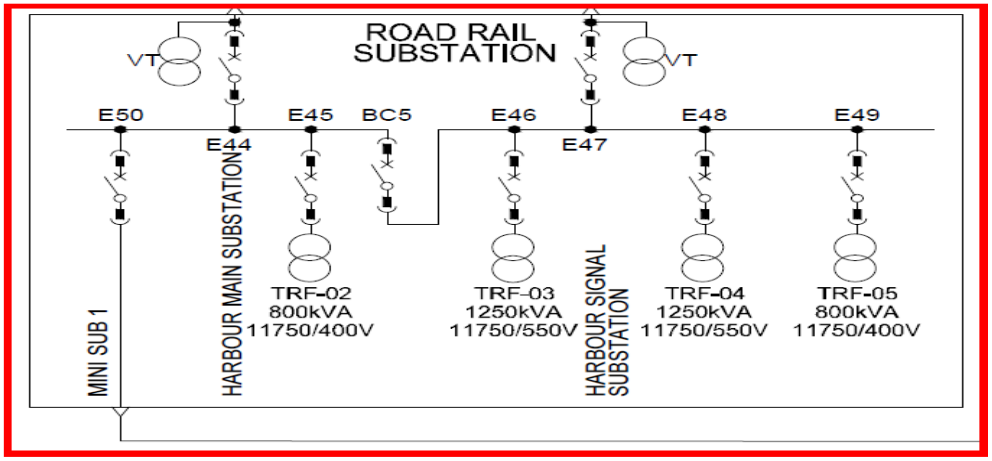


Figure 11: Road Rail Substation Switching diagram.

1.2.2 Findings

1.2.2.1 Room layout

1.2.2.1.1 There is no that there is no barrier between the MV and LV switch gear.

1.2.2.1.2 Figure 13 shows an ample size transformer room with five transformer bays and four transformers without oil containment.

Figure 12: Distribution transformers with no oil containment provision.

1.2.2.2 Technology and power system concerns

1.2.2.2.1 The TRF 2&5 oil sample test results reports that the oils fails against the specification measures for moisture and DGA.

1.2.2.2.2 This Substation is also fitted with old oil MV circuit breaker technology. See figure 14. The racking findings are similar to those discussed for the Admin container substation.

1.2.2.2.3 The switchgear is fitted with old relay technology that is of the disc type. There are few modern electronic relays as seen in figure 14.

Figure 13: Old oil circuit breaker MV switchgear

1.2.2.2.4 The switchgear shown in figure 15 *(Fig.15.1 400V and Fig15.2 550V)* is now old and is an old design. The 550V switchboard was used to supply cranes, it is out of service and is no longer required.

Figure 14: 400V and 550V switchgear

1.2.2.2.5 The substation had SCADA which is no longer working. See figure 16 for the instrumentation board.

Figure 15: SCADA instrumentation board

1.2.3 Recommendations

1.2.3.1 Room layout

1.2.3.1.1 Design, supply and install an oil containment in a form of bunding plate with *(suitable material)* around each transformer to satisfy the requirements of SANS 10142-1&2 and the fire substation building requirements.

1.2.3.1.2 A barrier shall be fitted to separate the MV and LV plant. See section 4.1.2. Any of rearrangement of switchgear positions shall be such that a minimal disruption to the reticulation system is achieved to help avoid cable joints.

1.2.3.1.3 The substation shall be shall be equipped with a wooden ladder.

1.2.3.1.4 Updated LV and MV single line drawings shall be displayed.

1.2.3.2 Power System and Technology

1.2.3.2.1 Design, supply and install new MV switchgear complete instrument transformers and morden electronic relays compatible with SANS 61850. The switchgear shall meet the requirements of section 4.3.3 of this report.

1.2.3.2.2 Design, supply and install a new DC power supply for the MV switchgear.

1.2.3.2.3 Design, supply and install new LV switchgear with automation functionality.

1.2.3.2.4 Design supply and install new lighting in accordance with the OHS Act Environmental regulations. The proposed lighting shall make use of energy efficient LED fittings.

1.2.3.2.5 Regen or replace the oil in TRF 2&5. []

1.3 Refrigeration Substation

1.3.1 General Layout

The substation consists of two *(11.75kV and 3.3kV)* medium voltage switchboard that are both single bus arrangements with. Figure 17 shows a single line diagram for the 11.75kV panels. The 3.3kV switchboard has nine panels which are is no longer used because the respective and 400V refrigeration loads are no longer operational. The cables and supply points are currently de-energized. The switchgear room also houses a low voltage board. The transformers are housed in a separate room of the same substation building. The single line does not show two 11.75kV/3.3kV transformers that are also housed in the transformer room. For this substation, covered Trenches are used as the primary cable management system.

The entire Port is reticulated with 2x150mm^2 XLPE cables and this substation is ring fed from feeders L14 and R15 of the Harbour main substation.

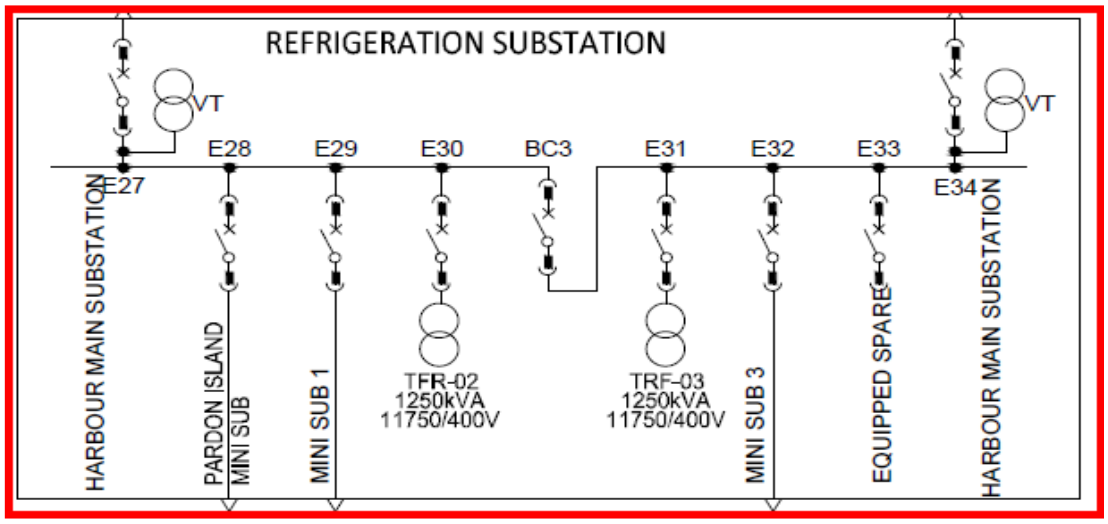


Figure 16: Refrigeration Substation Switching diagram.

1.3.2 Findings

1.3.2.1 Room layout

1.3.2.1.1 There is no that there is no barrier between the MV and LV switch gear. See Fig. 18.

Figure 17: MV and LV Switchgear all in one room with no barrier in-between.

1.3.2.1.2 Figure 19 shows a transformer room with four transformers without any form of oil containment.

1.3.2.1.3 The pointed roller door positions in the same figure are also sealed as shown and cannot be opened. This is a problem for cases of replacing the transformers.

Figure 18: Transformer Room Roller door Openings

1.3.2.2 Technology and Power System concerns

1.3.2.2.1 This substation is fitted with old oil MV circuit breaker technology like the preceding discussed substations. The protection relays are also of the old technology.

1.3.2.2.2 The low voltage switchgear shown in figure 20 with details of the interior in Figure 21,1&2 was designed such that a person can walk inside through the side door. This switchgear arrangement has no form of segregation between panels, meaning a fault in a specific location can easily affect more sections if not the entire switch gear. The switchgear qualifies as a confined space by definition of the OHS Act. Hence respective measures for such an enclosure are absent requirements.

