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Prinsip-prinsip Instalasi dan Keselamatan Listrik di RS dalam Era Endemi Covid-19 dan Revolusi Industri 4.0

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Hospital Engineering Forum 2021

Indonesian Association Hospital Engineering

Curriculum Vitae

Name:
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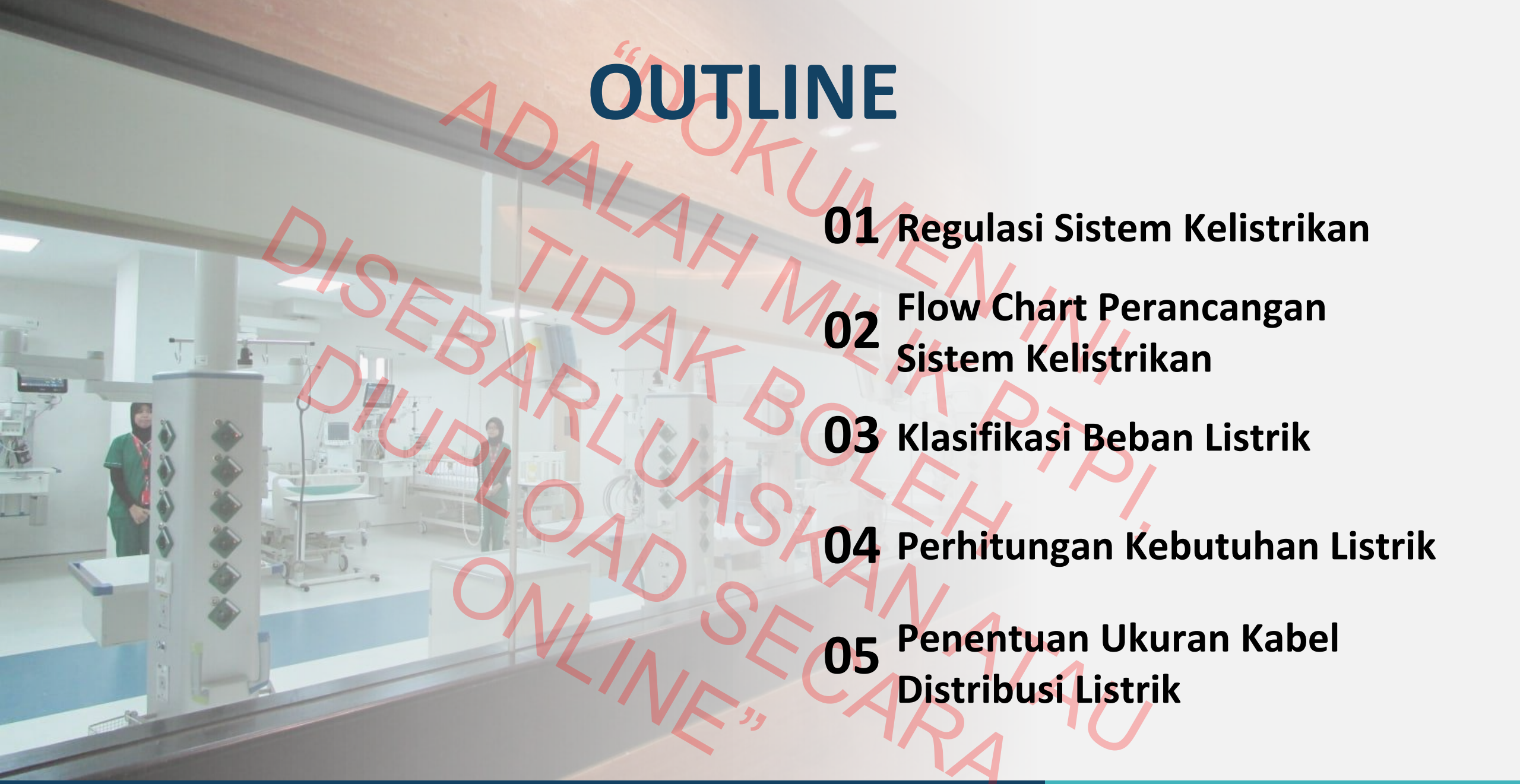
Ahli Teknik Tenaga Listrik-Utama

Education Background:
Sarjana Teknik Elektro UGM
Magister Teknik Elektro UGM

Work Experience :
Dosen Teknik Elektro Universitas Muhammadiyah Yogyakarta
Konsultan Elektrikal Rumah Sakit (2010 - Sekarang)
Organization Experience :
APEI
PTPI



OUTLINE

01 Regulasi Sistem Kelistrikan

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03 Klasifikasi Beban Listrik

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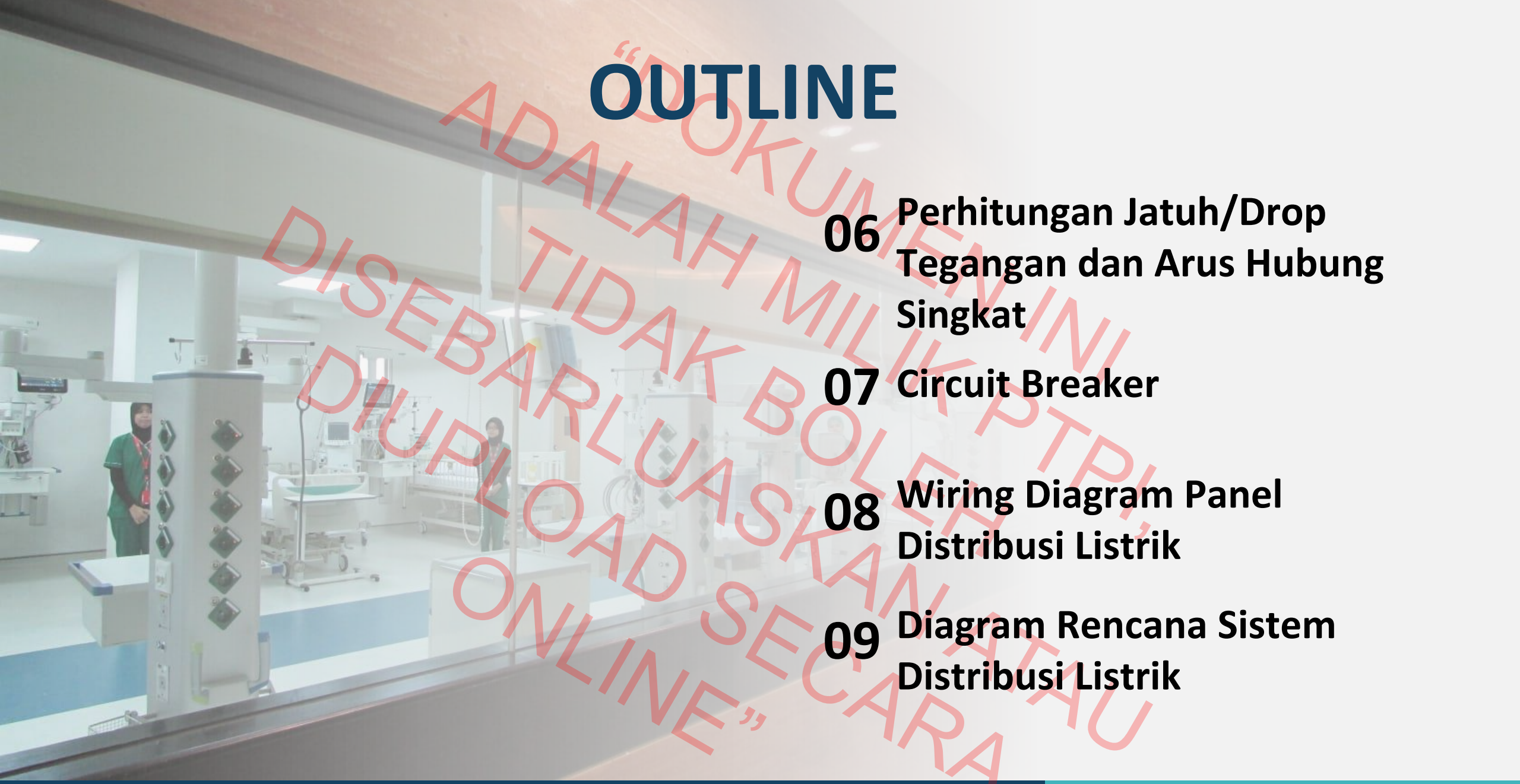


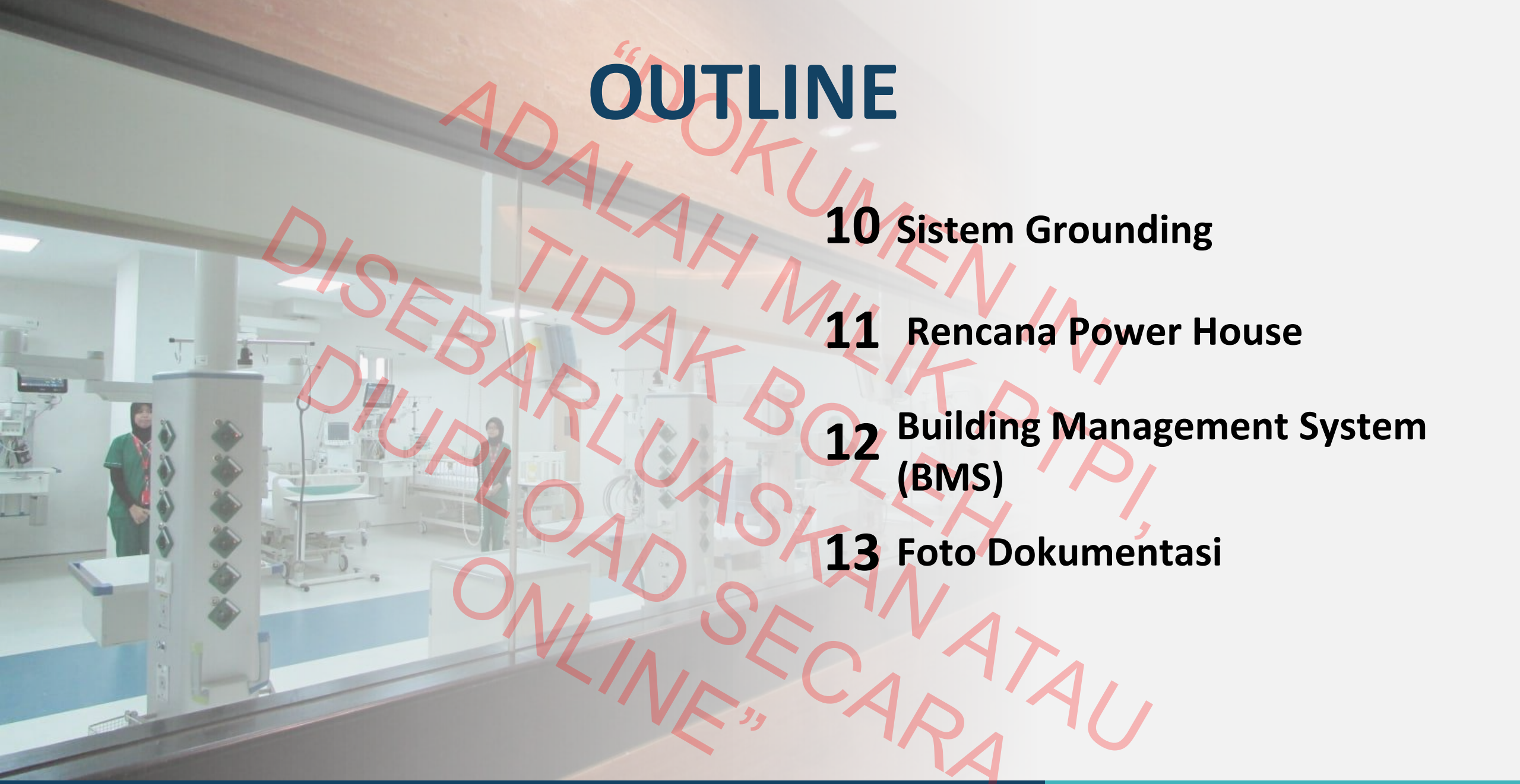
OUTLINE

06 Perhitungan Jatuh/Drop Tegangan dan Arus Hubung Singkat

07 Circuit Breaker

08 Wiring Diagram Panel Distribusi Listrik

09 Diagram Rencana Sistem Distribusi Listrik



OUTLINE

10 Sistem Grounding

11 Rencana Power House

12 Building Management System (BMS)

13 Foto Dokumentasi

1 Regulasi Sistem Kelistrikan

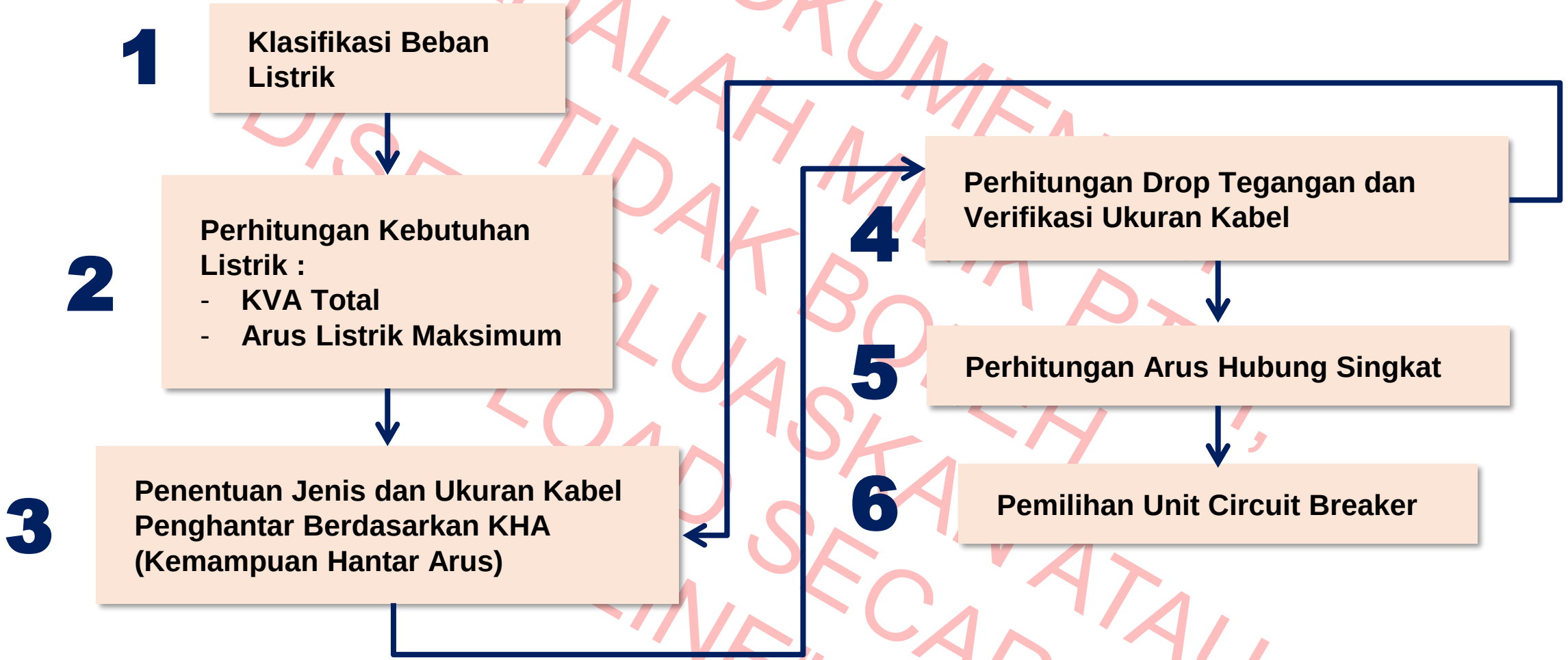
Regulasi Sistem Kelistrikan Rumah Sakit

1. SNI-04-0255-2020, tentang Persyaratan Umum Instalasi Listrik 2020.
2. SNI-04-0227-1994, tentang Tegangan Standar.
3. SNI-03-6575-2001, tentang Tata Cara Perancangan Sistem Pencahayaan Buatan pada Bangunan.
4. SNI-03-6574-2001, tentang Tata Cara Perancangan Pencahayaan Darurat, Tanda Arah dan Sistem Peringatan Bahaya pada Bangunan.
5. SNI-03-6197-2000, tentang Konversi Energi Sistem Pencahayaan.
6. SNI-03-7018-2004, tentang Sistem Pasokan Daya Darurat.
7. Peraturan Menteri Kesehatan Republik Indonesia Nomor 24 Tahun 2016 Tentang Persyaratan Teknis Bangunan dan Prasarana Rumah Sakit.
8. Peraturan Menteri Pekerjaan Umum RI, nomor : 02/PRT/M/2015 tanggal 18 Februari 2015, tentang Bangunan Gedung Hijau.
9. Undang-undang Republik Indonesia, nomor 28 tahun 2002, tentang bangunan gedung.

