ELECTRICAL ENGINEERING

REHABILITATION OF THE SAUDI MATERNITY HOSPITAL

KASSALA HEALTH CITADEL, SUDAN

DETAILED DESIGN

ampc International Health Consultants

jfa engenharia

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LIST OF WRITTEN DOCUMENTS

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LIST OF WRITTEN DOCUMENTS

REFERENCE / NUMBER	DESCRIPTION
ELE.01.COV.001	Cover
ELE.02.LOW.001	List of Written Documents
ELE.03.CAL.001	Calculations
ELE.05.MEM.001	Descriptive Memory
ELE.12.TCS.001	Technical specifications
ELE.13.LOD.001	List of Drawings

ELECTRICAL SIZING, PROTECTION AND CALCULATIONS - IEC 60364-5-52

CIRCUIT					WIRING / CONDUCTOR / CABLE																		POWER DEMAND							OVERLOAD CURRENT PROTECTION																		
Origin / Switchboard	Switchboard name (originating)	Switchboard name (destination) name of the circuit	Observations	Electric circuit name	Electrical Wiring (Cables or Busbar Trunking Systems)																	Installation Method (Reference)	Electrical Wiring Composition	Surface	P Active power	Cos Phi Power factor	S Apparent power	Ib Design current	Factors Diversity & Utilization	Ir' Rated power Apparent	Ib' Design current	Protective Devices Circuit-breaker (B) or Fuse (F)	Time/Current Characteristics Fuse (gG) or Circuit-breaker Magnetic+Thermal (B, C, D) and Electronic (E)	In Current setting	reg. adjustment	Ir rated current	Iz Courant de fonctionnement	1,45 Ir'	Iz Courant-carrying capacity		Ir'	Requirements Ib'<=In<=Iz	Requirements Iz<=1,45 Iz
					Copper (Cu) or Aluminium (Al)	thermoplastic PVC (V) or thermosetting (X)	Single-core (S) or Multi-core (M)	Three-phase (3) / Single-phase (1)	in Air (A) or Buried (E)																																				
																							[m²]	[kW]	-	[kVA]	[A]	Ks (diversity/coincidence factor) or Ku (utilisation factor)	[kVA]	[A]			[A]	-	[A]	[A]	[A]	BS 7671:2015 Table	[A]	[A]	BS 7671	BS 7671
Transformer Station MT 11kV	Transformateur 500kVA	Transformer Parallel Switchboard		MT01	Al	X	S	3	A	3	FR-N1 X1G1	3	x	240	+	1	x	240	F1	AIXS3-240	-	-	-	500	695.6	1	**500**	695.6	B	E	**800**	**0.90**	720	936	1639	B.52.13	1413	1130	True	True
	Transformateur 500kVA - N+1	Transformer Parallel Switchboard		MT02	Al	X	S	3	A	3	FR-N1 X1G1	3	x	240	+	1	x	240	F1	AIXS3-240	-	-	-	500	695.6	1	**500**	695.6	B	E	**800**	**0.90**	720	936	1639	B.52.13	1413	1130	True	True
	Transformer Parallel Switchboard	LTS (N)			Al	X	S	3	E	3	FR-N1 X1G1	3	x	240	+	1	x	240	D2	AIXS3-240	-	-	-	500	695.6	1	**500**	695.6	B	E	**800**	**0.90**	720	936	1489	B.52.5	870	1027	True	True
LTS (N)	LTS (N)	MLVS (N)		F01	Al	X	S	3	A	3	FR-N1 X1G1	3	x	240	+	1	x	240	F1	AIXS3-240	-	-	-	500	695.6	1	**500**	695.6	B	E	**800**	**0.90**	720	936	2049	B.52.13	1413	1413	True	True
	LTS (N)	S.Fire Pump (S)	Safety Services / Hydraulics	F02	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	16	+	2	G	16	E	CuXM3-16	-	6.3	0.80	7.8	10.9	1	**8**	10.9	B	C	**25**	**1.00**	25	36	145	B.52.12	100	100	True	True
Generators	Groupe Electrogène 450kVA	Generator Parallel Switchboard	450kVA ESP	F01	Cu	X	S	3	A	3	FR-N1 X1G1	3	x	185	+	1	x	185	D2	CuXS3-185	-	-	-	450	626.0	1	**450**	626.0	B	E	**800**	**0.80**	640	832	1409	B.52.5	972	972	True	True
	Groupe Electrogène 450kVA - N+1	Generator Parallel Switchboard	450kVA ESP	F02	Cu	X	S	3	A	3	FR-N1 X1G1	3	x	185	+	1	x	185	D2	CuXS3-185	-	-	-	450	626.0	1	**450**	626.0	B	E	**800**	**0.80**	640	832	1409	B.52.5	972	972	True	True
	Generator Parallel Switchboard	LTS (E)			Cu	X	S	3	A	3	FR-N1 X1G1	3	x	185	+	1	x	185	F1	CuXS3-185	-	-	-	450	626.0	1	**450**	626.0	B	E	**800**	**0.80**	640	832	2219	B.52.12	1530	1530	True	True
LTS (E)	LTS (E)	MLVS (E)		F01	Cu	X	S	3	A	3	FR-N1 X1G1	3	x	185	+	1	x	185	F1	CuXS3-185	-	-	-	500	695.6	1	**450**	626.0	B	E	**800**	**0.85**	680	884	2219	B.52.12	1530	1530	True	True
MLVS (N)	MLVS (N)	S.A.0 (E)		F01	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	50	+	2	G	25	E	CuXM3-50	-	-	-	63.7	88.6	0.7	**45**	62.1	B	E	**100**	**1.00**	100	130	159	B.52.12	192	109	True	True
	MLVS (N)	S.D.0 (E)		F02	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	70	+	2	G	35	E	CuXM3-70	-	-	-	73.0	101.5	0.9	**66**	91.4	B	E	**125**	**1.00**	125	163	203	B.52.12	246	140	True	True
	MLVS (N)	S.E.0 (E)		F03	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	95	+	2	G	50	E	CuXM3-95	-	-	-	99.4	138.3	0.7	**70**	96.8	B	E	**160**	**1.00**	160	208	246	B.52.12	298	170	True	True
	MLVS (N)	S.F.0 (E)		F04	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	6	+	2	G	6	E	CuXM3-6	157	-	-	7.9	10.9	1	**8**	10.9	B	C	**25**	**1.00**	25	36	45	B.52.12	54	31	True	True
	MLVS (N)	S.G.0 (E)		F05	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	10	+	2	G	10	E	CuXM3-10	-	-	-	21.2	29.5	0.9	**19**	26.5	B	C	**40**	**1.00**	40	58	62	B.52.12	75	43	True	True
	MLVS (N)	S.H.0 (E)		F06	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	25	+	2	G	16	E	CuXM3-25	-	-	-	28.2	39.2	1	**28**	39.2	B	B	**50**	**1.00**	50	73	105	B.52.12	127	72	True	True
	MLVS (N)	S.J.0 (E)		F07	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	50	+	2	G	25	E	CuXM3-50	-	-	-	61.3	85.3	0.7	**43**	59.7	B	E	**100**	**1.00**	100	130	159	B.52.12	192	109	True	True
	MLVS (N)	S.L.0.1 (E)		F08	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	35	+	2	G	16	E	CuXM3-35	-	-	-	36.9	51.3	1	**37**	51.3	B	B	**63**	**1.00**	63	91	131	B.52.12	158	90	True	True
S.A.0 (E)	S.A.0 (E)	S.A.1 (E)		F01	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	6	+	2	G	6	E	CuXM3-6	226	-	-	**9.0**	12.6	1	**9**	12.6	B	B	**25**	**1.00**	25	36	48	B.52.12	54	33	True	True
	S.A.0 (E)	S.A.2 (E)		F02	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	6	+	2	G	6	E	CuXM3-6	230	-	-	**9.2**	12.8	1	**9**	12.8	B	C	**25**	**1.00**	25	36	48	B.52.12	54	33	True	True
	S.A.0 (E)	S.A.3 (E)		F03	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	6	+	2	G	6	E	CuXM3-6	55	-	-	**2.2**	3.1	1	**2**	3.1	B	C	**20**	**1.00**	20	29	48	B.52.12	54	33	True	True
	S.A.0 (E)	S.A.4 (E)		F04	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	6	+	2	G	6	E	CuXM3-6	87	-	-	**3.5**	4.8	1	**3**	4.8	B	B	**20**	**1.00**	20	29	48	B.52.12	54	33	True	True
	MLVS (N)	S.B.0 (E)		F05	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	6	+	2	G	6	E	CuXM3-6	128	-	-	**6.4**	8.9	1	**6**	8.9	B	C	**20**	**1.00**	20	29	45	B.52.12	54	31	True	True
	S.A.0 (E)	S.C.Datacenter (E)		F06	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	25	+	2	G	16	E	CuXM3-25	20	-	-	**25.0**	34.8	1	**25**	34.8	B	B	**50**	**1.00**	50	73	112	B.52.12	127	77	True	True
	S.A.0 (E)	S.C.Security (E)		F07	Cu	X	M	1	A	1	FR-N1 X1G1	1	x	6	+	2	G	6	E	CuXM1-6	10	-	-	**0.4**	1.7	1	**0**	1.7	B	B	**25**	**1.00**	25	36	56	B.52.12	63	38	True	True
	S.A.0 (E)	Puissance Interne																					200			**8.0**		1	**8**											
S.D.0 (E)	S.D.0 (E)	S.D.1 (E)		F01	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	10	+	2	G	10	E	CuXM3-10	446	-	-	**22.3**	31.0	1	**22**	31.0	B	C	**40**	**1.00**	40	58	66	B.52.12	75	46	True	True
	S.D.0 (E)	S.K.1 (E)	Toilets	F02	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	6	+	2	G	6	E	CuXM3-6	230	-	-	**4.6**	6.4	1	**5**	6.4	B	B	**20**	**1.00**	20	29	48	B.52.12	54	33	True	True
	S.D.0 (E)	S.K.2 (E)	Cafeteria bar / Kitchen	F03	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	10	+	2	G	10	E	CuXM3-10	253	-	-	**15.2**	21.1	1	**15**	21.1	B	B	**32**	**1.00**	32	46	66	B.52.12	75	46	True	True
	S.D.0 (E)	Puissance Interne																					618			**30.9**		1	**31**											
S.E.0 (E)	S.E.0 (E)	S.OT.1 (IT) - UPS	Medical IT	F01	Cu	X	M	1	A	1	FR-N1 X1G1	1	x	16	+	2	G	16	E	CuXM1-16	-	-	-	**10.0**	41.7	1	**10**	41.7	B	C	**50**	**1.00**	50	73	107	B.52.12	115	74	True	True
	S.E.0 (E)	S.OT.2 (IT) - UPS	Medical IT	F02	Cu	X	M	1	A	1	FR-N1 X1G1	1	x	16	+	2	G	16	E	CuXM1-16	-	-	-	**10.0**	41.7	1	**10**	41.7	B	C	**50**	**1.00**	50	73	107	B.52.12	115	74	True	True
	S.E.0 (E)	S.OT.3 (IT) - UPS	Medical IT	F03	Cu	X	M	1	A	1	FR-N1 X1G1	1	x	16	+	2	G	16	E	CuXM1-16	-	-	-	**10.0**	41.7	1	**10**	41.7	B	C	**50**	**1.00**	50	73	107	B.52.12	115	74	True	True
	S.E.0 (E)	S.OT.4 (IT) - UPS	Medical IT	F04	Cu	X	M	1	A	1	FR-N1 X1G1	1	x	16	+	2	G	16	E	CuXM1-16	-	-	-	**10.0**	41.7	1	**10**	41.7	B	C	**50**	**1.00**	50	73	107	B.52.12	115	74	True	True
	S.E.0 (E)	S.PR (IT) - UPS	Medical IT	F05	Cu	X	M	1	A	1	FR-N1 X1G1	1	x	16	+	2	G	16	E	CuXM1-16	-	-	-	**10.0**	41.7	1	**10**	41.7	B	C	**50**	**1.00**	50	73	107	B.52.12	115	74	True	True
	S.E.0 (E)	S.E.1 (E)		F06	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	10	+	2	G	10	E	CuXM3-10	153	-	-	**9.2**	12.8	1	**9**	12.8	B	C	**25**	**1.00**	25	36	66	B.52.12	75	46	True	True
	S.E.0 (E)	S.VAC (E)		F07	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	16	+	2	G	16	E	CuXM3-16	-	25.0	0.90	**27.8**	38.6	1	**28**	38.6	B	C	**50**	**1.00**	50	73	88	B.52.12	100	61	True	True
	S.E.0 (E)	Puissance Interne																					207			**12.4**		1	**12**											
S.G.0 (E)	S.G.0 (E)	S.W.P.2 (E)	Hydraulics	F01	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	4	+	2	G	4	E	CuXM3-4	-	2.0	0.80	**2.5**	3.5	1	**3**	3.5	B	C	**20**	**1.00**	20	29	37	B.52.12	42	26	True	True
	S.G.0 (E)	S.W.S.1 (E)	Hydraulics	F02	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	4	+	2	G	4	E	CuXM3-4	-	9.0	0.80	**11.3**	15.7	1	**11**	15.7	B	C	**25**	**1.00**	25	36	37	B.52.12	42	26	True	True
	S.G.0 (E)	S.W.T. (E)	Hydraulics	F03	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	4	+	2	G	4	E	CuXM3-4	-	3.4	0.80	**4.3**	5.9	1	**4**	5.9	B	C	**20**	**1.00**	20	29	37	B.52.12	42	26	True	True
	S.G.0 (E)	Puissance Interne																					160			**3.2**		1	**3**											
S.H.0 (E)	S.H.0 (E)	S.H.1 (E)		F01	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	4	+	2	G	4	E	CuXM3-4	260	-	-	**13.0**	18.1	1	**13**	18.1	B	B	**25**	**1.00**	25	36	49	B.52.12	42	34	True	True
	S.H.0 (E)	Puissance Interne																					303			**15.2**		1	**15**											
S.J.0 (E)	S.J.0 (E)	S.J.1 (E)		F01	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	4	+	2	G	4	E	CuXM3-4	77	-	-	**3.9**	5.4	1	**4**	5.4	B	C	**20**	**1.00**	20	29	37	B.52.12	42	26	True	True
	S.J.0 (E)	S.J.2 (E)		F02	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	4	+	2	G	4	E	CuXM3-4	127	-	-	**6.4**	8.8	1	**6**	8.8	B	B	**20**	**1.00**	20	29	37	B.52.12	42	26	True	True
	S.J.0 (E)	S.J.3 (E)		F03	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	6	+	2	G	6	E	CuXM3-6	108	-	-	**6.5**	9.0	1	**6**	9.0	B	B	**20**	**1.00**	20	29	48	B.52.12	54	33	True	True
	S.J.0 (E)	S.J.4 (E)	Body Storage	F04	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	4	+	2	G	4	E	CuXM3-4	28	-	-	**1.4**	1.9	1	**1**	1.9	B	C	**20**	**1.00**	20	29	37	B.52.12	42	26	True	True
	S.J.0 (E)	S.J.5 (E)		F05	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	4	+	2	G	4	E	CuXM3-4	49	-	-	**2.5**	3.4	1	**2**	3.4	B	B	**20**	**1.00**	20	29	37	B.52.12	42	26	True	True
	S.J.0 (E)	S.J.ICU (IT) - UPS	Medical IT	F06	Cu	X	M	1	A	1	FR-N1 X1G1	1	x	16	+	2	G	16	E	CuXM1-16	-	-	-	**10.0**	41.7	1	**10**	41.7	B	C	**50**	**1.00**	50	73	107	B.52.12	115	74	True	True
	S.J.0 (E)	S.W.P.1 (E)	Hydraulics	F07	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	16	+	2	G	16	E	CuXM3-16	-	20.0	0.80	**25.0**	34.8	1	**25**	34.8	B	C	**50**	**1.00**	50	73	83	B.52.12	100	57	True	True
	S.J.0 (E)	Puissance Interne																					288			**5.8**		1	**6**											
S.L.0.1 (E)	S.L.0.1 (E)	S.L.0.2 (E)		F01	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	6	+	2	G	6	E	CuXM3-6	-	-	-	**16.6**	23.0	1	**17**	23.0	B	C	**25**	**1.00**	25	36	48	B.52.12	54	33	True	True
	S.L.0.1 (E)	S.L.1.1 (E)		F02	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	4	+	2	G	4	E	CuXM3-4	207	-	-	**8.3**	11.5	1	**8**	11.5	B	C	**20**	**1.00**	20	29	37	B.52.12	42	26	True	True
	S.L.0.1 (E)	S.I.0 (E)		F03	Cu	X	M	1	A	1	FR-N1 X1G1	1	x	4	+	2	G	4	E	CuXM1-4	188	-	-	**3.8**	15.7	1	**4**	15.7	B	B	**20**	**1.00**	20	29	43	B.52.12	49	30	True	True
	S.L.0.1 (E)	Puissance Interne																					207			**8.3**		1	**8**											
S.L.0.2 (E)	S.L.0.2 (E)	S.L.1.2 (E)		F01	Cu	X	M	3	A	1	FR-N1 X1G1	3	x	4	+	2	G	4	E	CuXM3-4	207	-	-	**8.3**	11.5	1	**8**	11.5	B	C	**25**	**1.00**	25	36	49	B.52.12	42	34	True	True
	S.L.0.2 (E)	Puissance Interne																					207			**8.3**		1	**8**											

