A CASE STUDY ON IMPROVEMENT OF HIGH VOLTAGE POWER DISTRIBUTION SYSTEM IN INTEC CAMPUS

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Abstract

This case study is concerned with the investigation on the existing high voltage power distribution system in Intec Campus. The investigations are due to increasing in load demand at Intec Campus thus have created some problems such as increasing in temperature of existing transformer at Substation No1, frequent breakdown and some others related problem. At the end of this study, some suggestions will be made in improving the high voltage power distribution system in Intec Campus.

1. INTRODUCTION

In this case study, the Intec Campus high voltage power distribution system is 11kV that is from the incoming TNB supply. The all 3 substations at Intec Campus categorized as indoor substations where all the equipment such as switchgear, transformer and circuit breaker were placed in small block building and this type of substation is quite safe for surrounding.

This case study is carry out in purpose of study the load demand in Intec Campus with increase in number capacity of student and to identify some problems that related to the high voltage power distribution system in Intec Campus. In this case study, the methodology that will use are by doing initial preparation and literature review, do data taking and review the data, record and analyze the result obtain and doing some suggestion of improvement.

2. OBJECTIVES

Below list the three objectives to do the case study on improvement of high voltage power distribution system in Intec Campus:

1) To study the existing electricity supply of main intake and the load demand of high voltage in Intec Campus.
1) To investigate related problems to load demand due to increase in quantity of students.
2) To suggest and implement on improving the stability of electricity supply in Intec Campus.

3. METHODOLOGY

Below list the some methods chosen:

- Initial preparation & literature review
  - Make site visit at distribution substation of Intec Campus
  - Doing some review on high voltage power distribution system
- Data taking & review data
  - Make observation and take reading at site visit
- Record & analyze the results obtain
  - Record the reading into graph plot
  - Analyze the gained plotted data
- Make some improvement
  - Doing some improvement
  - Give suggestions of solutions to related problem
  - Make discussion & conclusion

4. LITERATURE REVIEW

An electric supply system consists of power station, transmission lines and the distribution system. Electric power is produced at the power stations located generally quite away from the consumers, it is then transmitted by transmission lines and then finally distributed to consumer through a distribution network [1].

4.1 Switchgear

The term 'switchgear' is a generic term encompassing a wide range of products like circuit breakers, switches, switch fuse units, off-load isolators, HRC fuses, contactors, earth leakage circuit breakers (ELCBs), miniature circuit breakers (MCBs) and moulded case circuit breakers (MCCBs) [2].

4.2 Transformer

The transformer is an electromagnetic conversion device in which electrical energy received by primary winding is first converted into magnetic energy which is reconverted back into a useful electrical energy in other circuits [3]. The transformer can be either step-up or step-down transformer upon what the application and need.

The power equation in an ideal transformer given by [4]:

$$Pin = Vp\ Ip \cos\theta p \qquad (4.2.1)$$

$$Pout = Vs\ Is \cos\theta s \qquad (4.2.2)$$

Where :

Pin = Input power (W)
Pout = Output power (W)
Vp = Primary side voltage (V)
Vs = Secondary side voltage (V)
Ip = Primary side current (A)
Is = Secondary side current (A)
θp = Angle between Vp and Ip
θs = Angle between Vs and Is

4.3 Circuit Breaker

Circuit breaker is an equipment which can open or close a circuit under all conditions such as no load, full load and fault conditions [5]. It is designed that can operate manually under normal conditions and automatically under fault conditions.

5. ELECTRIC SUPPLY SYSTEM IN INTEC CAMPUS

5.1 Overview of High Voltage Power Distribution System in Intec Campus

Intec Campus uses 11kV high voltage power distribution system which 3 substations were used. The first one is main substation which is call as Substation No 1 located next to the tennis court that is near to the facilities department, the second one is Substation No 2 located near to the Block R at the back area of Intec Campus and the third substation is Substation of New Library that is located in HT room of New Library.

