(Appendix (A
Port-Sudan Substation and Transmission Line Data

MVA 130	= Total Power
MW 100	= Active power P
MVAr 80	= Reactive power Q
A 850	= Line current I_L
kV 220	= Line Voltage V_L
mm 17.9	= Diameter D
450k m	= Length L
Hz 50	= Frequency F
D_{RY} = 6.7 m	Distance among phases
D_{YB} = 11.8 m	
D_{RB} = 13.6 m	
MVA (30 /100/100) * 2	(Transformers(/30/110/220
Single circuit	Type of towers
37.2MVA in the sending-eng*3	Reactors in the line
MVA in tertiary winding 15*2	Reactors in the substation
Zebra	Conductor type
Porcelain Atbara & silicon Rubber Port Sudan terminal	Insulator type
& tower Porcelain 834) (tower silicon Rubber 400	Number of towers 1234

(Appendix (B
Port-Sudan Feeder line (a) Data from NEC

MVA 6.5	= Total Power
MW 5.1	= Active power P
MVAr 3.8	= Reactive power Q
A 113.11	= Line current I_L
kV 33	= Line Voltage V_L
mm 185	= Diameter D
k m 16	= Length L
Hz 50	= Frequency F
D_{RY} = 0.943 m	Distance among phases
D_{YB} = 0.943 m	
D_{RB} = 1.6 m	
0.807	= Pf
Single circuit	Type of poles

(Appendix (C

Program to calculate Inductive reactive power (Q_L) by Mat lap

```
clc
clear all


a=484.5e-6
w=2*pi*50
;v=220000
dry=6.700  ;%meter
len=450000
;dby=11.800
;drb=13.57


;(mu0=4*pi*10^(-7
;e0=8.85e-12
(((d=2*sqrt((a/(2*pi
;r=d/2
;(de=(dry*dby*drb)^(1/3
((L=mu0/(8*pi)*(1+4*log(de/r
((c=2*pi*e0/(log(de/r
(zc=sqrt(L/c
(bita=w*sqrt(L*c
x=sin(bita*len)/(1-cos(bita*len))*zc
(ql=(v^2/x
```

(Appendix (D

(Program to calculate capacitance reactive power (Qc

```
clc
clear all

a=484.5e-6
w=2*pi*50
;v=220000
dry=6.700  ;%meter
len=450000
;dby=11.800
;drb=13.570
p=100%48e6

;(mu0=4*pi*10^(-7
;e0=8.85e-12
(((d=2*sqrt((a/(2*pi
r=d/2
(de=(dry*dby*drb)^(1/3
((L=mu0/(8*pi)*(1+4*log(de/r
(c=2*pi*e0/log(de/r
(zc=sqrt(L/c
(bita=w*sqrt(L*c
x=sin(bita*len)*zc
;b=(p*x)/(v/1000)^2
(delta= asin(b
(delta=real(delta%
((qc=(v^2/x)*(cos(delta)-cos(bita*len
```

(Appendix (E

(program to calculate Voltage VS Reactive Power (Qc

```
clc
clear all
close all

a=484.5e-6
w=2*pi*50
;v=220000 %
;v=200000:5000:245000
dry=6.700  ;%meter
len=450000
;dby=11.800
;drb=13.570
p=48e6 %
p=[20e6 30e6 40e6 50e6 60e6 70e6 80e6 90e6 100e6 %
;[110e6
p=10e6:10e6:100e6
v=200000:5000: 245000
for i=1:10 % power counter
for j=1:10  % voltage counter

;(mu0=4*pi*10^(-7
;e0=8.85e-12
(((d=2*sqrt((a/(2*pi
;r=d/2
(de=(dry*dby*drb)^(1/3
((L=(mu0/(8*pi))*(1+4*log(de/r
((c=2*pi*e0/(log(de/r
(zc=sqrt(L/c
(bita=w*sqrt(L*c
x=sin(bita*len)*zc
;b=(p(i)*x)/(v(j)/1)^2
(delta= asin(b
(delta=real(delta%
((qc(j)=(v(j)^2/x)*(cos(delta)-cos(bita*len
```

```
end
figure          % % % % %
(plot(qc,v
;table(:,i)=qc'/1e6
hold on

title(['Voltage Vs Reactive Power,          % % % % %
([((Real Power =',num2str(p(i
('ylabel('Voltage
('xlabel('Reactive Power
end
```