						SHORT-CIRCUIT CURRENT FROM THE ORIGIN - (IMPEDANCE METHOD)															PROTECTIVE DEVICES OPERATING TIME / CONDUCTOR THERMAL FATIGUE								PROTECTIVE DEVICES SETTINGS - REQUIREMENTS FOR FAULT PROTECTION							
L Wiring Length		Δu Circuit Voltage-drop		Δu Total Voltage-drop from the origin		ρ Wiring Resistivity	Rcc Resistance	Xcc Reactance	Rcc Accumulated Value	Xcc Accumulated Value	Zcc Impedance	short-circuit current (Icc) Calculation	short-circuit current (Icc) Rated	Maximum current cut-off time (s)	Icc min 3F network (N)	Icc min 2F network (N)	Icc min FN network (N)	Icc min 3F network GE (E)	Icc min 2F network GE (E)	Icc min FN network GE (E)	Icc min	Thermal Fatigue Permitted (period at Icc max)	Icc min / Ireg (rated current Ir = x In)	Operating Time Fuse (ta)	Operating Time Breaker (ta)	Requirements Operating Time ta ≤ S	Requirements Operating Time ta ≤ tc	Busbar	Protection of People, Livestock and Property Earthing Scheme TN-S System (Icc minimum)							
[m]	[km]	[V]	%	[V]	%	[Ω.mm²/m]	[Ω]	[Ω]	[Ω]	[Ω]	[Ω]	[A]	[kA]	[s]	[kA]	[kA]	[kA]	[kA]	[kA]	[kA]	[kA]	[s]	-	[s]	[s]	-	-	N.° Conductor x Surface [mm]	Trip Type Circuit-breaker Im / In (min)	Trip Type Circuit-breaker Im / In (typical)	Im / In level of the Protective Devices that protect this cable	Im (magnetic tripping) Circuit-Breaker Im = x Ir		L.max (m) maximum length that ensures protection of persons	Requirement L < L max
6	0.006	0.37	0.15%	0.37	**0.15%**	0.0360	0.0003	0.0002	0.0074	0.0223	0.0235	11219	**15kA**	36.39	**10167.81**	**8805.59**	**9957.50**	-	-	-	8805.59	59.1	12.2	Breaker	0.02	**True**	**True**	5x(100x5)	1.5	10.0	**5.0**	5.0	x Ir	533.3	**True**
8	0.008	0.49	0.20%	0.49	**0.20%**	0.0360	0.0004	0.0002	0.0075	0.0224	0.0236	11180	**15kA**	36.64	**10132.42**	**8774.93**	**9854.22**	-	-	-	8774.93	59.5	12.2	Breaker	0.02	**True**	**True**	5x(100x5)	1.5	10.0	**5.0**	5.0	x Ir	533.3	**True**
8	0.008	0.49	0.20%	0.49	**0.20%**	0.0360	0.0004	0.0002	0.0037	0.0112	0.0118	22400	**25kA**	9.13	**20300.32**	**17580.59**	**9854.22**	-	-	-	9854.22	47.2	13.7	Breaker	0.02	**True**	**True**	5x(100x5)	1.5	10.0	**5.0**	5.0	x Ir	533.3	**True**
8	0.008	0.49	0.20%	0.98	**0.41%**	0.0360	0.0004	0.0002	0.0041	0.0114	0.0121	21785	**25kA**	9.65	19742.81	17097.78	9854.22	-	-	-	9854.22	47.2	13.7	Breaker	0.02	**True**	**True**	5x(100x5)	1.5	10.0	**1.5**	1.5	x Ir	1777.8	**True**
18	0.018	0.23	0.10%	0.72	**0.30%**	0.0225	0.0253	0.0014	0.0290	0.0126	0.0317	8341	**10kA**	0.08	7558.77	6546.09	2745.97	-	-	-	2745.97	0.7	109.8	Breaker	0.02	**True**	**True**	5x(12x2)	5.0	10.0	**10.0**	10.0	x Ir	273.1	**True**
8	0.008	0.40	0.17%	0.40	**0.17%**	0.0225	0.0003	0.0002	0.0003	0.1069	0.1069	2472	**6kA**	1031.15	-	-	-	**2239.88**	**1939.80**	**2230.83**	1939.80	1674.0	3.0	Breaker	0.02	**True**	**True**	5x(100x5)	1.5	10.0	**1.5**	1.5	x Ir	1673.8	**True**
11	0.011	0.55	0.23%	0.55	**0.23%**	0.0225	0.0004	0.0003	0.0004	0.1070	0.1070	2470	**6kA**	1032.70	-	-	-	**2238.20**	**1938.34**	**2225.71**	1938.34	1676.5	3.0	Breaker	0.02	**True**	**True**	5x(100x5)	1.5	10.0	**1.5**	1.5	x Ir	1673.8	**True**
8	0.008	0.40	0.17%	0.40	**0.17%**	0.0225	0.0003	0.0002	0.0002	0.0535	0.0535	4941	**6kA**	257.98	-	-	-	**4478.09**	**3878.14**	**2230.83**	2230.83	1265.7	3.5	Breaker	0.02	**True**	**True**	5x(100x5)	1.5	10.0	**1.5**	1.5	x Ir	1673.8	**True**
8	0.008	0.40	0.17%	0.81	**0.34%**	0.0225	0.0003	0.0002	0.0005	0.0537	0.0537	4921	**6kA**	260.07	-	-	-	**4460.11**	**3862.57**	**2230.83**	2230.83	1265.7	3.3	Breaker	0.02	**True**	**True**	5x(100x5)	1.5	10.0	**1.5**	1.5	x Ir	1575.4	**True**
125	0.125	3.16	1.32%	4.14	**1.73%**	0.0225	0.0563	0.0100	0.0604	0.0214	0.0641	4123	**6kA**	3.01	3736.92	3236.26	1006.26	2806.54	2430.53	909.39	909.39	61.8	9.1	Breaker	0.02	**True**	**True**	5x(20x3)	1.5	10.0	**5.0**	5.0	x Ir	284.4	**True**
117	0.117	3.26	1.36%	4.24	**1.77%**	0.0225	0.0376	0.0094	0.0417	0.0208	0.0466	5666	**6kA**	3.12	5135.33	4447.33	1447.66	3249.92	2814.52	1185.42	1185.42	71.3	9.5	Breaker	0.02	**True**	**True**	5x(25x3)	1.5	10.0	**6.0**	6.0	x Ir	265.5	**True**
83	0.083	1.91	0.79%	2.89	**1.20%**	0.0225	0.0197	0.0066	0.0238	0.0180	0.0299	8847	**10kA**	2.36	8018.10	6943.88	2553.09	3764.35	3260.03	1617.65	1617.65	70.5	10.1	Breaker	0.02	**True**	**True**	5x(30x3)	1.5	10.0	**7.0**	7.0	x Ir	249.6	**True**
41	0.041	1.36	0.57%	2.34	**0.98%**	0.0225	0.1538	0.0033	0.1579	0.0147	0.1586	1666	**6kA**	0.27	1509.79	1307.52	509.95	1455.85	1260.80	503.22	503.22	2.9	20.1	Breaker	0.02	**True**	**True**	5x(12x2)	5.0	10.0	**10.0**	10.0	x Ir	102.4	**True**
12	0.012	0.59	0.25%	1.57	**0.65%**	0.0225	0.0270	0.0010	0.0311	0.0124	0.0335	7886	**10kA**	0.03	7146.85	6189.36	2613.15	3913.71	3389.37	1757.19	1757.19	0.7	43.9	Breaker	0.02	**True**	**True**	5x(12x2)	5.0	10.0	**10.0**	10.0	x Ir	106.7	**True**
92	0.092	2.77	1.15%	3.75	**1.56%**	0.0225	0.0828	0.0074	0.0869	0.0188	0.0889	2970	**6kA**	1.45	2691.86	2331.22	784.10	2318.06	2007.50	743.83	743.83	23.1	14.9	Breaker	0.02	**True**	**True**	5x(15x2)	3.0	5.0	**5.0**	5.0	x Ir	333.0	**True**
63	0.063	1.53	0.64%	2.51	**1.05%**	0.0225	0.0284	0.0050	0.0325	0.0164	0.0364	7256	**10kA**	0.97	6575.71	5694.73	1897.60	3659.22	3168.98	1438.63	1438.63	24.7	14.4	Breaker	0.02	**True**	**True**	5x(20x3)	1.5	10.0	**5.0**	5.0	x Ir	284.4	**True**
121	0.121	3.49	1.45%	4.47	**1.86%**	0.0225	0.0778	0.0097	0.0819	0.0211	0.0846	3123	**6kA**	2.57	2830.19	2451.01	710.88	2376.92	2058.48	678.44	678.44	54.4	10.8	Breaker	0.02	**True**	**True**	5x(20x2)	3.0	5.0	**5.0**	5.0	x Ir	297.5	**True**
28	0.028	1.07	0.45%	5.22	**2.17%**	0.0225	0.1050	0.0022	0.1654	0.0236	0.1671	1581	**6kA**	0.29	1432.98	1241.00	740.23	1370.54	1186.92	715.08	715.08	1.4	28.6	Breaker	0.02	**True**	**True**	5x(12x2)	3.0	5.0	**5.0**	5.0	x Ir	204.8	**True**
24	0.024	0.94	0.39%	5.08	**2.12%**	0.0225	0.0900	0.0019	0.1504	0.0233	0.1522	1736	**6kA**	0.24	1573.13	1362.37	859.53	1489.24	1289.72	818.54	818.54	1.1	32.7	Breaker	0.02	**True**	**True**	5x(12x2)	5.0	10.0	**10.0**	10.0	x Ir	102.4	**True**
24	0.024	0.22	0.09%	4.37	**1.82%**	0.0225	0.0900	0.0019	0.1504	0.0233	0.1522	1736	**6kA**	0.24	1573.13	1362.37	859.53	1489.24	1289.72	818.54	818.54	1.1	40.9	Breaker	0.02	**True**	**True**	5x(12x2)	5.0	10.0	**10.0**	10.0	x Ir	128.0	**True**
56	0.056	0.83	0.34%	4.97	**2.07%**	0.0225	0.2100	0.0045	0.2704	0.0259	0.2716	973	**6kA**	0.78	881.38	763.30	375.17	869.50	753.01	373.28	373.28	5.3	18.7	Breaker	0.02	**True**	**True**	5x(12x2)	3.0	5.0	**5.0**	5.0	x Ir	256.0	**True**
33	0.033	0.90	0.37%	1.87	**0.78%**	0.0225	0.1238	0.0026	0.1279	0.0140	0.1287	2053	**6kA**	0.17	1860.83	1611.53	630.72	1754.79	1519.69	616.17	616.17	1.9	30.8	Breaker	0.02	**True**	**True**	5x(12x2)	5.0	10.0	**10.0**	10.0	x Ir	128.0	**True**
78	0.078	2.08	0.87%	6.23	**2.59%**	0.0225	0.0702	0.0062	0.1306	0.0276	0.1335	1979	**6kA**	3.26	1793.57	1553.28	919.22	1651.73	1430.44	855.73	855.73	17.5	17.1	Breaker	0.02	**True**	**True**	5x(15x2)	3.0	5.0	**5.0**	5.0	x Ir	333.0	**True**
55	0.055	0.28	0.12%	4.42	**1.84%**	0.0225	0.2063	0.0044	0.2666	0.0258	0.2679	986	**6kA**	0.76	893.69	773.96	381.90	881.19	763.13	379.85	379.85	5.1	15.2	Breaker	0.02	**True**	**True**	3x(12x2)	3.0	5.0	**5.0**	5.0	x Ir	204.8	**True**
	0.000																																				
16	0.016	0.92	0.38%	5.16	**2.15%**	0.0225	0.0360	0.0013	0.0777	0.0220	0.0808	3269	**6kA**	0.19	2962.70	2565.78	2028.42	2439.57	2112.73	1549.34	1549.34	0.9	38.7	Breaker	0.02	**True**	**True**	5x(12x2)	5.0	10.0	**10.0**	10.0	x Ir	106.7	**True**
103	0.103	2.01	0.84%	6.25	**2.60%**	0.0225	0.3863	0.0082	0.4280	0.0290	0.4290	616	**6kA**	1.94	558.08	483.31	205.17	556.34	481.80	205.29	205.17	17.5	10.3	Breaker	0.02	**True**	**True**	5x(12x2)	3.0	5.0	**5.0**	5.0	x Ir	256.0	**True**
102	0.102	3.98	1.66%	8.22	**3.43%**	0.0225	0.2295	0.0082	0.2712	0.0289	0.2728	968	**6kA**	2.18	877.64	760.06	343.38	864.49	748.67	341.57	341.57	17.5	10.7	Breaker	0.02	**True**	**True**	5x(12x2)	3.0	5.0	**5.0**	5.0	x Ir	266.7	**True**
13	0.013	0.64	0.26%	3.52	**1.47%**	0.0225	0.0183	0.0010	0.0421	0.0191	0.0462	5718	**6kA**	0.16	5182.16	4487.89	3576.88	3306.32	2863.36	1950.73	1950.73	1.4	39.0	Breaker	0.02	**True**	**True**	3x(15x2)	5.0	10.0	**10.0**	10.0	x Ir	136.5	**True**
19	0.019	0.93	0.39%	3.82	**1.59%**	0.0225	0.0267	0.0015	0.0505	0.0196	0.0542	4877	**6kA**	0.22	4419.81	3827.67	2622.69	3085.01	2671.70	1746.17	1746.17	1.7	34.9	Breaker	0.02	**True**	**True**	3x(15x2)	5.0	10.0	**10.0**	10.0	x Ir	136.5	**True**
21	0.021	1.03	0.43%	3.91	**1.63%**	0.0225	0.0295	0.0017	0.0533	0.0197	0.0569	4646	**6kA**	0.24	4210.91	3646.75	2405.83	3012.96	2609.30	1679.13	1679.13	1.9	33.6	Breaker	0.02	**True**	**True**	3x(15x2)	5.0	10.0	**10.0**	10.0	x Ir	136.5	**True**
27	0.027	1.32	0.55%	4.21	**1.75%**	0.0225	0.0380	0.0022	0.0618	0.0202	0.0650	4065	**6kA**	0.32	3684.23	3190.63	1924.86	2805.23	2429.40	1491.11	1491.11	2.4	29.8	Breaker	0.02	**True**	**True**	3x(15x2)	5.0	10.0	**10.0**	10.0	x Ir	136.5	**True**
38	0.038	1.86	0.77%	4.74	**1.98%**	0.0225	0.0534	0.0030	0.0772	0.0211	0.0801	3300	**6kA**	0.48	2990.47	2589.83	1405.49	2465.07	2134.81	1210.59	1210.59	3.6	24.2	Breaker	0.02	**True**	**True**	3x(15x2)	5.0	10.0	**10.0**	10.0	x Ir	136.5	**True**
34	0.034	0.80	0.33%	3.69	**1.54%**	0.0225	0.0765	0.0027	0.1003	0.0208	0.1024	2579	**6kA**	0.31	2337.49	2024.32	1003.54	2074.44	1796.51	932.89	932.89	2.3	37.3	Breaker	0.02	**True**	**True**	5x(12x2)	5.0	10.0	**10.0**	10.0	x Ir	170.7	**True**
27	0.027	1.22	0.51%	4.11	**1.71%**	0.0225	0.0380	0.0022	0.0618	0.0202	0.0650	4065	**6kA**	0.32	3684.23	3190.63	1924.86	2805.23	2429.40	1491.11	1491.11	2.4	29.8	Breaker	0.02	**True**	**True**	5x(15x2)	5.0	10.0	**10.0**	10.0	x Ir	136.5	**True**
4	0.004	0.06	0.03%	1.63	**0.68%**	0.0225	0.0225	0.0003	0.0536	0.0127	0.0551	4793	**6kA**	0.01	4343.87	3761.90	3064.31	3221.90	2790.25	1884.41	1884.41	0.1	94.2	Breaker	0.02	**True**	**True**	5x(12x2)	5.0	10.0	**10.0**	10.0	x Ir	85.3	**True**
3	0.003	0.21	0.09%	1.78	**0.74%**	0.0225	0.0169	0.0002	0.0480	0.0126	0.0496	5322	**6kA**	0.01	4823.26	4177.06	3853.83	3391.98	2937.54	2016.48	2016.48	0.1	80.7	Breaker	0.02	**True**	**True**	5x(12x2)	5.0	10.0	**10.0**	10.0	x Ir	68.3	**True**
5	0.005	0.13	0.06%	1.70	**0.71%**	0.0225	0.0281	0.0004	0.0593	0.0128	0.0606	4358	**6kA**	0.02	3949.40	3420.28	2535.10	3059.15	2649.30	1748.13	1748.13	0.1	87.4	Breaker	0.02	**True**	**True**	5x(12x2)	5.0	10.0	**10.0**	10.0	x Ir	85.3	**True**
41	0.041	3.37	1.41%	7.12	**2.97%**	0.0225	0.2306	0.0033	0.3176	0.0220	0.3183	830	**6kA**	0.48	752.07	651.31	342.13	747.06	646.97	341.21	341.21	2.8	13.6	Breaker	0.02	**True**	**True**	5x(12x2)	3.0	5.0	**5.0**	5.0	x Ir	136.5	**True**
31	0.031	0.76	0.31%	3.27	**1.36%**	0.0225	0.1744	0.0025	0.2069	0.0189	0.2077	1272	**6kA**	0.20	1152.50	998.10	450.79	1127.92	976.80	447.12	447.12	1.6	22.4	Breaker	0.02	**True**	**True**	5x(12x2)	5.0	10.0	**10.0**	10.0	x Ir	85.3	**True**
42	0.042	1.69	0.70%	4.20	**1.75%**	0.0225	0.2363	0.0034	0.2687	0.0198	0.2695	980	**6kA**	0.34	888.44	769.41	334.08	879.24	761.44	333.29	333.29	2.9	16.7	Breaker	0.02	**True**	**True**	5x(12x2)	3.0	5.0	**5.0**	5.0	x Ir	170.7	**True**
34	0.034	0.93	0.39%	3.45	**1.44%**	0.0225	0.1275	0.0027	0.1600	0.0192	0.1611	1639	**6kA**	0.27	1485.79	1286.73	612.59	1425.02	1234.10	599.45	599.45	2.0	30.0	Breaker	0.02	**True**	**True**	5x(12x2)	3.0	5.0	**5.0**	5.0	x Ir	256.0	**True**
23	0.023	0.20	0.08%	2.72	**1.13%**	0.0225	0.1294	0.0018	0.1619	0.0183	0.1629	1622	**6kA**	0.12	1469.72	1272.82	604.22	1412.99	1223.69	592.55	592.55	0.9	29.6	Breaker	0.02	**True**	**True**	5x(12x2)	5.0	10.0	**10.0**	10.0	x Ir	85.3	**True**
46	0.046	0.71	0.30%	3.23	**1.34%**	0.0225	0.2588	0.0037	0.2912	0.0201	0.2919	905	**6kA**	0.40	820.07	710.20	305.33	813.45	704.47	304.92	304.92	3.5	15.2	Breaker	0.02	**True**	**True**	5x(12x2)	3.0	5.0	**5.0**	5.0	x Ir	170.7	**True**
14	0.014	0.68	0.29%	3.20	**1.33%**	0.0225	0.0197	0.0011	0.0522	0.0176	0.0550	4799	**6kA**	0.23	4349.01	3766.35	3374.71	3106.97	2690.72	1917.09	1917.09	1.4	38.3	Breaker	0.02	**True**	**True**	3x(15x2)	5.0	10.0	**10.0**	10.0	x Ir	136.5	**True**
2	0.002	0.08	0.03%	2.60	**1.08%**	0.0225	0.0028	0.0002	0.0353	0.0166	0.0390	6772	**10kA**	0.11	6137.72	5315.42	8708.58	3580.98	3101.22	2227.42	2227.42	1.1	44.5	Breaker	0.02	**True**	**True**	5x(15x2)	5.0	10.0	**10.0**	10.0	x Ir	136.5	**True**
16	0.016	1.12	0.47%	5.59	**2.33%**	0.0225	0.0600	0.0013	0.1419	0.0224	0.1437	1839	**6kA**	0.22	1666.32	1443.07	1267.21	1568.24	1358.13	1133.44	1133.44	0.6	45.3	Breaker	0.02	**True**	**True**	5x(12x2)	5.0	10.0	**10.0**	10.0	x Ir	102.4	**True**
4	0.004	0.21	0.09%	4.68	**1.95%**	0.0225	0.0225	0.0003	0.1044	0.0214	0.1066	2478	**6kA**	0.05	2246.00	1945.09	3064.31	2007.98	1738.96	1884.41	1738.96	0.1	86.9	Breaker	0.02	**True**	**True**	5x(12x2)	5.0	10.0	**10.0**	10.0	x Ir	85.3	**True**
34	0.034	2.42	1.01%	6.89	**2.87%**	0.0225	0.1913	0.0027	0.2732	0.0238	0.2742	963	**6kA**	0.35	873.07	756.10	411.58	862.62	747.05	409.14	409.14	2.0	20.5	Breaker	0.02	**True**	**True**	3x(12x2)	3.0	5.0	**5.0**	5.0	x Ir	170.7	**True**
4	0.004	0.21	0.09%	5.80	**2.42%**	0.0225	0.0225	0.0003	0.1644	0.0227	0.1660	1592	**6kA**	0.13	1442.38	1249.13	3064.31	1380.46	1195.51	1884.41	1195.51	0.2	47.8	Breaker	0.02	**True**	**True**	5x(12x2)	5.0	10.0	**10.0**	10.0	x Ir	68.3	**True**