2

Flow Chart Perancangan Sistem Kelistrikan

Flow Chart Perancangan Sistem Kelistrikan Rumah Sakit



3 Klasifikasi Beban Listrik

Klasifikasi Beban Listrik

1. **Beban normal PLN :** Penerangan, stop kontak, AC, ventilasi mekanik, pompa air bersih, seluruh lift (termasuk unit lift kebakaran), peralatan medis, dan utilitas elektronik dan telekomunikasi dalam gedung.
2. **Beban normal genset :** seluruh beban pada kelompok beban normal PLN.
3. **Beban emergency :** kelompok beban yang aktif pada saat kebakaran atau kondisi sejenis, menggunakan sumber listrik dari genset. Beban ini meliputi : pompa pemadam kebakaran, pressurized fan tangga kebakaran, lift kebakaran, dan utilitas elektronik dan telekomunikasi dalam gedung.
4. **Beban dengan backup UPS (beban kritis) :** adalah beban yang tidak boleh padam / mati sama sekali, bahkan saat terjadi perpindahan sumber dari PLN ke genset ataupun sebaliknya. Beban ini meliputi : kamar operasi, ruang ICU / NICU / PICU / HCU / ICCU, ruang bersalin, IGD, hemodialisa, dan area medis lainnya sesuai dengan permenkes.

4 Perhitungan Kebutuhan Listrik

Perhitungan Kebutuhan Listrik

Kebutuhan listrik dihitung berdasarkan besaran daya aktif (watt) pada setiap beban listrik yang terpasang pada rumah sakit. Tahapan proses perhitungan kebutuhan listrik rumah sakit adalah sebagai berikut.

1. Membuat daftar seluruh beban yang akan dipasang, lengkap dengan data besaran daya aktif (watt) beban.
2. Menentukan klasifikasi beban listrik.
3. Membuat skedul beban listrik (akan ditunjukkan pada slide selanjutnya).

Skedul Beban Listrik Penerangan, Stop Kontak, AC, dan Ventilasi Mekanik

NO	FUNGSI	TOTAL WATT	BEBAN TERPASANG (AMP) R	S	T
1	PENERANGAN	1319	6.3		
2		1404		6.7	
3		712			3.4
4		1091	5.2		
5		709		3.4	
6		470			2.2
7		1353	6.5		
8		250		1.2	
9		891		4.3	
10	KOTAK KONTAK	600			3.2
11		400	2.1		
12		400		2.1	
13		300			1.6
14		500	2.7		
15		200		1.1	
16		200			1.1
17		200	1.1		
18		500		2.7	
19		400			2.1
20		400	2.1		
21		700		3.7	
22		400			2.1
23		500			2.7
24		400		2.1	
25		400			2.1
26		600	3.2		
27		400		2.1	
28		600			3.2
29		700	3.7		
30		700		3.7	
31		400			2.1
32		500	2.7		
33		500		2.7	
34		300			1.6
35		600	3.2		
36		400		2.1	
37		600			3.2
38		600	3.2		
39		300		1.6	
40		600			3.2
41		300	1.6		
42		200		1.1	
43		600			3.2
44		600	3.2		
45		600		3.2	
46		600			3.2
47		400		2.1	
48		500		2.7	
49	BM.TIN.2/1	890			4.7
50	BM.TIN.2/2	690			4.0
51	SPARE				
52					
53					
		27879	46.9	48.7	49.1

TOTAL KVA	31,8
TOTAL KW	27,9

Penerangan dan Stop Kontak

NO	FUNGSI	TOTAL WATT	BEBAN TERPASANG (AMP) R	S	T
1	POWER AC	300	1.6		
2		200		1.1	
3		220			1.2
4		370	2.0		
5		212		1.1	
6		420			2.2
7		231	1.2		
8		321		1.7	
9		365			2.0
10		388	2.1		
11		275		1.5	
12		200			1.1
13		400	2.1		
14	AXIAL EXHAUST FAN	250		1.3	
15		250			1.3
16		400			2.1
17		300		1.6	
18		250			1.3
19		400	2.1		
20		1000	1.8	1.8	1.8
21		1000	1.8	1.8	1.8
22	FRESH AIR FAN	250			1.3
23		300		1.6	
24		250		1.3	
25	SPARE				
26					
27					
		8552	14.7	14.8	16.2

TOTAL KVA	10,1
TOTAL KW	8,6

AC dan Ventilasi Mekanik

Skedul Beban Pompa Distribusi Air Bersih dan Pemadam Kebakaran

Pompa Distribusi Air Bersih

NO	PANEL	FUNGSI	BEBAN TERSAMBUNG					FK %	BEBAN NORMAL				
			(KVA)	(KW)	R	S	T		(KVA)	(KW)	R	S	T
1	PK POMPA TRANSFER AIR BERSIH	POWER POMPA TRANSFER AIR BERSIH	27,1	23,0	41,0	41,0	41,0	0,5	13,5	11,5	20,5	20,5	20,5
2	PK KURAS GWT	POWER POMPA KURAS GWT	2,4	2,0	3,6	3,6	3,6	0,5	1,2	1,0	1,8	1,8	1,8
3	PK KURAS RUANG POMPA	POWER KURAS RUANG POMPA	4,1	3,5	6,2	6,2	6,2	0,5	2,1	1,8	3,1	3,1	3,1
4	EXHAUST FAN	POWER EXHAUST FAN R. POMPA	1,8	1,5	2,7	2,7	2,7	0,7	1,2	1,1	1,9	1,9	1,9
			35,3	**30,0**	**53,5**	**53,5**	**53,5**		**18,0**	**15,3**	**27,3**	**27,3**	**27,3**
			KVA	**KW**	**A**	**A**	**A**		**KVA**	**KW**	**A**	**A**	**A**

BEBAN LISTRIK NORMAL

TOTAL KVA	18,0
TOTAL KW	15,3

Pompa Pemadam Kebakaran

NO	PANEL	BEBAN TERSAMBUNG					FK %	BEBAN NORMAL					BEBAN EMERGENCY				
		(KVA)	(KW)	R	S	T		(KVA)	(KW)	R	S	T	(KVA)	(KW)	R	S	T
1	PK ELECTRIC HYDRANT PUMP	156.5	133.0	237.1	237.1	237.1	-	-	-	-	-	-	156.5	133.0	237.1	237.1	237.1
2	PK JOCKEY PUMP	5.9	5.0	8.9	8.9	8.9	0.8	4.7	4.0	7.1	7.1	7.1	-	-	-	-	-
		162.4	**138.0**	**246.0**	**246.0**	**246.0**		**4.7**	**4.0**	**7.1**	**7.1**	**7.1**	**156.5**	**133.0**	**237.1**	**237.1**	**237.1**
		KVA	**KW**	**A**	**A**	**A**		**KVA**	**KW**	**A**	**A**	**A**	**KVA**	**KW**	**A**	**A**	**A**

BEBAN LISTRIK NORMAL

TOTAL KVA	4.7
TOTAL KW	4.0

TOTAL BEBAN LISTRIK EMERGENCY

TOTAL KVA	156.5
TOTAL KW	133.0

Skedul Beban Listrik Total Gedung Medik Sentral

NO	PANEL / FUNGSI	LOKASI	BEBAN TERSAMBUNG					FK %	BEBAN NORMAL					BEBAN EMERGENCY (KEBAKARAN)				
			(KVA)	(KW)	R	S	T		(KVA)	(KW)	R	S	T	(KVA)	(KW)	R	S	T
1	SDP LIFT & PRESS FAN	LT. MESIN LIFT	229.4	195.0	347.6	347.6	347.6	0.28	63.5	54.0	96.3	96.3	96.3	187.1	159.0	283.4	283.4	283.4
2	PP ELEKTRONIK	LANTAI 1	10.1	8.6	14.7	18.4	12.6	0.5	5.0	4.3	7.4	9.2	6.3	-	-	-	-	-
3	SDP GEDUNG PARKIR	LANTAI 1	8.3	7.5	12.6	10.6	14.3	0.7	5.8	5.3	8.8	7.5	10.0	-	-	-	-	-
4	LP.OL	LANTAI 1	2.0	1.9	2.4	2.6	3.9	0.5	1.0	0.9	1.2	1.3	2.0	-	-	-	-	-
5	PP 1	LANTAI 1	40.8	35.7	58.6	66.5	60.2	0.5	20.4	17.9	29.3	33.3	30.1	-	-	-	-	-
6	PPAC 1	LANTAI 1	7.9	6.7	10.7	12.5	12.6	0.5	3.9	3.3	5.3	6.2	6.3	-	-	-	-	-
7	PP RADIOLOGI	LANTAI 1	250.0	200.0	378.8	378.8	378.8	0.4	100.0	80.0	151.5	151.5	151.5	-	-	-	-	-
8	PP IGD	LANTAI 1	8.3	7.1	13.6	11.9	12.3	0.5	4.2	3.6	6.8	5.9	6.2	-	-	-	-	-
9	PP OK CITO (TAHAP SELANJUTNYA)	LANTAI 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-
10	PK AC OK CITO (8PK) (TAHAP SELANJUTNYA)	LANTAI 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-
11	PK SUMPIT AIR LIMBAH 1	LANTAI 1	2.4	2.0	3.6	3.6	3.6	0.5	1.2	1.0	1.8	1.8	1.8	-	-	-	-	-
12	PK SUMPIT AIR LIMBAH 2	LANTAI 1	7.1	6.0	10.7	10.7	10.7	0.5	3.5	3.0	5.3	5.3	5.3	-	-	-	-	-
13	PK SUMPIT AIR LIMBAH 3	LANTAI 1	2.4	2.0	3.6	3.6	3.6	0.5	1.2	1.0	1.8	1.8	1.8	-	-	-	-	-
14	PK POMPA LONG STORAGE	LANTAI 1	9.4	8.0	14.3	14.3	14.3	0.5	4.7	4.0	7.1	7.1	7.1	-	-	-	-	-
15	PP 2	LANTAI 2	31.8	27.9	46.9	48.7	49.1	0.5	15.9	13.9	23.4	24.4	24.6	-	-	-	-	-
16	PPAC 2	LANTAI 2	10.1	8.6	14.7	14.8	16.2	0.5	5.0	4.3	7.4	7.4	8.1	-	-	-	-	-
17	PP LAB	LANTAI 2	11.4	9.7	16.6	17.1	18.2	0.5	5.7	4.9	8.3	8.6	9.1	-	-	-	-	-
18	PP 3	LANTAI 3	49.0	42.5	71.4	77.2	74.0	0.5	24.5	21.2	35.7	38.6	37.0	-	-	-	-	-
19	PPAC 3	LANTAI 3	11.7	9.9	17.5	18.5	17.1	0.5	5.8	5.0	8.7	9.2	8.5	-	-	-	-	-
20	PP HD	LANTAI 3	28.2	24.0	42.8	42.8	42.8	0.5	14.1	12.0	21.4	21.4	21.4	-	-	-	-	-
21	LP 4	LANTAI 4	9.0	8.5	11.4	17.8	11.9	0.5	4.5	4.3	5.7	8.9	6.0	-	-	-	-	-
22	PP.4.1	LANTAI 4	9.1	7.7	11.2	15.0	15.0	0.5	4.5	3.9	5.6	7.5	7.5	-	-	-	-	-
23	PP.4.2	LANTAI 4	10.4	8.8	15.5	16.6	15.0	0.5	5.2	4.4	7.8	8.3	7.5	-	-	-	-	-
24	PPAC 4	LANTAI 4	284.7	242.0	429.0	431.9	433.1	0.5	142.3	121.0	214.5	215.9	216.6	-	-	-	-	-
25	PP VK	LANTAI 4	5.2	5.2	-	-	23.8	0.5	2.6	2.6	-	-	11.9	-	-	-	-	-
26	SDP CLEAN ROOM LANTAI 4	LANTAI 4	333.1	267.8	538.6	486.1	489.3	0.5	166.5	133.9	269.3	243.1	244.7	-	-	-	-	-
27	PP 4A	LANTAI 4A	8.0	7.1	11.5	14.5	10.5	0.5	4.0	3.6	5.7	7.3	5.2	-	-	-	-	-
28	PPAC 4A	LANTAI 4A	2.2	1.8	3.1	3.5	3.1	0.5	1.1	0.9	1.6	1.8	1.6	-	-	-	-	-
29	PP CSSD	LANTAI 4A	66.5	53.2	98.6	104.3	99.2	0.5	33.2	26.6	49.3	52.1	49.6	-	-	-	-	-
30	PK AC GUDANG STERIL (8PK)	LANTAI 4A	32.8	27.9	49.7	49.7	49.7	0.5	16.4	14.0	24.9	24.9	24.9	-	-	-	-	-
31	SDP MESIN LIFT	LT.MESIN LIFT	46.0	39.1	66.4	70.9	71.7	0.5	23.0	19.5	33.2	35.4	35.8	-	-	-	-	-
			1526.9	**1272.0**	**2315.8**	**2310.6**	**2314.0**		**688.9**	**574.0**	**1045.0**	**1042.0**	**1044.5**	**187.1**	**159.0**	**283.4**	**283.4**	**283.4**
			KVA	**KW**	**A**	**A**	**A**		**KVA**	**KW**	**A**	**A**	**A**	**KVA**	**KW**	**A**	**A**	**A**

