Power System Analysis

- Accra East 11kV -

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KOMLEMLE (MAIN
Feeder Name	F13(FK01)

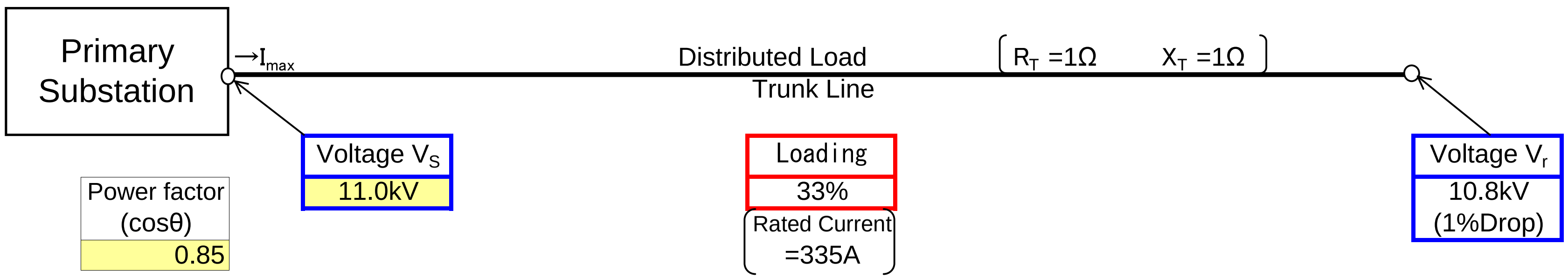
: Input data in colored cells

Type-1

Maximum Current I_{max}	
109A	

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	9km	
Type of Distributed Load	Equality	



Power factor (cosθ)	
0.85	

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

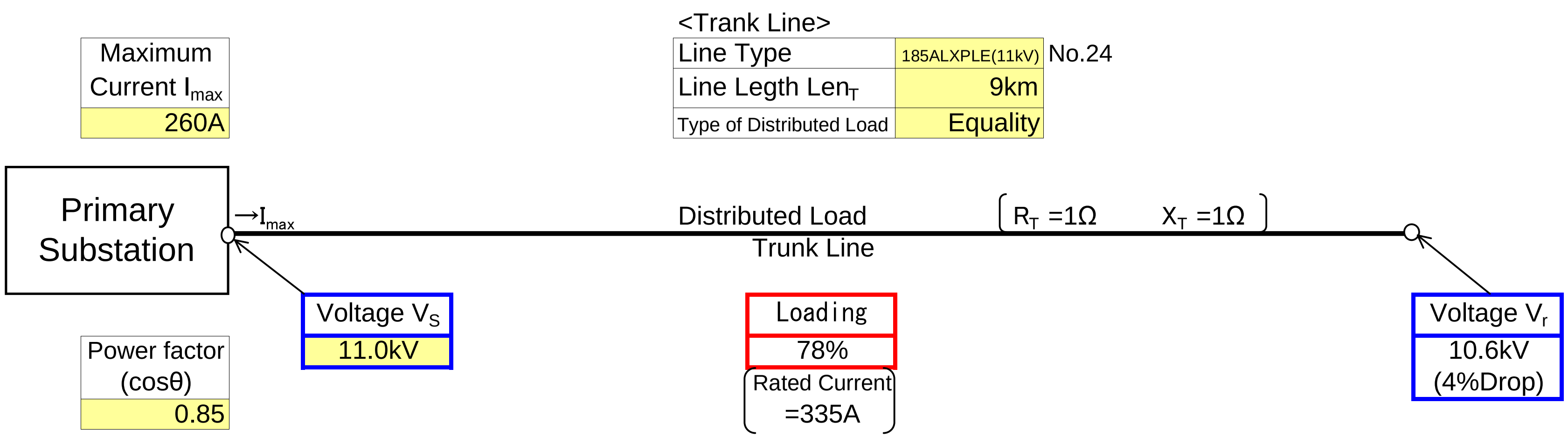
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KOMLEMLE (MAIN
Feeder Name	F03(FD38)

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

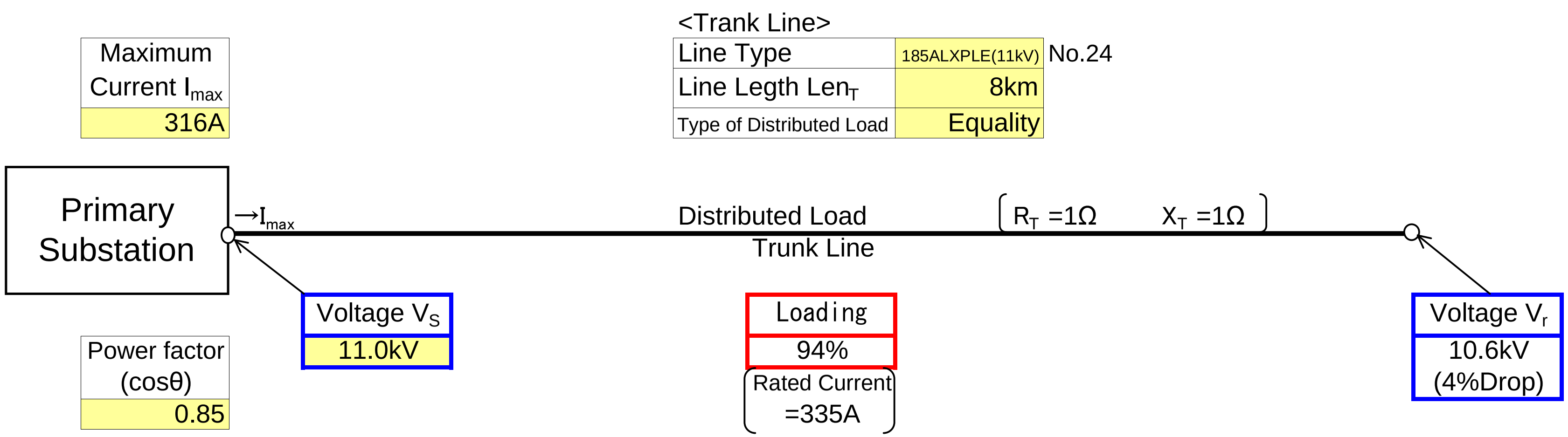
V_S	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KOMLEMLE (MAIN
Feeder Name	F15(FK02)

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_S	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KOMLEMLE (MAIN
Feeder Name	F11(FD19)

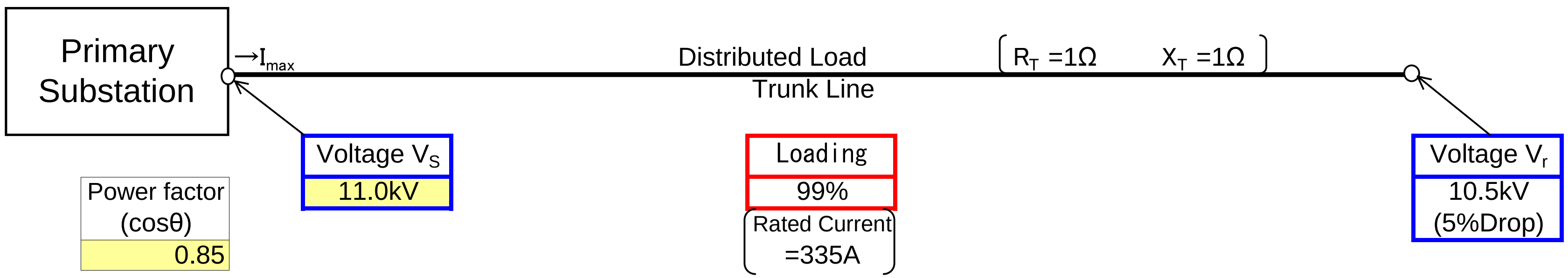
: Input data in colored cells

Type-1

Maximum Current I_{max}
333A

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	9km	
Type of Distributed Load	Equality	