ELECTRICAL ENGINEERING

REHABILITATION OF THE SAUDI MATERNITY HOSPITAL

KASSALA HEALTH CITADEL, SUDAN

DETAILED DESIGN

DESCRIPTIVE MEMORY

ampc International Health Consultants

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1. EXISTING INFRAESTRUTURES

1.1. ELECTRICITY

The current state of electrical installations in the Saudi Maternity Hospital, represents a hazardous situation, endangering not only for the material view, but also human life, considering that an incident may result in irrecoverable injuries or even fatal.

It is recommended that all electrical installations to be replaced, in order to ensure its correct functioning and prevent any risks to human and animal life or assets lost.

The major actual existing infrastructures on Saudi Maternity Hospital (SMH) are indicated below:

Current Medium Voltage Line:
There are current two power grid connections, one to Saudi Maternity Hospital (Northern) and the other to the Diagnostic Centre (East). The public grid connection to the Saudi Maternity Hospital is via an overhead power line, to the MV/LV transformer.

The main supply of the SMH is from 300KVA 11/0.415 KV transformer except New wards, connected from overhead line fed from Diagnostic Center (transformer).

Image 1 - Current overhead power line / Unburied Cables

Current Main Electrical Room:

The main switchboards room is in a very bad condition, contaminated with carbons and so main distribution board inside. The generator is installed in closed room without special provision to carry out the exhaust outside the room. All existing equipment is degraded and damaged.

Image 2 - Main switchboards room

Electrical Installations inside buildings:

The electrical installations inside buildings have a bad and dangerous electrical wiring systems, with, splices are open, damaged conductors and deteriorated equipment. Lighting is not sufficient in most areas due to damage to the luminaires.

The switchboards is outdated, and many are badly damaged. This is an extremely dangerous situation.

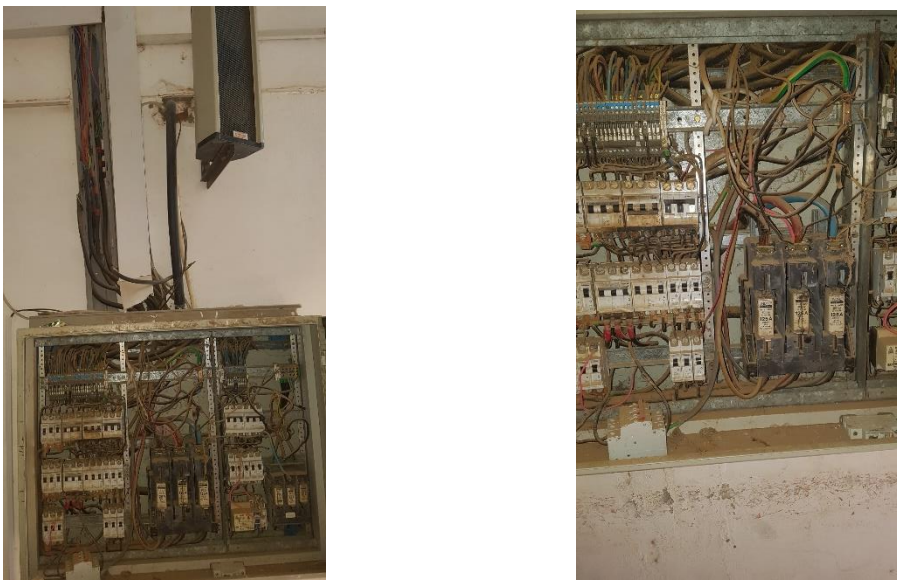


Image 3 – Indoor Switchboards / Wiring

Electrical Installations outside buildings:

Outside the buildings, the situation is identical to that verified inside, with the worsening of the installed equipment without adequate degree protection (IP+IK).

The most electrical conductors are not suitable for external use, they are unprotected, with open splices and visible degradation, increasing the risk for damage and possibly fire.

Image 4 - Outdoor Switchboards / Wiring

1.2. ITC

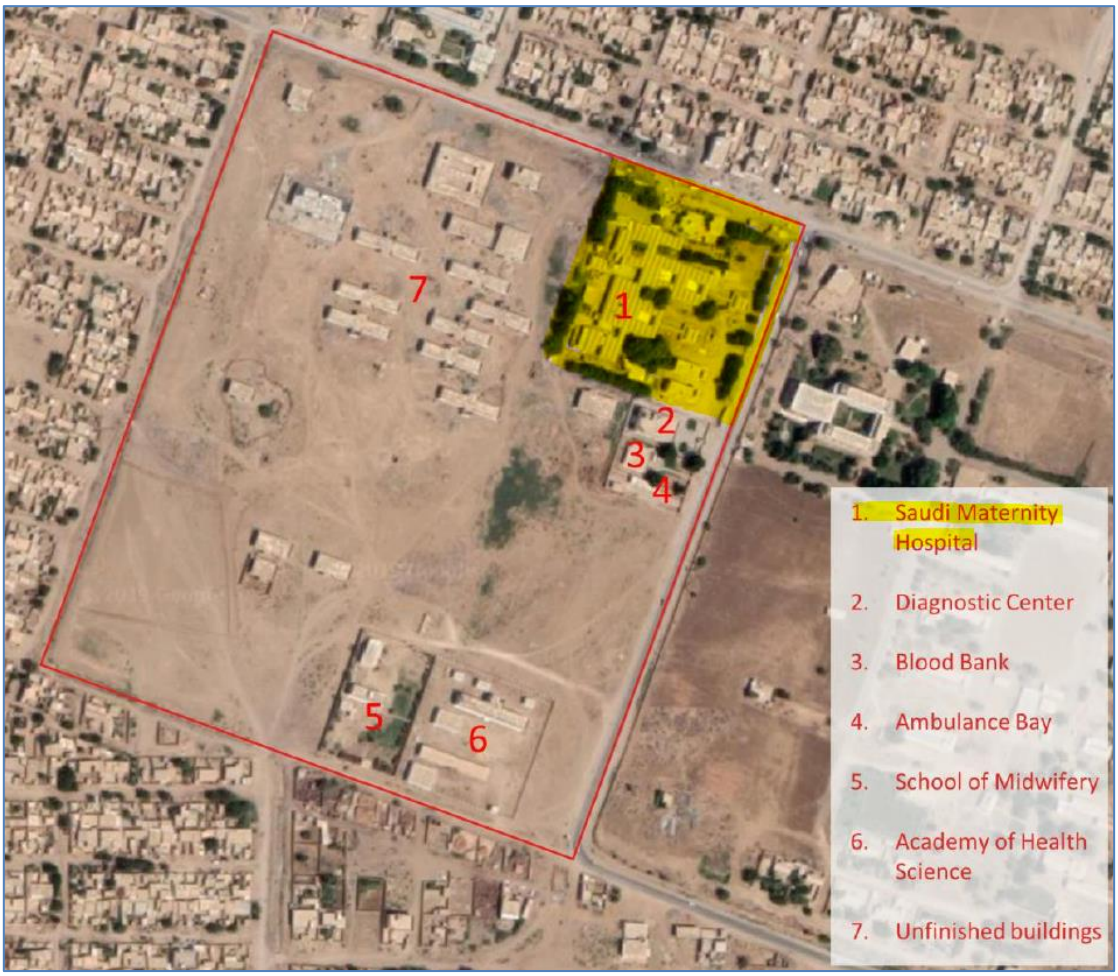
There are currently no telecommunications infrastructures.

2. ELECTRICAL ENGINNERING

2.1. INTRODUCTION

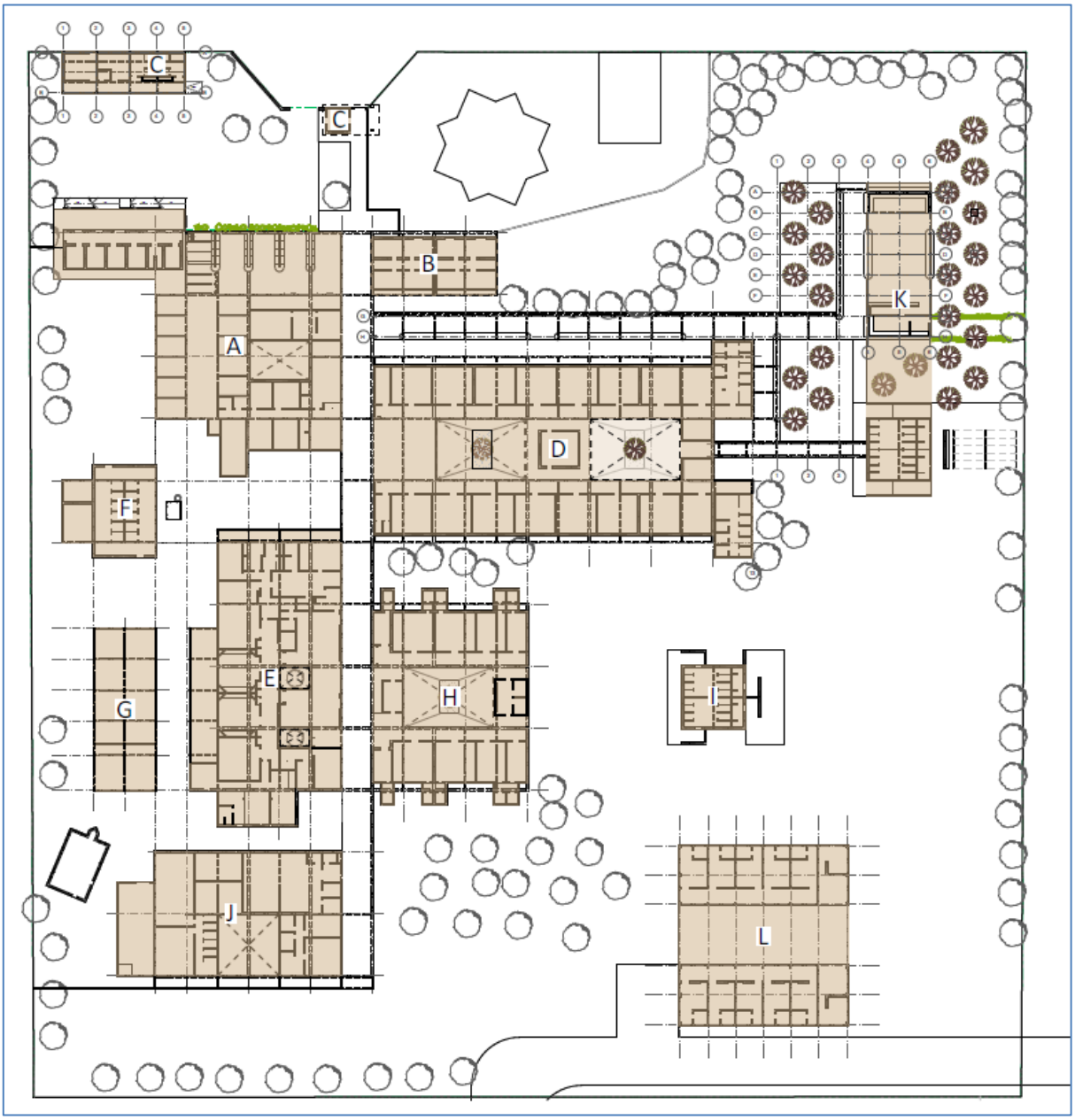
This document refers to the “Electrical Installations” study for the rehabilitation works at Saudi Maternity Hospital in Kassala Health Citadel in Sudan.

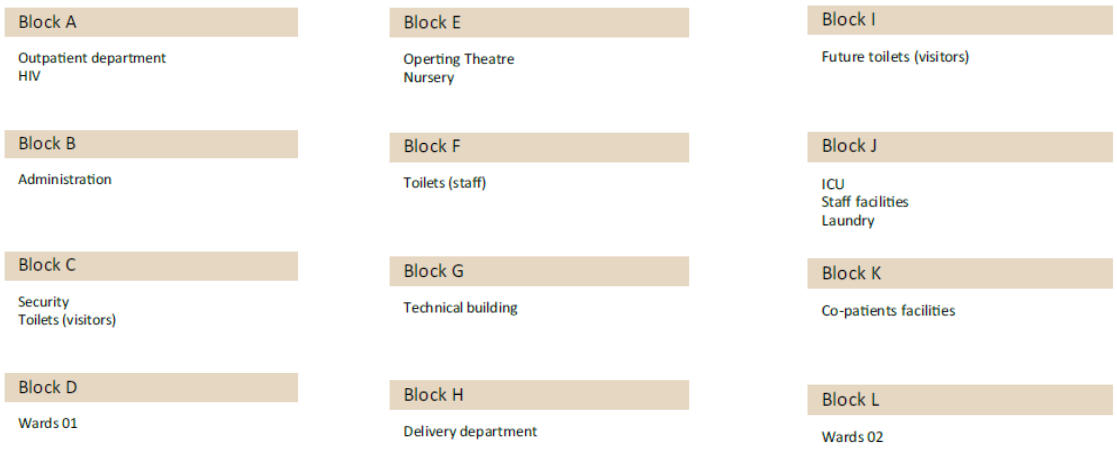
The Saudi Maternity Hospital was built in the 80’s and is operative since then. The architecture of the building has a strong character with arched roofs, concrete beams and brick walls. The hospital is concentrated along a central north-south oriented corridor, with departments attached. The interior of the building is characterized by patios. The hospital is enclosed by a fence and has the main entrance on the north side. The building is in need for a rehabilitation, this is part of the Kassala Health citadel development.



Picture 5 - Kassala Health Citadel in Sudan

The Saudi Maternity Hospital is divided into the following main blocks:





Picture 2 - Saudi Maternity Hospital Main Blocks

2.2. GENERALITIES

Considering the current state, the main goal of the proposed intervention is to ensure the proper functioning of electrical facilities and rectify all situation that can put at risk the safety of people, animals and assets.

The whole electrical installation design will be guided by concerns of:

- Reliability;
- Security;
- Safety of life and property;
- Reliability of power supply to the extent possible;
- Automatic protection of all electrical appliances through selective protection system;
- Simplicity of operation;
- Ease of maintenance;
- Flexibility of system.

It aims to provide infrastructure to ensure the safety and operation of the planned integrated Phase II facilities that will be part of the future Kassala Health Citadel (KHC).

2.3. REGULATION AND STANDARDS

The technical solutions adopted will be adequate and sufficient according to the nature and specificities, of the health facilities. The following codes and standards should be followed whenever possible for electrical installations:

- BS British Standards;
- I.E.C. International Electro Technical Commission;
- CENELEC European Committee for Electrotechnical Standardization;
- Regulation lay down by the local & State Government Authorities (when existent);
- Regulation lay down by the Electrical Local distribution authority (when existent).

The proposed solutions to the various facilities have in common the fact that they are technical solutions of proven quality and reliability, trying to always opt for newer technologies that offer quality and comfort, reduced energy consumption, easy maintenance, high response speed and technical simplicity. All of them will be adapted to local conditions and circumstances.

2.3.1. STANDARDS FOR EQUIPMENT AND MATERIALS

All electrical installations shall comply with the requirement of the regulations, relevant to local & State Government Authorities (Sudan).

All equipment, apparatus, materials and accessories complying with the current standards and/or conforming to relevant IEC (International Electromechanical Commission), CENELEC (European Committee for Electrotechnical Standardization) and ISO (International Standards Organization) recommendations shall be deemed to satisfy the requirements of the regulations, unless otherwise specified.

2.4. FEATURES OF THE LOCAL NETWORK

We are consider for the Project:

- Medium Voltage: 11kV for MV distribution;
- Low Voltage: Single Phase 240V and Three Phase 415V;
- Frequency: 50 Hz
- Power-supply utility: Local distribution authority Sudanese Electricity Distribution Company (SEDC)
- Common voltage brownouts and power outages, various failures a day, with durations of 4 to 8 hours;
- High temperatures around 33º…+41º, Low temperatures around 18º…+28º;
- 50% humidity in wet season, 16,5% in other seasons;
- Dust-storms and flooding of the Gash River.