TOTAL BEBAN LISTRIK NORMAL		*TOTAL BEBAN LISTRIK EMERGENCY*	
TOTAL KVA	688.9	TOTAL KVA	187.1
TOTAL KW	574.0	TOTAL KW	159.0

Skedul Beban Listrik Total Kawasan Rumah Sakit

NO	PANEL / FUNGSI	BEBAN TERSAMBUNG					FK %	BEBAN NORMAL					BEBAN EMERGENCY				
		(KVA)	(KW)	R	S	T		(KVA)	(KW)	R	S	T	(KVA)	(KW)	R	S	T
1	SDP GEDUNG	1526.9	1272.0	2315.8	2310.6	2314.0	0.45	688.9	574.0	1045.0	1042.0	1044.5	187.1	159.0	283.4	283.4	283.4
2	PP HYDRANT	162.4	138.0	246.0	246.0	246.0	0.03	4.7	4.0	7.1	7.1	7.1	156.5	133.0	237.1	237.1	237.1
3	SDP POMPA	35.3	30.0	53.5	53.5	53.5	0.51	18.0	15.3	27.3	27.3	27.3	-	-	-	-	-
4	PP JENAZAH	6.2	5.3	7.2	6.6	14.5	0.50	3.1	2.7	3.6	3.3	7.2	-	-	-	-	-
5	PP LAUNDRY	74.5	63.3	112.8	112.8	112.8	0.50	37.2	31.7	56.4	56.4	56.4	-	-	-	-	-
6	PP KITCHEN	27.1	23.0	39.2	44.6	39.2	0.50	13.5	11.5	19.6	22.3	19.6	-	-	-	-	-
7	PP GAS MEDIS	47.8	40.6	74.5	71.3	71.3	0.50	24.0	20.4	37.9	35.7	35.7	-	-	-	-	-
8	PP G. LAUNDRY & KITCHEN	6.1	5.3	8.7	8.1	10.9	0.50	3.0	2.6	4.3	4.1	5.4	-	-	-	-	-
9	PP IPSRS	4.4	3.8	5.1	11.6	3.4	0.50	2.2	1.9	2.6	5.8	1.7	-	-	-	-	-
10	PP POWER HOUSE	9.7	7.9	15.7	15.7	12.9	0.50	4.9	4.0	7.9	7.9	6.4	-	-	-	-	-
11	PK IPAL	24.1	20.5	36.5	36.5	36.5	0.50	12.1	10.3	18.3	18.3	18.3	-	-	-	-	-
		1924.4	1609.7	2915.1	2917.3	2915.0		811.7	678.3	1230.0	1230.0	1229.6	343.5	292.0	520.5	520.5	520.5
		KVA	KW	A	A	A		KVA	KW	A	A	A	KVA	KW	A	A	A

TOTAL BEBAN LISTRIK NORMAL

TOTAL KVA	811.7
TOTAL KW	678.3

TOTAL BEBAN LISTRIK EMERGENCY

TOTAL KVA	343.5
TOTAL KW	292.0

PERBAIKAN FAKTOR DAYA

Faktor Daya Instalasi	0.84
Faktor Daya Yang Diinginkan (Dikondisikan)	0.90
Kapasitor Diperlukan (kVAR)	117.3

INSTALASI KAPASITOR BANK

Total Kapasitor Dipasang (kVAR)	200.0
Kapasitas Maksimal Yang Diaktifkan (kVAR)	150.0
Faktor Daya Dihasilkan	0.92

BEBAN NORMAL DENGAN KAP. BANK

S	P	R	S	T
740.0	678.3	1121.3	1121.4	1121.0
KVA	KW	A	A	A

BEBAN LISTRIK NORMAL DENGAN KAP. BANK	
TOTAL KVA	740.0
TOTAL KW	678.3

5

Penentuan Jenis dan Ukuran Kabel Distribusi Listrik

Jenis-jenis Kabel Distribusi Listrik Tegangan Rendah

NYY 4 x (1.5-400) mm² 0.6/1 kV
Cu / PVC / PVC

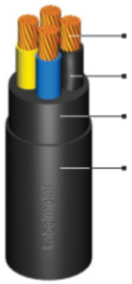
(Copper Conductor, PVC Insulated, PVC Sheathed)
Standard Specification : IEC 60502-1

Construction Data

Nom. Cross Section Area	Overall Diameter	Cable Weight
	approx.	approx.
mm²	mm	kg/km
1.5	13.8	259
2.5	15.0	324
4	17.3	453
6	18.7	563
10	21.5	794
16	23.5	1,083
25	27.5	1,558
35	30.0	2,018
50	35.5	2,466
70	39.0	3,334
95	44.5	4,491
120	48.5	5,504
150	54.5	6,787
185	59.0	8,392
240	66.0	10,818
300	72.5	13,326
400	82.5	16,969

Application :
Power cable : Indoors, cable trunking, outdoors and burried in the ground, for power stations, industry and switchgear as well as for urban supply networks, if mechanical damage is unlikely.

Special Features on Request :
- Fire Resistance
- Oil Resistance
- UV Resistance
- Flame Retardant Cat. A, B, C
- Flame Retardant Non Category
- Heat Resistance
- Anti Termite
- Anti Rodent
- Low Smoke Zero Halogen
- Nylon Coated



Note :
Conductor Shape
1.5 - 10 sqmm supplied in solid (re) or non compacted circular stranded (rm) conductor shape
16 sqmm supplied in non compacted circular stranded (rm) conductor shape
25 - 35 sqmm supplied in compacted circular stranded (cm) conductor shape
50 - 400 sqmm supplied in sector shaped stranded (sm) conductor

Standard Packing
1.5 - 70 sqmm supplied in wooden drum @ 1000 m
95 - 400 sqmm will be suplied in wooden drum on available length
Length Tolerance per drum ± 2%

NYFGbY 4 x (1.5-300) mm² 0.6/1 kV
Cu / PVC / SFWA / PVC

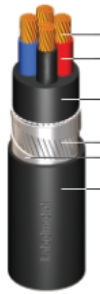
(Copper Conductor, PVC Insulated, Galvanized Steel Flat Wire Armor, PVC Sheathed)
Standard Specification : IEC 60502-1

Construction Data

Nom. Cross Section Area	Overall Diameter	Cable Weight
	approx.	approx.
mm²	mm	kg/km
1.5	17.9	630
2.5	18.0	662
4	19.0	773
6	20.5	912
10	23.0	1,174
16	25.5	1,520
25	29.0	2,053
35	32.0	2,584
50	37.5	3,173
70	40.5	4,087
95	46.5	5,359
120	50.5	6,459
150	56.5	7,868
185	61.0	9,556
240	68.0	12,138
300	74.5	14,773

Application :
For installation in the ground, indoors, cable trunking and outdoors if increased mechanical protection is required or where high-pulling stresses may occur during installation or operation.

Special Features on Request :
- Fire Resistance
- Oil Resistance
- UV Resistance
- Flame Retardant Cat. A, B, C
- Flame Retardant Non Category
- Heat Resistance
- Anti Termite
- Anti Rodent
- Low Smoke Zero Halogen



Note :
Conductor Shape
1.5 - 10 sqmm supplied in solid (re) or non compacted circular stranded (rm) conductor shape
16 sqmm supplied in non compacted circular stranded (rm) conductor shape
25 - 35 sqmm supplied in compacted circular stranded (cm) conductor shape
50 - 300 sqmm supplied in sector shaped stranded (sm) conductor

Standard Packing
1.5 - 50 sqmm supplied in wooden drum @ 1000 m
70 - 300 sqmm will be suplied in wooden drum on available length
Length Tolerance per drum ± 2%

NYY : Kabel Distribusi Tegangan Rendah Di Atas Rak

NYFGBY : Kabel Distribusi Tegangan Rendah Di Bawah Tanah

Jenis-jenis Kabel Distribusi Listrik Tegangan Menengah

N2XSY 1 x (35-800) mm² 12/20 kV

Cu / XLPE / CTS / PVC

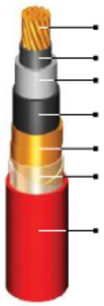
(Copper Conductor, XLPE Insulated, Copper Tape Screen, PVC Sheathed)
Standard Specification : SNI IEC 60502-2 : 2009

Construction Data

Nom. Cross Section Area	Overall Diameter	Cable Weight
	approx.	approx.
mm²	mm	kg/km
35	24.5	884
50	25.5	984
70	27.5	1,236
95	29.0	1,518
120	30.5	1,786
150	32.0	2,078
185	34.0	2,414
240	36.5	3,004
300	38.5	3,595
400	42.0	4,447
500	45.5	5,523
630	49.0	6,926
800	52.7	8,688

Application :
For power stations and switchgear as well as stations because of small bending radius in confined spaces indoors. As underground because of light weight where installation conditions are difficult.

Special Features on Request
- Tinned Coated Copper Conductor
- Oil Resistance
- UV Resistance
- Flame Retardant Cat. A, B, C
- Flame Retardant Non Category
- Anti Termite
- Anti Rodent
- Low Smoke Zero Halogen
- Nylon Coated



Note :
Conductor Shape
35 - 800 sqmm supplied in compacted circular stranded (cm) conductor shape

Tinned Coated Copper Conductor
Electrical properties for tinned coated copper conductor will be submitted upon request

Standard Packing
35 - 300 sqmm supplied in wooden drum @ 1000 m
400 - 800 sqmm will be suplied in wooden drum on available length
Length Tolerance per drum ± 2%

<u>N2XSY : Kabel Distribusi Tegangan Menengah Di Atas Rak</u>

N2XSEBY 3 x (35-300) mm² 12/20 kV

Cu / XLPE / CTS / PVC / STA / PVC

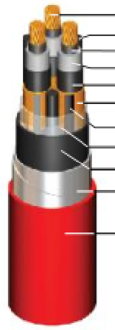
(Copper Conductor, XLPE Insulated, Copper Tape Screen, Galvanized Steel Tape Armor, PVC Sheathed)
Standard Specification : SNI IEC 60502-2 : 2009

Construction Data

Nom. Cross Section Area	Overall Diameter	Cable Weight
	approx.	approx.
mm²	mm	kg/km
35	56.5	4,322
50	59.0	4,883
70	63.0	5,836
95	66.5	6,905
120	70.0	7,907
150	74.0	9,096
185	77.5	10,488
240	84.5	13,454
300	89.5	15,722

Application :
For installation indoor, in ground direct burried, for power station and switchgear, if there is a risk that low mechanical damage may occur.

Special Features on Request
- Tinned Coated Copper Conductor
- Oil Resistance
- UV Resistance
- Flame Retardant Cat. A, B, C
- Flame Retardant Non Category
- Anti Termite
- Anti Rodent
- Low Smoke Zero Halogen



Note :
Conductor Shape
35 - 300 sqmm supplied in compacted circular stranded (cm) conductor shape

Tinned Coated Copper Conductor
Electrical properties for tinned coated copper conductor will be submitted upon request

Standard Packing
35 - 300 sqmm will be suplied in wooden drum on available length
Length Tolerance per drum ± 2%

<u>N2XSEBY : Kabel Distribusi Tegangan Menengah Di Bawah Tanah</u>

Menentukan Ukuran Kabel Distribusi Listrik

1. Ukuran kabel distribusi listrik dapat ditentukan jika nilai estimasi arus listrik pada masing-masing beban listrik diketahui.
2. Nilai estimasi arus listrik dapat dihitung jika besaran daya aktif (watt) beban diketahui.
3. Ukuran kabel distribusi listrik ditentukan dengan melihat tabel KHA (kemampuan hantar arus) kabel pada brosur.

Data KHA Kabel NYY dan NYFGBY

Electrical Data

Conductor			Inductance	Current - Carrying Capacity at 30°C *		Short circuit current at 1 sec
Nom. Cross Sect.	DC Resistance at 20°C	AC Resistance at 70°C		in air	in ground	
(mm²)	Max. (Ω/km)	Max. (Ω/km)	(mH/km)	Max. (A)	Max. (A)	Max. (kA)
1.5	12.1	14.478	0.328	22	27	0.17
2.5	7.41	8.866	0.304	29	35	0.29
4	4.61	5.516	0.303	39	46	0.46
6	3.08	3.685	0.288	50	57	0.69
10	1.83	2.190	0.269	68	77	1.15
16	1.15	1.376	0.255	90	99	1.84
25	0.727	0.870	0.255	121	128	2.88
35	0.524	0.627	0.246	149	154	4.03
50	0.387	0.464	0.247	173	173	5.75
70	0.268	0.321	0.238	215	212	8.05
95	0.193	0.232	0.238	266	255	10.93
120	0.153	0.184	0.233	308	289	13.80
150	0.124	0.150	0.233	357	327	17.25
185	0.0991	0.121	0.233	405	366	21.28
240	0.0754	0.093	0.232	482	425	27.60
300	0.0601	0.075	0.231	552	479	34.50
400	0.0470	0.060	0.229	643	545	41.20

** Further information about rating factor for certain cable arrangement can be found on supplementary technical information*

Data KHA Kabel NYY

Electrical Data

Conductor			Inductance	Current - Carrying Capacity at 30°C *		Short circuit current at 1 sec
Nom. Cross Sect.	DC Resistance at 20°C	AC Resistance at 70°C		in air	in ground	
(mm²)	Max. (Ω/km)	Max. (Ω/km)	(mH/km)	Max. (A)	Max. (A)	Max. (kA)
1.5	12.1	14.478	0.340	23	27	0.17
2.5	7.41	8.866	0.315	31	36	0.29
4	4.61	5.516	0.303	41	48	0.46
6	3.08	3.685	0.288	52	59	0.69
10	1.83	2.190	0.269	71	79	1.15
16	1.15	1.376	0.255	94	101	1.84
25	0.727	0.870	0.255	126	131	2.88
35	0.524	0.627	0.246	154	157	4.03
50	0.387	0.464	0.247	177	176	5.75
70	0.268	0.321	0.238	221	215	8.05
95	0.193	0.232	0.238	272	257	10.93
120	0.153	0.184	0.233	314	292	13.80
150	0.124	0.150	0.233	363	330	17.25
185	0.0991	0.121	0.233	412	369	21.28
240	0.0754	0.093	0.232	488	427	27.60
300	0.0601	0.075	0.231	559	481	34.50

** Further information about rating factor for certain cable arrangement can be found on supplementary technical information*