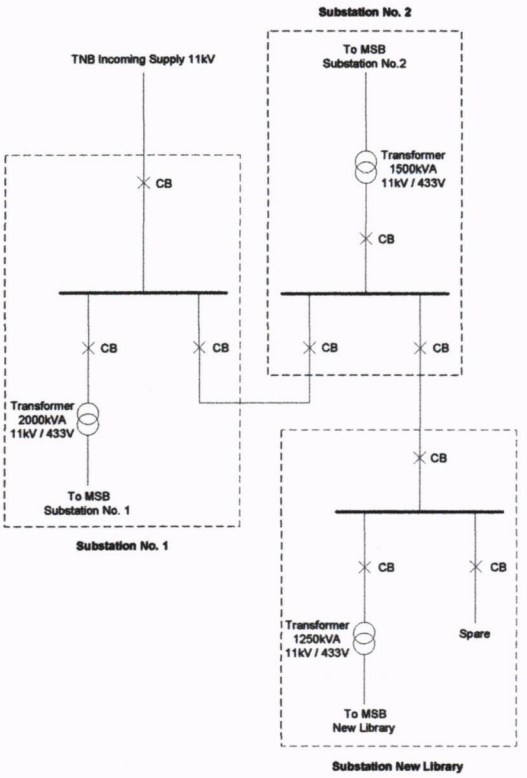

Figure 5.1.1: Schematic diagram of High Voltage Power Distribution System in Intec

5.2 Substation No 1

Figure 5.2.1: Substation No 1

Figure 5.2.2: Switchgear at Substation No 1

Figure 5.2.3: 2000kVA Transformer Substation No 1

Figure 5.2.4 below shows the schematic diagram of main substation which is Substation No 1 located near to the facilities department that have 1 unit 2000kVA transformer, 1 unit 11kV 25kA busbar, 3 unit 11kV 25kA gas insulated circuit breaker and HT cables.

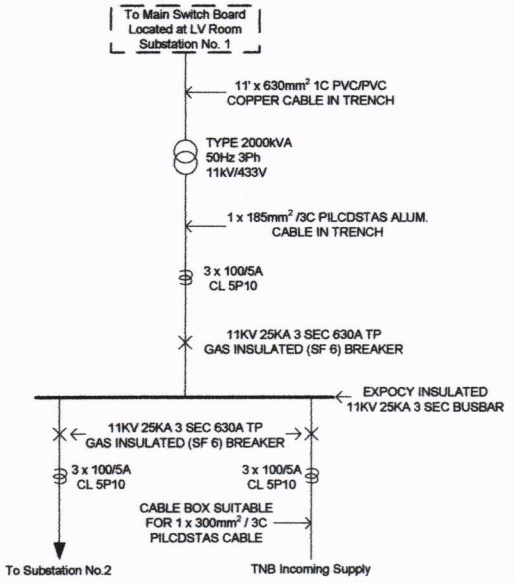

Figure 5.2.4: Schematic diagram of Substation No 1

This system is now facing problems because of increasing number of Intec's students and thus increases in the load demand. The main problem to this substation is the existing 1 unit 2000kVA transformer couldn't support load demand anymore thus make it increase in temperature and vibrate.

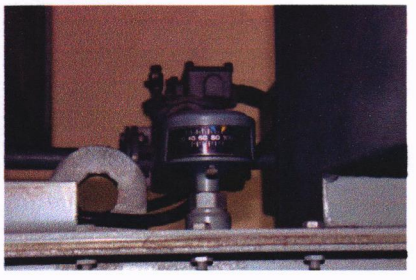

Figure 5.2.5: The transformer increase in temperature

This increasing of temperature leads to transformer's cable melting and this cable melting also cause by excessive usage of cable capacity that is over than 60% of its allowed cable capacity. The transformer also cannot be shutdown and need to work continuously because there is only 1 transformer in that substation.

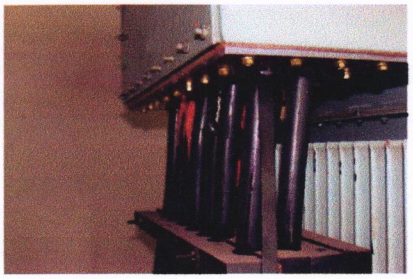

Figure 5.2.6: Transformer's cable melting

Another problem at this substation is frequent breakdown occur to 11kV 25kA Gas Insulated Circuit Breaker because inadequate supply during the peak period.