2.5. PRIMARY ELECTRIC SUPPLY (ENERGY SUPPLY COMPANY)

The power supply will be established from the local medium voltage power grid. Will represent the primary electric supply (PES) for whole KHC main campus.

There are current two power grid connections, one to Saudi Maternity Hospital (SMH) and the other to the Diagnostic Centre (DC).

The proposed solution, is to maintain the current north connection (SMH) and reuse parts of existing infrastructure.

The objective is to create a dual power supply, to form an internal medium voltage ring or loop, in order to maximise the resilience and minimise the actual single point of failure. That way, if one source is lost, the other provides de total power supply.

In order to achieve this objective, it will be necessary to reformulate or re-create the current MV Substations.

If possible, that two sources should be originate from separate public substations. Depends on the distribution operator local grid.

To help achieve the higher level of resilience, healthcare premises should, if possible, be supplied by a dual PES (ideally both at 100% fully rated).

2.5.1. MEDIUM VOLTAGE MAIN SUBSTATION

The intake/main substation (ISS), is planned to be installed near the complex periphery, in order to guarantee a direct and permanent access from the public roadway, unrestricted to the local Electrical Distributor (DNO).

We propose the creation of an inner ring of medium voltage, connected to the two main current substations. This ring will be design to be integrated, in the next phase, into a main ring for the entire KHC campus.

The ISS will feed the MV/LV Secondary Substations, through a medium-voltage internal network (MV Ring).

The medium voltage network inside the complex terrain is recommended to be carried out using buried armoured cables, protected in technical trenches.

The Transformer Substation will be prefabricated, made from G.R.C. (Glass fibre Reinforced Cement), or other equivalent material, which offers the robustness of concrete but lighter than concrete. This non-

corrosive enclosure, avoids the disadvantages generated by the metallic enclosure such as rise in temperature, condensation and corrosion.

2.6. SECONDARY SUBSTATIONS

Considering the new needs and the future expansions, the estimated electricity demand is approximately 500kVA (rated power).

The low voltage will be established from the MV/LV transformer station.

The transformer shall be capable of uninterrupted operation and will be for indoor installation, Oil type, with reduced load losses.

The solution developed ensure all technical conditions for the adoption of system resilience N+1. The strategy in the future is to maximise the resilience and minimise the actual single point of failure. The issue is the time to repair or replace a faulty transformer.

Distribution strategies that have two transformers, both 100% rated, supplied from a common primary supply, would provide a transformer system resilience of N+1.

While both transformers are on duty, they would share the load of the distribution network, approximately 50% being provided by each transformer. In the event of failure or for maintenance opportunities, either of the transformers can carry the full load.

A main low voltage switchboard (MLVS) is planned to be installed in the main switchboard room, where the low voltage power distribution network comes from, to supply the secondary distribution boards, in the different hospital buildings.

2.6.1. ELECTRICAL POWER NEEDS

In order to design a new main power distribution unit, it's mandatory to estimate of the electrical power needs of the hospital's buildings.

The calculation methodology is based on our experience in healthcare facilities, the available international literatures data, and adapted to local conditions.

Electric Power Estimation - Transformers Demand					
Source of Supply	**Facilities**	**NF Area [m²]**	**Power per area (VA per m²)**	**Diversity factor (ks)**	**Maximum Estimated Apparent Power (kVA)**
MV/LV Secondary Substation 1	Saudi Maternity Hospital	5 772	50	1.0	288.6
				Reserve / Future expansions (20%):	58
				Power Demand:	350
				Transformer Rated Power (kVA):	**500**
Summary of the current situation (**Transformers**): - Saudi Maternity Hospital / 300kVA Transformer					

Table 1 - Transformers Demand

As presented in table 1, it has been evaluated an electrical power needs of 290 kVA. In addition, the project considered a future reserve of 20%, added to the total electricity needs. Therefore, the total electrical power demand is evaluated to be around **350 kVA**.

The propose criterion for the individual calculation of transformers, consider the equipment designed to 90% for the total load, to ensure a lower loss operating point, improving the equipment performance.

2.7. SECONDARY POWER SUPPLY

Considering the chronic power shortage in the country and increasing power cuts, it is essential to have an alternate power source to meet electrical power consumption's requirements under break down/power cuts conditions, which is also in accordance with the standards and international best practice.

To ensure the continuous electric supply, was established a backup plan, thru the installation of emergency and standby generators, for automatic operation, serving as the secondary power supply (SPS) to the entire hospital (essential and non-essential loads).

An ATS system (Automatic Transfer Switch) will manage the emergency load connection, between the primary electric supply and the diesel generator (secondary power supply (SPS)).

In normal course these loads shall be fed by PES supply through Transformers. But in case of power failure, the D.G Sets shall feed these loads.

Since there are no other important campus functions, or buildings having large Life Safety loads such as electric-powered fire pumps, smoke control systems, etc. only require Emergency power for Life Safety/Aid needs.

2.7.1. BACKUP PLAN

We propose the installation of two diesel generator sets, 450 kVA (ESP), (3 phase, 50 Hz, 415 volts, with Auto Start / Stop installation), taking into consideration the 500kVA of the new transformers.

The developed solution guarantees adoption of N+1 system resilience. The strategy is to maximise the resilience and minimise the actual single point of failure.

The autonomy of the diesel generator system is ensured by a **fuel tank**, on surface or buried under the generators site, with a **48 hours capacity** at 100% of ESP (Emergency Energy).

After properly maintenance, it may be possible to reuse the 450kVA current generator found to be in really good condition, and ensuring the operation (N+1).

2.7.2. BACKUP POWER DEMAND

According to the field reports, most of the existent backup generators, are inadequate or, out of service, or non-existent.

In order to design a new backup generator system, it's mandatory to estimate of the backup power demands of the hospital's rehabilitated buildings.

Electric Power Estimation - Generators Demand					
Source of Supply	**Facilities**	**NF Area [m²]**	**Power per area (VA per m²)**	**Diversity factor (ks)**	**Maximum Estimated Apparent Power (kVA)**
MV/LV Secondary Substation 1	Saudi Maternity Hospital	5 772	50	1.0	288.6
				Reserve / Future expansions (20%):	58
				Power Demand:	289
				Generator Rated Power (kVA):	**450**
Summary of the current situation (**Generators**): - 450kVA (Hospital) + 60kVA (Part of Hospital) + 42kVA (Operation Theatre)					

Table 2- Generators Demand

As presented in the table 2, it has been evaluated a backup power needs of **450 kVA (ESP)**.

As previously stated, it is proposed to install diesel generators, applying individual sizing criteria, equal to transformers, serving as secondary power supply (SPS) for the entire hospital (essential and non-essential loads).

2.8. TERTIARY POWER SUPPLY

Tertiary power supplies are generally used as a backup supply for a given period of time (autonomy) or to start SPSs. Double-conversion UPS units are most commonly used for tertiary power supplies to dedicated final-circuit outlets, used for example in clinical risk grade areas.

The most common application of a double conversion UPS is to provide tertiary power for Medical IT systems. The UPS batteries maintain an electrical supply following an outage of the PES and prior to the SPS standby generators becoming available.

IT electrical system include an insulation-monitoring device to provide an alarm on loss of IMD connections, insulation failure, overload and high temperature. We consider that a battery life of 1 h is required for this isolated power supply (IPS).

At this stage, we consider providing a Medical IT system for the following services:

- Operating Theatres;
- Operating Recovery and Preparation room;
- Intensive Care Unit (ICU);

2.9. ISS SUBSTATION & MV/LV TRANSFORMER SUBSTATION

2.9.1. ISS SUBSTATION

The intake/main substation (ISS) is planned to be installed near the complex periphery, in order to guarantee a direct and permanent access from the public roadway, unrestricted to the local Electrical Distributor. The ISS will be established in the Block C.

The ISS basically consists of the following distinct parts:

- Delivery room: Where the switching apparatus of the utility is installed. This room must be of a size to allow any construction of the in-feed/output system which the utility has to realise.
- Instrument room: Where the measuring units are located. Both these rooms must have public road access to allow intervention by authorised personnel whether the user is present or not.
- User room: Destined to contain the MV switching apparatus which are the concern of the user. This room must normally be adjacent to the other two rooms.

The consumer has access only to part of the installation, access to the MV entrance part being reserved to the utility personnel (meter reading, operations, etc.).

2.9.2. MV/LV TRANSFORMER SUBSTATION

The MV/LV substation provide the interface between the distribution MV and LV. Basically consists of the MV & LV protection devices (switch room), and the transformer housing/room.

The transformer substation is located in the Block G, as close as possible to the load center.

2.10. DIESEL GENERATOR (DIESEL GENSET)

In order to allow the supply of the Maternity, the project design envisaged the execution of a backup plant, with the installation of generators, voltage 415/240V, 50Hz, for automatic operation, with control panel and with all equipment needed for maximum attenuation of noise, according to the manufacturer's specifications, for the supply of normal and priority loads of the entire building.

The manufacturer of the generating station must also supply and install the control panel, synchronization and parallelism, which shall be placed in the main switchboard room.

The plant will consist of 2 (two) generator sets of 450kVA (ESP) unit power that will be installed to rescue the priority and the security services.

The two generator sets are connected to the main generator sets switchboard (GPS) that feeds the main low voltage switchboards (LTS & MLVS).

The interconnections between the generator sets and the switchboards shall be made with cables of 0.6 / 1.0kV, flame retardant, halogen free cables, with low smoke and toxic gas emissions, in accordance with current regulations.

Each generator will have individual fuel tank incorporated into the equipment, allowing its operation in emergencies. A large fuel tank should be installed outdoors, located near the generating sets, in an easy access area for replenishment and maintenance, to allow the extended operation of the backup system. They will also supply the individual fuel tanks of each generator.

The backup system will allow the feeding of all the charges of the Maternity.

In case of prolonged interruption of current supplied by the operator, and taking into account the limitation of hours of continuous use of the generator station, the project design provides the possibility of deactivation of the non-priority loads, with automatic cut-off of the installed circuit breakers in the main low voltage panel, intended for supplying the general low-voltage switchboards for non-critical loads, making it easier to take advantage of the generated current supply for the critical loads.

All generators must be connected to a synchronization panel and parallelism provided by the manufacturer of generators, with a microprocessor for synchronization, monitoring, protection, control and voltage control of the backup system to enable perfect operation of the entire generator system.

The system shall be fully automated, with automated load management, slow load / discharge and power factor controller to avoid overload in the generator system, and user configurable demand control system to save fuel and allow better optimization of the generator system.

The system shall also monitor the load with such way that allow the selection of the quantity of generators to be used, in the case where the demand power of the load allows the partial use of the generating set, the quantity of generator sets can be added with the increase of the load.

The entire system must allow the power supply to be restored by the generating sets for the entire hospital in no more than 15 seconds.

The dimensions and installations of the generator sets installed in containers and the panels of control, synchronization and parallelism, as well as the dimensions of the refuelling fuel tanks, must be duly approved by the equipment manufacturer prior to its execution.

2.11. ELECTRICAL POWER DISTRIBUTION

The low voltage energy distribution will be provided from Main Switchboard (MLVS) located adjacent to the MV/LV Transformer Station. The emergency energy distribution will be provided by a power generator, consisting of cables installed on perforated tray run horizontally to the Main Switchboard (MLVS) location.

The power to critical loads such as ICT networks will be guaranteed by UPS systems.

From the Main Switchboard shall be established power distribution to the various secondary distribution switchboards in the hospital.

Compensation shall be provided by automatically controlled capacitor banks. This type of equipment provides automatic control of compensation, maintaining within close limits, a selected level of power factor. Such equipment is applied at points in an installation where the active-power and/or reactive-power variations are relatively large, i.e. at the busbars of the main power distribution board.

The current distribution in the building obeying the general distribution system, as shown on the diagrams and plans.

According to the distribution diagrams and single-line diagrams, the networks are classified in:

- (N) - Normal supply networks - non-critical circuits of non-priority loads, which can be deactivated without prejudice to the safety of patients and the hospital complex, and with little prejudice to the continuity of hospital activities;
- (E) - Emergency supply networks - Critical load circuits, fundamental for keeping patients alive and for the safety of the building population;
- (U) - Uninterrupted supply networks - essential load circuits with interruptions lasting less than 15 s, fundamental for patient life and safety;
- (S) - Security networks - Security load circuits, fundamental in case of fire.

The IT Medical system is a sub-network with uninterrupted power supply, separation transformer and insulation control device considered in medical facilities to support critical care.

2.11.1. NORMAL & EMERGENCY POWER SYSTEM (N/E)

As previously mentioned, the normal power supply is established from the local medium voltage power grid.

The emergency power supply is an independent source of electrical power that supports important electrical systems on loss of normal power supply, thru the installation of emergency and standby generators.

Although they are independent sources of electricity, both the normal and the emergency power supply use the same network, designated (Normal / Emergency).

2.11.2. UNINTERRUPTED POWER SYSTEM (U)

There will be a decentralized uninterruptible power supply system for ICT equipment. The source will consist of a rack mount UPS.

For the supply of critical loads of the IT-Medical system will be considered a local inverter, specific for this compartment or service.

The Uninterrupted Power System will have modules, with sealed case batteries and a System Control Box.

The UPS equipment will automatically keep the AC current in the specified tolerance standard for the critical load without interruption, during a failure or network anomalies.

The equipment must have at least the following additional functions:

- Multi-Processor Controller;
- Independent voltage adjustment per phase;
- Static Bypass and Maintenance;
- Serial, RS-232 and RS-485 communication channels;
- Management and monitoring software, with event recording;
- Automatic shutdown;
- Possibility of redundant and parallel start-ups;
- Possibility of functioning in economic mode;
- Test and programmable charge of the battery;
- "Auto-Restart" function.

2.11.3. MEDICAL IT SYSTEM

For the supply of the operating theatres and bed panels of intensive care units (ICU) and post-interventional surveillance (SSPI), will be provided medical IT system, with inverter, separation transformer and isolation controller device.

The medical IT scheme should be used for circuits the supply medical electrical equipment and systems for survival and surgical applications, and other equipment located in the patient's environment.

At least one transformer must be provided per operating theatre or intervention local.

The isolation transformers will have an ungrounded electrostatic and neutral shield, installed before the electrical switchboards. The transformers must comply with the standard EN 61558-2-15 (C 52-558-2-15), and will be fed from the general low voltage switchboards, which will be the uninterrupted system of current.

The project provided for the installation of the isolation transformers in a specific area, which will have to be confirmed by the equipment supplier.

The isolation transformers form the IT-Medical system are intended to maintain the stability of the necessary voltage and current levels, in order to avoid potential problems in high-sensitivity electronic equipment, also to ensure protection against indirect contacts and avoid the shutdown of the respective electrical cabinets and consecutive power outages in the case of a first phase-to-earth short circuit.

The entire IT-Medical system will need to be monitored by insulation monitoring devices (ISDs) installed in the electrical cabinets, with the announcer in the nursing station, who oversees the installation and sets off the alarm.

Each medical IT scheme must be equipped with an insulation monitoring device complying with standard EN 61557-8 (C 42-198-8) and specially designed for use in a medical IT scheme.

The temperature of isolation transformers monitoring devices (DST) for the monitoring system should also be installed in electrical cabinets and interconnected with the sensors in the isolation transformers, which will signal their own potential overloads.

The project has provided all necessary infrastructure for the insulation and temperature monitoring system, between electrical cabinets, isolation transformers and announcer of nursing stations. The cabling will be the responsibility of the system provider.

The electrical cabinets shall have an earth grounding strip and potential equalisation grounding strip, which must be interconnected.

All metallic masses of non-electrical equipment and stands shall be interconnected to the potential equalisation grounding strip.

It will be up to the installing company to provide the complete electrical switchboard, with DSI, DST and insulation transformers in accordance with the project.

The circuits fed by the medical IT scheme and in particular those supplying the socket-outlets must not be protected by DDRs.

Isolation Transformers:

Transformers must comply with standard EN 61558-2-15 (C 52-558-2-15)

The rated output power of such transformers is not greater than 10 kVA. If necessary, it is advisable to distribute the circuits to feed on several transformers not working, in any case, in parallel.

If the supply of three-phase loads is necessary, a dedicated transformer must be provided for this purpose with a secondary voltage not higher than 250 V.

The circuits supplying the transformers of medical IT scheme should not be overload protected, but only against short circuits.

Monitoring of overloads and temperature rise of transformers must be ensured.

Transformers should be implemented as close as possible, either indoors or outdoors, to the medical site.

Isolation Controller Device (ISD):

The DST consists of an insulation sensor installed in the electrical cabinet of the IT-Medical system.

Each IT-Medical circuit will have to be supervised by an insulation control device and must meet the minimum requirements indicated in standard EN 61557-8 (C 42-198-8).

Surge Arresters (DST):

The DST consists of a PTC Thermistor temperature sensor, indicates a temperature greater than 120º by sending a signal to the DSI / DST when the separation transformer is over temperature. Simple installation and connection to the DSI / DST with electric cables.

2.11.4. ELECTRICAL DISTRIBUTION ARCHITECTURE

It's planned to adopt a low voltage power network, with a radial (single cable) distribution type.

The low voltage distribution network is recommended to be establish in buried technical trenches, carried out using copper or aluminum cables that are protected with in rigid, non-metallic conduit, or direct in the ground (direct burial cable).

There are disadvantages of running wires overhead include having poles, and the dangers of having an exposed power line that can be touched by ladders, or damaged by tree branches or other natural elements.

Where possible, depending on site availability, this network can be installed under the walkway covers that connect major hospital buildings. In this case, cables and trays shall be suitable for outdoor electrical installations.

For the low voltage power distribution, it's proposed to use the neutral earthing combined scheme (TN-S system), where the PE (Protective Earth) and N (Neutral conductor) are separate conductors that are connected together only near the power source.

A suitable earth electrode shall be used. The type and embedded depth of the earth electrode shall be chosen in a way that the resistance doesn't increase above 1Ω in case of soil drying.

A lightning protection system is proposed to be installed that ensure the total coverage of the hospital and reduce the risk impacts and resulting damages.