Figure 19: 400V Switchgear with a door opening on the side.

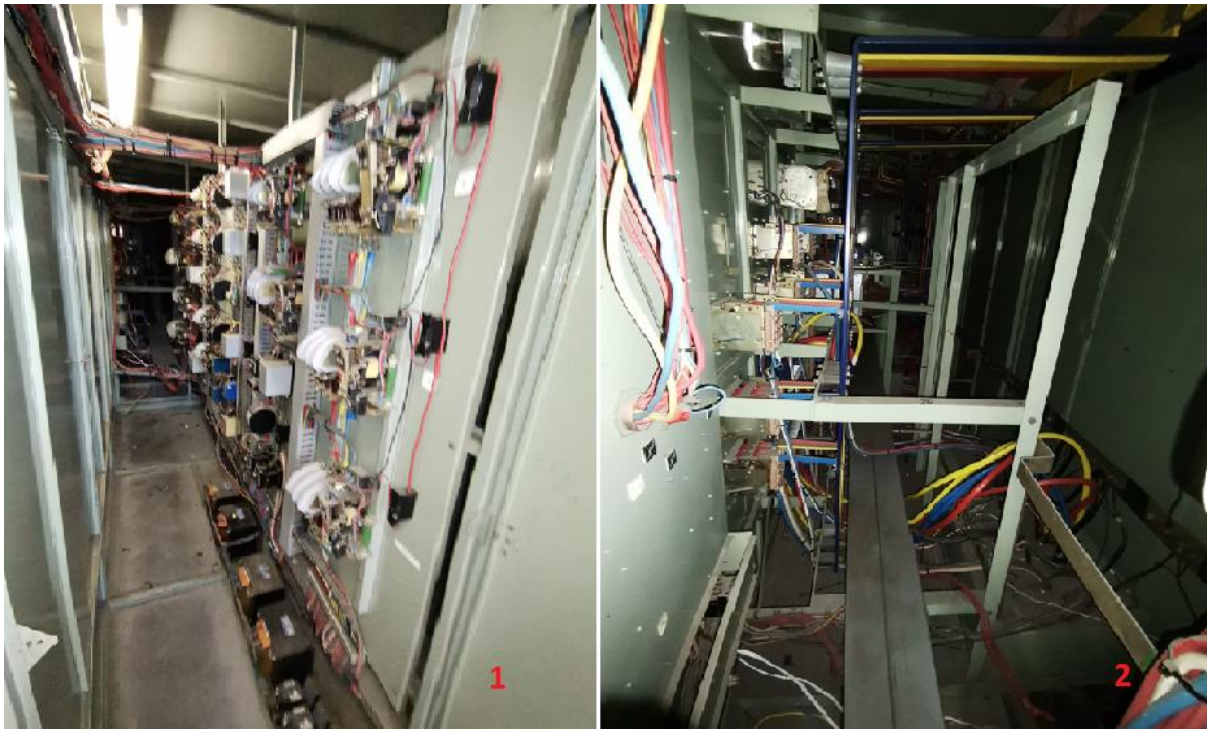


Figure 20: Inside Details of the 400V LV Switchgear.

1.3.2.2.3 Currently only the 11.75kV/400V Transformer 3 is in operation and therefore the bus section of the LV switchboard is closed and the incomer from the other LV transformer 2 is open. TRF 2 is faulty and was replaced with the existing TRF 2 which is worked for 3-4 months and also caught a fault and isolated as of the day of the assessment. The N+! Redundancy is compromised at this LV level.

1.3.2.2.4 Transformer 3 which is operational is also with apparent problems of oil leakage. Figure 22 shows oil leaks on the floor, the TRF auxiliaries and the seal of the TRF tank. Such problems do not only affect the level of the oil but are indications that impurities can invade in locations where there are leaks and thus affect the properties of the oil. The maintenance team is following this problem closely and have tried to fix the leaks on the auxiliaries without success.

1.3.2.2.5 The oil sample test from 2019 reports that the moisture content is high and the dielectric strength is on a borderline.

Figure 21,1 TRF Oil Leakage of the Floor. 2, TRF Auxiliaries with Oil Leaks. 3, Tank Seal with Oil Leaks

1.3.3 Recommendations

1.3.3.1 Room layout

1.3.3.1.1 Remove the seal in the Transformer room roller doors and reinstall new roller doors to allow for the removal and installation of new or existing TRFs in the room.

1.3.3.1.2 Design, supply and install an oil containment in a form of bunding plate with *(suitable material)* around each transformer.

1.3.3.1.3 A barrier shall be fitted to separate the MV and LV plant.

1.3.3.1.4 The substation shall be shall be equipped with a wooden ladder.

1.3.3.1.5 Updated LV and MV single line drawings shall be displayed.

1.3.3.2 Design and Technology

1.3.3.2.1 Design, supply and install new MV switchgear complete instrument transformers and morden electronic relays compatible with SANS 61850. The switchgear shall meet the requirements of section 4.3.3 of this report.

1.3.3.2.2 Design, supply and install a new DC power supply for the MV switchgear.

1.3.3.2.3 Design, supply and install new LV switchgear with automation functionality.

1.3.3.2.4 Design supply and install new lighting in accordance with the OHS Act Environmental regulations. The proposed lighting shall make use of energy efficient LED fittings.

1.3.3.2.5 Prioritise the problem of the leaking TRF 3 that is operational. Since there is currently no N+1 redundancy because of the faulty TRF 2, any fault on TRF 3 would result in loss of supply to the respective loads.

1.3.3.2.6 Find the root cause of the consistent fault on TRF 2 and fix the fault.

1.3.3.2.7 Test the extent of the fault of the TRF 2 supply on the transformer and ensure that found damages/threats on the transformer are resolved before putting the transformer back to service.

1.3.3.2.8 Recommendation (5.4.3.5,6,7&8) shall be attended to as priority. The TPT engineering team which undertook the conditional assessment can in addition assist to analyse the LV power system behaviour to inform possible root causes of the faults on TRF 2.

1.3.3.2.9 The overall recommendation for the oil sample test report produced in 2019 suggests that the oil condition and PCB levels fails against the specification measures and needs to be replaced [].

1.3.3.2.10 No oil sample test results were found on the other transformers in the substation.

1.4 CAE Substation

1.4.1 General Layout

The substation consists of a medium voltage switchboard as shown in figure 23. The transformers are housed in a separate room of the same substation building.

The substation is ring fed from the harbour main substation through the container admin substation and directly from R12 feeder breaker. See annexure A for the overall Port single line diagram.