Data KHA Kabel NYFGBY

Data KHA Kabel N2XSY dan N2XSEBY

Electrical Data

Conductor			Inductance		Current - Carrying Capacity at 30° C *				Short circuit current at 1 sec	
			Trefoil formation	Flat formation	in air	in ground	in air	in ground		
Nom. Cross Sect. (mm²)	DC Resistance at 20°C Max. (Ω/km)	AC Resistance at 90°C Max. (Ω/km)	(mH/km)	(mH/km)	Max. (A)	Max. (A)	Max. (A)	Max. (A)	Conductor Max. (kA)	Screen Max. (kA)
35	0.524	0.668	0.432	0.478	200	182	204	186	5.01	1.14
50	0.387	0.494	0.413	0.459	238	214	243	219	7.15	1.14
70	0.268	0.342	0.390	0.437	297	262	304	269	10.01	1.14
95	0.193	0.247	0.373	0.419	361	314	369	321	13.59	1.14
120	0.153	0.196	0.360	0.407	416	357	427	365	17.16	1.14
150	0.124	0.159	0.348	0.394	474	401	486	410	21.45	1.14
185	0.0991	0.128	0.337	0.384	542	452	556	462	26.46	1.14
240	0.0754	0.098	0.325	0.371	641	524	657	536	34.32	1.14
300	0.0601	0.079	0.315	0.361	735	590	753	604	42.90	1.14
400	0.0470	0.063	0.304	0.350	855	672	876	686	57.20	1.14
500	0.0366	0.051	0.294	0.341	987	759	1011	775	71.50	1.14
630	0.0283	0.041	0.286	0.332	1133	853	1160	871	90.09	1.14
800	0.0221	0.036	0.277	0.324	1253	948	1316	966	114.40	1.14

** Further information about rating factor for certain cable arrangement can be found on supplementary technical information*

Data KHA Kabel N2XSY

Electrical Data

Conductor			Inductance	Current - Carrying Capacity at 30° C *		Short circuit current at 1 sec	
				in air	in ground		
Nom. Cross Sect. (mm²)	DC Resistance at 20°C Max. (Ω/km)	AC Resistance at 90°C Max. (Ω/km)	(mH/km)	Max. (A)	Max. (A)	Conductor Max. (kA)	Screen Max. (kA)
35	0.524	0.668	0.395	190	174	5.01	1.03
50	0.387	0.494	0.379	226	205	7.15	1.03
70	0.268	0.342	0.357	280	250	10.01	1.03
95	0.193	0.247	0.341	338	298	13.59	1.37
120	0.153	0.196	0.328	387	338	17.16	1.37
150	0.124	0.159	0.318	437	378	21.45	1.37
185	0.0991	0.128	0.308	497	426	26.46	1.37
240	0.0754	0.098	0.296	580	488	34.32	1.37
300	0.0601	0.079	0.287	655	545	42.90	1.37

** Further information about rating factor for certain cable arrangement can be found on supplementary technical information*

Data KHA Kabel N2XSEBY

6

Perhitungan Drop Tegangan dan Arus Hubung Singkat

Perhitungan Jatuh Tegangan

Jatuh/Drop tegangan dihitung berdasarkan arus listrik dan impedansi kabel, menggunakan rumus sebagai berikut :

$$Vdrop = I \times Z \times \sqrt{3}$$

Di mana :

V drop : drop tegangan (volt)
I : arus listrik yang mengalir (berdasarkan estimasi kebutuhan listrik)
Z : nilai impedansi kabel penghantar, diperoleh dari perhitungan resistansi dan induktansi kabel menggunakan rumus sebagai berikut : $Z = \sqrt{R^2 + X^2}$

Catatan :
Nilai resistansi dan induktansi kabel diperoleh dari data sheet.

Rumus Turunan Perhitungan Drop Tegangan

Circuit	Voltage drop (ΔU)	
	in volts	in %
Phase/phase	$\Delta U = 2 I_B (R \cos\varphi + X \sin\varphi) L$	$\frac{100\ \Delta U}{Un}$
Phase/neutral	$\Delta U = 2 I_B (R \cos\varphi + X \sin\varphi) L$	$\frac{100\ \Delta U}{Vn}$
Balanced 3-phase: 3 phases (with or without neutral)	$\Delta U = \sqrt{3}\, I_B (R \cos\varphi + X \sin\varphi) L$	$\frac{100\ \Delta U}{Un}$

Fig. G27: Voltage-drop formulae

Maximum Voltage Drop Limit

Type of installations	Lighting circuits	Other uses (heating and power)
A low-voltage service connection from a LV public power distribution network	3 %	5 %
Consumers MV/LV substation supplied from a public distribution MV system	6 %	8 %

Fig. G25: Maximum voltage-drop between the service-connection point and the point of utilization (IEC60364-5-52 table G.52.1)

Rumus Perhitungan Arus Hubung Singkat (Isc)

Salah satu metode yang dapat digunakan untuk menghitung arus hubung singkat adalah metode impedansi (impedance method).

$$Isc = \frac{Un}{\sqrt{3}\sum(Z)}$$

Di mana :

Isc	:	arus hubung singkat
Un	:	tegangan line to line (380 volt)
Σ (Z)	:	penjumlahan seluruh nilai impedansi dari trafo s.d. lokasi (titik) arus hubung singkat yang akan dihitung
Z atau Zsc	:	nilai impedansi kabel penghantar, diperoleh dari perhitungan resistansi dan induktansi kabel menggunakan rumus sebagai berikut : $Zsc = \sqrt{R^2 + X^2}$

Catatan :
Nilai resistansi dan induktansi kabel diperoleh dari brosur.

Rumus Turunan Perhitungan Arus Hubung Singkat (Isc)

The case of one transformer

- In a simplified approach, the impedance of the MV system is assumed to be

negligibly small, so that: $Isc = \frac{In \times 100}{Usc}$ where $In = \frac{S \times 10^3}{U_{20}\sqrt{3}}$ and:

S = kVA rating of the transformer
U_{20} = phase-to-phase secondary volts on open circuit
In = nominal current in amps
Isc = short-circuit fault current in amps
Usc = short-circuit impedance voltage of the transformer in %.

Typical values of Usc for distribution transformers are given in **Figure G31**.

Transformer rating (kVA)	Usc in %	
	Oil-immersed	Cast-resin dry type
50 to 750	4	6
800 to 3200	6	6

Fig. G31: Typical values of Usc for different kVA ratings of transformers with MV windings ⩽ 20 kV

Contoh Tabel Perhitungan Drop Tegangan dan Arus Hubung Singkat (1)

No	Nama Panel	Panel Sumber	Panjang Kabel (meter)	Jenis Kabel / Penghantar	Resistansi Kabel / Penghantar (Ohm/km)	Induktansi Kabel / Penghantar (mH/km)	Impedansi Kabel / Penghantar (Ohm)	Tegangan Listrik Sumber (volt)	Arus Listrik (Ampere)	Drop Tegangan / Vdrop (volt)	Tegangan Listrik Di Panel	Persentase Drop Tegangan	Arus Hubung Singkat (Isc) (KA)	Breaking Capacity Minimal - Circuit Breaker Panel (KA)
1	LVMDP	Trafo 2000 KVA	17	NYY 4x(8x1x300)mm2	0,00707547	0,2	0,00012033	380	2604	0,543	379,457	0,14%	51,963	65
2	PP Power House	LVMDP	14	NYY 4x6 mm2	3,685	0,288	0,05159	379,457	5	0,447	379,011	0,26%	6,691	18
3	PP Gas Medis	LVMDP	48	NYY 4x35 mm2	0,627	0,246	0,030096	379,457	31	1,616	377,841	0,57%	10,183	18
4	SDP Gedung A 1	LVMDP	69	NYFGBY (4x300mm2)x5 mm2	0,015	0,2	0,00103509	379,457	1673	2,999	376,458	0,93%	35,227	50
5	SDP Gedung A 2	LVMDP	81	NYFGBY 4x(2x300) mm2	0,0375	0,2	0,00303754	379,457	730	3,841	375,617	1,15%	30,032	50
6	SDP Gedung B	LVMDP	128	NYFGBY 4x300 mm2	0,075	0,2	0,00960003	379,457	120	1,995	377,462	0,67%	20,433	36
7	SDP Gedung C	LVMDP	48	NYFGBY 4x300 mm2	0,075	0,2	0,00360001	379,457	294	1,833	377,624	0,63%	29,007	50
8	SDP Gedung D & E	LVMDP	131	NYFGBY 4x185 mm2	0,121	0,233	0,01585103	379,457	95	2,608	376,849	0,83%	15,601	36
9	PK IPAL 1	LVMDP	53	NYY 4x10 mm2	2,19	0,269	0,11607	379,457	13	2,613	376,844	0,83%	3,269	10
10	PK IPAL 2	LVMDP	80	NYY 4x10 mm2	2,19	0,269	0,1752	379,457	10	3,034	376,423	0,94%	2,227	10
11	PP Hydrant	SDP Gedung A 1	35	FRC 4x1x300 mm2	0,075	0,2	0,00262501	376,458	349	1,587	374,871	1,35%	28,675	50
12	SDP Pompa	SDP Gedung A 1	35	NYY 4x50 mm2	0,464	0,247	0,01624	376,458	62	1,744	374,714	1,39%	14,723	36
13	PP GF	SDP Gedung A 1	10	NYY 4x16 mm2	1,376	0,255	0,01376	376,458	20	0,477	375,981	1,06%	16,209	36
14	PPAC GF	SDP Gedung A 1	10	NYY 4x70 mm2	0,321	0,238	0,00321	376,458	46	0,256	376,202	1,00%	27,652	50
15	PP Elektronik	SDP Gedung A 1	48	FRC 4x1x16 mm2	1,376	0,255	0,066048	376,458	7	0,801	375,657	1,14%	5,311	10
16	PP IGD	SDP Gedung A 1	99	NYY 4x6 mm2	3,685	0,288	0,364815	376,458	6	3,791	372,667	1,93%	1,089	10
17	PP 1	SDP Gedung A 1	17	NYY 4x95 mm2	0,232	0,238	0,003944	376,458	39	0,266	376,192	1,00%	26,358	36
18	PPAC 1	SDP Gedung A 1	17	NYY 4x50 mm2	0,464	0,247	0,007888	376,458	69	0,943	375,515	1,18%	21,028	36
19	PP HD 1	SDP Gedung A 1	104	NYY 4x50 mm2	0,464	0,247	0,04825601	376,458	41	3,427	373,031	1,83%	6,838	18
20	PP HD 2	SDP Gedung A 1	104	NYY 4x50 mm2	0,464	0,247	0,04825601	376,458	41	3,427	373,031	1,83%	6,838	18
21	PP Radiologi	SDP Gedung A 1	65	NYY 4x(2x185) mm2	0,0605	0,2	0,00393252	376,458	246	1,676	374,782	1,37%	26,279	36
22	PP Cathlab	SDP Gedung A 1	57	NYY 4x1x300 mm2	0,075	0,2	0,00427502	376,458	121	0,896	375,562	1,17%	25,771	36
23	PP 2	SDP Gedung A 1	22	NYY 4x25 mm2	0,87	0,255	0,01914	376,458	26	0,862	375,596	1,16%	13,373	18
24	PPAC 2	SDP Gedung A 1	22	NYY 4x120 mm2	0,0605	0,2	0,00133101	376,458	77	0,178	376,280	0,98%	31,629	50
25	PP VK	SDP Gedung A 1	98	NYY 4x6 mm2	3,685	0,288	0,36113	376,458	5	3,127	373,331	1,76%	1,101	10
26	PP 3	SDP Gedung A 1	27	NYY 4x25 mm2	0,87	0,255	0,02349	376,458	27	1,098	375,359	1,22%	11,715	18
27	PPAC 3	SDP Gedung A 1	27	NYY 4x16 mm2	1,376	0,255	0,037152	376,458	17	1,094	375,364	1,22%	8,442	18
28	PP ICU	SDP Gedung A 1	115	NYY 4x10 mm2	2,19	0,269	0,25185	376,458	17	7,415	369,043	2,88%	1,540	10
29	PP CSSD	SDP Gedung A 1	115	NYY 4x50 mm2	0,464	0,247	0,05336001	376,458	42	3,882	372,576	1,95%	6,294	10

Keterangan :

1. Arus hubung singkat di panel LVMDP : 51,9 KA (Trafo : 2000 KVA)

2. Drop tegangan tertinggi di gedung A1 : 2,88% (Tegangan : 369 volt) pada panel PP.ICU lantai 3

Contoh Tabel Perhitungan Drop Tegangan dan Arus Hubung Singkat (2)

30	SDP Clean Room	SDP Gedung A 1	27	NYY 4x(3x1x240) mm2	0,031	0,2	0,00083702	376,458	441	0,639	375,819	1,10%	32,829	50
31	PP 4	SDP Gedung A 1	32	NYY 4x16 mm2	1,376	0,255	0,044032	376,458	18	1,373	375,085	1,29%	7,396	10
32	PPAC 4	SDP Gedung A 1	32	NYY 4x35 mm2	0,627	0,246	0,020064	376,458	33	1,147	375,311	1,23%	12,975	18
33	PP 5	SDP Gedung A 1	37	NYY 4x16 mm2	1,376	0,255	0,050912	376,458	17	1,499	374,959	1,33%	6,582	10
34	PPAC 5	SDP Gedung A 1	37	NYY 4x35 mm2	0,627	0,246	0,023199	376,458	31	1,246	375,212	1,26%	11,808	18
35	PP 6	SDP Gedung A 1	42	NYY 4x16 mm2	1,376	0,255	0,057792	376,458	19	1,902	374,556	1,43%	5,924	10
36	PPAC 6	SDP Gedung A 1	42	NYY 4x35 mm2	0,627	0,246	0,026334	376,458	31	1,414	375,044	1,30%	10,831	18
37	PP 7	SDP Gedung A 1	47	NYY 4x10 mm2	2,19	0,269	0,10293	376,458	13	2,318	374,140	1,54%	3,589	10
38	PPAC 7	SDP Gedung A 1	47	NYY 4x50 mm2	0,464	0,247	0,021808	376,458	37	1,398	375,060	1,30%	12,292	18
39	SDP Atap	SDP Gedung A 1	52	NYY 4x35 mm2	0,627	0,246	0,032604	376,458	29	1,638	374,820	1,36%	9,295	18
40	SDP Lift & Press Fan	SDP Gedung A 1	52	FRC 4x1x95 mm2	0,232	0,238	0,01206401	376,458	63	1,316	375,142	1,28%	17,324	36
41	PP GF	SDP Gedung A 2	10	NYY 4x10 mm2	2,19	0,269	0,0219	375,617	14	0,531	375,086	1,29%	11,571	18
42	PPAC GF	SDP Gedung A 2	10	NYY 4x16 mm2	1,376	0,255	0,01376	375,617	20	0,477	375,140	1,28%	14,996	36
43	PP Kitchen	SDP Gedung A 2	57	NYY 4x16 mm2	1,376	0,255	0,078432	375,617	22	2,989	372,628	1,94%	4,446	10
44	PP 1	SDP Gedung A 2	17	NYY 4x16 mm2	1,376	0,255	0,023392	375,617	18	0,729	374,887	1,35%	11,100	18
45	PPAC 1	SDP Gedung A 2	17	NYY 4x70 mm2	0,321	0,238	0,005457	375,617	46	0,435	375,182	1,27%	21,478	36
46	PP 2	SDP Gedung A 2	22	NYY 4x25 mm2	0,87	0,255	0,01914	375,617	22	0,729	374,887	1,35%	12,535	18
47	PPAC 2	SDP Gedung A 2	22	NYY 4x95 mm2	0,232	0,238	0,005104	375,617	66	0,583	375,033	1,31%	21,871	36
48	PP Endoscopy 1	SDP Gedung A 2	46	NYY 4x6 mm2	3,685	0,288	0,16951	375,617	3	0,881	374,736	1,39%	2,249	10
49	PP Endoscopy 2	SDP Gedung A 2	46	NYY 4x6 mm2	3,685	0,288	0,16951	375,617	3	0,881	374,736	1,39%	2,249	10
50	PP 3	SDP Gedung A 2	27	NYY 4x16 mm2	1,376	0,255	0,037152	375,617	20	1,287	374,330	1,49%	8,088	18
51	PPAC 3	SDP Gedung A 2	27	NYY 4x16 mm2	1,376	0,255	0,037152	375,617	20	1,287	374,330	1,49%	8,088	18
52	SDP Clean Room	SDP Gedung A 2	27	NYY 4x(2x185) mm2	0,0605	0,2	0,00163351	375,617	177	0,501	375,116	1,29%	26,809	36
53	PP 4	SDP Gedung A 2	32	NYY 4x10 mm2	2,19	0,269	0,07008	375,617	18	2,185	373,432	1,73%	4,900	10
54	PPAC 4	SDP Gedung A 2	32	NYY 4x35 mm2	0,627	0,246	0,020064	375,617	33	1,147	374,470	1,46%	12,179	18
55	PP 5	SDP Gedung A 2	37	NYY 4x16 mm2	1,376	0,255	0,050912	375,617	20	1,764	373,853	1,62%	6,359	10
56	PPAC 5	SDP Gedung A 2	37	NYY 4x35 mm2	0,627	0,246	0,023199	375,617	33	1,326	374,291	1,50%	11,141	18
57	PP 6	SDP Gedung A 2	42	NYY 4x16 mm2	1,376	0,255	0,057792	375,617	20	2,002	373,615	1,68%	5,744	10
58	PPAC 6	SDP Gedung A 2	42	NYY 4x35 mm2	0,627	0,246	0,026334	375,617	31	1,414	374,203	1,53%	10,267	18
59	PP 7	SDP Gedung A 2	47	NYY 4x10 mm2	2,19	0,269	0,10293	375,617	16	2,852	372,764	1,90%	3,514	10
60	PPAC 7	SDP Gedung A 2	47	NYY 4x50 mm2	0,464	0,247	0,021808	375,617	37	1,398	374,219	1,52%	11,574	18
61	SDP Atap	SDP Gedung A 2	52	NYY 4x25 mm2	0,87	0,255	0,04524	375,617	20	1,567	374,050	1,57%	6,974	18
62	SDP Lift & Press Fan	SDP Gedung A 2	52	FRC 4x1x95 mm2	0,232	0,238	0,01206401	375,617	58	1,212	374,405	1,47%	15,949	36