Inside the buildings, the electrical wiring shall be carried out with one of the following ways:

- Exposed, installed in cable trays;
- In-wall trunking system, provided with independent channels;
- Exposed and Fixed on the walls and ceilings by clamps, but mechanically protected by conduits.

It's proposed that the electric cables be installed in cable trays in the main horizontal and vertical paths.

As an alternative to the embedded wiring, the connecting cables to the compartments and the appliances can be carried out by using visible threaded pipes of an adequate diameter or using wall trunking system.

The electrical wiring in the technical rooms shall be visible and fixed by clamps.

2.12. LOW VOLTAGE SWITCHGEAR

All distribution boards either main, sub-main or final DBs shall be installed in locations to which access is available at all times for operation, testing, inspection, maintenance and repair.

Main, sub-main or final Distribution Board/s shall not be installed within bath rooms, toilet, damp or wet locations, bed rooms, kitchen, above sinks, store rooms, high ambient rooms, dangerous or hazardous locations or below any stair case.

Each distribution board shall incorporate means for isolation of mains supply in the form of either circuit breaker or incomer isolator as applicable.

Every circuit breaker or fuse within the distribution board shall be identified and labelled to indicate the apparatus or circuit it controls.

Each final distribution board shall only supply the circuits in the same floor area, where the distribution board is located, except for specific applications such as stair case & common corridor-lighting in high rise buildings.

Incoming supply cable installed to any distribution board shall be totally segregated and identified from the outgoing circuit cables/wiring.

All distribution boards shall be installed flush or surface mounted at a height not exceeding 2 metres from the finished floor level to the top of the distribution board.

2.13. AUTOMATIC VOLTAGE REGULATOR

We propose the installation of an automatic voltage regulator (AVR) in the Main Distribution Board (MLVS).

An AVR is used to regulate the fluctuating voltage. Voltage stability is very important to note because it can affect the electrical system. In a large-scale interconnection system, a manual voltage stabilizer is never used and instead an automatic voltage stabilizer is installed called an AVR (Automatic Voltage Regulator).

The function of AVR is as follows:

- The AVR compares voltage with a preset reference voltage.
- If the voltage is less than the reference voltage, the AVR increases D.C. voltage across the Generator field

2.14. ELECTRICAL INSTALLATIONS (INSIDE BUILDINGS)

For electrical installations inside buildings, the following requirements were considered:

- Distribution Boards (Switch Boards);
- Internal power distribution systems;
- Earthing System and Lightning-protection System;
- Lighting System (LED fixtures are proposed);
- Emergency Light;
- Power Outlets;
- Equipment's Supply (portable and non-portable electrical machines, air conditioning…);
- IT-Medical system (when applicable);
- All associated infrastructure (Cables and conductors, Cable trays, Ducts, Boxes, Pipes, etc.)

For priority loads (medical IT services), will be considered a decentralized UPS's Systems, restricted to supporting critical care and essential services rather than being a main (whole site). Will be the tertiary power supplies (TPS).

Inside the building, the electrical wiring shall be carried out with one of the following ways:

- Exposed, installed in cable trays;
- In-wall trunking system, provided with independent channels;
- Exposed and Fixed on the walls and ceilings by clamps, but mechanically protected by conduits.

It's proposed that the electric cables be installed in cable trays in the main horizontal and vertical paths.

As an alternative to the embedded wiring, the connecting cables to the compartments and the appliances can be carried out by using visible threaded pipes of an adequate diameter or using wall trunking system.

The electrical wiring in the technical rooms shall be visible and fixed by clamps.

2.15. SOCKETS AND ELECTRICAL EQUIPMENT POWER SUPPLY

The different user facilities will be provided with sockets, designed to general purposes and to power certain fixed electrical equipment's.

The sockets are distributed in accordance with the needs of the various hospital environments, in accordance with the point distribution project provided by the architecture. General purpose sockets 2P+T - 240V, standard, white, standard IEC and BS have been provided.

The sockets for uninterrupted circuits, with 240V voltage, will be standard of type 2P+T, red in colour, standard IEC and BS.

The boxes of connections with cover will have to be placed in the points of supply single-phase and three-phase provided in the project, while the connectors will have to be placed at the point of the cables of these circuits.

The circuits for sockets have been designed in profiles, electrical ducts and electrical conduit, and will have to respond to the project details.

In amendments profiles, electrical ducts and electrical conduits appropriate parts will be used in accordance with the project technical specifications. In joints of electrical conduits with boards, galvanized plugs and washers should be used.

The sockets for general use shall be, as appropriate, monophasic, triphasic or associated in combined blocks, destined to power mobile receivers allocated to various services.

All sockets shall be provided with earthing contact, in surface mounting, flush mounting and wall trunking mounting versions.

The sockets interior frames are differentiated by colour according to the type of source they are connected to, namely:

- Normal feed - white
- Power generator - red
- UPS - green

The sockets will be single phase "British Standard" type with earth terminal, for rated current 16 A.

When installed in locations assigned to the permanence or public circulation, sockets shall be alveoli protected type.

All sockets are for flush mounting or surface mounting, robust construction, of unbreakable material, essentially installed in walls.

2.16. NORMAL AND GENERAL LIGHTING

The luminaires selection and dimensioning are not part of this electrical installation design.

As regard to the light level and light colour, shall comply with the international recommendations to present more in particular to the IEC (International Electro-technical Commission).

Illumination calculations were carried out, through which they can demonstrate compliance with these recommendations.

In the offices and considering a relevant day lighting contribution will be considered dimmable luminaries associated to presence and brightness sensor, in order to maintain a constant light level throughout the different hours of the day.

In the most significant sites shall be considered the following Illuminance levels and maximum visual discomfort:

The lighting distribution has been designed using single-phase 240V or 415V three-phase circuits in special cases.

In the closed rooms, the switch will be installed inside the rooms, near to the access.

Ballasts for fluorescent lamps shall be electronic type, with high power factor for quick start.

For the recessed lightings in the false ceiling with BS standard 2P+T plugs shall be used with a gap in drivers of 60 cm, for greater flexibility during maintenance.

The cords and switches of the lighting shall be executed with cables with double insulation, fire retardant, halogen free, with low emission of smoke and toxic gases, with distance up to 1.5 meters. Above this length, the cables must be installed in electrical ducts.

The boxes of connections with cover will have to be placed in the points of supply single-phase and three-phase provided in the project, while the connectors will have to be placed at the point of the cables of these circuits.

The circuits for lighting have been designed in profiles, electrical ducts and electrical conduit, and will have to respond to the project details.

In amendments profiles, electrical ducts and electrical conduits appropriate parts will be used in accordance with the project technical specifications. In joints of electrical conduits with boards, galvanized plugs and washers should be used.

2.17. EXTERIOR LIGHTING

Outdoor lighting will be developed in collaboration with the architecture team.

The circuits are divided into several circuits corresponding to functional areas of the building.

The lighting remote control will be provided by:

- DAYLIGHT measured by a light sensor (photoelectric cell) - Automatically turn OFF exterior lights in response to the presence of daylight;
- TIME EVENT via an astronomical time switch or programmable schedule control - Automatically turn exterior and parking structure lighting OFF during night hours when they are no longer needed (based on a schedule). Automatically reduce exterior and parking structure lighting during hours when they are no longer needed but must stay ON (based on a schedule).

All these lights will comply with applicable standards.

2.18. EMERGENCY AND SAFETY LIGHTING

The security lighting realized the functions marking of the circulations and the anti-panic lighting.

These lighting fittings have the mission to ensure the evacuation of the occupants in case of interruption of the lighting circuits of the circulations and receiving premises.

The system automatically performs all the test functions to minimize maintenance staff time.

The ambient and signage lightings shall be achieved by assigning at least two main safety lighting equipment and two separate circuits to each path, leading the personnel to the outside.

All the ambient and signage lightings comply with applicable standards applicable to health facilities.

2.19. ELECTRIC WIRING

All equipment and materials used in electrical installations shall be of good quality. Complying with the relevant section/clause of this regulation as a minimum requirement.

Every item of equipment used in the installation shall be designed and rated for operations on the nominal electric supply voltage

All kinds of electrical wiring shall be installed under the following conditions:

- At sight, installed in cable trays;
- In wall trunking system, provided with independent channels;
- Fixed at sight on the walls and ceilings by clamps, but mechanically protected by conduits.

In this context, it is envisaged that the electrical wiring establishment method shall be, by area, the following:

- Technical Areas - Fixed at sight by clamps;
- Offices, Rooms, Hallways and Sanitary Facilities - embed in building elements, placed in the cable trays, or fixed by clamps when hidden by false ceilings.

2.19.1. CABLE AND CONDUCTORS

For general purposes and in normal situations PVC/XLPE insulated, stranded copper conductor cables complying with respective Standards (BS/IEC) shall be used for all fixed wiring installation of buildings and other premises as applicable.

Cables and conductors to provide shall have the following characteristics of fire behaviour:

- Flame retardant (CEI-60332-1);
- No fire propagator (CEI-60332-3);
- Fire resistant (CEI-60331-21);
- Halogen-free (When required by local regulation).

All cables shall comply with the relevant BS/IEC Standard, and be used for appropriate application.

2.19.2. IDENTIFICATION OF CONDUCTORS BY COLOUR

Wiring shall be so arranged or marked that it can be identified for inspection, testing, repairs or alteration of the installation.

Where an electrical conduit is required, it shall be distinguished from a pipeline or other services.

Identification of conductors by colour for new electrical installations shall be according to the next Table.

2.20. CONDUITS AND FITTINGS

PVC conduits and fittings used in building installation shall be from high impact rigid PVC, suitable for use at ambient temperature up to 48º C. The material shall not soften or suffer structural degradation at a temperature of 70º C and shall be non-hygroscopic, fire retardant.

Steel conduits and fittings shall comply with relevant specifications and shall be hot dip galvanized to class 4 protection, both inside and outside.

Conduit systems must be designed and installed so as to exclude moisture, dust and dirt. Small drainage holes must be provided at the lowest part of the system to avoid the accumulation of condensed moisture.

PVC conduits shall be provided with copper/brass terminals.

2.21. CABLE TRAY

In common sections to several electrical cables, cable trays shall be provided for laying the cables horizontally or vertically.

The cable trays must be fixed to walls or ceilings by suitable accessories which will ensure a good fixation, and should be treated against corrosion when metallic.

The cable trays that are installed together, may be placed at various levels, where deemed convenient.

Electrical cables must be tied or simply supported to ensure a good stability and parallelism between them.

Along with cable trays shall be provided all necessary accessories whenever there is a change of section or direction.

The cable trays are dimensioned in such way to have a reserve of 30% of the width and they will always be accessible to allow subsequent developments in the building.

The cable will be installed on one or two horizontal sheets maximum (or clovers for unipolar cables of the same circuit following the sections)

The cable trays are made of metal and stripped cable with equipotential bonding of 10 mm² made of copper is connected to them every 50 cm maximum, all the supports of the tray are connected to this stripped cable.

The supports of cable trays can be common with the supports of the other ducts in the circulations.

2.22. TRUNKING SYSTEM

Bi-compartmentalized PVC trunking shall be considered in some places.

Sizes and types of trunking shall be as called for in the various sections of the Specification or on the drawings, or shall in any case by sufficient size to accommodate the wiring required whilst still ensuring the appropriate space factor.

Plastic trunking shall be rigid PVC heavy gauge, white, high impact complete with lid, full length back tray and manufactured fittings.

Plastic trunking shall be installed in accordance with manufacturer's recommendations.

Plastic trunkings shall be secured rigidly to building fabrics using round headed steel wood screws in manufactured plugs with oversize washers to prevent screw heads pulling through holes in trunking

All plastic trunkings shall incorporate protective conductors.

All changes in direction of plastic trunking shall be carried out via purpose made accessories.

Plastic trunking shall be cut to length and access holes for conduit entry etc. shall be cut using only the manufacturer's special tools.

Surface fixed plastic trunking shall be routed as unobtrusively as possible following the architectural features of the room even if this entails longer runs of trunking. Trunking shall be run along full wall lengths and must not terminate part way along a wall, unless specified to the contrary.

Plastic trunking shall not be routed through areas suffering high or low temperatures.

2.23. BOXES

The boxes to be installed will be manufactured with halogen-free materials and will have low emissions of opaque smokes and toxic gases in case of fire. The types of boxes to be installed are:

- Boxes for a nested mounting, dedicated to the input and / or output of cables and circuit branching.
- Boxes for a nested mounting, dedicated to the switches and sockets fixing.
- Boxes with clamps for mounting on walls and false ceilings, dedicated to the switches and sockets fixing.
- Boxes for surface mounting, dedicated to the input and / or output of cables and circuit branching.
- Boxes for cable end with terminals, for surface mounting.

Each time metal boxes are installed, all elements will be equipotential with copper conductors or copper braids for moving elements.

2.24. BED HEAD UNITS (BHU)

Bed head panels combining high voltage equipment, low current and medical fluid network will be installed mainly in the rooms of accommodation units (ward). These panels will come in place of the traditional bed head units.

For a bed, the equipment provided is as follows:

- Mood lighting and care,
- Standby lighting;
- Reading lighting;
- Earthed Socket (BS Type) - 16A;
- Data Outlet 2xRJ45 CAT 6;
- Connection sockets for patient call / orders lighting;

All these lights will comply with current standards applicable to health facilities.

2.25. GROUNDING (EARTH) CONNECTION SYSTEM

The general ground network will be unique (TN-S), which will be guaranteed by an overall ground resistance of less than or equal to 1 ohm.

The distribution scheme of the critical medical premises will be of "medical" IT type.

The earth ring will be tied to the foundation level of the pillars of the metal armour.

Protection against direct lightning will be provided by a grid of conductors forming a Faraday cage and a lightning rod with initiation device (PDA).

The protection of persons against indirect contact will be made by the direct connection of earth terminal to earth, by devices with magneto thermal regulator and also by the use of sensitive devices with differential residual voltage.

2.26. LIGHTNING PROTECTION

It's planned to install lightning protection by lightning rod to allow the lightning currents flow to earth. This installation will cover the entire building, as well as the liberation station and transformer station.

The installation will be in compliance with the standards, consisting of two lightning rods with initiation device (PDA).

The lightning rod comprises:

- A point caprice in stainless steel, with elongated tubes; fixing to stud without rigging. Height following protection study;
- Two downlights for lightning rod made completely outdoors, in stripped copper conductor / cable of 50 mm², following the shortest path. In the roof, the fixation of the conductors on glued bases on the waterproofing. In the façade, fixation every 0.30 m.
- At 2 m from the ground, a lightning counter and a cut-off terminal for measuring the resistance of the earth electrode, for descent. Below this terminal, the descent conductor will be mechanically protected in a galvanized steel sheath;
- Two grounding connections made by 3 copper conductors 50mm², about 2 m, at 60 °, forming "crow's feet", buried at 0.80 m depth. Grounding value to obtain: less than 10 ohm;
- The metal elements on the roof will be connected by flat copper conductor 20x2.5 mm;
- They will be interconnected with the bottom loop of excavation of the building (main land).

For the installation see the details of the project Design.

2.27. VERIFICATIONS AND TESTS

The tests will include the following operations:

Examination verification

Intended to check if the permanently connected electrical equipment is:

- Complies with the regulations and standards.
- Selected and installed in accordance with the manufacturer's specifications, standards and instructions;
- Has no visible damage that may affect security or function.

This verification must include at least:

- Check of the good condition of the equipment;
- Control of cable sections;
- Control of protective devices;
- Presence of appropriate cutting and control devices;
- Choice of appropriate materials;
- Identification of neutral conductors and protective conductors;
- Realization of the connections of the drivers.

Tests:

- continuity of the protective conductors and connections;
- Insulation resistance in accordance with British Standard BS7671:2015 or equivalent;
- Measurement of the resistance of earth ground of the protective devices.

ELECTRICAL ENGINEERING

REHABILITATION OF THE SAUDI MATERNITY HOSPITAL

KASSALA HEALTH CITADEL, SUDAN

DETAILED DESIGN

TECHNICAL SPECIFICATIONS (EQUIPMENT AND MATERIALS)

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1. SCOPE OF WORKS AND REQUIREMENTS

1.1. GENERAL

The technical specifications and drawings are intended for the description and the execution of a completely finished work.

The Contractor shall carry out all the necessary works for successful installation of the electrical services as described and set out in this section of the Technical Specification, Bills of Quantities, other sections of the electrical documents and accompanying Drawings in accordance with the General Electrical Specification herewith.

The Works, the major elements of which are scheduled below, includes the supply of all labour, material, equipment, plant and components necessary for complete installation and setting out work in respect of the entire electrical services requirements within the proposed development and rendering it in complete working condition in respect of but not limited to the following installations:

- Primary & Secondary distribution (MV switchgear);
- Power Transformers;
- Power Generator;
- Energy Distribution;
- Truncking Systems;
- Distribution Electrical Switchboards;
- Earth Network and Foundations / Lightning Protection;
- Sockets for general purpose / Power Supplies;
- General Lighting / Emergency light;
- Fire Protection System;

The following items detail the solutions to be adopted.

1.2. SCOPE OF REQUIREMENT

The word “installation” shall mean not only the major items of plant and apparatus conveyed by this Specification and the Contract, but also all the incidental sundry components necessary for the complete execution of the work and for the proper operation of the installation, with their labour charges, regardless whether these sundry components are mentioned in detail in the tender documents issued in connection with the Contract.

2. ISS SUBSTATION & MV/LV TRANSFORMER SUBSTATION

2.1. MV SWITCHGEAR CUBICLES

The cubicles (cells) will be modular of prefabricated type, metal-enclosed, forming a single-piece assembly and equipped with fixed air-insulated medium voltage switchgear. Air-insulated technology will be used.

The cubicles (cells) will be aligned on the front of the board.

MV cubicle (cell) design must allow easy access to the protection fuse, and the connections that will be made from the front of the equipment.

Operational factors and classifications for the design and construction of the MV cubicle:

- Rated voltage max. 24 kV (11 kV);
- Rated current to 630 A;
- Rated frequency 50 Hz;
- Rated short-time withstand current 16 kA / 1s;
- Protection class IP4X;
- Range of ambient temperature: –5 °C ... +41 °C

The connections will be made from the bottom. The company shall command the civil engineering reservations needed for the direct penetration for the cables into the MV cubicles that will be placed on the ground and in the foundation cubicles.