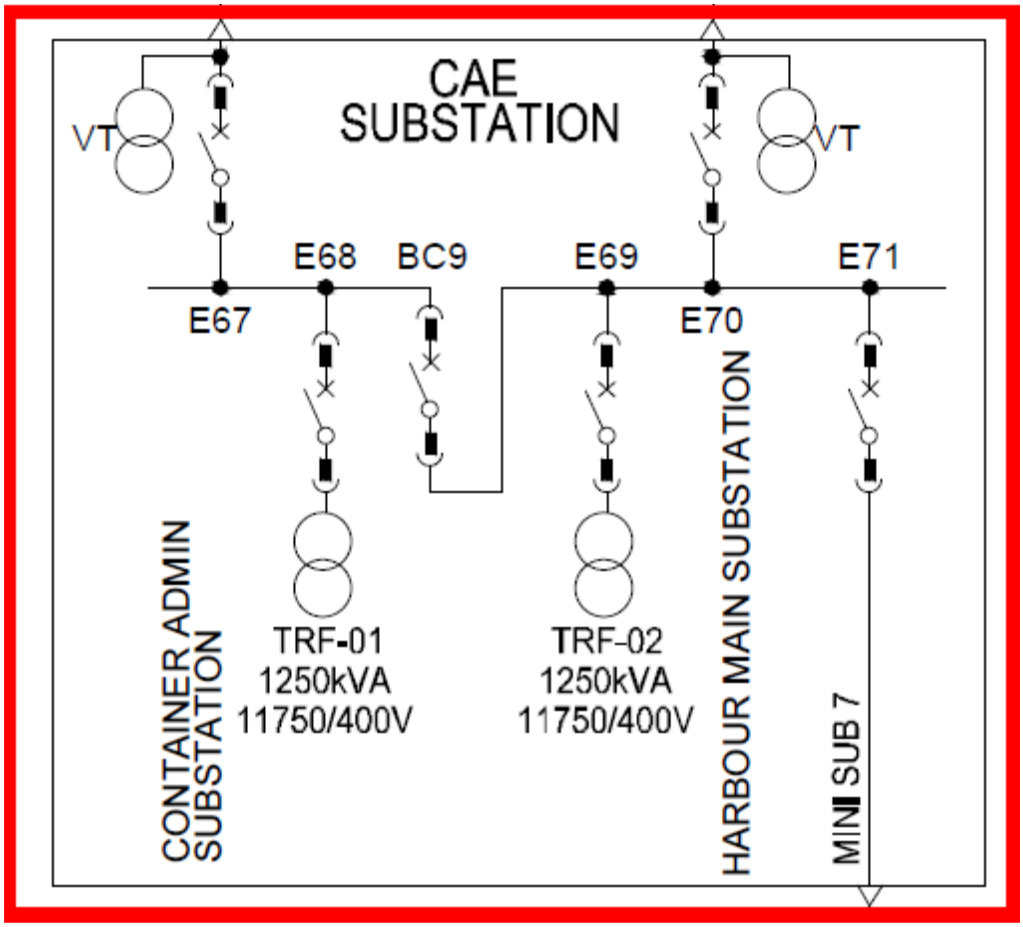


Figure 22: CAE Substation Switching diagram.

1.4.2 Findings

1.4.2.1 Room layout

1.4.2.1.1 There is no that there is no barrier between the MV and LV switch gear. See Fig. 24.

1.4.2.1.2 There is also a door pointed with an arrow which leads to an Electrical workshop area. This door opens inwards and presents a risk of unauthorised entry from the personnel occupying the workshop.

Figure 23: MV and LV Switchgear in one room with no barrier in-between.

1.4.2.1.3 Figure 25 shows evidence of roof leaks on the flow and on the wall.

Figure 24: Transformer Room Roof Leak Stain

1.4.2.2 Technology and Power System concerns

1.4.2.2.1 This substation is fitted with old oil MV circuit breaker technology like the preceding discussed substations. The protection relays are also of the old technology.

1.4.2.2.2 The low voltage switchgear shown in figure 26 is old and uses a combination of breakers and fuses. Detail 2 shows that the different fuse sizes are used for the same three phase feeder because of the shortage of equal spares. Detail 3 points to a link conducting material used in the absence of a fuse which is a risk because of no protection to potential faults.

Figure 25: 400V Switchgear with (1) breakers and (2&3) details of the fuses

1.4.2.2.3 The DC power supply for the MV switchgear was tested and found to be almost dead as shown in figure 27. The dead batteries were replaced with the new batteries that were sourced by the electricians during the assessment. This literally meant the MV protection was entirely compromised at the time before the replacement.

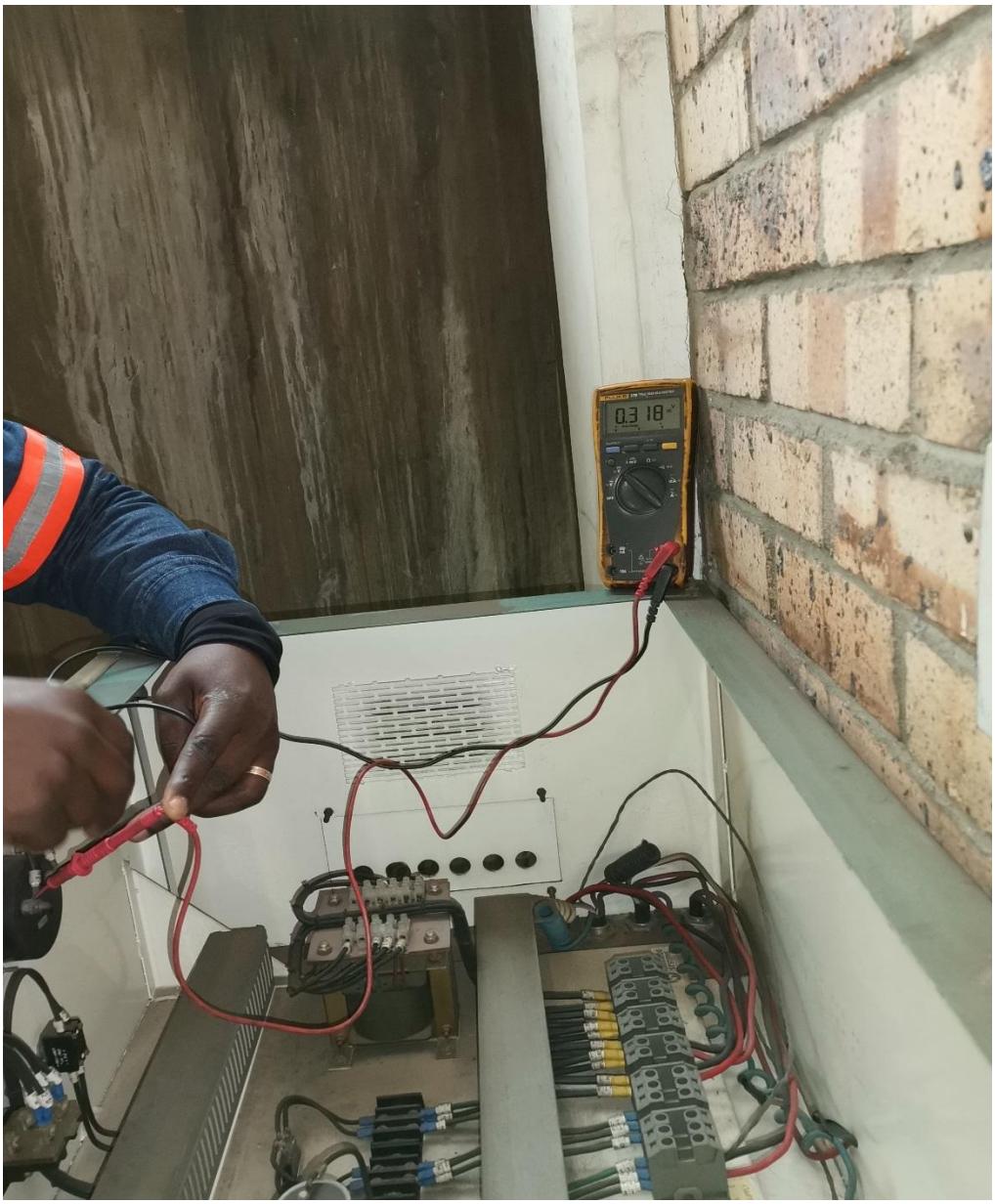


Figure 26: Testing of the DC supply for the MV switchgear.

1.4.2.2.4 Figure 28 shows a disconnected cable in one of the MV incomers. The cable is supposed to be 2x150mm2 terminated as a parallel connection but one cable is now used because of the cable fault on the accompanying cable. The Electricians on site advised that the cable has been faulty and disconnected for some time and there are no known planes to fix the fault. This problem violates the design principle of the network such as load capacity and the design fault level. By removing one cable as seen directly increases the design fault level. Such values are imperative in fault level studies and thus informs the protection settings for the plant.

Figure 27: Faulty MV Incomer Cable Disconnected

1.4.2.2.5 The TRF 1&2 oil sample tests from 2019 reports that the moisture content is high and the dielectric strength is on a borderline [].