(Appendix (F

Program to calculate Voltage VS Reactive Power (Qc) In the City

```
clc
clear all
close all

;a=185e-6
;w=2*pi*50
;v=33000 %
;v=36000:-500:31500
'v
dry=94.3  ;%meter
;len=16000
;dby=94.3
;drb=94.3
p=10e6 %
;p=1e6:1e6:10e6
'p
;qc= 8e6:-0.5e6:3.5e6
'qc
for i=1:10 % Active power counter
for j=1:10  % Reactive power counter

;(mu0=4*pi*10^(-7
;e0=8.85e-12
;(((d=2*sqrt((a/(2*pi
;r=d/2
;(de=(dry*dby*drb)^(1/3
;((L=mu0/(8*pi)*(1+4*log(de/r
;((c=2*pi*e0/(log(de/r
;(zc=sqrt(L/c
;(bita=w*sqrt(L*c
;x=sin(bita*len)*zc
;b=(p(i)*x)/v(j)^2
;(delta= asin(b
(delta=real(delta%
; ((qc(j)=(v(j)^2/x)*(cos(delta)-cos(bita*len
```

```
;(((v(j)=sqrt(qc(j)*x/(cos(delta)-cos(bita*len

end
figure %%%%%
(plot(qc,v
;table(:,i)=qc'/1e6
'qc
'v
hold on

title(['Voltage Vs Reactive Power, %%%%%
([((Real Power =',num2str(p(i
('ylabel('Voltage
('xlabel('Reactive Power
end
```

(Selection of supply voltage Appendix (G

Limiting load & distance
.MVA, 3 km and below 5
.MVA, 3-10 km and for lower load levels 5
.MVA, 10-30 km 5
.MVA, up to 25 km 10
.MVA, above 25 km 10
.MVA, up to 30 km 20
.Above 20 MVA

Imperial Formula to select suitable supply Voltage

(V = 5.5 × √ (L/1.6+P/100
-:Where
.V: system voltage in KV
.L: load distance in km
.P: load in KW

(Appendix (H

Conductor Designations

The following is a list of the more commonly used aluminum :conductors accompanied by their designation

All Aluminum Conductor	AAC
.All aluminum conductor with no steel for support	
All Aluminum Alloy Conductor	AAAC
.Conductor with only aluminum alloy strands	
Aluminum Conductor Aluminum Alloy Reinforced	ACAR
Aluminum conductor with one or more strands of .aluminum alloy	
Aluminum Conductor Steel Reinforced	ACSR
.Aluminum conductor with one or more strands of steel	
Aluminum Conductor Steel Supported	ACSS
Aluminum conductor totally supported by the strands .of steel	
Alumoweld Conductor made up of aluminum coated .steel strands	AW

(Appendix (I

Table (2) Reference Values of Voltage limit in AC Network

permissible lowest Voltage L-L Voltage	permissible Highest Voltage L-L voltage	System Voltage L-L Voltage	Class
V 220	V 264	Vph to 240 n	L.V ((1ph
V 380	V 440	V 415	L.V ((3ph
3KV	KV 3.6	KV 3.3	M.H.V
KV 6	KV 7.2	KV 6.6	M.H.V
KV 10	KV 12	KV 11	N.H.V
KV 20	KV 24	KV 22	M.H.V
KV 30	KV 36	K V 33	M.H.V
KV 60	KV 72.5	KV 66	H.V
KV 120	KV 145	KV 132	H.V
KV 200	KV 245	KV 220	E.H.V
KV 380	KV 420	KV 400	E.H.V
KV 750	KV 800	KV 760	U.H.V

Where

L.V = Low Voltage
M.V = Medium Voltage
H.V = High Voltage
M.H.V = medium High Voltage
E.H.V = Extra High Voltage
U.H.V = Ultra High Voltage

(Appendix (J

Table (1.1) different types of towers

Angle of deviation	**Insulator set type**	**Applicable for**	**Tower of Type**	
^{o}(3 – 0)	Suspension	plain area of the route, and for small Angles of line deviation with .their extension	Suspension	AA
^{o} (10- 3 \ 0-5)	Tension	straight run of the transmission line route and Light angles of the line	Anchor / Angle	BB
^{o}(30 – 10)	Tension	Positions of less angle deviation	Angle	
^{o} (60 - 30)		Position of medium angle deviation		
^{o}(90 - 60)		Position of heavy angle deviation		
^{o}(90 - 0)	Tension	the end of lines at switching stations	Terminal	FF
^{o}(2 - 0)	Tension	River Crossing Type (0 - 2)^{o}	River Crossing	AAR
^{o}(60- 25)	Tension	Anchor type and use	Transpositio	AAL

°(30 - 0)	Tension	whenever Transposition 0f conductors is required	n (Anchor)	