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

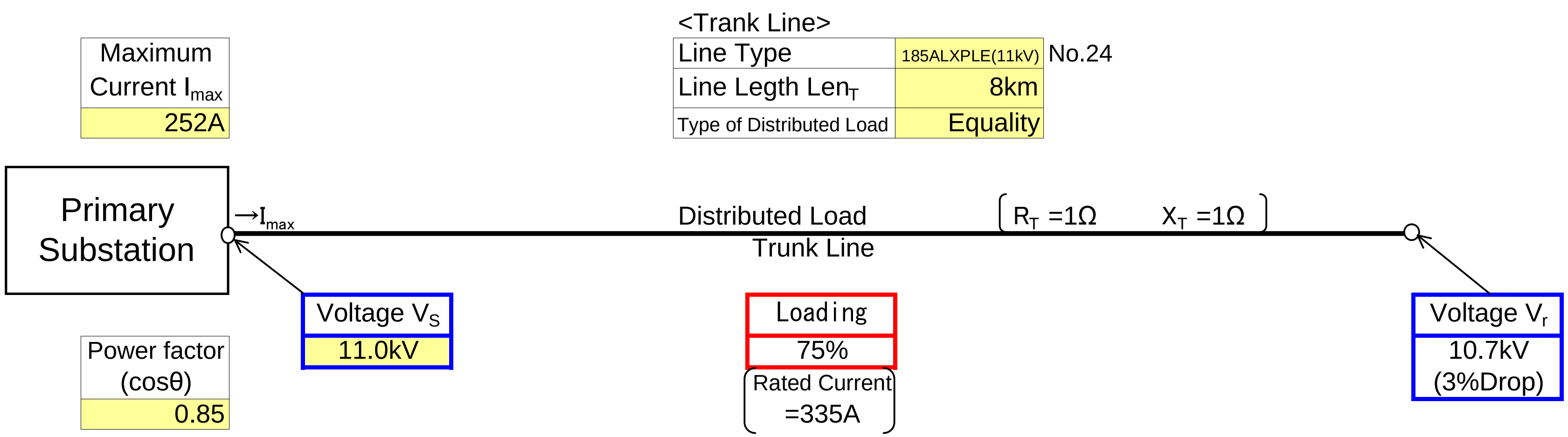
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KOMLEMLE (MAIN
Feeder Name	F04(FD48)

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ADENTA(MAIN T)
Feeder Name	T04(REDCO)

: Input data in colored cells

Type-3

Maximum Current I_{max}
415A

Power factor (cosθ)
0.85

Primary Substation

→I_{max}

Voltage V_s: 11.0kV

<Trank Line 1>

Load L_{T1}	A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}		

L_{T1} (Distributed Load) (R_{T1} =1Ω X_{T1} =2Ω)

Trunk Line 1 — Loading 91% — Rated Current =455A

Voltage V_{i1}: 9.5kV (14%Drop)

<Trank Line 2>

Load L_{T2}	A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	2km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}		

L_{T2} (Distributed Load) (R_{T2} =1Ω X_{T2} =1Ω)

Trunk Line 2 — Loading 44% — Rated Current =455A

Voltage V_{i2}: 9.2kV (19%Drop)

<Branch Line 2>

Load L_{B2}	67A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B2}	815kVA	

L_{B2} (Distributed or Concentrated Load) (R_{B2} =1Ω X_{B2} =1Ω)

Branch Line 2 — Loading 15% — Rated Current =455A

Voltage V_{r2}: 9.1kV (17%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =1Ω X_{B1} =1Ω)

Branch Line 1 — Loading 47% — Rated Current =455A

Voltage V_{r1}: 9.3kV (16%Drop)

<Branch Line 1>

Load L_{B1}	215A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B1}	2630kVA	

L_{B3} (Distributed or Concentrated Load) (R_{B3} =1Ω X_{B3} =1Ω)

Branch Line 3 — Loading 29% — Rated Current =455A

Voltage V_{r3}: 9.0kV (18%Drop)

<Branch Line 3>

Load L_{B3}	133A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B3}	4km	
Total Transformer Capacity of secondary substations CAP_{B3}	1630kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

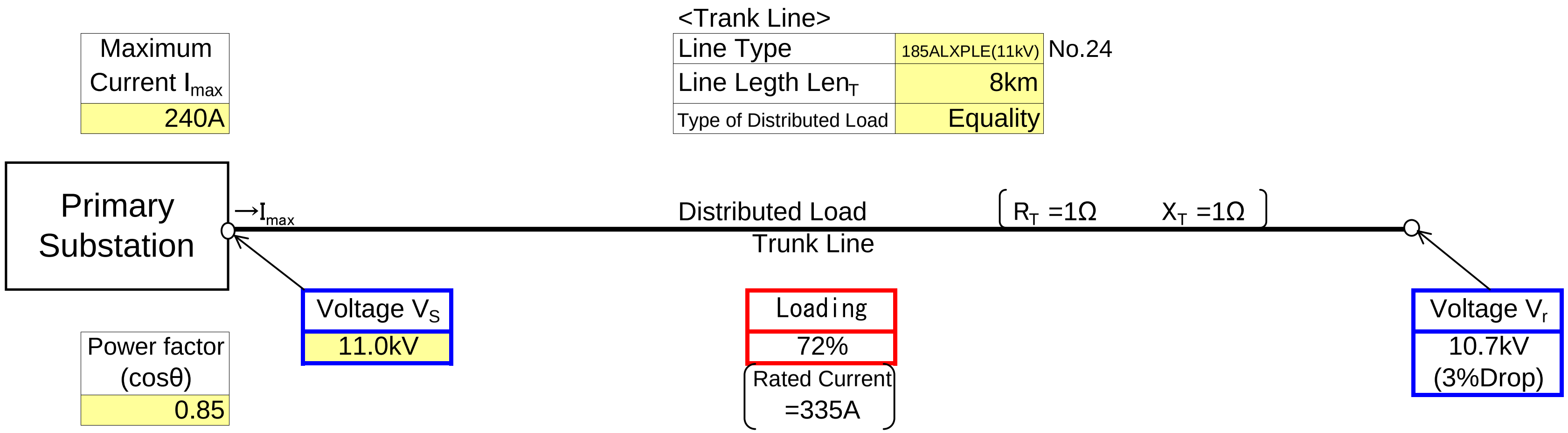
V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	WER HOUSE(MAIN
Feeder Name	G013(G56)

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

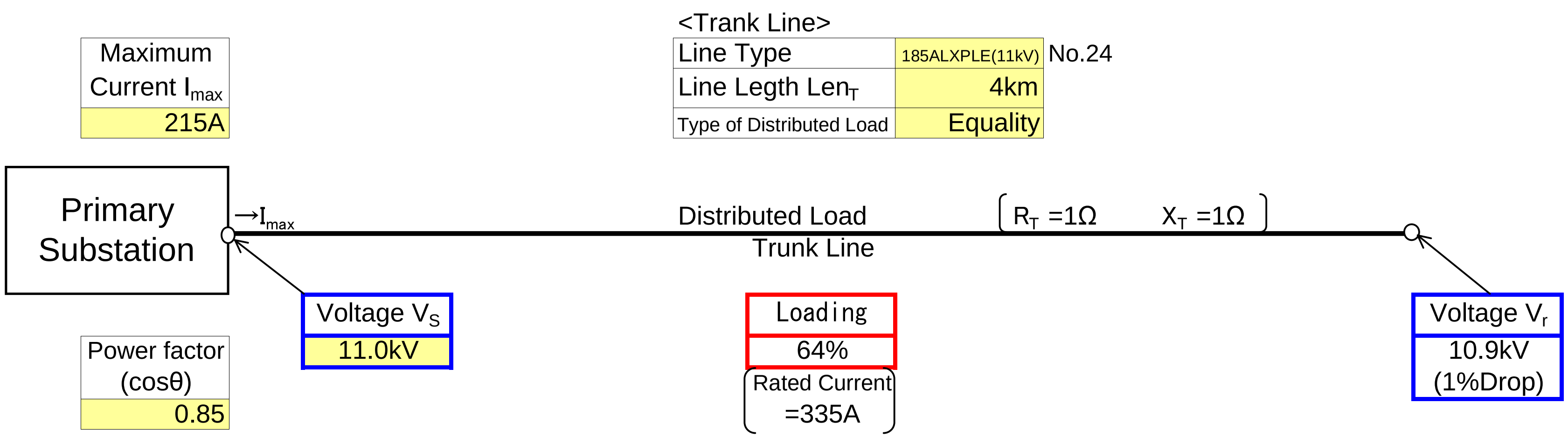
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	WER HOUSE(MAIN
Feeder Name	G07(G06)