Keterangan :

1. Drop tegangan tertinggi di gedung A2 : 1,94% (Tegangan : 373 volt) pada panel PP.Kitchen lantai ground

7 Circuit Breaker

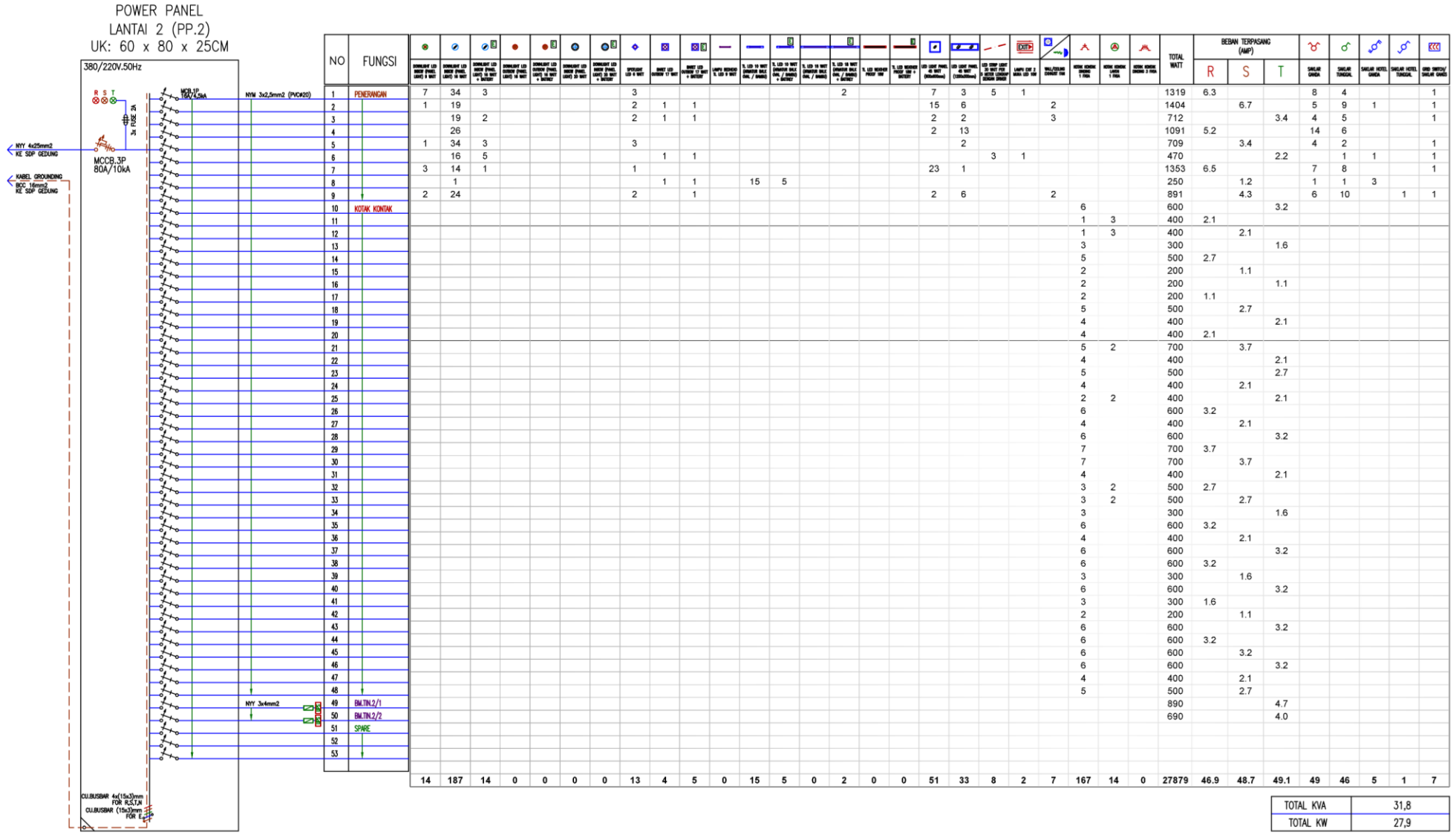
Circuit Breaker

- Fungsi :
- 1. Pengaman Arus Lebih
- 2. Pengaman Hubung Singkat

8

Wiring Diagram Panel Distribusi Listrik

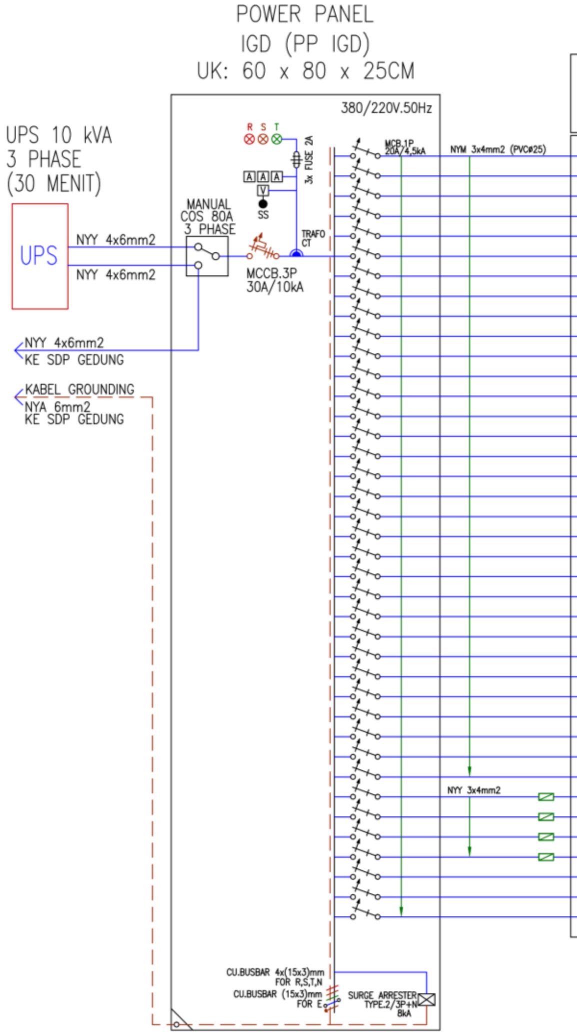
Wiring Diagram Panel Listrik Penerangan dan Stop Kontak



NO	FUNGSI	TOTAL WATT	BEBAN TERPASANG (AMP) R	S	T
1	PENERANGAN	1319	6.3		
2		1404		6.7	
3		712			3.4
4		1091	5.2		
5		709		3.4	
6		470			2.2
7		1353	6.5		
8		250		1.2	
9		891		4.3	
10	KOTAK KONTAK	600			3.2
11		400	2.1		
12		400		2.1	
13		300			1.6
14		500	2.7		
15		200		1.1	
16		200			1.1
17		200	1.1		
18		500		2.7	
19		400			2.1
20		400	2.1		
21		700		3.7	
22		400			2.1
23		500			2.7
24		400		2.1	
25		400			2.1
26		600	3.2		
27		400		2.1	
28		600			3.2
29		700	3.7		
30		700		3.7	
31		400			2.1
32		500	2.7		
33		500		2.7	
34		300			1.6
35		600	3.2		
36		400		2.1	
37		600			3.2
38		600	3.2		
39		300		1.6	
40		600			3.2
41		300	1.6		
42		200		1.1	
43		600			3.2
44		600	3.2		
45		600		3.2	
46		600			3.2
47		400		2.1	
48		500		2.7	
49	BMLTN.2/1	890			4.7
50	BMLTN.2/2	690			4.0
51	SPARE				
52					
53					
		27879	46.9	48.7	49.1

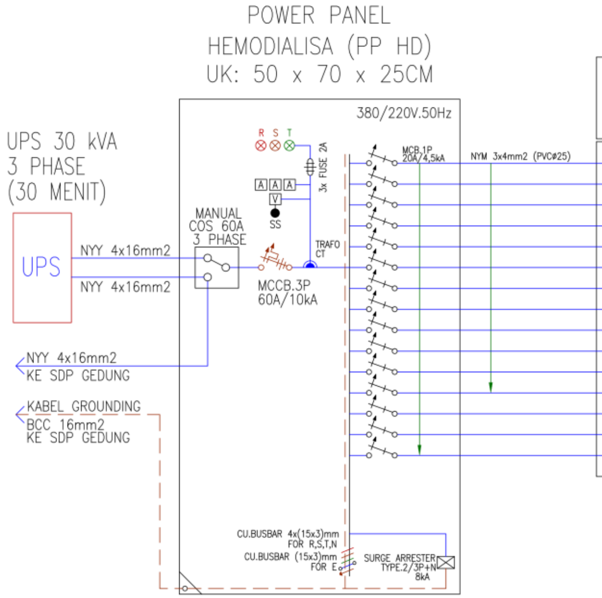
TOTAL KVA	31,8
TOTAL KW	27,9

Wiring Diagram Panel Listrik IGD dan Hemodialisa, dengan UPS



NO	FUNGSI	KOTAK KONTAK DINDING	TOTAL WATT	BEBAN TERPASANG (AMP) R	S	T
1	KOTAK KONTAK	3	300	1.6		
2		3	300		1.6	
3		1	100			0.5
4		1	100	0.5		
5		1	100		0.5	
6		1	100			0.5
7		1	100	0.5		
8		1	100		0.5	
9		1	100			0.5
10		1	100	0.5		
11		1	100		0.5	
12		1	100			0.5
13		1	100	0.5		
14		1	100		0.5	
15		1	100			0.5
16		1	100	0.5		
17		1	100		0.5	
18		1	100			0.5
19		1	100	0.5		
20		1	100		0.5	
21		1	100			0.5
22		1	100		0.5	
23		1	100		0.5	
24		1	100			0.5
25		1	100	0.5		
26		1	100		0.5	
27		1	100			0.5
28		1	100		0.5	
29		1	100		0.5	
30		1	100			0.5
31		1	100	0.5		
32		1	100		0.5	
33	BM.TRANSIT.1/1		1322			7.0
34	BM.RESUSITASI.1/1		661	3.5		
35	BM.TIN.1/1		740		3.9	
36	BM.TIN.1/2		802	4.2		
37	SPARE					
38						
39						
		36	7125	13.6	11.9	12.3