The cubicles will be fixed to the ground by threaded rods or T-nuts and M8 screws, according to the manufacturer's specifications.

In order to avoid intrusion of rodents into the cubicles, the cubicles shall have a minimum protection rating of IP 4X and the cable passages in the lower part will be done through pass prefabricated cables to maintain this IP 4X.

General Characteristics:

- Modular construction;
- Expandable;
- Small installation area;
- Operational simplicity;
- Exclusively operated from the front;
- Internal arc resistant;

- Equipped with a vacuum circuit breaker with high electric and mechanical life (E3 and M2 classes) or contactor;
- Reliable and requires little maintenance;
- Insertion/extraction of the circuit breaker with the compartment door closed;
- Several optional equipment.

2.2. POWER TRANSFORMER

This specification covers design, engineering, manufacture, assembly, stage testing, inspection and testing before supply and delivery at site.

The Power Transformer shall conform in all respects to highest standards of engineering, design, workmanship, this specification and the latest revisions of relevant standards at the time of offer and the employer shall have the power to reject any work or material, which, in his judgment, is not in full accordance therewith. The Transformer(s) offered, shall be complete with all components, necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of supply, irrespective of whether those are specifically brought out in this specification and / or the commercial order or not.

The transformer and accessories shall be designed to facilitate operation, inspection, maintenance and repairs. The design shall incorporate every precaution and provision for the safety of equipment as well as staff engaged in operation and maintenance of equipment

Each transformer shall be capable of uninterrupted operation and shall have the minimum characteristics as follows:

- Cooling methods: Oil type transformers (Oil-Immersed - Hermetically Sealed) ONAN
- Transformer rating (Standard): 500 kVA;
- Cooling medium:
- Primary voltage: 11kV;
- Secondary voltage: 415/240 V;
- Frequency: 50 Hz;
- Coupling: Dyn 11;
- Rated voltage (medium voltage) max. 24 kV
- Rated short-time withstand current (medium voltage) 16 kA / 1s;
- Rated insulation voltage (low voltage) 1,000 V;

- Rated current (low voltage) up to max. 2,500 A;
- Protection class IP2X.
- Type of mounting: On Wheels, Mounted on rails.

The Transformers shall be suitable for satisfactory continuous operation under the local climatic conditions.

2.3. ENERGY METER

The meter should be able to perform satisfactorily in hot climate. The climate conditions are also prone to wide variations in the ambient conditions. The meter shall work satisfactorily even under lightning conditions and also the meter performance and life shall not be affected due to dust present in the atmosphere.

Energy meter along with its accessories shall withstand following extreme operating conditions.

- Voltage: 70% to 120 % of V ref;
- Frequency: 50 ± 5% Hz;

The manufacturer can also offer meters, which can withstand higher variations.

The meter should be only factory calibrated and no modification of calibration should be possible at site to ensure none tampering of meter at site.

3. DIESEL GENERATOR (DIESEL GENSET)

3.1. DESCRIPTION OF FEATURES

3.1.1. DESCRIPTION

The purpose of this document is to describe the generating set installations.

The 450kVA (ESP) generating set will operate as backup generators in place of the main power grid in the event of a mains power failure.

The connection between the power plant and the low voltage central control panel is included in the Mains switchboard.

The installations include:

- Supply, transport and installation of generating set(s), coolant system, exhaust silencer, machine cabinets;
- Installation of generating set(s) on the site;
- Exhaust circuit including chimney;
- Fuel circuit including daily service tank and tank;
- Ventilation circuit including rain screen grilles;
- Electrical connection of generating set to cabinet and generating set auxiliary;
- Site smoke control;
- Installation commissioning;
- Training;
- Studies and documentation.

3.1.2. APPLICABLE DIRECTIVES AND STANDARDS

Reference system for the Standards and directives governing generating sets.

Directives

- Machines directive (1)	98/37/CE
- Low voltage directive	206/95/CE
- EMC directive (2)	89/336/CEE
- Outdoor directive	2000/14/CE
- (3) Directive 2006/42/CE (29/12/94)	
- (4) Directive 2004/108/CE (01/07/07)	

General Information

- Engine output	ISO 3046-1
- Performance, generating set application classes, methods of application , and others.	ISO 8528-1 to 10
- Generating set safety	EN 12601
- General safety principles	ISO 12100

Engine

- Measuring exhaust gas emissions	ISO 8178

- Engine safety EN 1679-1

Alternator

- Rotating electrical machines IEC 60034

Electrical equipment

- Electrical safety IEC 60364-4-41
- Control gear and switchgear ISO 8528-4
- Low voltage equipment IEC 60947-1 à 13
- Low voltage equipment assemblies IEC 60439-1
- Degrees of protection (IP) provided by enclosures for electrical equipment IEC 60529

This list is not exhaustive. It summarizes the main standards and directives which apply.

3.1.3. QUALITY

The entire project (studies, construction and installation) shall be managed using a business management process according to ISO 9001 certification guidelines (2000 version).

The company shall include in its tender a summary of its Quality Management Procedure.

3.1.4. DEFINITION OF SERVICE

The emergency standby power is the standby power available for emergency use under variable loads in accordance with ISO 8528-1. No overload is available for this service.

Emergency standby power applies to installations served by a reliable utility source. Standby power is applicable to varying loads for the duration of the utility power interruption.

3.2. DESCRIPTION OF FEATURES

It is considered the supply and installation of a power generator Unit, 900kVA output in Standby Power (ESP) and 405kVA in prime service, (PRP "Prime Power" according to norm ISO 8528-1), FP=0,8, 50 Hz and 1.500 rpm, including a Fuel tank with a capacity of 540 litters, filled, for a range of 11 hr at 100% of the Prime Power.

3.2.1. FACTORY TESTS

The purpose of the tests, attended by the customer or his representative, is to validate the technical performance of the generating sets.

Tests on the complete generating sets assembled in the factory, in the presence of the Client, the Project Manager and the control office. The costs of transport and accommodation are borne by the contractor for this lot.

Visual inspection of the station before starting:

Static examination enabling the conformity of the assembled elements to be inspected:

- General appearance (paints, finish, welding, mountings, etc.)
- Dimensional (overall dimensions, etc…)
- Indications of the manufacturer's plates
- Protection against direct contact (busbars, etc.…)
- Dimensioning of the connection points (electrical or mechanical)
- Inspection of the circuit breaker (number of poles, starting value, etc.)

Functional tests:

- Tests on safety devices;
- Checking of information on the command and control desk or cabinet;
- Visual inspection of the circuit sealing: cooling circuit, oil circuit and fuel circuit;
- Checks on absence of vibrations and abnormal noises;
- Examination of the starting and stopping cycle;
- Operating tests of the automatic control units.

Load tests:

The load tests will be carried out in steps of 25 %, 50 %, 75 %, 100 % and 110% on cos phi 1 liquid resistances.

At each of these steps the following must be recorded, indicating the electrical parameters:

- Voltage;
- Frequency;
- Intensity;
- Power.

At 100 % and 110 %, additional oil pressure and water temperature recordings must also be noted.

Load impacts:

The load impact measurements must be carried out at different steps of the power assigned with a flat table tracer.

A graphic recording of the frequency and voltage transients must be performed at each of the following impacts:

- > 0 -25 % / 25 - 0%
- > 0 -50 % / 50 - 0%
- a test at maximum power meeting the acceptance criteria for the voltage and frequency drops
- a test at the maximum power applied to the set outside the acceptance criteria
- The results must be entered on a sheet of tests listed in the quality system.

Validation:

After the tests a factory acceptance test report must be signed.

3.2.2. TECHNICAL DOCUMENTATION

User and maintenance manual for generating sets

This reference material provides users with information concerning the equipment, operating instructions, and guidelines on daily maintenance.

- Documentation for alternators General information -Safety instructions -Installation -Special maintenance instructions.
- Descriptive documentation and user manuals for control units: this documentation provides users with information concerning the equipment and operating instructions.
- Technical documentation for engines
- Technical

Engine parts catalogue

This documentation enables users to identify a part for the purposes of ordering a replacement.

- Repair and workshop manual
- This documentation enables expert users to carry out equipment repairs.
- Wiring diagrams of the command and control system
- Factory test procedures for the assembled sets

– Summary of the Quality Management manual

3.3. MONITORING AND CONTROL SWITCHBOARD

The power generator set is equipped with a reliable monitoring and control switchboard. This equipment is mounted on the power generator.

3.3.1. AUTOMATIC SWITCHBOARD

The equipment must be based on a programmable module with three microprocessors, specialized in their respective tasks of electrical measurements, the generator logic and communications group, which gives the equipment a good performance process.

Should be prepared to work under extreme ambient temperatures from -30ºC to + 70ºC; and a great protection against electrical disturbances such as lightning discharges.

The screen must be at least a TFT Color 5.7 "display. The front panel keys must allow access to different screens.

4. TERTIARY POWER SUPPLY (UPS)

For priority loads (medical IT services) and ICT equipment, will be considered a decentralized UPS's Systems, restricted to supporting critical care and essential services rather than being a main (whole site) SPS.

- Medical (UPS system) – for medical and healthcare applications;
- ICT (UPS system) – for ICT equipment. The source will consist of a rack mount UPS.

Observation: For Priority loads (critical care) central UPS systems have risks to be consider, like location and segregation of UPS distribution cabling and switchboard configuration, to avoid a single fire or fault affecting the whole system.

The Topology of the UPS Systems must be VFI (Voltage and Frequency Independent accordingly with classification mentioned in the IEC62040-3Standard), in order to guarantee filtered and stable output voltage to the load, independently from the input voltage. This means that the output is obtained by two converters in cascade. The first converter rectifies the AC input voltage, the second converter (Inverter) transforms the DC voltage, coming from the rectifier, in AC voltage to supply the load. This double conversion allows to completely clean eventual disturbs from the mains. In case of anomalies in the input voltage, the DC voltage, which supply the Inverter, can be obtained, thought a booster circuit, from batteries. In this way the output is always guaranteed with continuity. In case of overloads or faults, the automatic static by-pass guarantees the load supply.

4.1. STANDARDS

- EN 62040-1-1 (Security);
- EN 62040-2 (EMC);
- EN 62040-3 (Performance and Topology);
- CE Certification;
- IP 20 (according to IEC 60529).

4.2. FUNCTION PRINCIPLE

The UPS should be of the On-line double conversion and work in the following ways:

- Normal operation - When the network is present;
- Under Batteries - When the network is not present or is outside the tolerances;
- Normal Operation with Battery Recharging - When the network returns;
- Operation in static bypass - When the overload occurs;
- Operation in Bypass Manual - For maintenance operations.

5. LOW VOLTAGE SWITCHGEAR

5.1. MAIN & SUB-MAIN DISTRIBUTION BOARDS

The Main & Sub-Main Distribution Board/s (MDB/s & SMDB/s) shall be of floor-standing, totally enclosed type, built up from enclosed units housing the Air Circuit Breakers (ACB), Moulded Case Circuit Breakers (MCCB), Fuses, Contactors, Relays, Bus Bars and other ancillary equipment as shown on the drawings.

MLVS shall fully comply with BS EN 60439 – 1 and the segregation amongst the Switchgear components shall be of Form 3b.

The Bus Bar system of the MDB shall be capable to withstand the electrical and mechanical stresses and temperature rise produced by a fault with a magnitude of 25kA for 3 seconds.

The construction of the indoor type MDB shall be designed to have the degree of protection of IP42 or higher in accordance with the standard requirement of IEC 60529.

The construction of the MDB shall be modular construction metal enclosure by electro galvanized steel sheets not less than 2mm thick and Epoxy powder coated to BS 4800 to provide resistance to corrosion.

The panel shall be built up on substantial framing with all necessary stiffeners and supports with no cross struts. The entire panel shall be vermin proof.

Front access doors shall be provided and with hinges and lockable handles to facilitate inspection and maintenance. Removable gland plates shall be provided at the top and at the bottom of the switchboard with knockouts or blanked off openings for incoming and outgoing circuit cables.

All doors shall have concealed hinges and where necessary, shall be interlocked with the switch mechanism. All doors shall be provided with gaskets made of Neoprene or other equal and approved material to prevent ingress of dust.

5.2. SUB & FINAL DISTRIBUTION BOARDS

The distribution Board/s (DB/s) installed for connection of the final Circuits within the electrical installations shall be factory built complying with BS EN 61439/IEC 61439. An integral isolator shall be provided for isolation of the incoming supply. The circuit breaker accessories, etc. shall generally comply with the international standards. Re-wirable type fuses shall not be permitted in any type of wiring installation.

5.3. EQUIPMENT REQUIREMENTS

For each equipment, required IP rating and short circuit rating capacity will be specified.

All the equipment's will be factory fabricated in an approved factory having modern fabrication and testing process. It shall have seven tank pre-treatment process comprising of degreasing, rinsing, de-rusting, rinsing, phosphatising, rinsing and passivation followed by powder coat painting having a paint thickness of 60 microns or as specified. The powder paint will be subjected to oven-heated process. All panels will be provided with suitable gasket to make it dust/ vermin proof.

As a general practice only prewired MCB/HRC type DBs shall be used, on account of their superior technical features, compared to conventional DBs, which don't allow for proper wiring space and wiring termination. Rewirable fuse type DBs shall not be used.

5.4. SWITCHBOARDS CHARACTERISTICS

a) WALL MOUNT

The body frame and door should be metal with interior self-extinguishing polyester. Should be versatile and flexible composition and easy installation. The chassis should be removable for bench electrification. Should allow modular devices assembling simply and rapidly, with the following main features:

- Rated current 630A
- Degree of Protection IP 31
- Isolation I
- Standard IEC 61439
- Mechanical impacts IK 10
- rated insulation voltage for the main busbars 1000 V
- peak withstand current Ipk 53 kA
- short time withstand current Icw 25 kA ef/ 1 s
- Frequency: 50/60 Hz
- Color White RAL 9001
- Frame height 450 a 1750mm
- Widths 600 mm
- Depths 260 mm + door
- Reversible door Transparent

Reference equipment: Schneider / Prisma G, or equivalent.

b) General Characteristics of the devices/mechanisms

The low voltage switchgear shall comply with EN 60 947.

Switches General:

Four-pole load break, compact type, with the rated current indicated on the drawings.

Residual current device or ground-fault circuit equipment (RCD or GFPE):

Bipolar or four poles set for the rated current and rated differential triggering currents indicated on the drawings.

Switches:

Unipolar or bipolar, modular type, with the rated current indicated on the drawings.

Breakers:

With the number of poles indicated on the drawings and ultimate breaking capacity appropriated for the switchboard in which they are installed.

Shall be modular type or in molded case, depending on the sizes and the frames where they will be installed.

Residual-current circuit breaker with overload protection (RCBO):

Bipolar or four pole set for the intensities and shooting nominal differential currents indicated on the drawings.

Contactors:

Shall be provided for the operating rated current AC3.

Voltage flags:

Shall be modular with optical indicator.

Disconnectors fuses:

Shall be equipped with fuses with high rupturing capacity, withdrawable type via knob tipper, equipped with cylindrical fuses 10,3 x38, and size indicated in drawings.

Rail:

In ladder and fitted with rail plastic transparent protection, insulating and self-extinguishing.

Rulers Terminals:

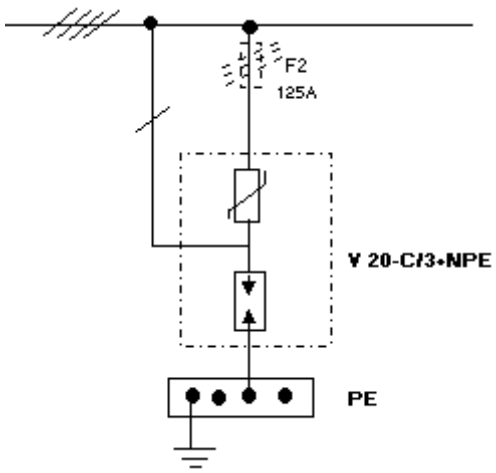
Terminals with insulating body, nonflammable, insensitive to climate and thermal variations.

All terminals shall be marked to allow simple referencing. The terminal blocks shall be withdrawable type.

Reference equipment: SCHNEIDER / Multi9 and Compact, or equivalent.

Surge Arresters:

Overvoltage, embedded within a closed box, with the following features:

Switchboard: Surge arrester on monoblock base with pluggable protection modules, electrified in 3 +1 scheme, equipped with varistors between phases and neutral with 20kA nominal discharge capacity (8/20) and module NPE between neutral and earth of 50kA (8/20). With local signaling of the operating status of the varistor: - Model: V20-C / 3 + NPE 125A Fuses Necessary when the overall protection exceeds 125A	

Reference equipment: Obo Bettermann / V20-C/3+NPE, or equivalent.

5.5. MANUAL MUSHROOM HEAD BUTTON

Emergency pushbutton with breakable glass suitable for surface mounting, red body and mushroom button head, unlocking by key, equipped with two signalling LEDs (red / green - 230V - 20mA).

Features:

- In accordance with standard NFC 15-100
- IP44 - IK07
- Class II insulation
- Equipped with contacts 1NO +1 NC
- Dimensions: 125x125x71mm

Reference equipment: LEGRAND /Model 380 09, or equivalent.

6. EARTH CONNECTION

6.1. EARTHING SYSTEM – FOUNDATION EARTH ELECTRODE

Foundation earth electrodes are conductive metal parts embedded in the concrete of the building foundation. Concrete embedded directly in the ground has natural moisture content and can be considered as conductive matter, with conductivity similar to that of the earth. Because of the large area of this type of electrode, low resistance can be achieved.

Furthermore, the concrete protects the metal parts against corrosion and steel electrode elements embedded in the concrete do not need any additional corrosive protection. Foundation earth electrodes are nowadays recommended as a very practical solution to building earthing.