: Input data in colored cells

Type-1



=====Equation=====

$$V_r = V_s - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	WER HOUSE(MAIN
Feeder Name	G11(G13)

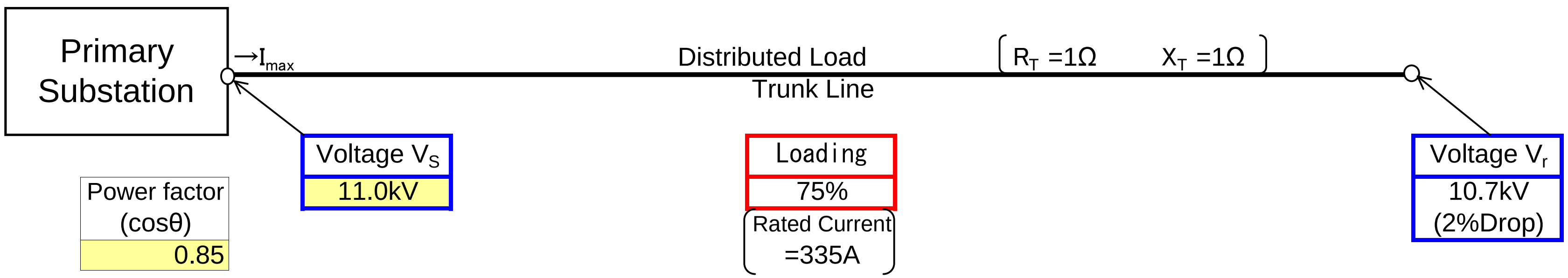
: Input data in colored cells

Type-1

Maximum Current I_{max}
250A

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	7km	
Type of Distributed Load	Equality	



Power factor (cosθ)
0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

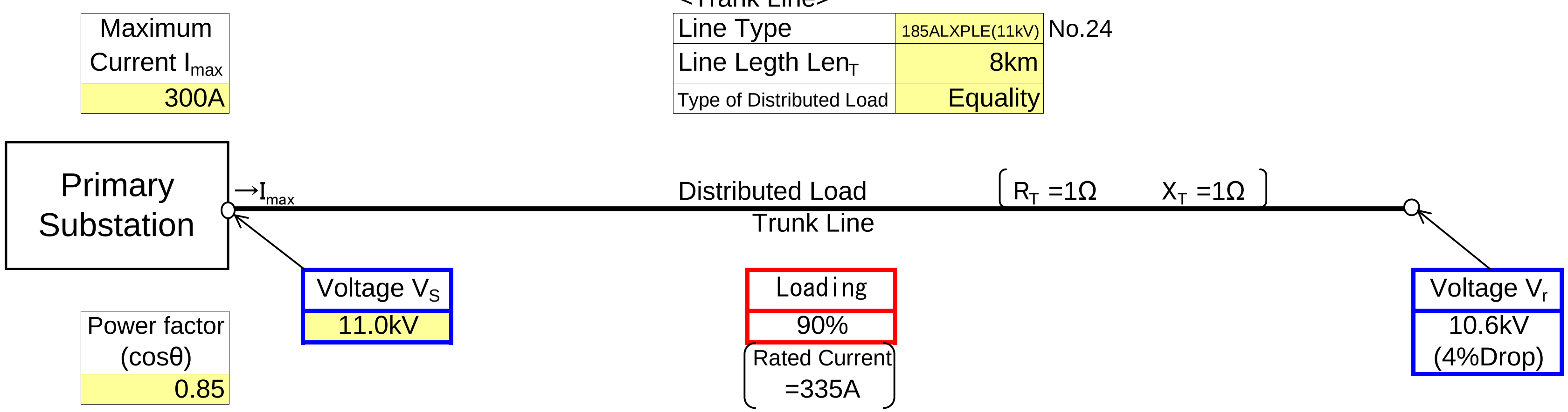
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	WER HOUSE(MAIN
Feeder Name	G19(G60)

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

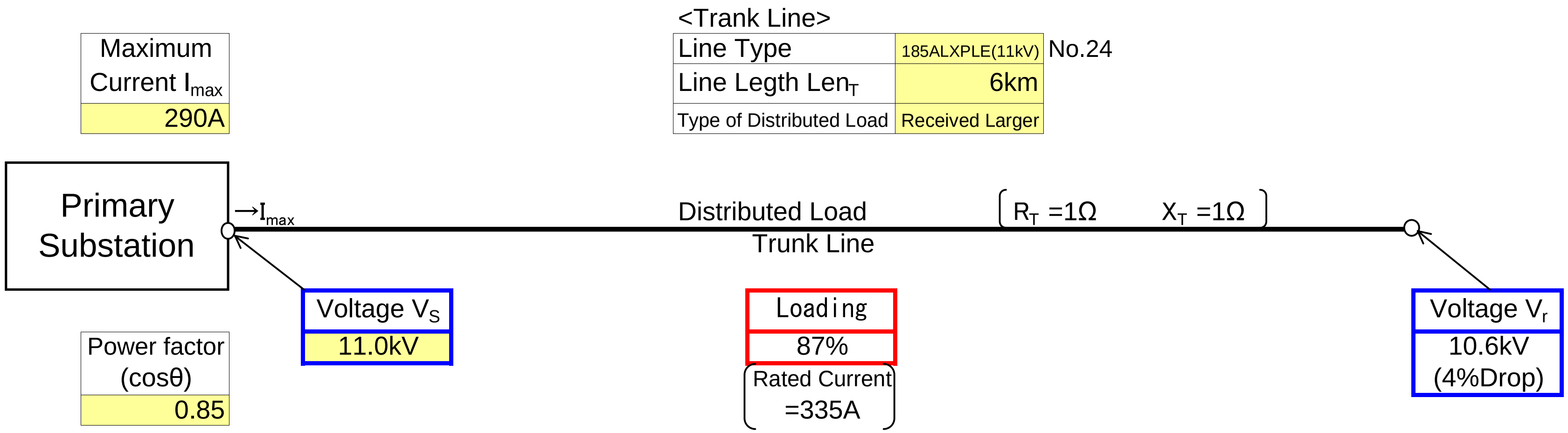
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	WER HOUSE(MAIN
Feeder Name	G12(G47)

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

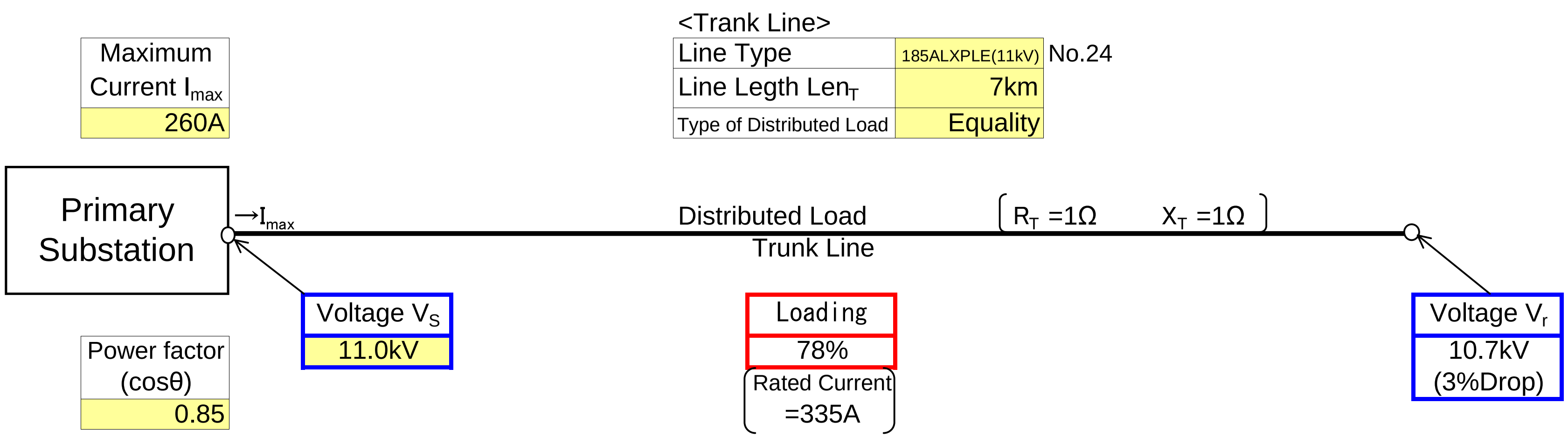
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	WER HOUSE(MAIN
Feeder Name	G02(G33)