1.4.3 Recommendations

1.4.3.1 Room layout

1.4.3.1.1 Change the door leading to the electrical work shop from the MV room to a correct fire rated door that opens outwards from the MV room. Also put signage to ensure restriction of unauthorised entry to the substation from the workshop.

1.4.3.1.2 Design, supply and install an oil containment in a form of bunding plate with *(suitable material)* around each transformer.

1.4.3.1.3 A barrier shall be fitted to separate the MV and LV plant.

1.4.3.1.4 The substation shall be shall be equipped with a wooden ladder.

1.4.3.1.5 Updated LV and MV single line drawings shall be displayed.

1.4.3.1.6 Refurbish the roof to repair the roof leaks.

1.4.3.2 Design and Technology

1.4.3.2.1 Design, supply and install new MV switchgear complete instrument transformers and morden electronic relays compatible with SANS 61850. The switchgear shall meet the requirements of section 4.3.3 of this report.

1.4.3.2.2 Design, supply and install a new DC power supply for the MV switchgear.

1.4.3.2.3 Design, supply and install new LV switchgear with automation functionality.

1.4.3.2.4 Design supply and install new lighting in accordance with the OHS Act Environmental regulations. The proposed lighting shall make use of energy efficient LED fittings.

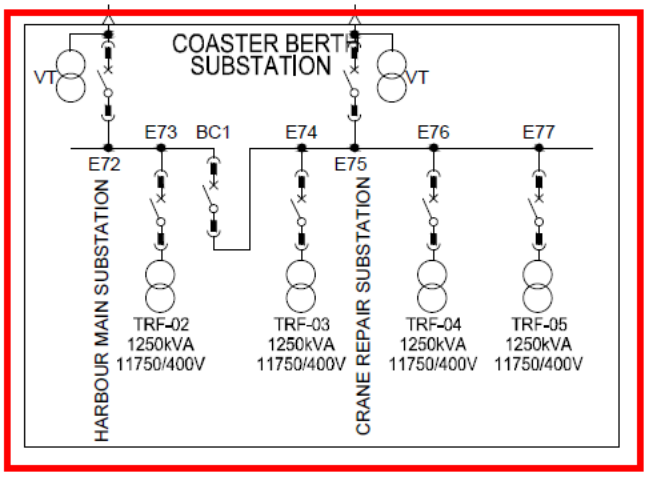
1.4.3.2.5 The overall recommendation for the oil sample test report produced in 2019 suggests that the oil condition and PCB levels fails against the specification measures and needs to be replaced [].

Coaster Berth Substation

5.8.1 General Layout

The substation consists of a medium voltage switchboard that is a single bus arrangement with seven medium panels. The panels comprise of two incomers, a bus-sec, and four feeders as shown in figure 34. The switchgear room also houses low voltage panels 400V fed from four transformers. The transformers are housed in a separate room of the same substation building. Covered Trenches are used as the primary cable management system.

The substation is ring fed by 2x150mm$_2$ XLPE cables from feeders L11 of the Harbour main substation and through E79 of the Crane Repair Substation. See annexure A for the overall Port Electrical Reticulation single line diagram.



5.8.3 Recommendations

5.8.3.1 Room layout

5.8.3.1.1 Design, supply and install an oil containment in a form of bunding plate with *(suitable material)* around the transformer.

5.8.3.1.2 A barrier shall be fitted to separate the MV and LV plant.

5.8.3.1.3 The substation shall be shall be equipped with a wooden ladder.

5.8.3.1.4 Updated LV and MV single line drawings shall be displayed.

5.8.3.2 Design and Technology

5.8.3.2.1 Design, supply and install new MV switchgear complete instrument transformers and modern electronic relays compatible with SANS 61850. The switchgear shall meet the requirements of section 4.3.3 of this report.
5.8.3.2.2 Design, supply and install a new DC power supply for the MV switchgear.
5.8.3.2.3 Design, supply and install new LV switchgear with automation functionality.
5.8.3.2.4 Design supply and install new lighting in accordance with the OHS Act Environmental regulations. The proposed lighting shall make use of energy efficient LED fittings.
5.8.3.2.5 No results were found for this substation transformer on the oil sample tests report.

2 Power System and Common Recommendations

Section 5 findings and recommendations focuses on the non-compliant aspects of the substations because of the theme of the assessment. A lot of positive practices regulated by the OHS Act for switching and transformer premises were found and commended by the team which undertook the investigation. The fixed electrical installation shall be subjected to full testing (as frequent and reasonably practicable) of the earthing and bonding system, interlocking, earth switching, mechanical testing, and testing of all related protection and safety systems. The investigation team also studied the standard operating procedures, routine test results and power system model studies. The data presented was found to be acceptable and up-to-date in relation to standard practice which is at least two years for stringent hazardous locations. The team however further recommends that for the following to be actioned as part of the important actions:

1. Testing of the earthing and bonding systems.
2. Extra effort in cleaning the substation rooms, there was common evidence of dust and oil spillages in all the substations.
3. Include a thermography analysis as part of the routine tests to detect abnormal temperatures or changes in temperature that may indicate problems in their incipient stages. Serious failures and outages may be avoided when problems can be identified and remedied early. Early detection permits more effective maintenance planning and scheduled outages.
4. As part of the refurbishments, the contractor shall redo the floor finishes of all the substations and paint the walls as required.’
5. Undertake a new power system protection and load flow study to complement the recommended substation upgrades. The Electrical Port Master Plan shall be considered to make provisions for expansion plans in the simulation studies.
6. Design supply and install a SCADA system for the entire network.

3 Conclusion

CTCT Substations Conditional Assessment

A conditional assessment of five substations in the Port of Cape Town was conducted by an Engineering team from TPT. This report mainly discusses the findings and recommendations to comply with the requirements of the enforced regulations for substations. Designs of building modifications, switchgear and reticulation system are required to precede the proposed supply and installations as upgrades. A detailed cost estimate was derived from the recommendations and included as part of this report in Annexure 2. There were no apparent structural and civil engineering problems to note but an allowance has been made on the budget and respective fields competent engineers shall assess and advise accordingly during the design stage.

The Investigation team commends that the business supports and approve funding to undertake the required upgrades.