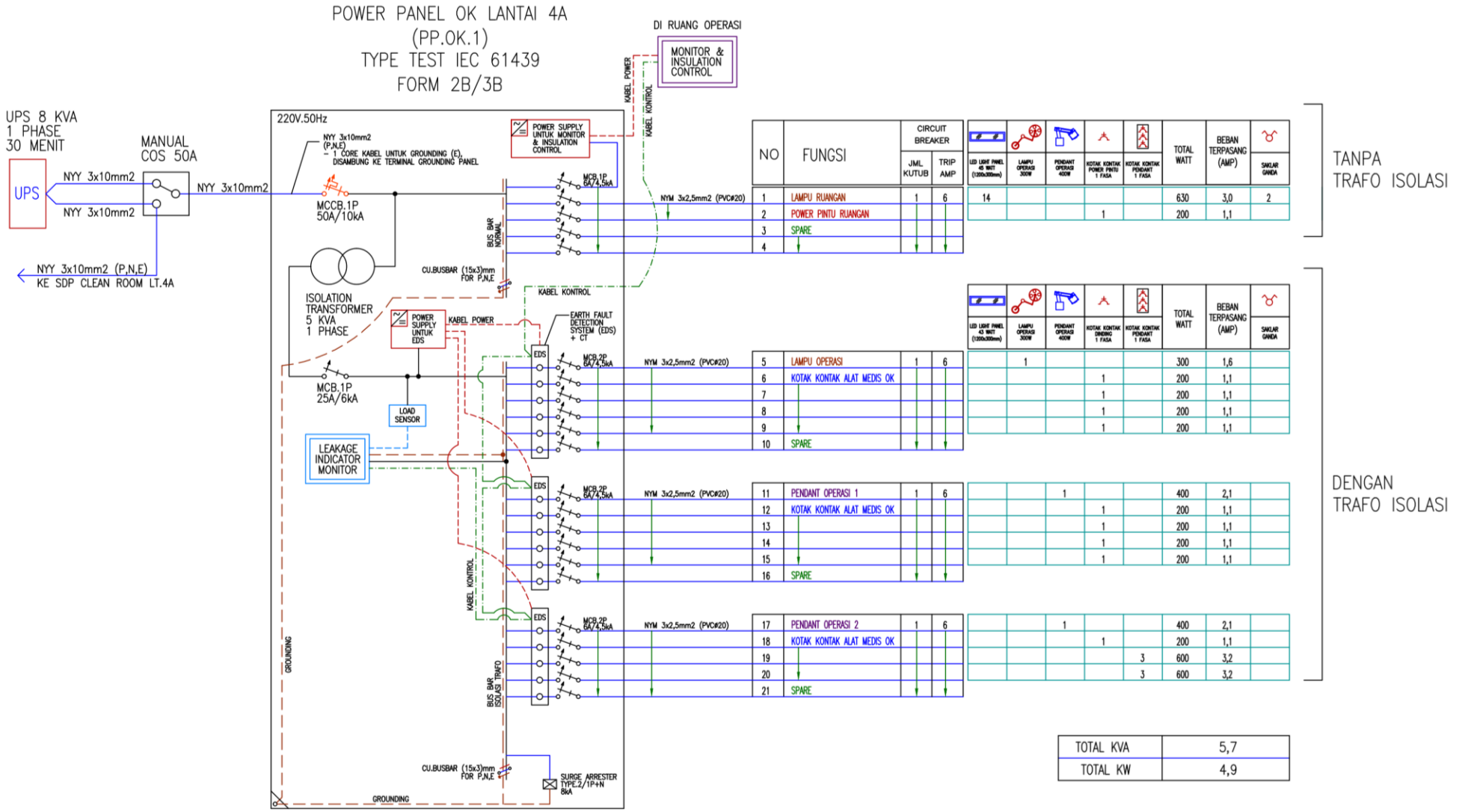
TOTAL KVA	8,3
TOTAL KW	7,1



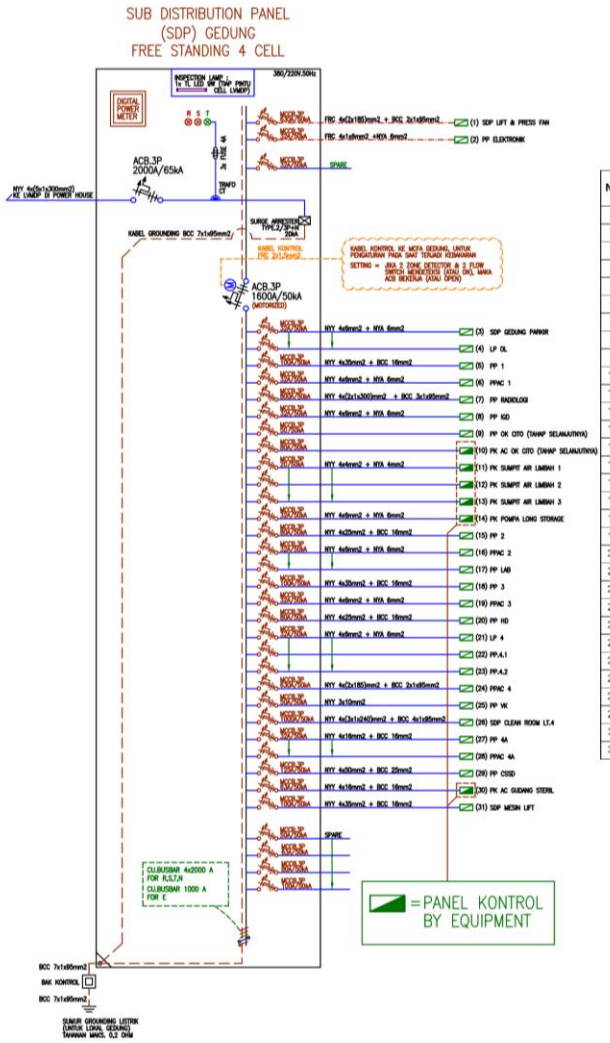
NO	FUNGSI	KOTAK KONTAK BEDHEAD (ISI 3 BUAH) 1 FASA	TOTAL WATT	BEBAN TERPASANG (AMP) R	S	T
1	MESIN HD	1	2000	10,7		
2		1	2000		10,7	
3		1	2000			10,7
4		1	2000	10,7		
5		1	2000		10,7	
6		1	2000			10,7
7		1	2000	10,7		
8		1	2000		10,7	
9		1	2000			10,7
10		1	2000	10,7		
11		1	2000		10,7	
12		1	2000			10,7
13	SPARE					
14						
15						
		12	24000	42,8	42,8	42,8

TOTAL KVA	28,2
TOTAL KW	24,0

Wiring Diagram Panel Listrik Kamar Operasi (PP.OT / Operating Theater)



Wiring Diagram Panel Listrik Utama Gedung Medik Rumah Sakit, Dengan Coupler Pemisah Beban Normal dan Beban Emergency Kebakaran

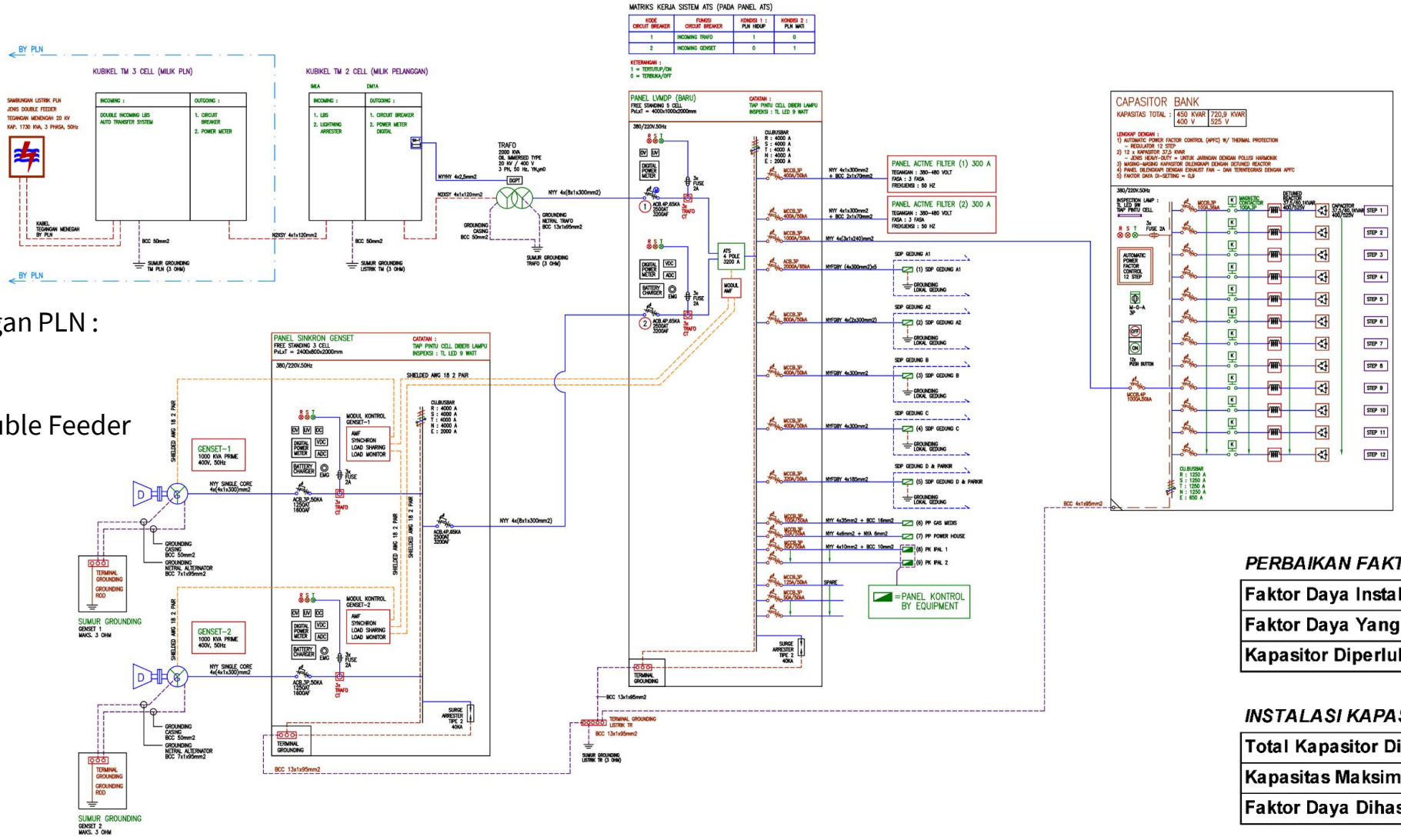


SKEDUL BEBAN SDP GEDUNG

NO	PANEL / FUNGSI	LOKASI	BEBAN TERSAMBUNG					FK %	BEBAN NORMAL					BEBAN EMERGENCY (KEBAKARAN)				
			(KVA)	(KW)	R	S	T		(KVA)	(KW)	R	S	T	(KVA)	(KW)	R	S	T
1	SDP LIFT & PRESS FAN	LT. MESIN LIFT	229.4	195.0	347.6	347.6	347.6	0.28	63.5	54.0	96.3	96.3	96.3	187.1	159.0	283.4	283.4	283.4
2	PP ELEKTRONIK	LANTAI 1	10.1	8.6	14.7	18.4	12.6	0.5	5.0	4.3	7.4	9.2	6.3	-	-	-	-	-
3	SDP GEDUNG PARKIR	LANTAI 1	8.3	7.5	12.6	10.6	14.3	0.7	5.8	5.3	8.8	7.5	10.0	-	-	-	-	-
4	LP.OL	LANTAI 1	2.0	1.9	2.4	2.6	3.9	0.5	1.0	0.9	1.2	1.3	2.0	-	-	-	-	-
5	PP 1	LANTAI 1	40.8	35.7	58.6	66.5	60.2	0.5	20.4	17.9	29.3	33.3	30.1	-	-	-	-	-
6	PPAC 1	LANTAI 1	7.9	6.7	10.7	12.5	12.6	0.5	3.9	3.3	5.3	6.2	6.3	-	-	-	-	-
7	PP RADIOLOGI	LANTAI 1	250.0	200.0	378.8	378.8	378.8	0.4	100.0	80.0	151.5	151.5	151.5	-	-	-	-	-
8	PP IGD	LANTAI 1	8.3	7.1	13.6	11.9	12.3	0.5	4.2	3.6	6.8	5.9	6.2	-	-	-	-	-
9	PP OK CITO (TAHAP SELANJUTNYA)	LANTAI 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-
10	PK AC OK CITO (6PK) (TAHAP SELANJUTNYA)	LANTAI 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-
11	PK SUMPIT AIR LIMBAH 1	LANTAI 1	2.4	2.0	3.6	3.6	3.6	0.5	1.2	1.0	1.8	1.8	1.8	-	-	-	-	-
12	PK SUMPIT AIR LIMBAH 2	LANTAI 1	7.1	6.0	10.7	10.7	10.7	0.5	3.5	3.0	5.3	5.3	5.3	-	-	-	-	-
13	PK SUMPIT AIR LIMBAH 3	LANTAI 1	2.4	2.0	3.6	3.6	3.6	0.5	1.2	1.0	1.8	1.8	1.8	-	-	-	-	-
14	PK POMPA LONG STORAGE	LANTAI 1	9.4	8.0	14.3	14.3	14.3	0.5	4.7	4.0	7.1	7.1	7.1	-	-	-	-	-
15	PP 2	LANTAI 2	31.8	27.9	46.9	48.7	49.1	0.5	15.9	13.9	23.4	24.4	24.6	-	-	-	-	-
16	PPAC 2	LANTAI 2	10.1	8.6	14.7	14.8	16.2	0.5	5.0	4.3	7.4	7.4	8.1	-	-	-	-	-
17	PP LAB	LANTAI 2	11.4	9.7	16.6	17.1	18.2	0.5	5.7	4.9	8.3	8.6	9.1	-	-	-	-	-
18	PP 3	LANTAI 3	49.0	42.5	71.4	77.2	74.0	0.5	24.5	21.2	35.7	38.6	37.0	-	-	-	-	-
19	PPAC 3	LANTAI 3	11.7	9.9	17.5	18.5	17.1	0.5	5.8	5.0	8.7	9.2	8.5	-	-	-	-	-
20	PP HD	LANTAI 3	28.2	24.0	42.8	42.8	42.8	0.5	14.1	12.0	21.4	21.4	21.4	-	-	-	-	-
21	LP 4	LANTAI 4	9.0	8.5	11.4	17.8	11.9	0.5	4.5	4.3	5.7	8.9	6.0	-	-	-	-	-
22	PP.4.1	LANTAI 4	9.1	7.7	11.2	15.0	15.0	0.5	4.5	3.9	5.6	7.5	7.5	-	-	-	-	-
23	PP.4.2	LANTAI 4	10.4	8.8	15.5	16.6	15.0	0.5	5.2	4.4	7.8	8.3	7.5	-	-	-	-	-
24	PPAC 4	LANTAI 4	284.7	242.0	429.0	431.9	433.1	0.5	142.3	121.0	214.5	215.9	216.6	-	-	-	-	-
25	PP VK	LANTAI 4	5.2	5.2	-	-	23.8	0.5	2.6	2.6	-	-	11.9	-	-	-	-	-
26	SDP CLEAN ROOM LANTAI 4	LANTAI 4	333.1	267.8	538.6	486.1	489.3	0.5	166.5	133.9	269.3	243.1	244.7	-	-	-	-	-
27	PP 4A	LANTAI 4A	8.0	7.1	11.5	14.5	10.5	0.5	4.0	3.6	5.7	7.3	5.2	-	-	-	-	-
28	PPAC 4A	LANTAI 4A	2.2	1.8	3.1	3.5	3.1	0.5	1.1	0.9	1.6	1.8	1.6	-	-	-	-	-
29	PP CSSD	LANTAI 4A	66.5	53.2	98.6	104.3	99.2	0.5	33.2	26.6	49.3	52.1	49.6	-	-	-	-	-
30	PK AC GUDANG STERIL (8PK)	LANTAI 4A	32.8	27.9	49.7	49.7	49.7	0.5	16.4	14.0	24.9	24.9	24.9	-	-	-	-	-
31	SDP MESIN LIFT	LT.MESIN LIFT	46.0	39.1	66.4	70.9	71.7	0.5	23.0	19.5	33.2	35.4	35.8	-	-	-	-	-
			1526.9 KVA	1272.0 KW	2315.8 A	2310.6 A	2314.0 A		688.9 KVA	574.0 KW	1045.0 A	1042.0 A	1044.5 A	187.1 KVA	159.0 KW	283.4 A	283.4 A	283.4 A

TOTAL BEBAN LISTRIK NORMAL		*TOTAL BEBAN LISTRIK EMERGENCY*	
TOTAL KVA	688.9	TOTAL KVA	187.1
TOTAL KW	574.0	TOTAL KW	159.0

Wiring Diagram Panel Listrik Utama Tegangan Rendah, Sistem ATS-AMF, Panel Sinkron Genset, dan Kapasitor Bank



Sambungan PLN :

1730 KVA

Jenis Double Feeder

Kapasitor Bank :

Aktif Maks. 450 KVAR

Kapasitas Total : 550 KVAR

PERBAIKAN FAKTOR DAYA

Faktor Daya Instalasi	0,79
Faktor Daya Yang Diinginkan (Dikondisikan)	0,90
Kapasitor Diperlukan (kVAR)	434,4