: Input data in colored cells

Type-1



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$$

V_S	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	WER HOUSE(MAIN
Feeder Name	G06(G64)

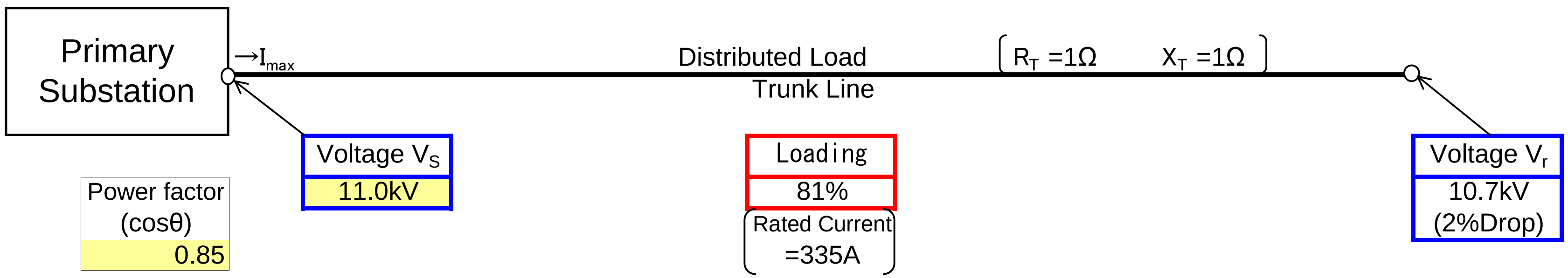
: Input data in colored cells

Type-1

Maximum Current I_{max}	
270A	

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	6km	
Type of Distributed Load	Equality	



Power factor (cosθ)	
0.85	

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

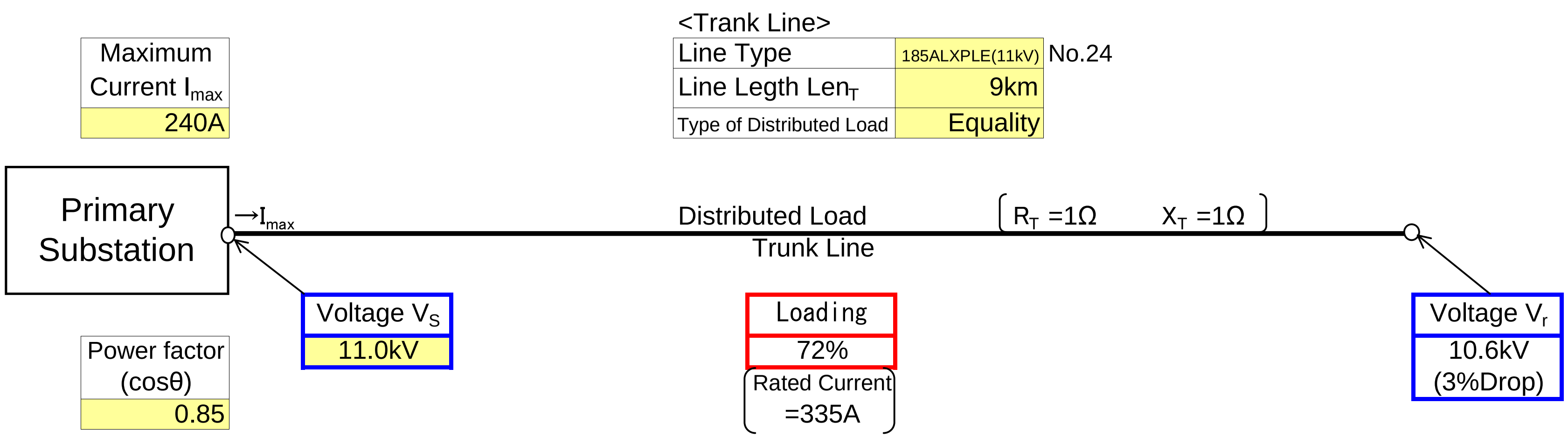
V_s : Supply Voltage	R_T : Resistance	f_T : Dispersal Load Factor	
V_r : Received Voltage	X_T : Reactance		
I_{max} : Maximum Current	cosθ : Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	WER HOUSE(MAIN
Feeder Name	G04(G351)

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	WER HOUSE(MAIN
Feeder Name	G21(G25)

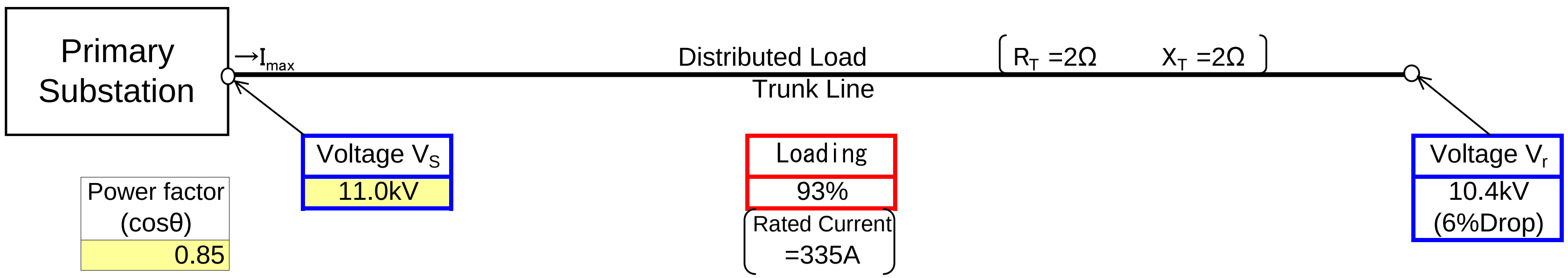
: Input data in colored cells

Type-1

Maximum Current I_{max}	310A

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	12km	
Type of Distributed Load	Equality	



Power factor (cosθ)	0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	CHIMOTA(MAIN H
Feeder Name	H02(H351)

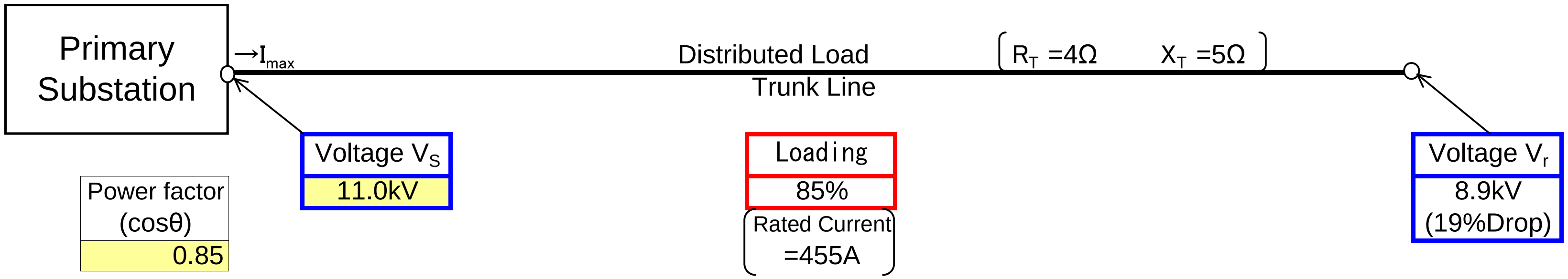
: Input data in colored cells

Type-1

Maximum Current I_{max}	
387A	

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	15km	
Type of Distributed Load	Equality	