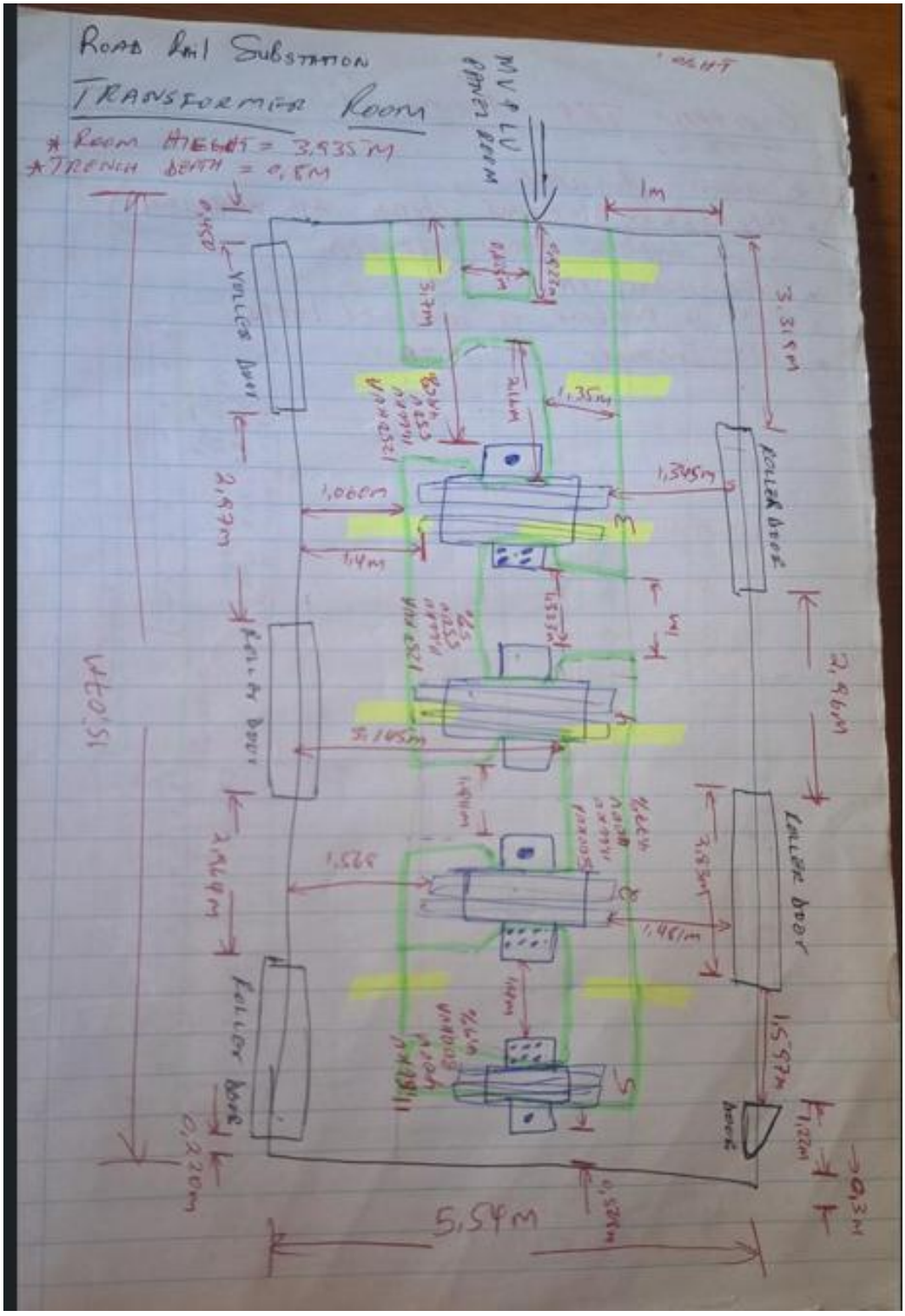
4 References

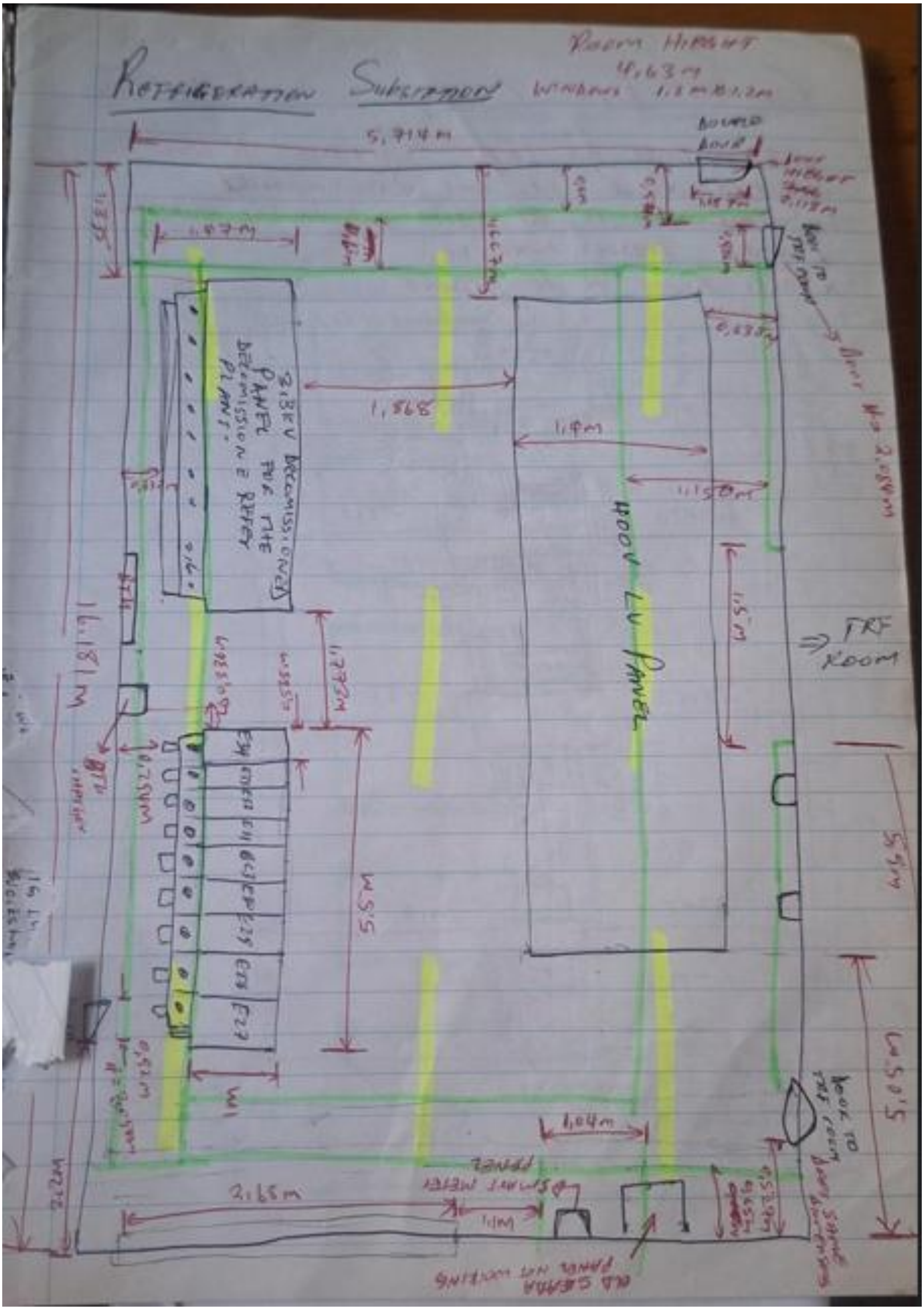
1. *Richard Blakeley, August 2012, Oil Circuit Breaker Retrofit and Switchgear Safety Solutions.*
2. *Bryan Johnson, 2013, Development of Standards for MV Switchgear Rated for Arc Protection.*
3. *Tony Parsons, 02/2007, A comparison of Circuit Breakers and Fuses for low Voltage Applications*
4. *GAPS Guidelines 5.9.0.2, Transformer Failures.*