Figure 5.2.7: 11kV 25kA Gas Insulated Circuit Breaker Substation No 1

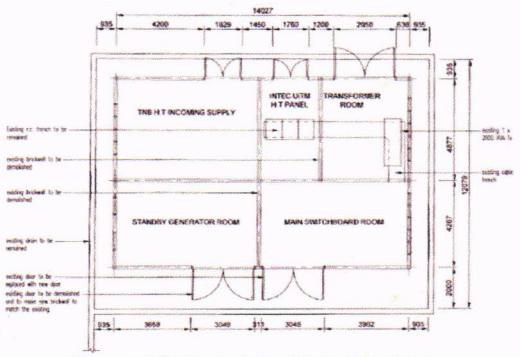

Figure 5.2.8: Floor plant of Substation No 1

5.3 Substation No 2

Figure 5.3.1: Substation No 2

Figure 5.3.2: Switchgear at Substation No 2

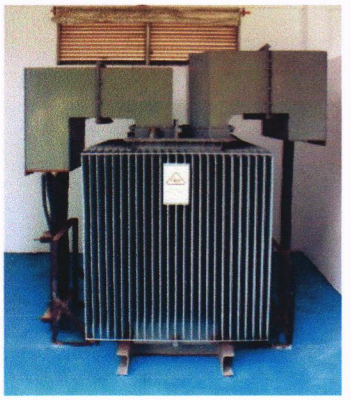

Figure 5.3.3: 1500kVA Transformer Substation No 2

Figure 5.3.4 below shows the schematic diagram of Substation No 2 located near to the Block R at the back area of Intec Campus that have 1 unit 1500kVA transformer, 1 unit 11kV 25kA busbar, 3 unit 11kV 25kA gas insulated circuit breaker and HT cables.

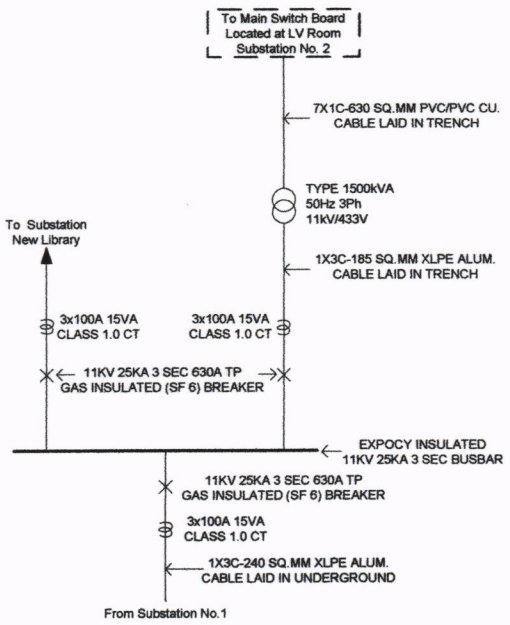

Figure 5.3.4: Schematic diagram of Substation No 2

This substation didn't facing any problem either with the equipment or location and can deliver the supply to the load properly.

5.4 Substation of New Library

Figure 5.4.1: Substation of New Library

Figure 5.4.2: Switchgear at Substation New Library

Figure 5.4.3: 1250kVA Transformer Substation New Library

Figure 5.4.4 below shows the schematic diagram of Substation New Library located in HT room of New Library that have 1 unit 1250kVA transformer, 1 unit 11kV 25kA busbar, 3 unit 11kV 25kA gas insulated circuit breaker and HT cables.