Power factor (cosθ)	
0.85	

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	\CHIMOTA(MAIN H
Feeder Name	H05(H06)

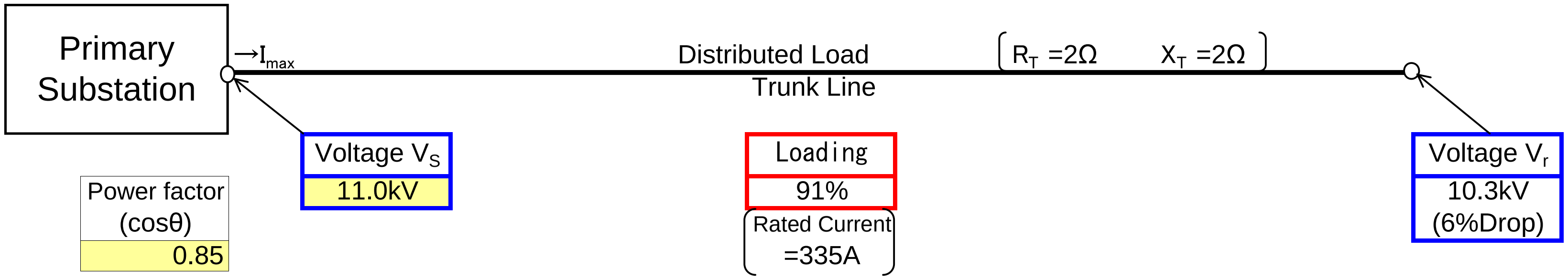
: Input data in colored cells

Type-1

Maximum Current I_{max}
304A

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	13km	
Type of Distributed Load	Equality	



Power factor (cosθ)
0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	CHIMOTA(MAIN H
Feeder Name	H10(H10)

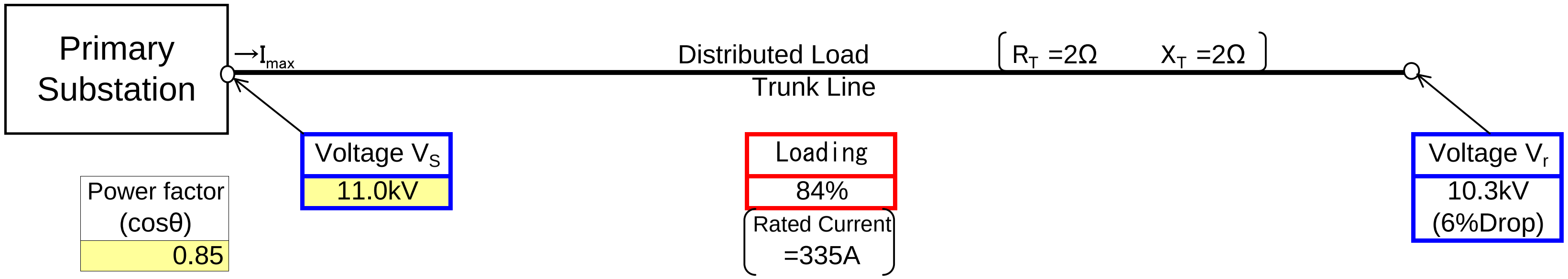
: Input data in colored cells

Type-1

Maximum Current I_{max}	280A
Power factor (cosθ)	0.85

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	14km	
Type of Distributed Load	Equality	



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	CHIMOTA(MAIN H
Feeder Name	H04(H07)

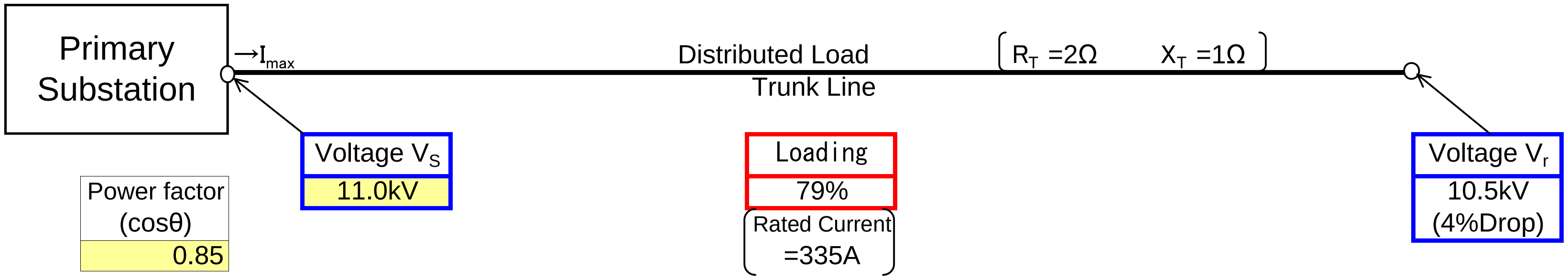
: Input data in colored cells

Type-1

Maximum Current I_{max}	265A
Power factor (cosθ)	0.85

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	11km	
Type of Distributed Load	Equality	



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

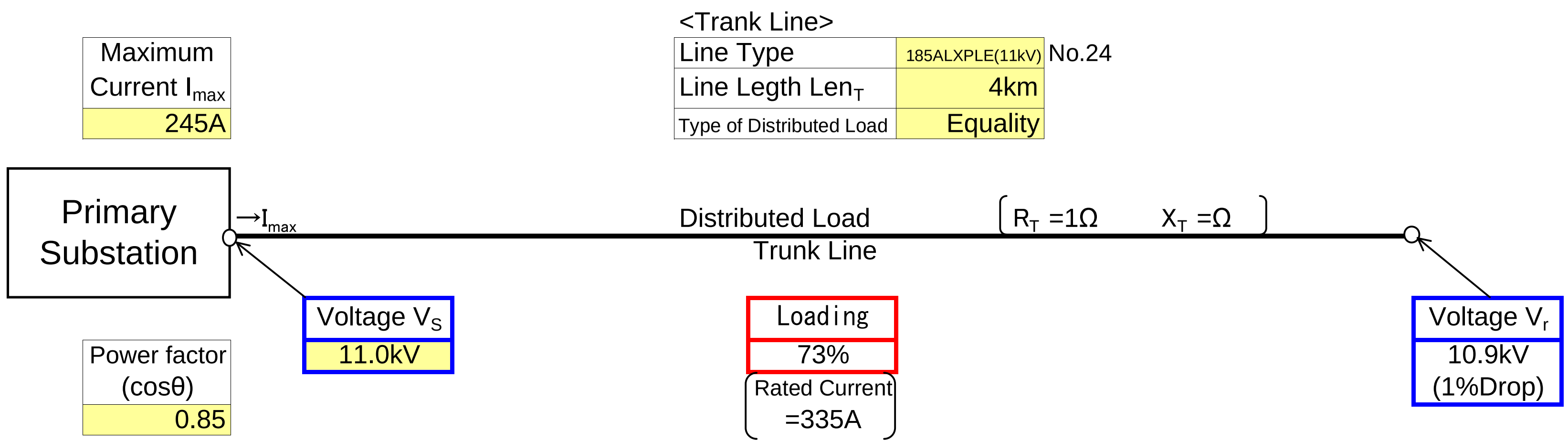
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	\CHIMOTA(MAIN H
Feeder Name	H07(H351)

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	CHIMOTA(MAIN H
Feeder Name	H08(H24)

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	180A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	12km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	4975kVA	