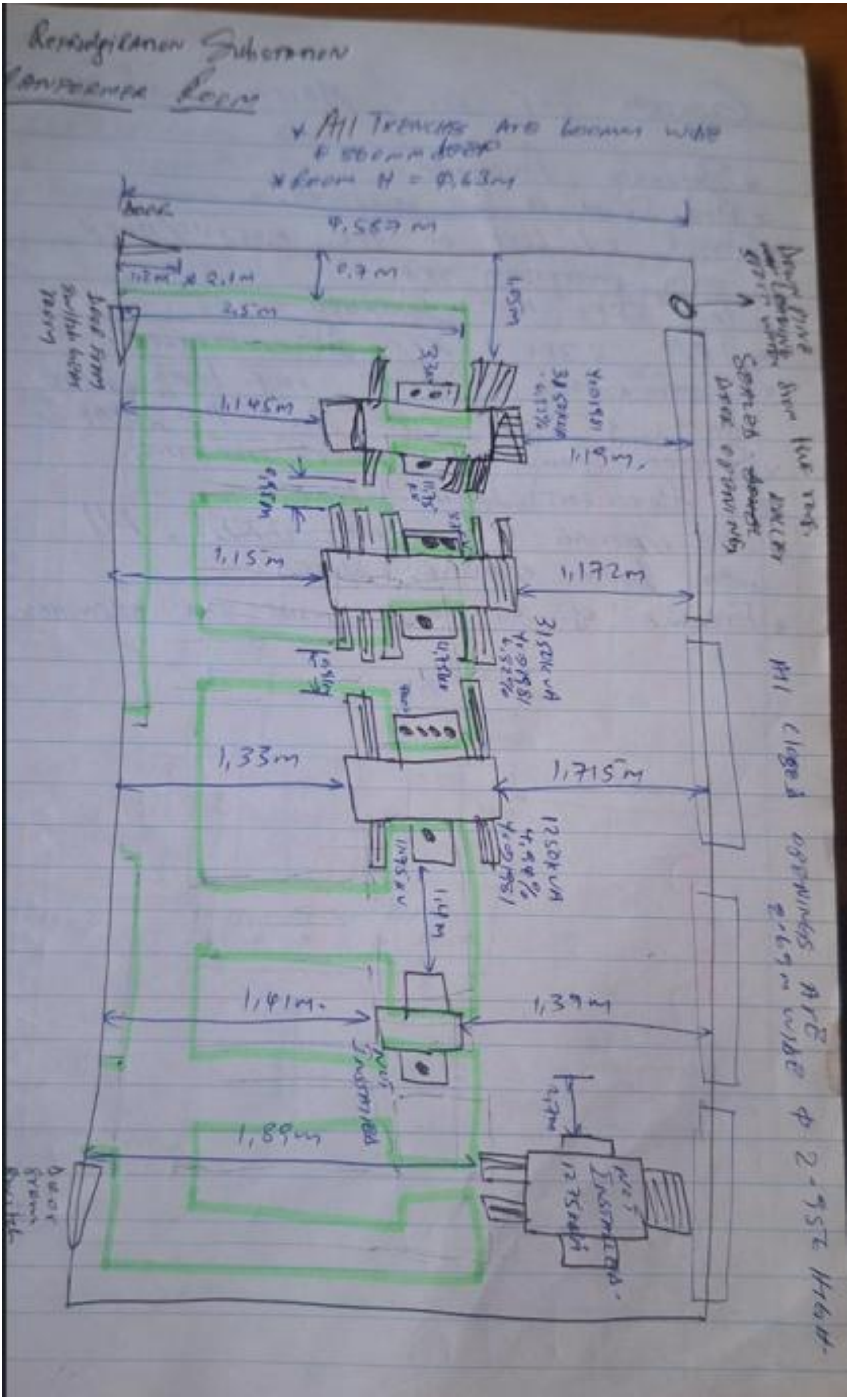
5 Annexure 1: Electrical Reticulation Overall 11.75kV Single Line Diagram

6 Annexure 2: Electrical Cost Estimate

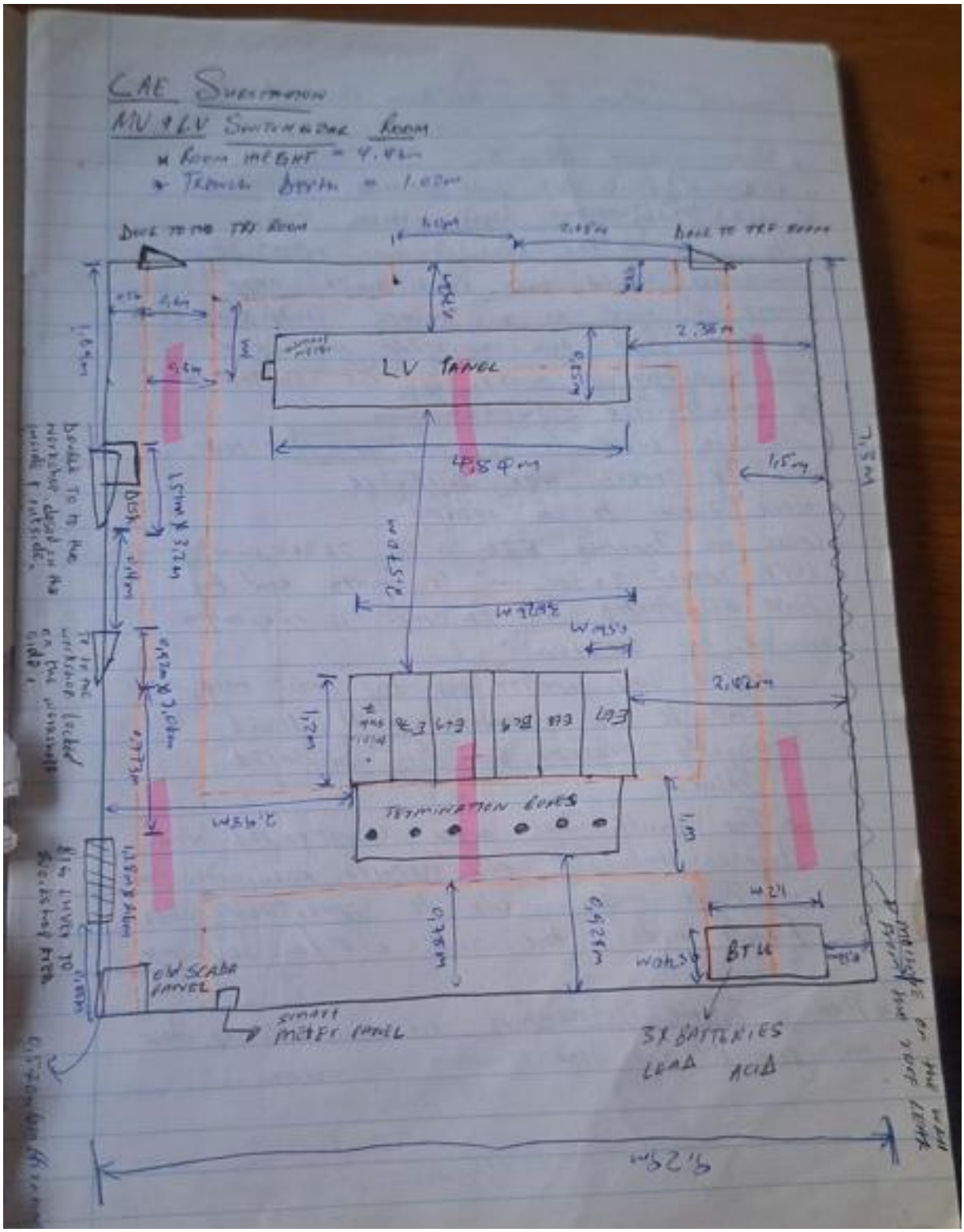
7 Free hand drawings as additional information