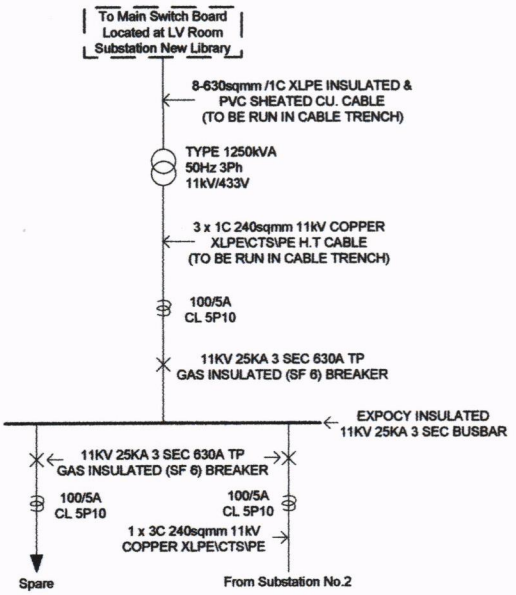

Figure 5.4.4: Schematic diagram of Substation New Library

This substation has no problem with load or with any equipment since this substation is still new. However the problem comes through the location of HT room which is located behind the water pump room as shown in Figure 5.4.5 below. This may cause a hazard if an accident happens to the water pump room.

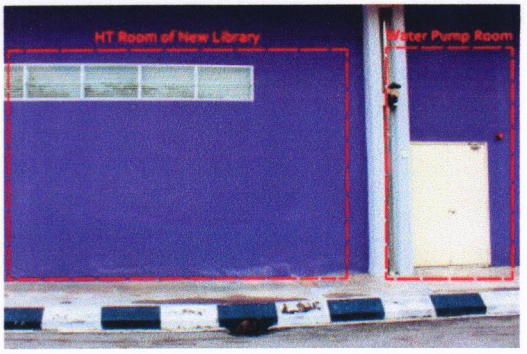

Figure 5.4.5: Side view Substation of New Library

Figure 5.4.6: Inside water pump room

6. RESULT & DATA ANALYSIS

6.1 Electricity Power Consumption of Intec Campus

Table 6.0.1 below shows the electricity power consumption of Intec Campus in year 2010. These readings of electricity consumption data or kWh were taken at every month in year 2010.

Month	kWh
January	301242
February	493312
March	463064
April	595735
May	575301
June	493431
July	419566
August	577529
September	600715
October	442957
November	595493
December	572722

Table 6.0.1: Electricity Power Consumption of Intec Campus in Year 2010

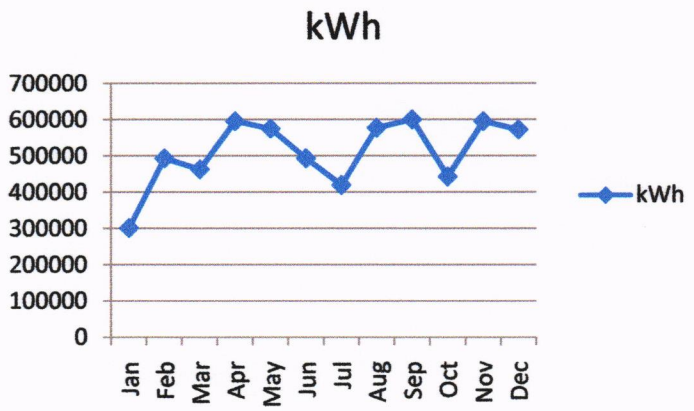

Figure 6.0.2: Plotted Graph of kWh VS Month

From the plotted graph of kWh VS Month in year 2010 of Figure 6.0.2 above, we can see that the peak usage of electricity or highest electricity consumption is in month of April and September which are recorded as 595735kWh in April and 600715kWh in September.

This is due to month of examination. Students use this time to study before the final examination and involve a lot of electricity usage such as to lighting their desks until late night and usage of others electrical appliances.

Month	Number of Tripping Recorded
January	0
February	2
March	1
April	11
May	4
June	2
July	1
August	3
September	10
October	1
November	5
December	3

Figure 6.0.3: Number of Tripping Recorded by Month in Year 2010

Frequent breakdown usually occur in this two month because inadequate supply during the peak period.