6.1.1. MATERIALS

The earth electrode is made from:

Inside the concrete

- Flat conductor with a rectangular cross-section 30x3,5mm, galvanized steel according ISO 1461
- Spacer 250mm long, galvanized steel,
- Cross-connector for flat conductors, galvanized steel,
- Cross-connector for flat conductors and round conductors, galvanized steel,
- Connection terminal for reinforcing steels, galvanized steel,

Outside of the concrete – In the ground

- Flat conductor with a rectangular cross-section 30x3,5mm, made of stainless steel
- Earthing rod Ø 20mm x 1500mm, made of stainless steel
- Connection clip for earthing rod, stainless steel

6.2. EQUIPOTENTIAL BONDING

The equipotential bonding system is the link between external lightning protection, surge protection and earthing. In order to avoid damage inside the building, a lightning protection equipotential bonding is necessary.

6.2.1. SYSTEM COMPONENTS TO BE CONNECTED

The following system components must be connected to the equipotential bonding:

- Metal carcass of the structure
- Metal installations
- External conductive components
- Electrical energy and information
- Technology systems

6.2.2. INSTALLING THE EQUIPOTENTIAL BONDING

The equipotential bonding should be installed at the basement or at ground level. The electrical energy and information technology lines must be connected to the equipotential bonding via Type 1 lightning current arresters. The arresters must be connected to the equipotential bonding as close as possible to where the lines enter the building. The surge arrester connection must comply with DIN VDE 0100-534.

6.2.3. MATERIALS

The following cross-sections apply as minimum dimensions for connections in the lightning protection equipotential bonding

- Copper: 16 mm²
- Aluminum: 25 mm²
- Steel: 50 mm²

Main equipotential bonding rail – copper 40x5 mm with 10 lock bolts M10, type 1802/10 Cu,

Local equipotential bonding rail – brass with cover, type 1801/VDE

Reference equipment: Obo Bettermann or equivalent.

6.3. MAIN EARTHING TERMINAL

A solid copper main earthing terminal of ample size shall be provided for every electrical installation at a position near the main incoming switch or switchboard for the connection of:

- the circuit protective conductors,
- the main equipotential bonding conductors,
- the functional earthing conductors,
- the earthing conductors and
- the lightning protective system bonding conductors.

To create the equipotential zone. The main earthing terminal shall be connected to Earth via an earthing conductor to an earth electrode or a group of electrodes.

Where an installation distributes to a number of buildings or units, a separate main earthing terminal shall be provided for each individual building or unit at the point of intake thereby creating a separate equipotential zone in each building or unit.

7. LIGHTNING PROTECTION SYSTEM

Lightning protection systems shall be installed in accordance with the Particular Specification and Drawings, and as directed by the Architect.

The installation shall conform to the requirements and recommendations set out in the British Standard BS 6651 “Code of Practice for Protection of Structures against Lightning”

7.1. DOWN-CONDUCTORS (ARRESTOR SYSTEM)

The arrestor system routes the lightning current from interception system to earthing system. The number of arrestors is derived from the scope of the building to be protected. Care must be taken to ensure that the current paths are short and installed without loops. The number of down conductors is showing in the drawings

The use of reinforcements as conductors optimizes shielding against external electromagnetic interferences.

7.1.1. NATURAL COMPONENTS

The interconnected steel framework of the structure is to be used as natural down-conductors.

Accessories:

- Construction clamp to 20mm, type 5010/20FT for connection, on bottom of steel pillar with earth conductor and on the top with interception system.

7.1.2. CONDUCTORS INSIDE CONCRETE PILLARS

In building structures that feature steel reinforced concrete pillars and walls, the conductors can be routed in the reinforcements.

The down-conductors are established inside the steel reinforced concrete pillars.

The conductors also have to be clamped to the steel reinforcements.

Earthing fixed points should be used as connection points for conductors and equipotential bonding.

7.1.3. MATERIALS

- Round conductor cross-section 50mm², Ø 8mm, galvanized steel according ISO 1461;
- Cross-connector for round conductors, galvanized steel;
- Connection terminal for reinforcing steels, galvanized steel;
- Earthing fixing point, made of stainless steel, contact plate Ø 79 mm, thread M10;
- Construction clamp to 20mm, galvanized steel.

7.2. DOWN-CONDUCTORS (ARRESTOR SYSTEM)

The external LPS is intended to intercept direct lightning flashes to the structure, including flashes to the side of the structure, and conduct the lightning current from the point of strike to ground. The external LPS is also intended to disperse this current into the earth without causing thermal or mechanical damage, or dangerous sparking which may trigger fire or explosions.

The interception system is composed by the combination of the following elements:

- Meshed conductors;
- Rods.

7.2.1. INTERCEPTION SYSTEM FOR BUILDINGS WITH ROOF STRUCTURES

All metallic parts of a building and electrically powered equipment and their supply cables must be integrated into the lightning protection system. This measure is required to avoid dangerous sparking between both interception system and arrestor and also the metallic building parts and electrical equipment.

The insulation by separation distance is necessary for air-conditioning systems, photovoltaic systems, electrical sensors/actuators or metallic vent pipes with conductive lead into the building.

7.2.2. MATERIALS

- Round cable, galvanized steel according ISO 1461;
- Vario Quick connector, steel galvanized, for T, cross and parallel connections;
- Roof cable holder for flat roofs, stone from concrete with plastic bottom;
- Interception rod, aluminum, with concrete stand;

Reference equipment: Obo Bettermann or equivalent.

8. LIGHTING

In this chapter we consider the following types of lighting:

- Normal Ambient lighting;
- Emergency lighting.

8.1. NORMAL AMBIENT LIGHTING

8.1.1. GENERAL

All luminaires must be an approved type and manufacture, and be manufactured in accordance with the appropriate Design and Installation Standards and Requirements.

LED lighting only shall be used. The installer / manufacturer shall warrant the equipment, control gear, drivers, and luminaire for 5 years or 50,000 hours from the formal completion of the works.

All luminaires shall properly electrified with lamps and accessories for a voltage of 240 V, 50 Hz.

All luminaires are fixed to the ceiling or walls in order to ensure a strong fixation.

All lighting appliances shall follow the directive to electromagnetic compatibility relating.

The lighting appliances shall conform to IEC 598, regarding the implementation and security.

8.1.2. INDOOR LUMINAIRES DESCRIPTION

See the legend of the lighting drawings and the attached technical report.

8.2. EMERGENCY LIGHTNING

In the situation of normal network failure, will enter service security lighting will ensure the minimum illumination for safe evacuation and easy public abroad and execution of maneuvers concerning the safety of aid and intervention.

The emergency lighting shall consist of two types of lighting:

- Lighting Circulation (evacuation)
- Lighting Environment (anti-panic)

The emergency lighting to be implemented consists of autonomous blocks equipped with led lamps.

8.2.1. CIRCULATION LIGHTING

In all corridors and escape routes will be installed autonomous blocks fitted with a led lamp 3W, for continuous operation, powered from batteries incorporated in the unit, which will ensure the safe evacuation and easy public (in fault situations network).

The autonomous blocks possess autonomy of at least one (1) hour.

All autonomous blocks will be endowed with pictographic symbols, clearly indicating access to outside according to Ordinance 1456A/95.

The light path of movement of each evacuation length exceeding 15m is made by at least two independent blocks.

8.2.2. ANTI-PANIC LIGHTING

The emergency and safety lighting will be guaranteed by the normal ambient lighting, supplied by the backup power system of the hospital

8.3. EXTERNAL LIGHTING

Where specified in the project, complete external lighting systems must be provided, including supply and assembly of all posts, columns and supports.

Includes free standing columns, and luminaires fix to structures and buildings.

The luminaires mounted on buildings, must have the wiring routed within the building.

All columns must be of the flange base type, suitable for fixing to concrete foundations.

8.4. INSTALLATION

8.4.1. PENDANT

Tube pendant shall comprise a dome cover and a biscuit ring and a piece of screwed steel conduit of suitable length to give the required mounting height of the luminaire.

Plain pendant shall comprise a ceiling rose and a cord-grip lampholder connected by a flexible cord having a suitable length to give the required mounting height of the lamp shade.

8.4.2. LUMINAIRE MOUNTED ON PATTRESS

When a luminaire is not provided with facility for a surface cable entry, the luminaire shall be mounted on pattress. The cable shall then enter the luminaire from the rear through a slot and a hole formed in the pattress.

8.4.3. CEILING ROSE

Ceiling rose shall not be used for the attachment of more than one outgoing flexible cord or cable unless it is specially designed for multiple pendants.

8.4.4. CABLE IN ENCLOSED LUMINAIRE

Cables within an enclosed type luminaire shall be of heat resistant type. Cables entering the luminaire shall be protected by heat resistant insulating sleeves. The sleeves within the luminaire shall be extended to a distance of 150mm outside the luminaire.

Heat resisting cables shall be selected in accordance with the appropriate tables given in IEC 60364.

8.4.5. SPECIAL REQUIREMENTS FOR OUTDOOR LUMINAIRES

Outdoor luminaires shall be able to withstand the weather. Metal work should be protected against corrosion, and parts which have to be removed for access to the interior shall be provided with proper gaskets to restrict the entrance of moisture and dirt. Mounting brackets shall be heavily galvanized and stainless steel or galvanized bolts and nuts shall be used.

The adjustment bolts and nuts of a luminaire which is mounted on high level shall be captive to prevent accidental loss during servicing. Safety chains shall be provided to hold the luminaire from falling. A luminaire installed in a location within hand reach shall be of robust construct, fitted with an impact-resistant transparent or diffusing front panel, and shall have secret key fixings for the panel to the body of the luminaire.

Where necessary, wire guards shall be fitted over the front panel to give extra protection.

8.5. DEVICES

All devices/mechanisms will be for the rated current 10, 250 V, 50 Hz

8.5.1. FLUSH MOUNT

The devices/mechanisms for flush mounting is fixed to switchgear boxes fit through appropriate supports. The various appliances when installed in groups always take individual frames.

Reference equipment: Berker (British Standard) / model K1, or equivalent.

8.5.2. SURFACE MOUNT

The surface mount devices/mechanisms will be waterproof type IP55 - IK07.

Reference equipment: Berker (British Standard) / model Aquatec, or equivalent.

8.5.3. INSTALLATION OF DOMESTIC SWITCHES

Switch for domestic and similar purposes shall be mounted at a height of 1350mm above finished floor level unless otherwise specified.

When lighting switches are mounted adjacent to one another, they shall be grouped in a single enclosure (multi-gang box) and shall share a common switch plate, subject to a maximum of three lighting switches per single-gang plate.

Lighting switches installed adjacent to a door shall be located on the handle side of the door, and shall be as near to the door as practicable.

8.6. PRESENCE DETECTORS AND LUMINOSITY

8.6.1. WALL MOUNTED

- Wall motion detector with the sensing field 180 ° relay model
- With acoustic sensor for use in embedded spaces injured or obstacles
- Programmable distance remote control, p. former., permanent light
- ON / OFF and automatic read function of the current brightness value
- Compatible with tag switches, substituting therefore any conventional switch
- Model IP 44 suitable for damp rooms, garages and access to caves
- Vandal resistant cover with stainless steel screws (accessory)

- Double-socket terminals for through-wiring allow for quick and simple assembly
- Manual switching of the switch ON / OFF / AUTO integrated
- Prevents inadvertent switching, for example, small animals to hide part of the sensing field with vertical adjustable cap included
- Mounting box IP 54 with three tabs membrane cable.
- Function integrated impulses to trigger PLC ladder or signaling devices/mechanisms and application in intelligent buildings

Technical characteristics:

- System voltage 240 V CA, 50 Hz
- Approximate power consumption. 0,9 W
- Detection field 180° horizontal, 60° vertical
- Reach 8 m, with mounting height of 1.1 m - 2,2 m
- Adjustment options: level through mechanical potentiometers; the electronic level with infrared remote control; Mobil-PDi/MDi (included)
- Power Switching 240 V CA 50 Hz: 2300 W/10 A (cos ϕ = 1), 1150 VA/5 A (cos ϕ = 0,5)

Timing:

- Pulse of about 15 s - 30 min.
- Brightness value about 5 - 2000 Lux
- Input device "slave" Yes
- Allowable temperature -25 °C...+55 °C
- Protection Level IP 44
- Protection Class II
- Certification TUV Sud
- Mounting Type Wall Mount
- Casing UV-resistant polycarbonate

Reference equipment: BEG, model 180i/R+Panel IP44 or equivalent.

8.6.2. CEILING INSTALLATION

a) ON/ OFF CONTROL

Presence detector with field detection 360, 10m range, ceiling mount, recessed.

Recommended mounting height of 2.5 m in height

Channel 1 for lighting control based on the presence, with constant measuring the amount of light, making the drive lighting when natural light level drops below the programmed through software calculation inserted into the detector.

Model IP 20 for mounting recessed.

Control and programming via remote control, ability to turn on / off the light permanently.

Possibility of expanding the field of detection of the detector by coupling master Slave detectors

Reference equipment: BEG, model PD9-M-FC-White or equivalent.

b) ON/ OFF CONTROL IP65

Presence detector with field detection 360, 10m range, ceiling mount, recessed. Recommended mounting height of 2.5 m in height

Channel 1 potential free control for lighting because of the presence with constant measuring the amount of light, making the drive lighting when natural light level drops below the programmed through software calculation inserted into the detector.

Model IP 65 for mounting recessed.

Control and programming via remote control, ability to turn on / off the light permanently.

Possibility of expanding the field of detection of the detector by coupling master 1 slave detector, which can be installed up to 3m detector master

For use in bathrooms, shower cabins, among other.

Reference equipment: BEG, model PD9-M-SDB-FC-white or equivalent.

9. SOCKETS-OUTLETS AND DRIVING FORCE

All sockets used will be always provided with earthing contact, British Standard model, in versions for surface mounting, mounting pad and installation in trough footer.

9.1. SOCKETS

9.1.1. SINGLE-PHASE SOCKET

The single-phase sockets with earth terminal, will be British Standard type with rated current 16 A, 240 V, 50 Hz, designed without active parts accessible to the user.

The sockets installed on technical areas shall be suitable for surface mounting. Elsewhere shall be suitable for flush mounting.

a) Flush Mounting

The sockets for flushed mounting are housed inside the devices recessed-mounting boxes, to which they are fixed by screws.

All sockets when installed together, always inherit individual mirrors.

Reference equipment: Berker (British Standard) / model K1 or equivalent

b) Cable Tray Mounting

The single-phase sockets for mounting on underfloor boxes shall be British Standard type.

Reference equipment: Berker (British Standard) / model K1 or equivalent.

9.2. INSTALLATION OF SOCKET OUTLETS

Socket outlet intended for supplying a fixed or stationary appliance shall be located as near as possible to the appliance.

Socket outlet shall be mounted at a height of 1350mm above finished floor level in kitchens, sculleries, ironing rooms and the like. In other locations, they shall be mounted at 300mm from finished floor level, 75mm from surface top measured from bottom of socket outlet or as specified.

The installation of socket outlets in hazardous areas should be avoided as far as possible. Where it is absolutely essential to install a socket outlet in such area, the socket outlet shall be type ‘e’ - increased safety conforming to IEC 60309-3 and shall be controlled by a sparkles switch. The socket outlet shall be interlocked with the plug so that removal or insertion shall not be possible unless the controlling switch is

in the OFF position. The plug shall have shrouded pins and the design of the pin contacts shall be such as to guard against development of hot spots or sparking.

10. CABLE TRAY

In sections common to several electrical cables shall be proposed cable trays (shelves) for laying the cables horizontally or vertically.

The cable trays are fixed to walls or ceilings by suitable fixing devices which ensure a good attachment, and when they are metallic shall be treated against corrosion.

The cable trays that are installed together, may be placed at various levels, where deemed appropriate.

Electrical cables are tied or simply supported so as to ensure a good stability and parallelism between them.

Along with cable routes shall be provided the necessary accessories whenever there is change of section or direction.

In addition to the proposed cable tray more can be installed in other false ceiling areas in alternative to cables fixed by clamps mounted at sight.

In the floor transitions shall be considered cable trays with dimensions identical to those used in the horizontal pathways.

10.1. FIXING

Cable trays shall be fixed securely to the walls, ceiling or other structure by means of mild steel hangers or brackets of adequate mechanical strength. The hangers or brackets shall be painted with anti-rust epoxy paint unless otherwise specified. Fixings for cable trays shall be disposed at regular intervals not exceeding 1.2m for straight run and at a distance not exceeding 225mm on both sides from a bend or intersection.

A minimum clear space of 20mm shall be left behind all cable trays.

10.2. FIXING OF CABLE ON TRAY

Saddles for securing multi-core cables to the cable tray shall be made from PVC covered metal strip, and shall be shaped to the form of the cables to be secured. The saddles shall be fixed to the cable tray by means of corrosion resistant cheese-headed screws and nuts. The shanks of the screws shall not protrude beyond the nuts by more than three threads. Where saddles exceed 150mm in length, intermediate fixings shall be provided such that the maximum spacing between screws shall not exceed 150mm.

Single-core cables shall be secured to the cable tray by clamps made of wood or other non-ferrous materials specially designed to suit the dimension of the cables. The clamp shall be secured to the cable tray by means of bolts, washers and nuts.

Cable saddles or cable clamps shall be provided along the entire cable route with their spacings in accordance with the manufacturer's recommendation.

10.3. CABLE TRAY IN STEEL PLATE

The cable trays in steel plate perforated galvanized by Sendzimir method.

Shall be installed where indicated on plans and will support the various wiring.

Reference equipment: Obo Bettermann, model RKS-Magic FS or equivalent.

10.4. SERVICE OUTLET

Service outlet for twelve accessories module 45 in three GB3 mounting boxes for use in raised floors systems. Universal fixing bracket, adjustable to raised floor thicknesses to 65 mm. Carpet protection frame, hinged cover and cord outlet made of polyamide. Allow 5 mm floor covering recess in the hinged cover, if necessary, adjustable to 3, 8 or 10 mm.

Reference equipment: OBO Ackermann, model GES9DBK1 or equivalent.

11. WIRING

Cables for lighting and bell circuits shall have CSA of not less than 1.5mm², and those for power circuits shall have CSA of not less than 2.5mm². Internal wiring in factory made panel or equipment may comprise cables of different suitable CSA determined by the manufacturer.

The CSA of any cable shall not be reduced at its point of termination, junction, joints, etc.

Where signal cables of less 1.0mm² are to be terminated, approximately 15mm long of cable insulation shall be removed and half the length of the bare conductor shall be bent into the other half to form a solid part prior to the insertion into the termination.