<Branch Line 1>

Load L_{B1}	76A	
Line Type	185ALXPLE(11kV)	No.24
Type of Load	Equality	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B1}	2100kVA	

Maximum Current I_{max}	281A

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) R_T =2Ω X_T =2Ω

Trunk Line

Loading
84%

Rated Current =335A

Voltage V_S
11.0kV

Voltage V_i
10.2kV (7%Drop)

Power factor (cosθ)
0.85

L_{B1} (Distributed or Concentrated Load) R_{B1} =Ω X_{B1} =Ω

Branch Line 1

Loading
23%

Rated Current =335A

Voltage V_{r1}
10.2kV (7%Drop)

L_{B2} (Distributed or Concentrated Load) R_{B2} =Ω X_{B2} =Ω

Branch Line 2

Loading
8%

Rated Current =335A

Voltage V_{r2}
10.2kV (7%Drop)

<Branch Line 2>

Load L_{B2}	25A	
Line Type	185ALXPLE(11kV)	No.24
Type of Load	Equality	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B2}	700kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor

V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	CH BACK ROAD(M
Feeder Name	K03(K09)

: Input data in colored cells

Type-2

Maximum Current I_{max}
210A

Power factor (cosθ)
0.85

<Trank Line>

Load L_T	111A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	4215kVA	

<Branch Line 1>

Load L_{B1}	34A	
Line Type	185ALXPLE(11kV)	No.24
Type of Load	Equality	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B1}	1315kVA	

Primary Substation

→I_{max} L_T (Distributed Load) (R_T =1Ω X_T =1Ω)

Trunk Line

Loading
63%

(Rated Current =335A)

Voltage V_S
11.0kV

Voltage V_i
10.7kV (3%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =Ω X_{B1} =Ω)

Branch Line 1

Loading
10%

(Rated Current =335A)

Voltage V_{r1}
10.7kV (3%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =1Ω X_{B2} =1Ω)

Branch Line 2

Loading
19%

(Rated Current =335A)

Voltage V_{r2}
10.6kV (3%Drop)

<Branch Line 2>

Load L_{B2}	65A	
Line Type	185ALXPLE(11kV)	No.24
Type of Load	Equality	
Line Length Len_{B1}	5km	
Total Transformer Capacity of secondary substations CAP_{B2}	2480kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage; I_{max} : Maximum Current; R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage; L_T : Load (Trunk line); X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage; L_{B1} : Load (Branch Line 1); cosθ : Power Factor

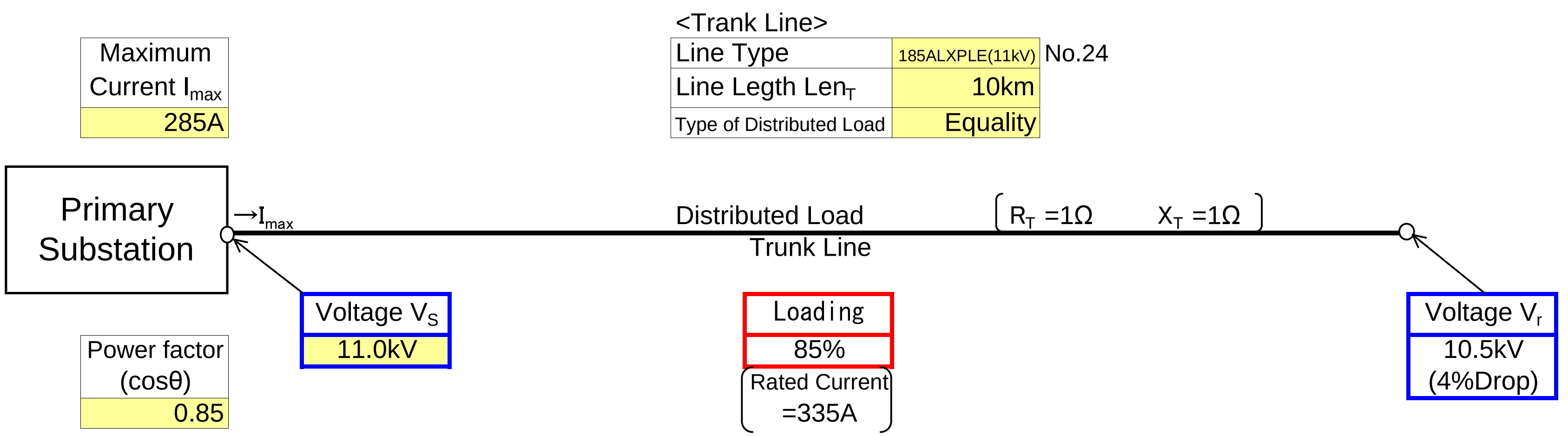
V_{r2} : Received Voltage; L_{B2} : Load (Branch Line 2); f_T, f_{B1}, f_{B2} : Dispersal Load Factor; CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	CH BACK ROAD(M
Feeder Name	K04(K10)

: Input data in colored cells

Type-1



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	CH BACK ROAD(M
Feeder Name	K05(K150)

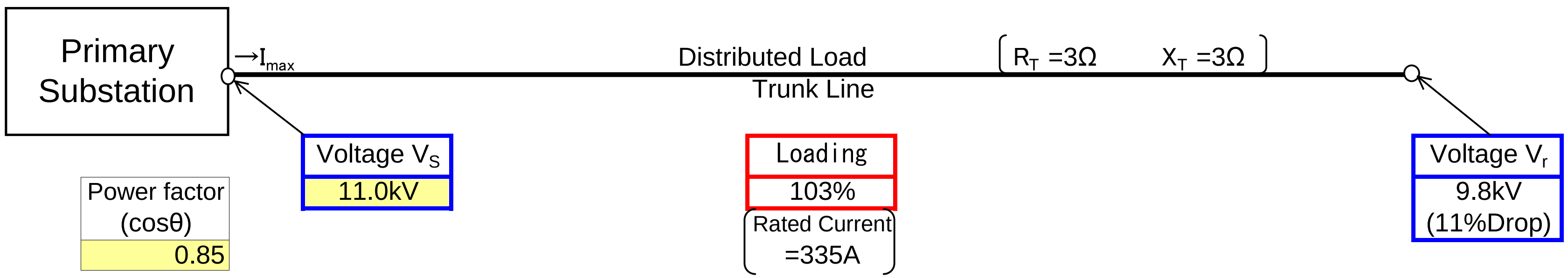
: Input data in colored cells

Type-1

Maximum Current I_{max}	
346A	

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	20km	
Type of Distributed Load	Equality	



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

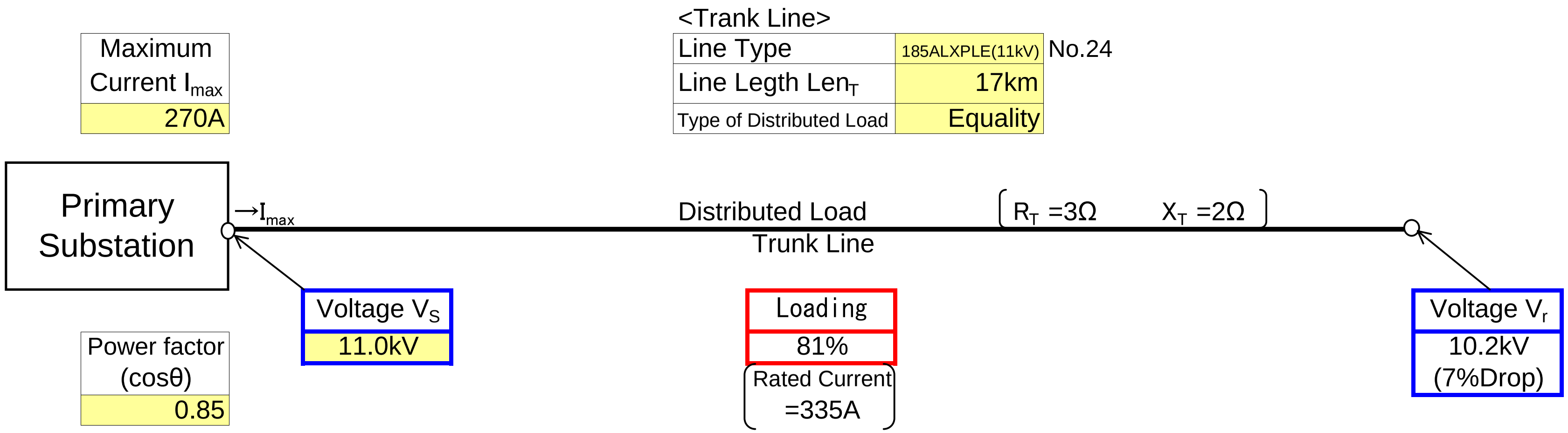
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	CH BACK ROAD(M
Feeder Name	K13(K13)