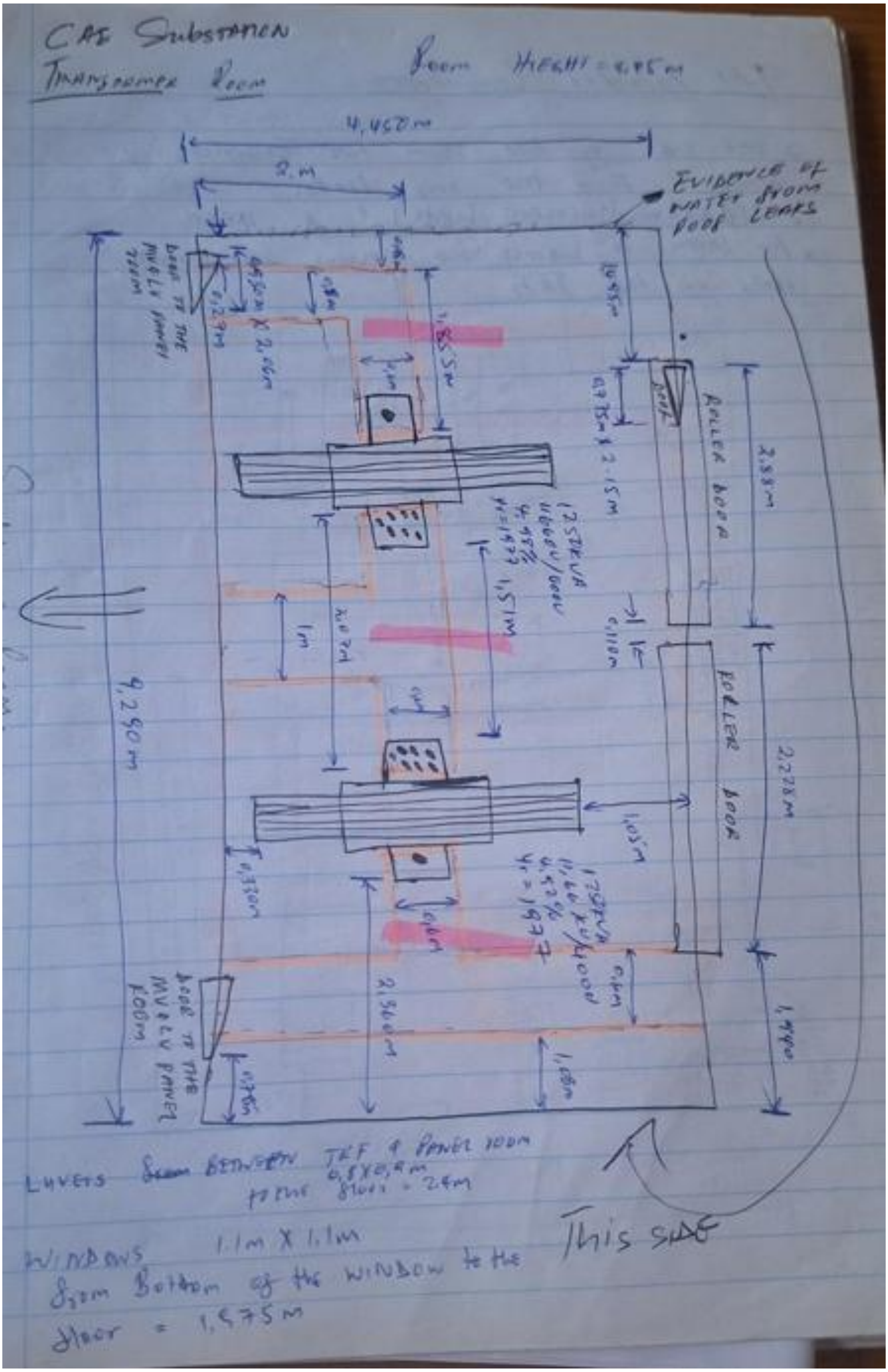


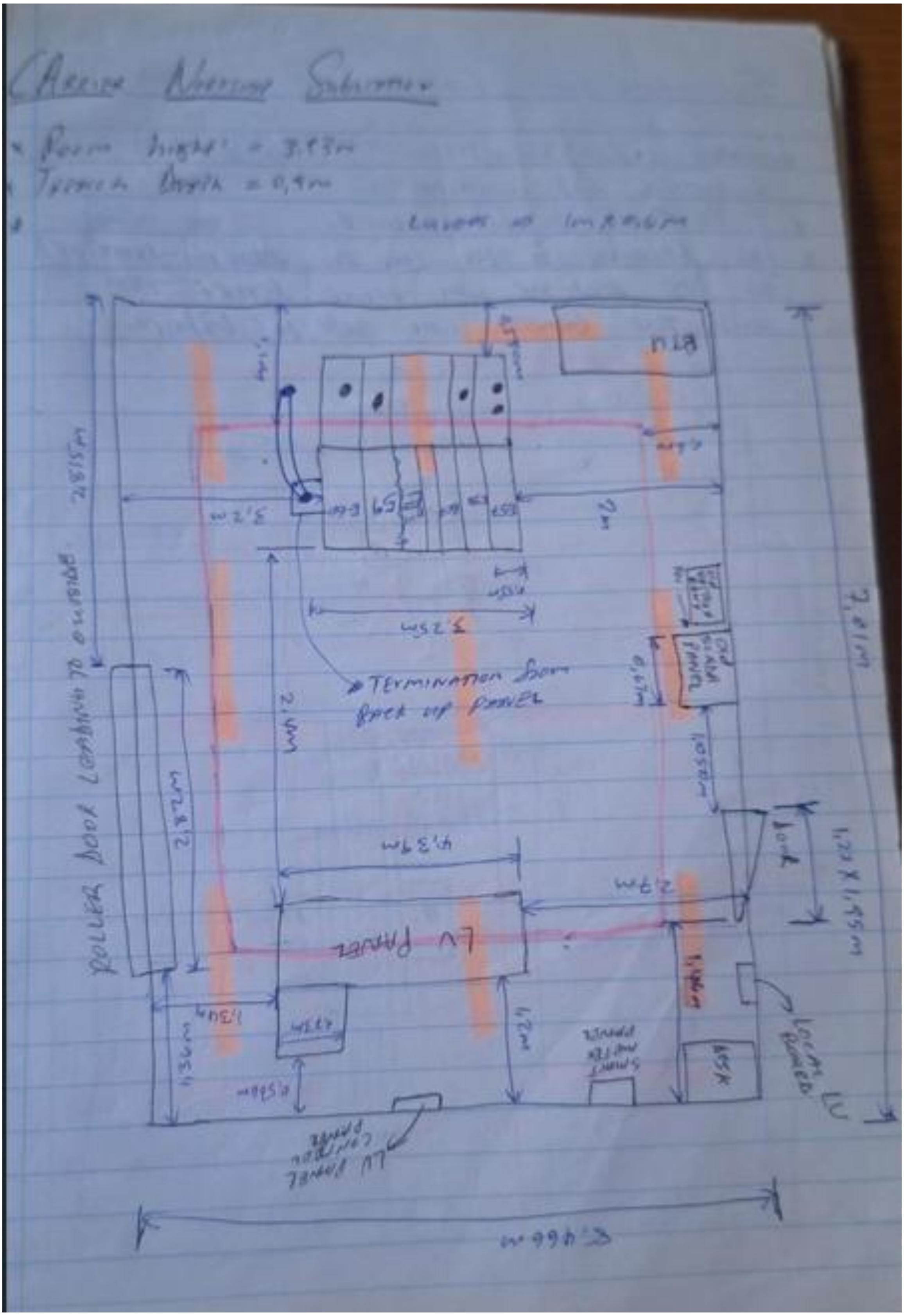

Refrigeration Substation
Room Height
4,63m
5,714m
1,568
400V LV Panel
16,181m
TRF Room
5,55m
2,16m
1,04m
1,1m
Smart meter panel
Old Siemens panel not working