6.2 Electricity Bill of Intec Campus


L ELEKTRIK

TENAGA NASIONAL BERHAD

Figure 6.2.1: Sample of Electricity Bill for March 2011

BAYARAN BIL ELEKTRIK BAGI TAHUN 2010

BULAN	TARIKH INVOICE	NO INVOICE	JUMLAH	JUMLAH BULANAN	JUMLAH KESELURUHAN
JANUARI	1/1/2010	1510000406409/1209	112,745.00		112,745.00
	1/4/2010	1510000783200/1209	367.20		113,112.20
	1/4/2010	1510000783309/1209	1,392.30		114,504.50
	1/1/2010	1510000783407/1209	3,228.40		117,732.90
	1/1/2010	1510000416809/1209	4,209.80		121,942.70
	1/1/2010	1510000455610/1209	9,933.35		131,876.05
	1/1/2010	1510000455501/1209	9,928.95	141,805.00	141,805.00
FEBRUARI	2/1/2010	1510000783407/0110	4,760.80		4,760.80
	2/1/2010	1510000416809/0110	11,266.45		16,027.25
	2/1/2010	1510000455610/0110	18,799.15		34,826.40
	2/1/2010	1510000455501/0110	24,007.40		58,833.80
	2/2/2010	1510000783309/0110	2,466.15		61,299.95
	2/2/2010	1510000783200/0110	147.30		61,447.25
	2/1/2010	1510000443402/0110	477.55		61,924.80
	2/1/2010	1510000406409/0110	165,533.65		227,458.45
	2/1/2010	1510000783407/02	4,760.80	232,219.25	232,219.25
MAC	3/1/2010	1510000783200/0210	1,193.00		1,193.00
	3/1/2010	1510000406409/0210	155,742.50		156,935.50
	3/1/2010	1510000783309/0210	2,063.60		158,999.10
	3/1/2010	1510000416809/0210	9,709.45		168,708.55
	3/1/2010	1510000443402/0210	14,458.25		183,166.80
	3/1/2010	1510000455610/0210	15,461.55		198,628.35
	3/1/2010	1510000455501/0210	19,351.75	217,980.10	217,980.10
APRIL	4/1/2010	1510000783309/0310	2,919.15		2,919.15
	4/1/2010	1510000783200/0310	2,324.85		5,244.00
	4/1/2010	1510000406409/0310	197,308.45		202,552.45
	4/1/2010	1510000455501/0310	24,048.30		226,600.75
	4/1/2010	1510000443402/0310	18,910.25		245,511.00
	4/1/2010	1510000455610/0310	17,990.45		263,501.45
	4/1/2010	1510000416809/0310	12,455.90		275,957.35
	4/1/2010	1510000783407/0310	4,475.80	280,433.15	280,433.15
MEI	5/3/2010	1510000783200/0410	2,313.30		2,313.30
	5/3/2010	1510000783200/410	2,313.30		4,626.60
	5/1/2010	1510000783407/0410	5,041.50		9,668.10
	5/3/2010	1510000783309/0410	3,400.30		13,068.40
	5/1/2010	1510000455501/0410	26,341.35		39,409.75
	5/1/2010	1510000416809/0410	12,860.00		52,269.75
	5/1/2010	1510000455610/0410	18,599.05		70,868.80
	5/1/2010	1510000443402/0410	18,825.40		89,694.20
	5/1/2010	1510000406409/0410	181,119.80	270,814.00	270,814.00
JUN	6/1/2010	1510000783309/0510	3,661.20		3,661.20
	6/1/2010	1510000416809/0510	11,670.60		15,331.80
	6/1/2010	1510000783407/0510	6,128.10		21,459.90
	6/1/2010	1510000783200/0510	1,001.00		22,460.90
	6/1/2010	1510000443402/0510	10,944.15		33,405.05
	6/1/2010	1510000455610/0510	22,518.25		55,923.30
	6/1/2010	1510000455501/0510	28,218.35		84,141.65
	6/1/2010	1510000406409/0510	148,133.70	232,275.35	232,275.35
JULAI	7/1/2010	1510000783407/0610	5,616.75		5,616.75
	7/1/2010	1510000416809/0610	5,673.55		11,290.30