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	CH BACK ROAD(M
Feeder Name	K06(K60)

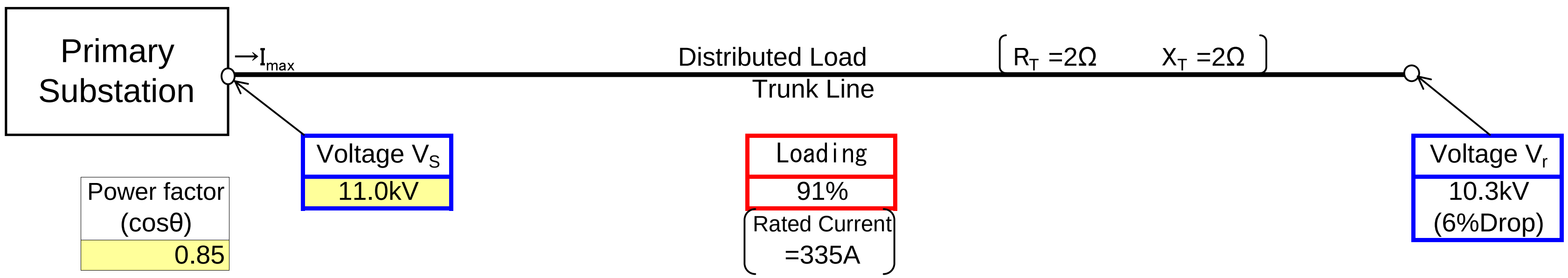
: Input data in colored cells

Type-1

Maximum Current I_{max}
305A

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	13km	
Type of Distributed Load	Equality	



Power factor (cosθ)
0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	CH BACK ROAD(M
Feeder Name	K10(K61)

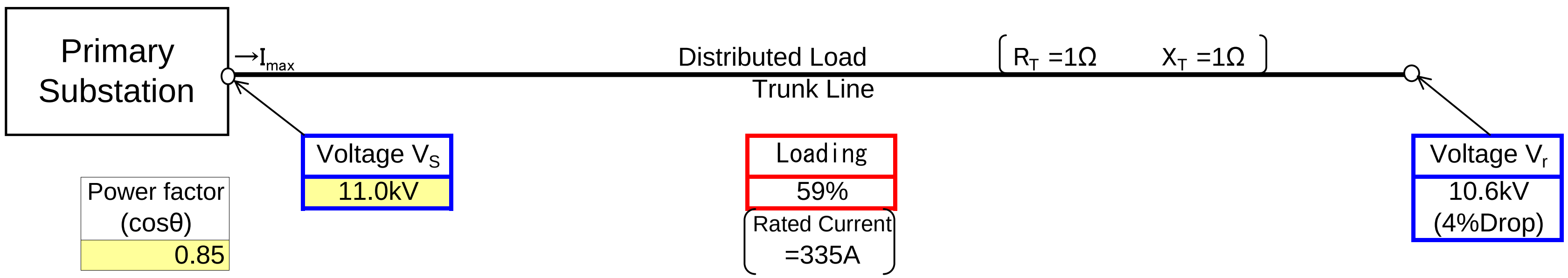
: Input data in colored cells

Type-1

Maximum Current I_{max}	198A
Power factor (cosθ)	0.85

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	9km	
Type of Distributed Load	Received Larger	



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	CH BACK ROAD(M
Feeder Name	K11(K06)

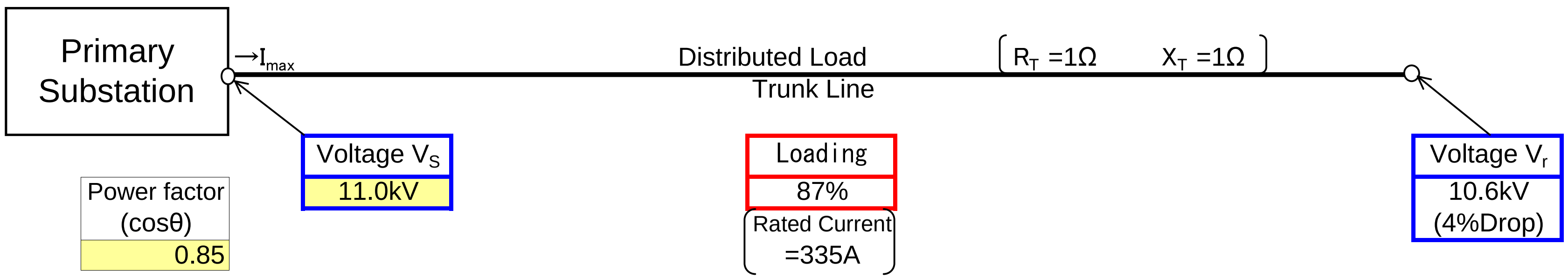
: Input data in colored cells

Type-1

Maximum Current I_{max}	
	290A

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	8km	
Type of Distributed Load	Equality	



=====Equation=====

$$V_r = V_s - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	CH BACK ROAD(M
Feeder Name	K12(K07)

: Input data in colored cells

Type-2

<Trank Line>

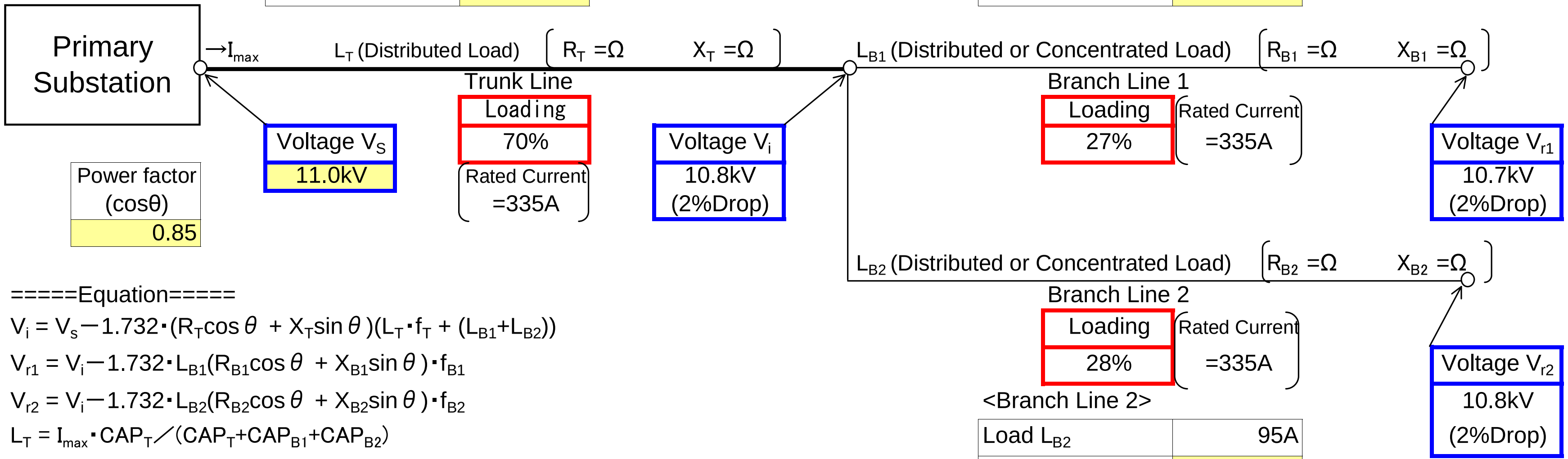
Load L_T	46A
Line Type	185ALXPLE(11kV) No.24
Line Legth Len_T	3km
Type of Distributed Load	Equality
Total Transformer Capacity of secondary substations CAP_T	1000kVA