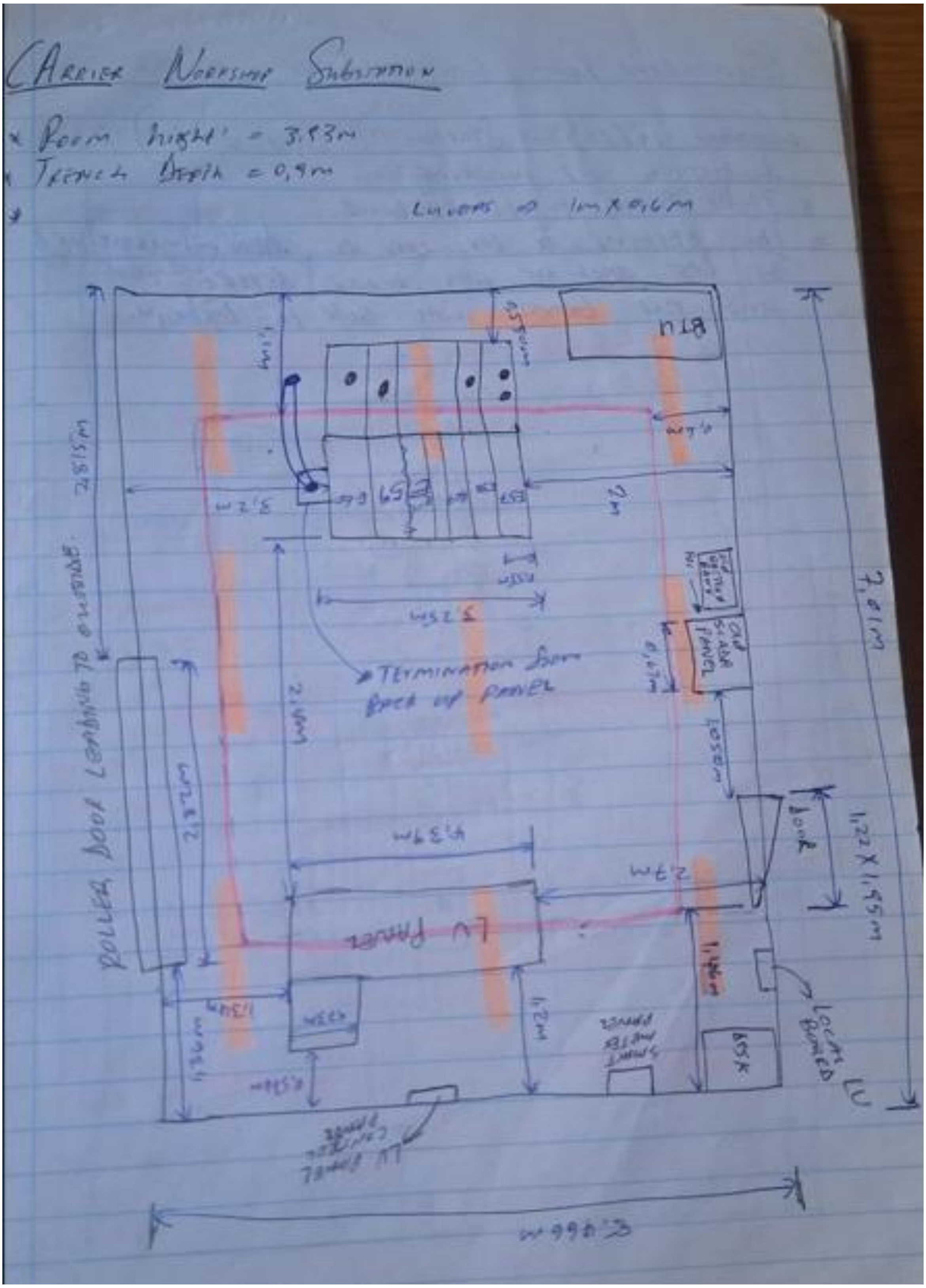


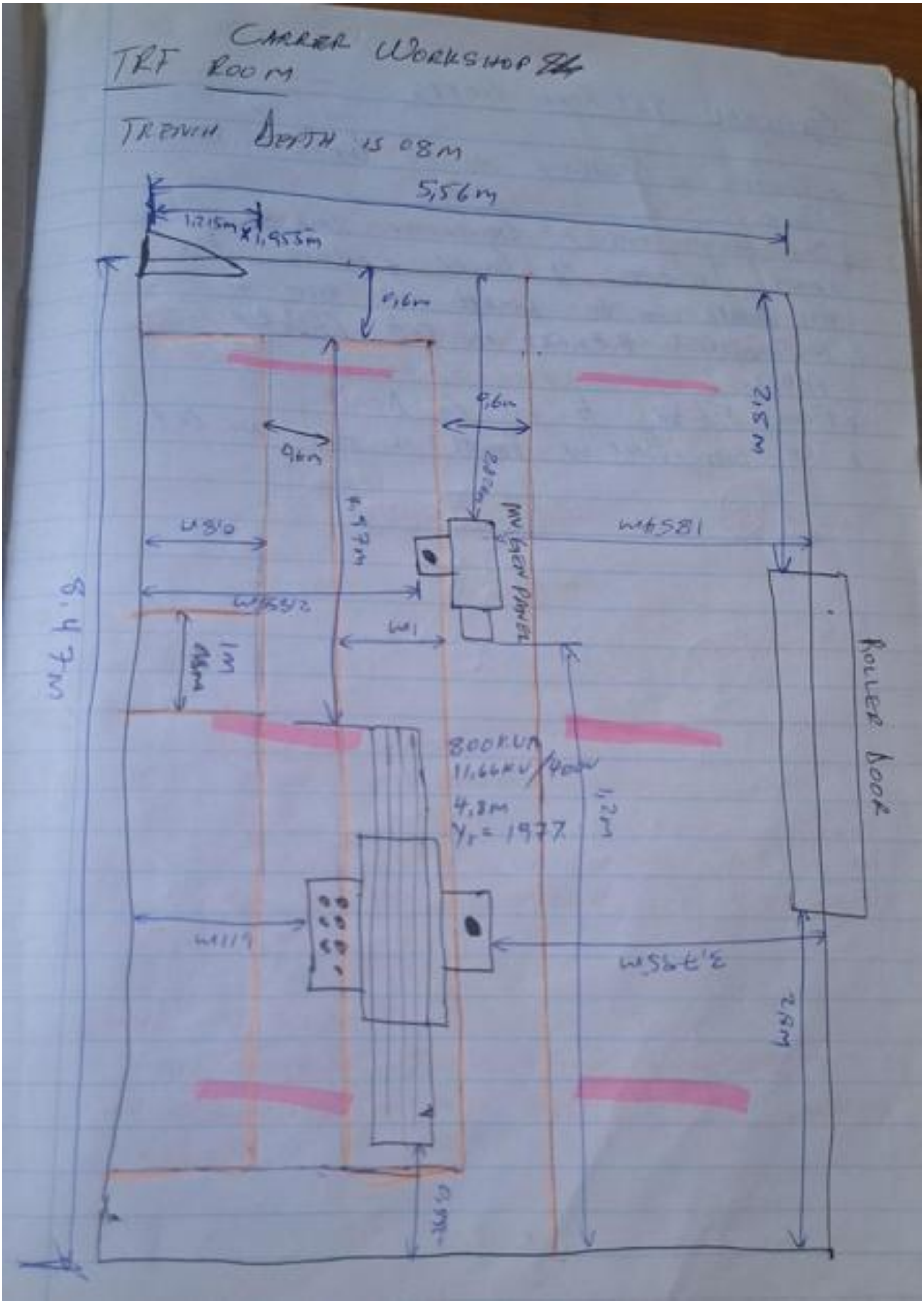
* All Trenches Are 600mm wide
* 600mm deep
0,7 m
2,5m
1,145m
1,15m
1,33m
1,41m.
1,89m
1,19m
1,172m
1,715m
1,39m
315kVA
1250kVA
All closed openings are


LV PANEL
TERMINATION BOXES
BTU
3X BATTERIES
LEAD ACID
SMART METER PANEL
DOOR TO THE TX1 ROOM


Transformer Room
4,450 m
2 m
Evidence of water from roof leaks
Roller door
Roller door
9,290 m
Door to the MV&LV panel room
Door to the MV&LV panel room
1,1m X 1,1m
This side


Room hight = 3,93m
Trench Depth = 0,9m
RTU
TERMINATION from back up panel
LV PANEL
ROLLER DOOR LEADING TO OUTSIDE
DOOR
LOCAL LV BOARD
SMART METER PANEL
DESK
LV PANEL CONTROL PANEL
7,01m
5,466m


Room hight = 3,53m
Trench Depth = 0,9m
Louvers → 1m X 0,6m
RTU
LV PANEL
Termination from back of panel
ROLLER DOOR LEADING TO OUTSIDE
Door
1,22 X 1,95m
7,01m
8,966m
Local LV Board


CARRER WORKSHOP
TRF ROOM
TRENCH DEPTH IS 08M
5,56m
2,8M
MV GEN PANEL
800KVA
4,8M
ROLLER DOOR
8,47M
1,2M