In areas with ceiling void, between the cable tray and the terminal equipment, it shall be provided cable mechanical protection, consisting on tubes fixed on clamps.

In general, and as an alternative to cables fixed directly on clamps, they can be threaded into tubes of appropriate diameter, as long as the distances to overcome are appreciable.

The conduits to apply the salient premises must be formed by halogen-free material not flame spreader, and may be of thermoplastic material, VD type, when in masonry elements.

The tubes when installed in a building void (ceiling void), shall be mounted on plastic brackets:

- 1 conduit .....simple band
- 2 conduits .....double band
- more of 2 conduits .....band in perforated trays

The maximum distance between brackets will be:

- 0,50 m for conduit Ø 16 and Ø 20
- 1,00 m for conduits of diameter equal or greater than Ø 25

The diameters of the conduits for cables provided are as follows

All screws of clamps should be galvanized iron or brass

The tubes when in masonry should be embed 3 cm from the surface of the walls and involved in cement grout of the same composition as the wall.

The connection between the tubes themselves shall be made by appropriate unions, properly bonded by cellulosic type glue.

For wire threading ease, the conduits should intercalate terminal boxes with appropriate dimensions for the number and diameter of conduits, in each 10 meters of the straight sections and all points considered focal (changes in direction and curves).

In embed premises all conduits should intercept the mechanism recessed-mounting boxes vertically (from below or above), not being allowed oblique routes.

12. BOXES

a) Junction boxes and passage for surface mounting

The boxes are made of halogen-free material should be of good quality.

Shall have the following minimum dimensions:

- 80 x 80 x 42 mm – for pipes Ø 16 and Ø 20 up to a maximum of 5 entries.
- 103 x 103 x 45 mm – for pipes Ø 25 up to a maximum of 5 entries.

- 160 x 102 x 55 mm – for pipes Ø 32.

In the bonds boxes to use pipes shall be of the same material nozzles rigid boxes with nut.

In the cable connections to the boxes using cable glands will be based with the proper dimensions to the diameters of the cables.

The covers are fixed by means of screws cadmium-plated or chrome plated brass.

In junction boxes, the connections of the conductors shall be made by means of end plates in nickel plated brass with porcelain base.

Reference equipment: Obo Bettermann, or equivalent.

b) Junction boxes flush mounting

These boxes shall have minimum dimensions for the boxes indicated earlier, are suitable for mounting pad, made of rigid PVC, and should be of good quality and reputed brand in the market. In connection with these cases the RV, will be used with mouthpieces rigid anvil, properly bonded.

Reference equipment: Obo Bettermann, or equivalent.

c) Mechanism recessed-mounting boxes

For mounting the devices/mechanisms, flushed, shall be used PVC rigid boxes of good quality and from a reputed brand in the market.

In case of circuit shunt may be used slings recessed-mounting boxes (only in socket circuits) as long as it is in the same compartment.

The mechanisms must be fixed to the boxes via screw, nickel plated brass, or galvanized.

A color code shall be used for marking the junction boxes to identify the circuits to which they belong: security lighting, outlets and telecommunication. This code must appear on a list to be displayed in a plastic bag, near the electrical panel.

Reference equipment: Obo Bettermann, or equivalent.

d) Terminal boxes

Thermoplastic box, halogen-free, for flush mounting, self-extinguishing, with minimum dimensions of 100x100x45mm including cover and all wiring accessories.

Reference equipment: Obo Bettermann, or equivalent.

13. FIXING SCREW AND BOLT

Machine screws and nuts shall be to ISO/R885. Hexagon bolts, screws and nuts shall be to BS EN 24016, BS EN 24018 and BS EN 24034. Wood screws shall be to BS 1210 with countersunk head unless otherwise specified. Bolts, nuts and washers shall be manufactured from non-ferrous materials. Holes for bolts, screws and other fixings shall be drilled or stamped, and no larger than required for clearance of the bolt, screw, etc.

14. TRUNKING SYSTEM

Bi-compartmentalized PVC trunking shall be considered in some places.

Sizes and types of trunking shall be as called for in the various sections of the Specification or on the drawings, or shall in any case by sufficient size to accommodate the wiring required whilst still ensuring the appropriate space factor.

Plastic trunking shall be rigid PVC heavy gauge, white, high impact complete with lid, full length back tray and manufactured fittings.

Plastic trunking shall be installed in accordance with manufacturer's recommendations.

Plastic trunkings shall be secured rigidly to building fabrics using round headed steel wood screws in manufactured plugs with oversize washers to prevent screw heads pulling through holes in trunking

All plastic trunkings shall incorporate protective conductors.

All changes in direction of plastic trunking shall be carried out via purpose made accessories.

Plastic trunking shall be cut to length and access holes for conduit entry etc. shall be cut using only the manufacturer's special tools.

Surface fixed plastic trunking shall be routed as unobtrusively as possible following the architectural features of the room even if this entails longer runs of trunking. Trunking shall be run along full wall lengths and must not terminate part way along a wall, unless specified to the contrary.

Plastic trunking shall not be routed through areas suffering high or low temperatures.

PVC trunking and fittings shall comply with IEC 61084-1. The nominal dimensions of PVC cable trunking shall be selected from any of the following numbers in mm:

12.5, 16.0, 20.0, 25.0, 32.0, 37.5, 40.0, 50.0, 75.0, 100.0 and 150.0

Trunking shall have covers secured by purpose-made rivets. Covers of the clip-on type will be acceptable for trunking sizes up to 100 x 100 mm.

Reference equipment: Obo Bettermann, or equivalent.

15. HEAD WALL UNITS

The bed head unit is placed on the wall above the patient bed. It includes all the elements that are required for patient treatment and from nursing personnel and provides lighting (general and local), electrical energy (sockets), data (telephone, nurse call, etc.), medical gases and vacuum.

In rooms with architectural difficulties, where wall mounted installation is not possible, special types of BHU are suggested:

- Suspended (single / double);
- Vertical / pendant.

The following needs were identified:

- ICU Room J.12 (Block J);
- Recovery Room E.39 and Preparation Room E.40 (Block E);
- Operating Room (Block E - E48 to E52);
- NICU E,20 (Block E).

The bed head unit must be manufactured from a special profile of aluminium and coated with electrostatic paint. The characteristics of various types of the bed head units are presented in Table Annexe.

Standards:

- EN ISO 9001 and EN ISO 13485: Quality management systems;
- CE Medical Devices Marking according to 93/42/EEC Directive;
- EN ISO 11197: Medical supply units;
- EN ISO 7396-1: Medical gas pipeline systems - Part 1;
- EN 60601-1: Medical electrical equipment - Part 1.

Special care:

For Operation Theatre / ICU Resuscitation:

Reference equipment: TLV, model Fluidys (Special care) or equivalent.

Normal care rooms:

For NICU and Recovery/Preparation rooms.

Reference equipment: TLV, model Fluidys (Normal care) or equivalent.

Image 1 - Head Wall Units images

16. CABLE BURIED DIRECT IN GROUND

16.1. PROTECTION TO CABLE

Power cables buried direct in ground shall be armoured. They shall be buried at a depth of not less than 450mm and shall be protected by means of approved cable cover tiles. The bottom of the cable trench shall be covered, to a depth not less than the diameter of the largest cable, with a bedding layer of sand or fine soil. On top of the cables, an after layer of sand or fine soil, to a depth of 100mm, shall again be provided. The sand or fine soil shall not be larger than 13mm sieve.

Particular care shall be taken to ensure that there shall be no pebbles or small stones in the bedding layer or after layer of the fine sand or soil.

The cables shall then be covered, throughout the entire route, by approved type cable cover tiles which shall be laid on top of the after layer.

16.2. CABLE MARKER

The route of all power cables buried direct in ground shall be clearly indicated by cable markers laid on the ground. The cable markers shall be engraved with the following wording: "DANGER - BSB ELECTRIC CABLES"

Cable markers shall be placed at regular intervals not exceeding 60m apart and also at positions where the cable route changes direction.

At the position of each underground junction box, a cable marker shall also be installed. Such markers shall be engraved, in addition to the wordings mentioned above, the appropriate information, such as "3 way Joint Box".

17. POWER CABLES

Power cables are mainly for electricity supply and distribution. They shall be manufactured under British Approvals Service for Cables (BASEC) licence or an equivalent quality surveillance scheme (e.g. European Committee for Electrotechnical Standardization (CENELEC) Harmonization Scheme) and bear BASEC marking or the appropriate marking of the equivalent quality surveillance scheme (e.g. CENELEC HAR).

Power cables shall have grading as specified in Sub-section C2.2 below.

Cabling facilities will include cable ducts, cable trays and cable ladder.

17.1. TYPES OF POWER CABLES

Power cables for supply and distribution shall be one or a combination of the following types as specified in the Particular Specification or on the Drawings:

- 600/1000V cross-linked polyethylene (XLPE) insulated, PVC sheathed copper cables with armour, single-core, two-core, three-core or four-core, suitable for conductor operating temperature not exceeding 90oC – IEC 60502-1,
- 600/1000V low emission of smoke and corrosive gases cross-linked polyethylene (XLPE) insulated and sheathed copper cable with armour, single-core, two-core, three-core or four-core, suitable for conductor operating temperature not exceeding 90oC – BS 6724,
- 600/1000V fire resistant, low emission of smoke and corrosive gases cross-linked polyethylene (XLPE) insulated and sheathed copper cable with armour, two-core, three-core or four-core, suitable for conductor operating temperature not exceeding 90oC - Category F2 of BS 7846,
- 600/1000V PVC insulated, PVC sheathed copper cables with armour, single-core, two-core, three-core or four-core, suitable for conductor operating temperature not exceeding 70oC – IEC 60502-1,
- 600/1000V paper insulated, lead sheathed copper cables with armour, single-core, two-core, three-core or four-core, suitable for conductor operating temperature not exceeding 80oC – IEC 60055-1 and IEC 60055-2.

18. PLASTIC OR PVC CONDUIT

Rigid plain PVC conduits shall comply with IEC 60614-2-2 and rigid plain PVC conduit fittings shall comply with IEC 61035. Conduits shall have classification as below:

- According to mechanical properties - for heavy mechanical stress;
- According to temperature - with a permanent application temperature range of -5°C to +60°C.

19. OPERATION AND MAINTENANCE MANUALS

Upon completion of the installation, the Contractor shall submit copies of operations and maintenance (O&M) manual to the Architect incorporating all amendments made during the course of the Contract, all as specified in the contract documents.

20. TESTING AND COMMISSIONING PROCEDURE

Upon completion of the installation but prior to acceptance, the Contractor shall submit to the Architect in good time a schedule showing the appropriate testing and commissioning procedures to be carried out. The schedule shall be agreed by the Architect before any testing and commissioning work is carried out.

21. ANNEXES

Proposed Bed Head Unfits configuration:

				Medical Gases							Electrical Installation											
Service	Compartment	Quantities	Type	O2	N2O	CO2	ACR (4,5 bars)	ACR (8 bars)	VIDE	SEGA	Socket Outlet 2P+E	Socket Outlet 2P+E (UPS)	Connection equipotential	Indirect lighting controlled by a switch	Direct lighting controlled by switch	Simple switch to control general lighting	Double switch for controlling general lighting	Dimmer to control general lighting	Single plug type RJ45 Cat.6	Double plug type RJ45 Cat.6	Nurse call module (buttons and patient handler) *	Nurse call module (buttons, voice and patient manipulator) *
ICU	ICU Room J.12 (Block J)	8	Horizontal Head Wall Unit (HW - 1)	2	-	-	1	-	-	-	3	2	1	1	1	1	-	-	-	-	1	-
Recovery/Preparation	Recovery Room E.39 and E.40 (Block E)	10	Horizontal Head Wall Unit (HW - 2)	1	-	-	1	-	-	-	3	2	1	1	1	-	-	-	-	-	-	-
Operating Theater	Operating Room (Block E - E48 to E52)	4	Horizontal Head Wall Unit (HW - 3)	3	-	-	2	2	-	-	-	2	1	-	1	-	-	-	-	-	-	-
NICU	NICU E,20 (Block E)	4	Horizontal Head Wall Unit (HW - 4)	1	-	-	1	-	-	-	4	-	1	-	-	-	-	-	-	-	-	-
Note: All equipment must be Antimicrobial.																						

Image 2 - Head Wall Units configuration

ELECTRICAL ENGINEERING

REHABILITATION OF THE SAUDI MATERNITY HOSPITAL

KASSALA HEALTH CITADEL, SUDAN

DETAILED DESIGN

DRAWINGS LIST

DRAWINGS LIST

REFERENCE / NUMBER	DESCRIPTION	SCALE:
ELE.01.PLT.001	Medium Voltage Network Ground Floor	1/200 & 1/50
ELE.01.PLT.002	Power Distribution Normal & Standby Supply Ground Floor and Block G	1/200 & 1/100
ELE.01.PLT.003	Power Distribution Normal & Standby Supply First Floor - L Building	1/200 & 1/100
ELE.01.PLT.004	Power Distribution (Uninterruptible Supply) Block E and J	1/100
ELE.01.PLT.101	Earthing System Ground Floor ; Block C ; Block G ; Block E and Block J	1/200 & 1/100
ELE.01.PLT.102	Earthing System Roof Floor	1/200
ELE.01.PLT.201	Outdoor Infrastructures Ground Floor	1/200
ELE.01.PLT.202	Cable Tray Ground Floor - Blocks A, F and G	1/100
ELE.01.PLT.203	Cable Tray Ground Floor - Blocks B and D	1/100
ELE.01.PLT.204	Cable Tray Ground F - Blocks C,J, K and L	1/100
ELE.01.PLT.205	Cable Tray Ground Floor - Blocks E, H and I	1/100
ELE.01.PLT.206	Electrical Installation Cable Tray First Floor - Block L	1/100
ELE.01.PLT.301	Power Outlet (General Feeding) Ground Floor - Blocks A, F and G	1/200
ELE.01.PLT.302	Power Outlet (General Feeding) Ground Floor - Blocks B and D	1/100

ELE.01.PLT.303	Power Outlet (General Feeding) Ground F - Blocks C,J, K and L	1/100
ELE.01.PLT.304	Power Outlet (General Feeding) Ground Floor - Blocks E, H and I	1/100
ELE.01.PLT.305	Power Outlet (General Feeding) First Floor - Block L	1/100
ELE.01.PLT.306	Power Outlet (UPS) First Floor - Block L	1/100
ELE.01.PLT.307	Power Outlet (UPS) First Floor - Block L	1/100
ELE.01.PLT.401	Specific Equipment's Feeding Ground Floor - Blocks A, F and G	1/100
ELE.01.PLT.402	Specific Equipment's Feeding Ground Floor - Blocks B and D	1/100
ELE.01.PLT.403	Specific Equipment's Feeding Ground F - Blocks C,J, K and L	1/100
ELE.01.PLT.404	Specific Equipment's Feeding Ground Floor - Blocks E, H and I	1/100
ELE.01.PLT.405	Specific Equipment's Feeding First Floor - Block L	1/100
ELE.01.PLT.501	Lighting (Indoor) Ground Floor - Blocks A, F and G	1/100
ELE.01.PLT.502	Lighting (Indoor) Ground Floor - Blocks B and D	1/100
ELE.01.PLT.503	Lighting (Indoor) Ground F - Blocks C,J, K and L	1/100
ELE.01.PLT.504	Lighting (Indoor) Ground Floor - Blocks E, H and I	1/100
ELE.01.PLT.505	Lighting (Indoor) First Floor - Block L	1/100
ELE.01.PLT.506	Lighting (Outdoor) RoofFloor	1/200
ELE.01.PLT.601	Emergency Lighting Ground Floor - Blocks A, F and G	1/100
ELE.01.PLT.602	Emergency Lighting Ground Floor - Blocks B and D	1/100
ELE.01.PLT.603	Emergency Lighting Ground F - Blocks C,J, K and L	1/100
ELE.01.PLT.604	Lighting (Indoor) Ground Floor - Blocks E, H and I	1/100

ELE.01.PLT.605	Emergency Lighting First Floor - Block L	1/100
ELE.04.DET.001	Details Earthing System	N/S
ELE.04.DET.002	Details Transformer Substation	N/S
ELE.04.DET.003	Details Generator	N/S
ELE.04.DET.004	Details Manhole Chamber's Cable Tray's MV Trenches	N/S
ELE.05.SCH.001	Schematic Diagram Power Distribution	N/S
ELE.05.SCH.002	Schematic Diagram MV Ring MV Substation and Transformer Substation	N/S
ELE.05.SCH.003	Schematic Diagram-One line L.T.S	N/S
ELE.05.SCH.004	Schematic Diagram-One line M.L.V.S	N/S
ELE.05.SCH.005	Legende Detail 1	N/S
ELE.05.SCH.006	Schematic Diagram-One line S.A.0 (E) ; S.A.1 (E) S.A.2 (E)	N/S
ELE.05.SCH.007	Schematic Diagram-One line S.A.3 (E) ; S.A.4 (E) S.B.0 (E) ; S.C.DC (E)	N/S
ELE.05.SCH.008	Schematic Diagram-One line S.C.S (E) ; S.D.1 (E) S.D.0 (E)	N/S
ELE.05.SCH.009	Schematic Diagram-One line S.E.0 (E) ; S.E.1 (E) S.F.0 (E) ; S.G.0 (E)	N/S
ELE.05.SCH.010	Schematic Diagram-One line S.H.0 (E) ; S.H.1 (E) S.I.0 (E) ; S.J.0 (E)	N/S

ELE.05.SCH.011	Schematic Diagram-One line S.J.1 (E) ; S.J.2 (E) S.J.3 (E) ; S.J.4 (E)	N/S
ELE.05.SCH.012	Schematic Diagram-One line S.J.5 (E) ; S.K.1 (E) S.K.2 (E) ; S.L.0.1 (E)	N/S
ELE.05.SCH.013	Schematic Diagram-One line S.L.0.2 (E) ; S.L.1.1 (E) S.L.1.2 (E) ; S.L.0.1 (E)	N/S
ELE.05.SCH.014	Schematic Diagram-One line S.P.R (IT) ;	N/S
ELE.05.SCH.015	Schematic Diagram-One line S.OR.x (IT) (x=1 ; 2 ; 3 ; 4)	N/S
ELE.05.SCH.016	Schematic Diagram-One line S.J.ICU (IT)	N/S