Figure 6.2.2(a): Summary of Electricity Bill for year 2010

	7/1/2010	1510000443402/0610	7,340.75		18,631.05
	7/1/2010	1510000455501/0610	21,771.90		40,402.95
	7/1/2010	1510000455610/0610	22,120.45		62,523.40
	7/1/2010	1510000783200/0610	2,773.45		65,296.85
	7/1/2010	1510000783309/0610	2,927.50		68,224.35
	7/1/2010	1510000406409/0610	129,280.00	197,504.35	197,504.35
OGOS	8/2/2010	1510000783200/0710	2,578.90		2,578.90
	8/2/2010	1510000783309/0710	2,823.85		5,402.75
	8/1/2010	1510000406409/0710	186,830.35		192,233.10
	8/1/2010	1510000783407/0710	5,560.00		197,793.10
	8/1/2010	1510000416809/0710	8,842.80		206,635.90
	8/1/2010	1510000443402/0710	14,966.45		221,602.35
	8/1/2010	1510000455610/0710	23,419.80		245,022.15
	8/1/2010	1510000455501/0710	26,841.55	271,863.70	271,863.70
SEPTEMBER	9/1/2010	1510000783200/0810	2,461.80		2,461.80
	9/1/2010	1510000783309/0810	2,946.95		5,408.75
	9/1/2010	1510000406409/0810	187,277.30		192,686.05
	9/1/2010	1510000783407/0810	4,659.60		197,345.65
	9/1/2010	1510000416809/0810	10,987.00		208,332.65
	9/1/2010	1510000443402/0810	18,230.35		226,563.00
	9/1/2010	1510000455610/0810	25,178.95		251,741.95
	9/1/2010	1510000455501/0810	31,035.10	282,777.05	282,777.05
OKTOBER	10/1/2010	1510000783200/0910	1,809.50		1,809.50
	10/1/2010	1510000783407/0910	2,957.65		4,767.15
	10/1/2010	1510000406409/0910	148,052.70		152,819.85
	10/1/2010	1510000443402/0910	12,904.45		165,724.30
	10/1/2010	1510000455610/0910	14,593.30		180,317.60
	10/1/2010	1510000416809/0910	7,117.80		187,435.40
	10/1/2010	1510000455501/0910	21,080.55	208,515.95	208,515.95
NOVEMBER	01/11/2010	1510000783200/1010	3,848.10		3,848.10
	01/11/2010	1510000406409/1010	188,181.25		192,029.35
	01/11/2010	1510000783309/1010	5,442.85		197,472.20
	01/11/2010	1510000416809/1010	11,061.60		208,533.80
	01/11/2010	1510000443402/1010	18,878.95		227,412.75
	01/11/2010	1510000455610/1010	21,417.75		248,830.50
	01/11/2010	1510000455501/1010	31,489.35	280,319.85	280,319.85
DISEMBER	01/12/2010	1510000416809/1110	7,085.65		7,085.65
	01/12/2010	1510000783407/1110	8,312.00		15,397.65
	01/12/2010	1510000443402/1110	11,254.05		26,651.70
	01/12/2010	1510000455610/1110	17,335.80		43,987.50
	01/12/2010	1510000455501/1110	21,480.00		65,467.50
	01/12/2010	1510000455610/1110R	65,467.50		130,935.00
	01/12/2010	1510000783309/1110	2,541.45		133,476.45
	01/12/2010	1510000783200/1110	3,091.05		136,567.50
	01/12/2010	1510000406409/1110	133,032.55	269,600.05	269,600.05
				2,886,107.80	

Figure 6.2.2(b): Continuous Summary of Electricity Bill for year 2010

7. PROPOSED SYSTEM

The high voltage power distribution system in Intec campus need to do some improvements to ensure the supply is adequate to supply to the load and for the improvement of safety features.

For the substation No 1, 1 new unit 2000kVA transformer needs to be installed to support the demand load.

This adding of new transformer to the system leads to few others equipments installation such as new switchgear, new circuit breaker and also high voltage cables.

The installation of this few others equipment and high voltage cable must be done by the appropriate contractor who is having expertise in this field and needs to fulfill the IEE Wiring Regulation. The proposed schematic diagram of Substation No 1 is shown as in Figure 7.0.1 below.