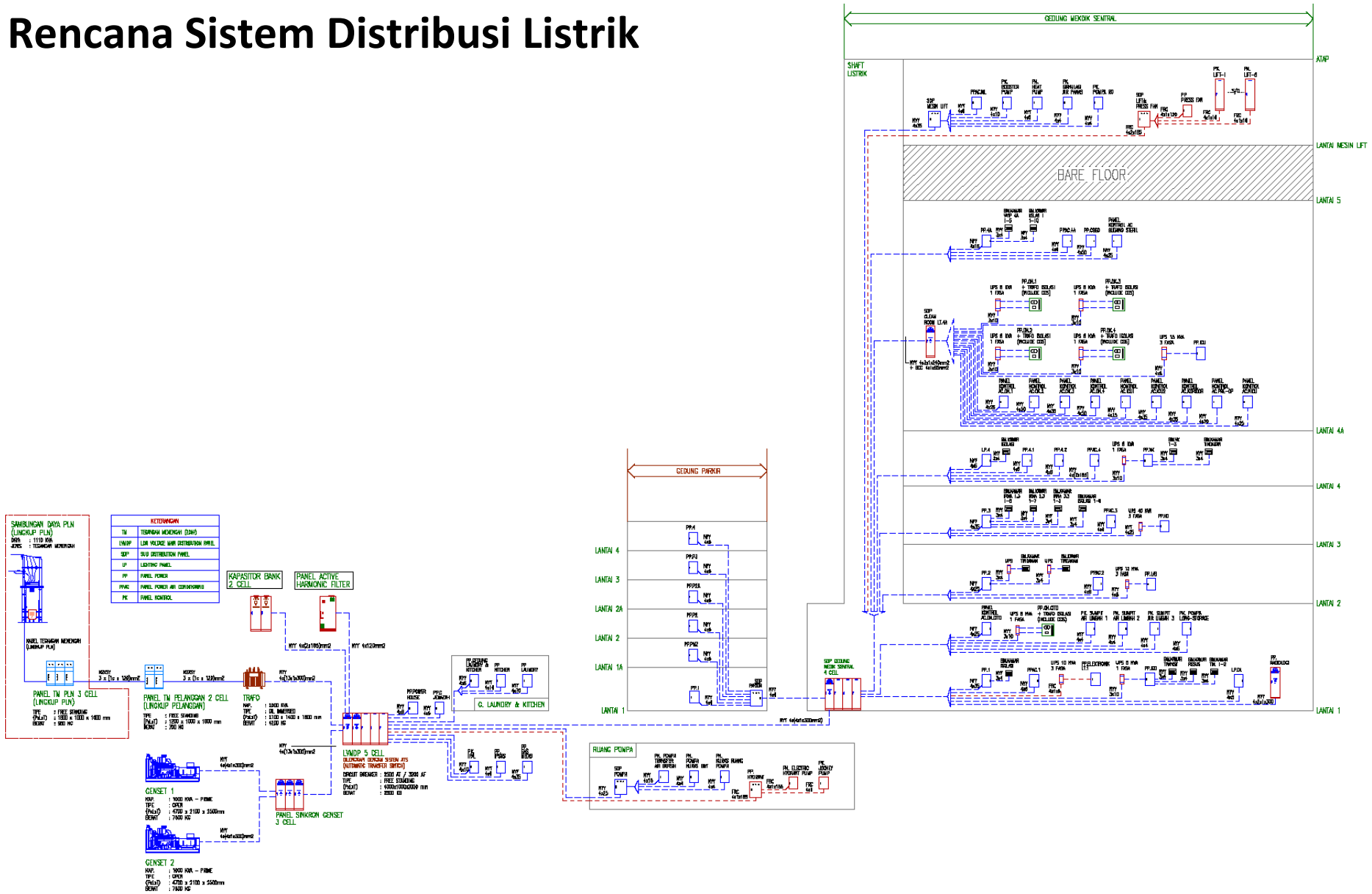
INSTALASI KAPASITOR BANK

Total Kapasitor Dipasang (kVAR)	550,0
Kapasitas Maksimal Yang Diaktifkan (kVAR)	450,0
Faktor Daya Dihasilkan	0,90

9

Diagram Rencana Sistem Distribusi Listrik

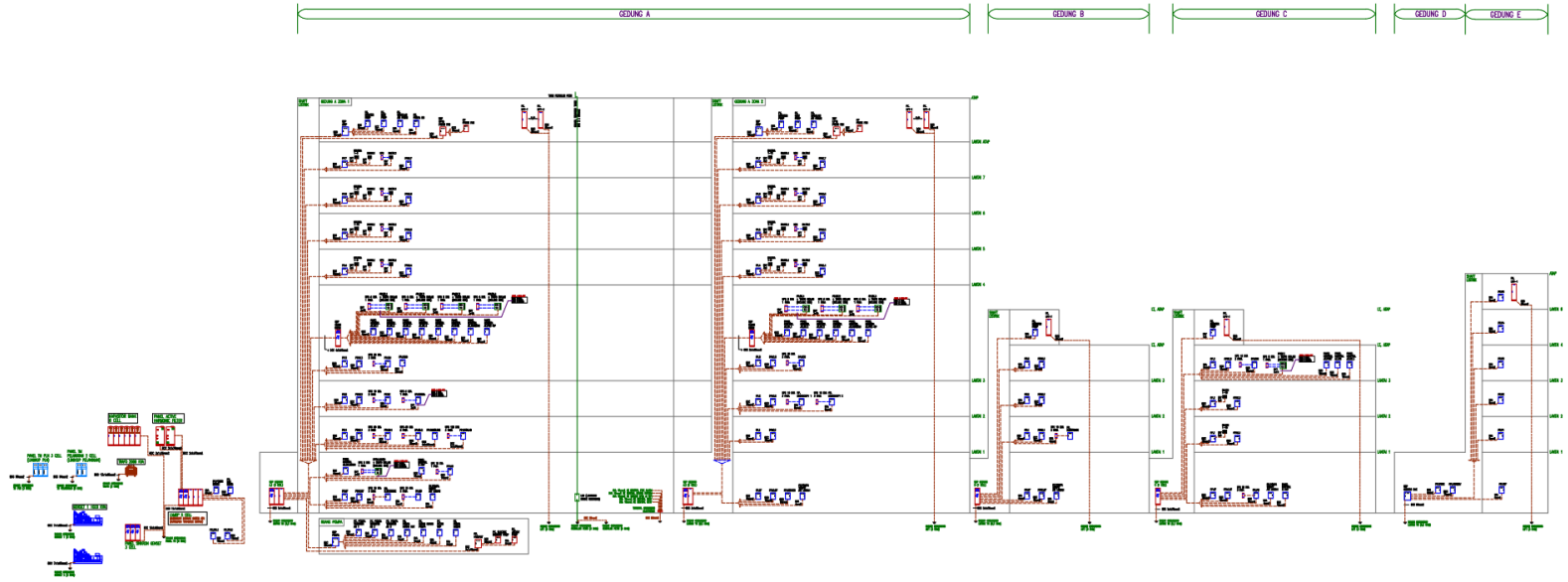
Diagram Rencana Sistem Distribusi Listrik



10

Sistem Grounding

Diagram Rencana Sistem Grounding



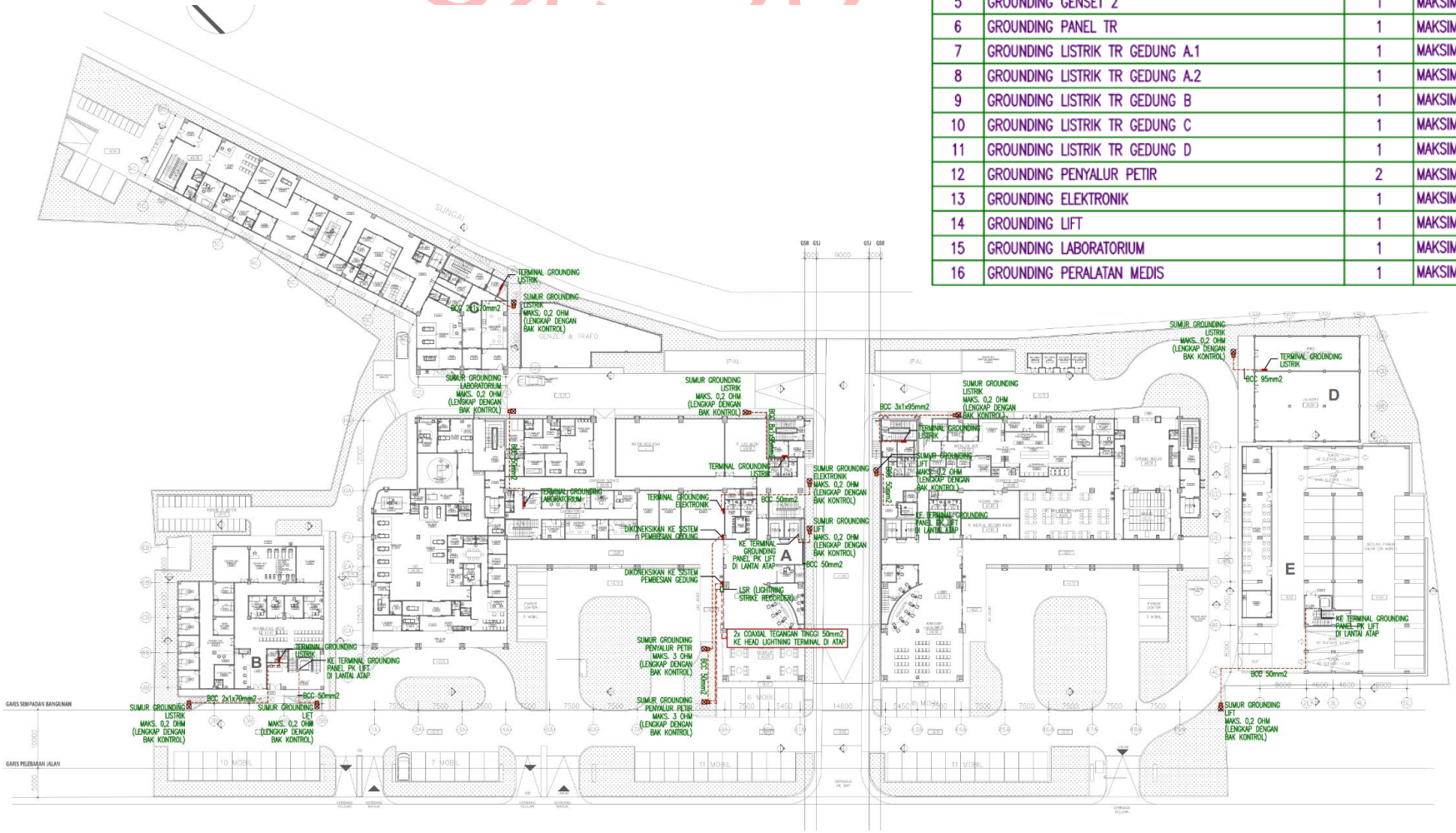
Daftar Sumur Grounding :

NO	NAMA PERALATAN	QTY	SPESIFIKASI
1	GROUNDING PANEL TM PLN	1	MAKSIMUM 3 OHM
2	GROUNDING PANEL TM PELANGGAN	1	MAKSIMUM 3 OHM
3	GROUNDING TARFO	1	MAKSIMUM 3 OHM
4	GROUNDING GENSET 1	1	MAKSIMUM 3 OHM
5	GROUNDING GENSET 2	1	MAKSIMUM 3 OHM
6	GROUNDING PANEL TR	1	MAKSIMUM 3 OHM
7	GROUNDING LISTRIK TR GEDUNG A.1	1	MAKSIMUM 0,2 OHM
8	GROUNDING LISTRIK TR GEDUNG A.2	1	MAKSIMUM 0,2 OHM
9	GROUNDING LISTRIK TR GEDUNG B	1	MAKSIMUM 0,2 OHM
10	GROUNDING LISTRIK TR GEDUNG C	1	MAKSIMUM 0,2 OHM
11	GROUNDING LISTRIK TR GEDUNG D	1	MAKSIMUM 0,2 OHM
12	GROUNDING PENYALUR PETIR	2	MAKSIMUM 3 OHM
13	GROUNDING ELEKTRONIK	1	MAKSIMUM 0,2 OHM
14	GROUNDING LIFT	1	MAKSIMUM 0,2 OHM
15	GROUNDING LABORATORIUM	1	MAKSIMUM 0,2 OHM
16	GROUNDING PERALATAN MEDIS	1	MAKSIMUM 0,2 OHM

Rencana Instalasi Sumur Grounding

Daftar Sumur Grounding :