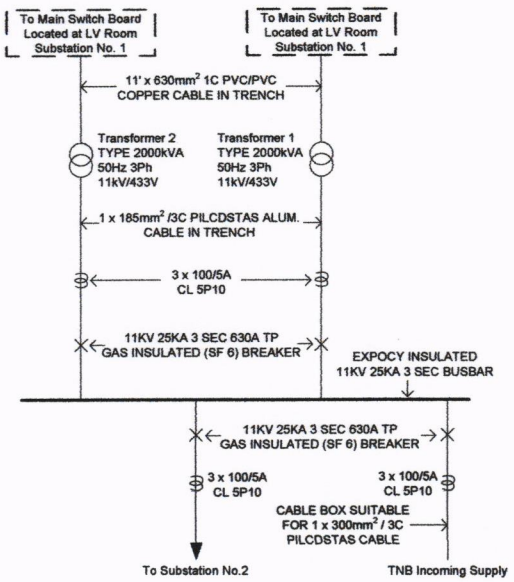

Figure 7.0.1: Propose schematic diagram of Substation No 1

Installation of new transformer can prolong the lifetime of the transformer and also installation appropriate size of cable is necessary to ensure that no excessive load to the cable.

Below are several steps in cable sizing procedures that need to be follow in calculating proposed new cable size:

i. Determine the design current, I_b:

$$Ib = \frac{Pin \times Diversity\ Factor}{V}$$

ii. Select the protective device from IEE Wiring Regulation Table with fulfill the condition rating current, $I_n < I_b$

iii. Select relevant correction factors of ambient temperature C_a, cable grouping C_g and thermal insulation C_i from IEE Wiring Regulation Table

iv. Determine current carrying capacity, I_z:

$$Iz = \frac{In}{Ca \times Cg \times Ci}$$

v. Determine the cable size by referring IEE Wiring Regulation Table

vi. Check the voltage drop, VD:

$$VD = \frac{(mV/A/m) \times length \times Ib}{1000}$$

vii. Check shock compliance

viii. Check the cross-sectional area of phase and protective conductor size, CPC from IEE Wiring Regulation Table

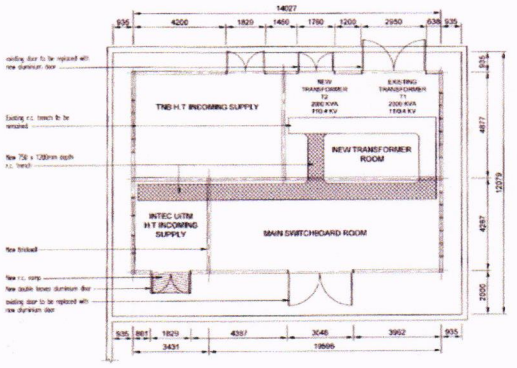

Figure 7.0.2: Propose floor plant of Substation No 1

For the Substation No 2, there is no any installation of equipment needed since there is no major problem to this substation. Only periodic maintenance will be recommended.

For the Substation of New library, the water pump room behind the HT room needs to relocate to other place because it will be a hazard if an accident happens to the water pump room such as serious water leakage. The other option if not relocate is to ensure the water pump room is really safe if any hazard happens by doing proper water proofing.

The overall Intec High Voltage Power Distribution System is recommended to change into ring system. Ring system is one way for backup system and also gives stability to the system. If one of the others substations being faulty or under maintenance, the other substations still can backup and deliver supply to the load.

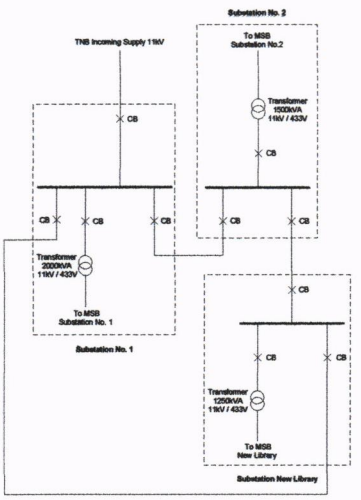

Figure 7.0.3: Propose Schematic diagram of High Voltage Power Distribution System in Intec

8. CONCLUSION

From the study carried out, it can be seen that some improvements should be made to improve the high voltage power distribution system in Intec Campus. This all suggestions of improvements have been stated in section of proposed system above. By this some suggestions of improvements it will hope that problems related to high voltage power distribution system of Intec Campus can be solve.

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