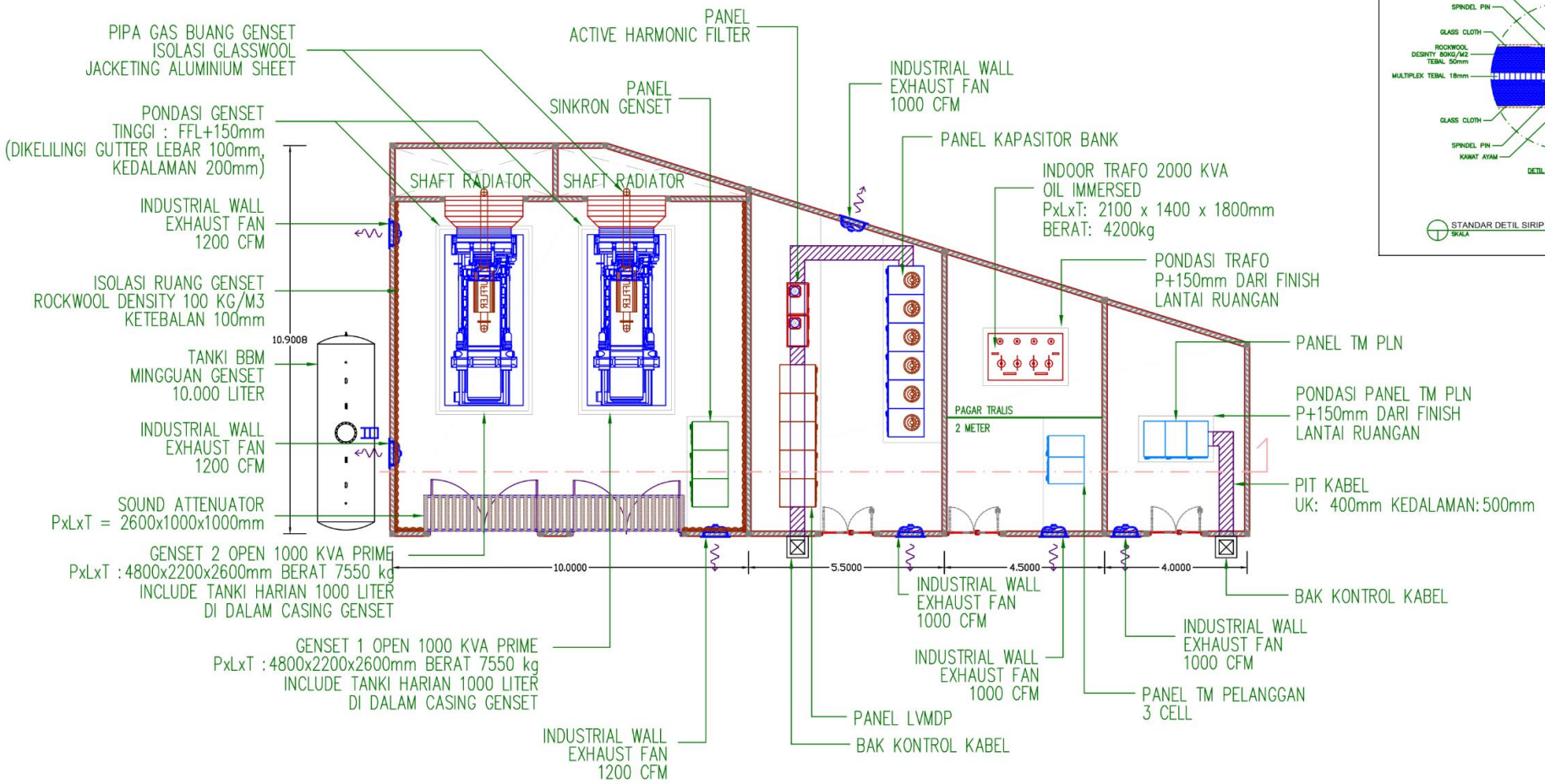
NO	NAMA PERALATAN	QTY	SPESIFIKASI
1	GROUNDING PANEL TM PLN	1	MAKSIMUM 3 OHM
2	GROUNDING PANEL TM PELANGGAN	1	MAKSIMUM 3 OHM
3	GROUNDING TARFO	1	MAKSIMUM 3 OHM
4	GROUNDING GENSET 1	1	MAKSIMUM 3 OHM
5	GROUNDING GENSET 2	1	MAKSIMUM 3 OHM
6	GROUNDING PANEL TR	1	MAKSIMUM 3 OHM
7	GROUNDING LISTRIK TR GEDUNG A.1	1	MAKSIMUM 0,2 OHM
8	GROUNDING LISTRIK TR GEDUNG A.2	1	MAKSIMUM 0,2 OHM
9	GROUNDING LISTRIK TR GEDUNG B	1	MAKSIMUM 0,2 OHM
10	GROUNDING LISTRIK TR GEDUNG C	1	MAKSIMUM 0,2 OHM
11	GROUNDING LISTRIK TR GEDUNG D	1	MAKSIMUM 0,2 OHM
12	GROUNDING PENYALUR PETIR	2	MAKSIMUM 3 OHM
13	GROUNDING ELEKTRONIK	1	MAKSIMUM 0,2 OHM
14	GROUNDING LIFT	1	MAKSIMUM 0,2 OHM
15	GROUNDING LABORATORIUM	1	MAKSIMUM 0,2 OHM
16	GROUNDING PERALATAN MEDIS	1	MAKSIMUM 0,2 OHM



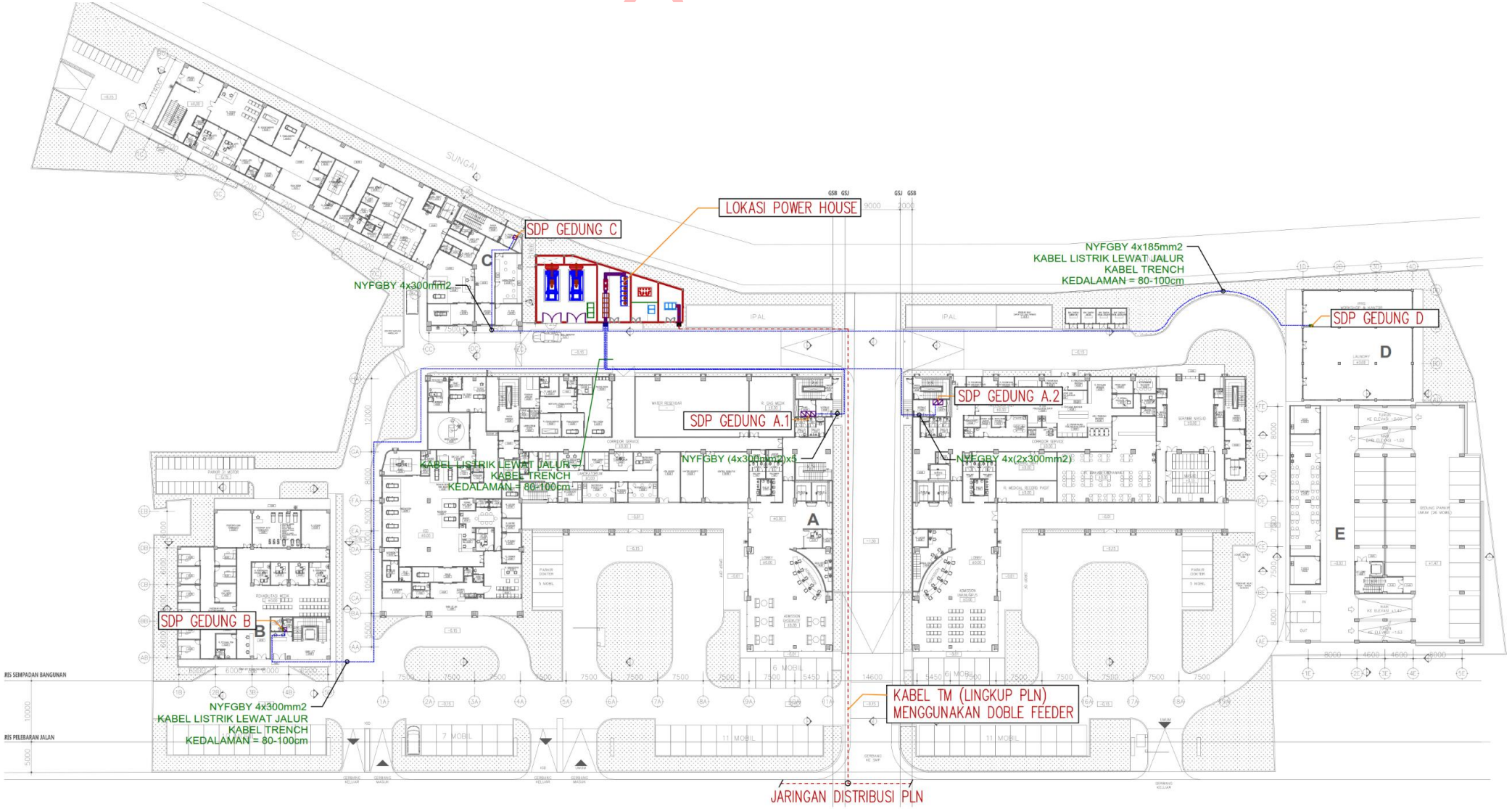
11

Denah Rencana Power House

Denah Rencana Power House



Denah Lokasi Power House Pada Siteplan Rumah Sakit



12

Building Management System (BMS)

Building Management System (BMS) Untuk Menunjang Smart Hospital

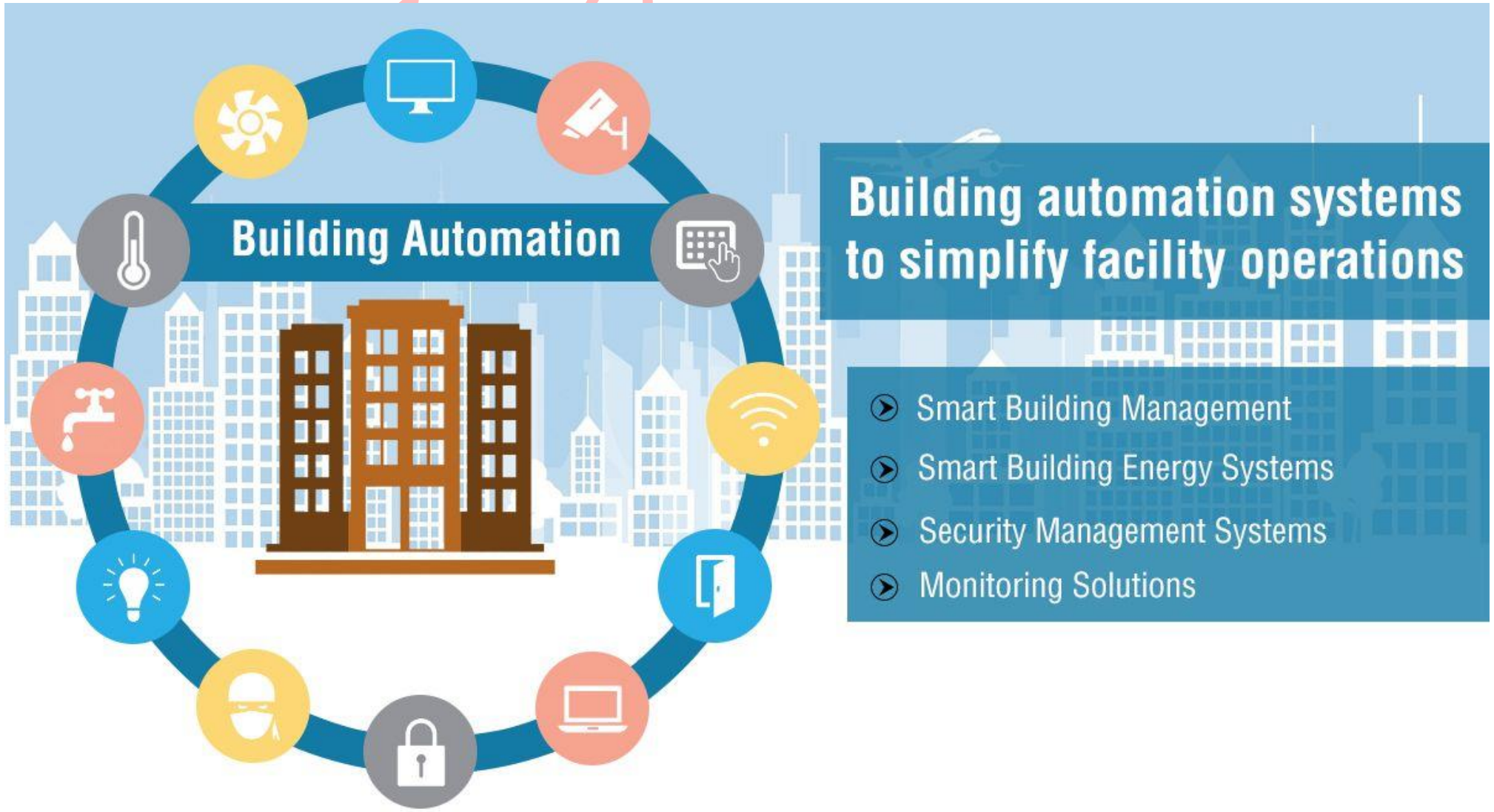


Diagram Skematik Building Management System (BMS)

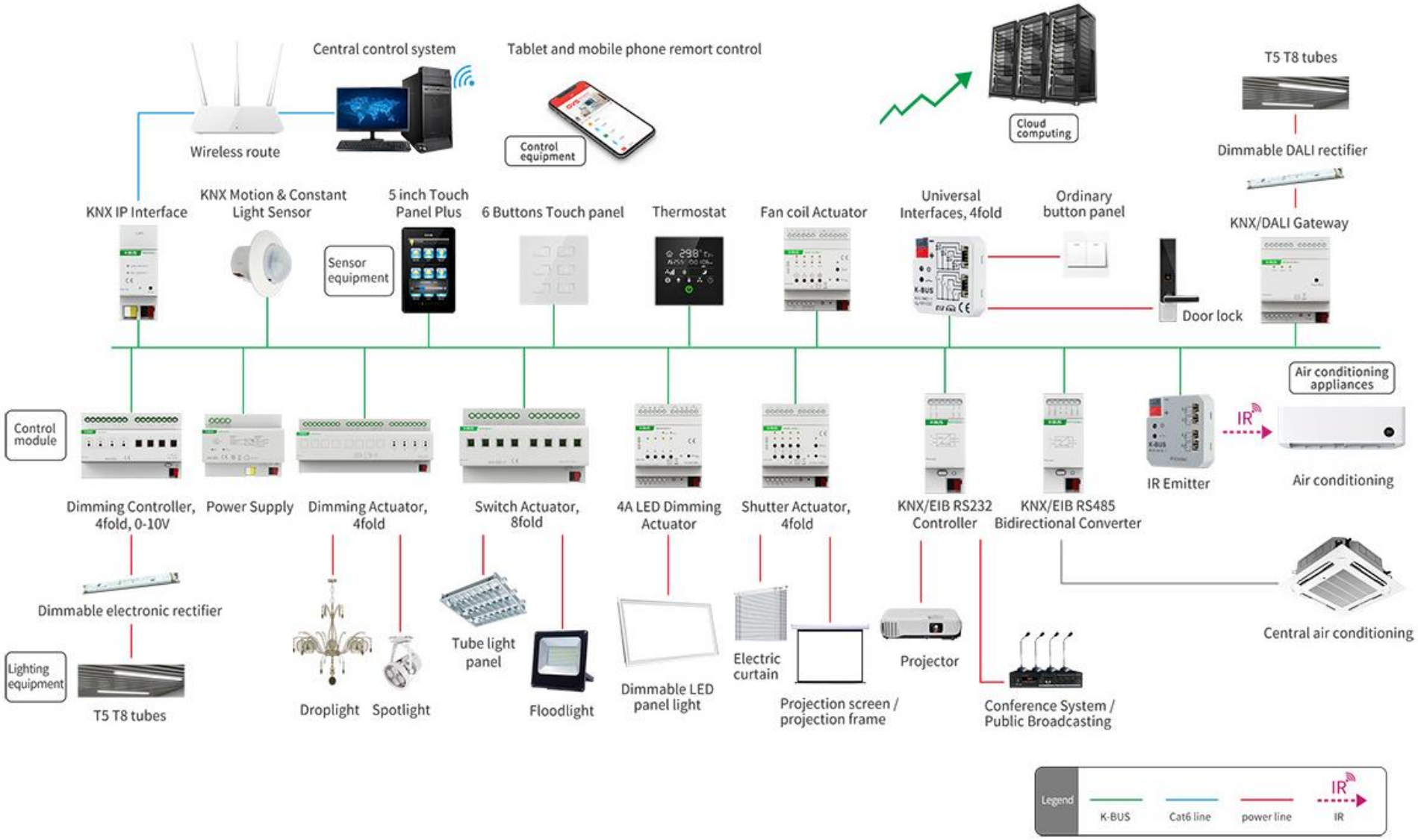


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Foto Dokumentasi

Foto Pemasangan Peralatan Distribusi Listrik

Foto Pemasangan Peralatan Distribusi Listrik

CONCLUSION

Dalam perancangan sistem kelistrikan rumah sakit, beberapa hal penting yang harus diperhatikan, yakni : klasifikasi beban listrik, perhitungan beban listrik, jatuh/drop tegangan kabel distribusi, dan perhitungan arus hubung singkat.

Hal tersebut diperlukan agar keamanan dan keselamatan listrik di rumah sakit terpenuhi.

Thank You