<Branch Line 1>

Load L_{B1}	92A
Line Type	185ALXPLE(11kV) No.24
Type of Load	Equality
Line Length Len_{B1}	3km
Total Transformer Capacity of secondary substations CAP_{B1}	2000kVA

Maximum Current I_{max}	233A

Power factor ($\cos\theta$)	0.85



<Branch Line 2>

Load L_{B2}	95A
Line Type	185ALXPLE(11kV) No.24
Type of Load	Equality
Line Length Len_{B1}	2km
Total Transformer Capacity of secondary substations CAP_{B2}	2065kVA

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage; I_{max} : Maximum Current; R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage; L_T : Load (Trunk line); X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage; L_{B1} : Load (Branch Line 1); $\cos\theta$: Power Factor

V_{r2} : Received Voltage; L_{B2} : Load (Branch Line 2); f_T, f_{B1}, f_{B2} : Dispersal Load Factor; CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	JRMA CAMP(MAIN
Feeder Name	L11(L01)

: Input data in colored cells

Type-2

Maximum Current I_{max}	260A

Power factor (cosθ)	0.85

<Trank Line>

Load L_T	75A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	2630kVA	

<Branch Line 1>

Load L_{B1}	157A	
Line Type	185ALXPLE(11kV)	No.24
Type of Load	Equality	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B1}	5500kVA	

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =1Ω X_T =1Ω)

Trunk Line

Loading
78%

(Rated Current =335A)

Voltage V_S
11.0kV

Voltage V_i
10.4kV (5%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =Ω X_{B1} =Ω)

Branch Line 1

Loading
47%

(Rated Current =335A)

Voltage V_{r1}
10.3kV (6%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =1Ω X_{B2} =1Ω)

Branch Line 2

Loading
9%

(Rated Current =335A)

Voltage V_{r2}
10.4kV (6%Drop)

<Branch Line 2>

Load L_{B2}	28A	
Line Type	185ALXPLE(11kV)	No.24
Type of Load	Equality	
Line Length Len_{B1}	7km	
Total Transformer Capacity of secondary substations CAP_{B2}	1000kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	JRMA CAMP(MAIN
Feeder Name	L10(L22)

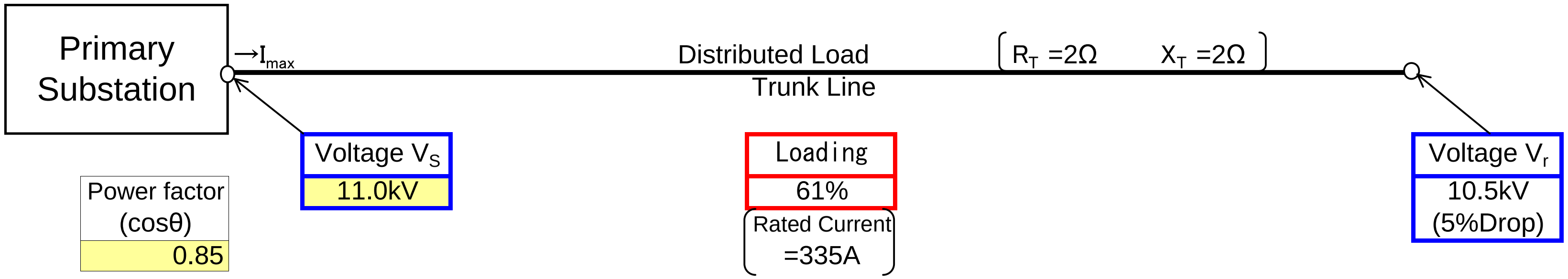
: Input data in colored cells

Type-1

Maximum Current I_{max}	205A

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	15km	
Type of Distributed Load	Equality	



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$$

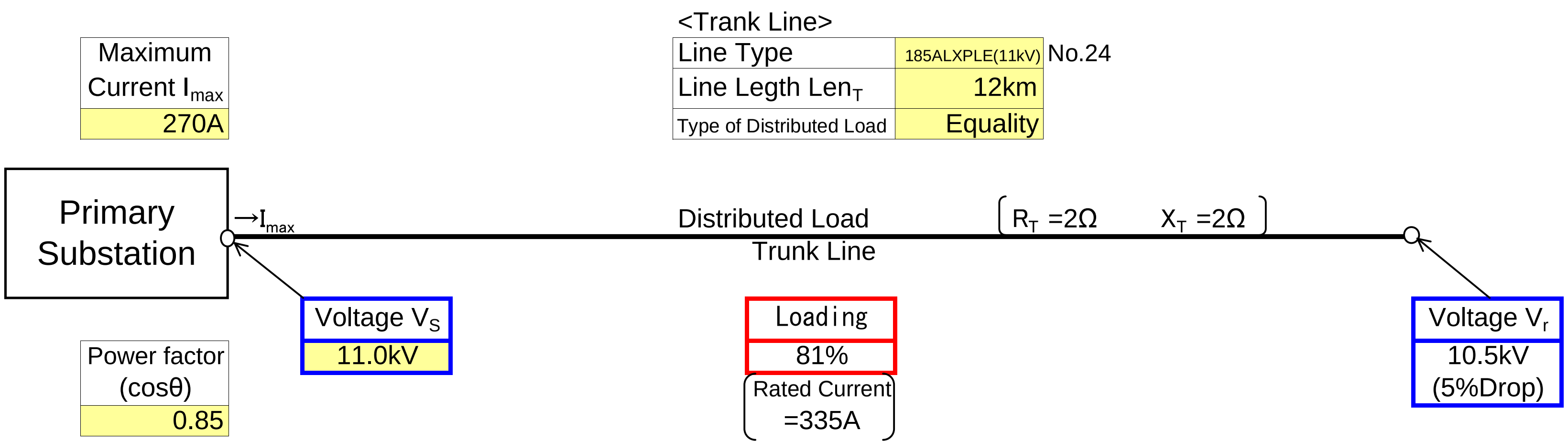
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	JRMA CAMP(MAIN
Feeder Name	L06(L12)

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	JRMA CAMP(MAIN
Feeder Name	L04(L03)

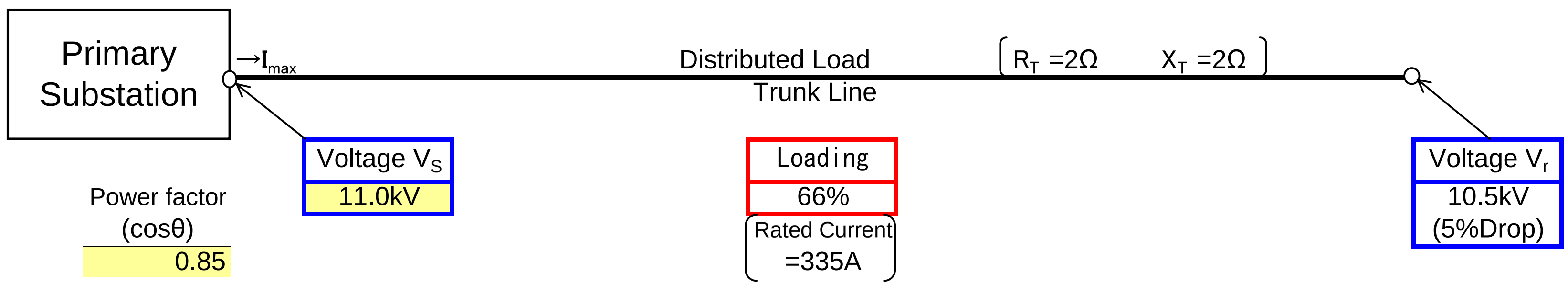
: Input data in colored cells

Type-1

Maximum Current I_{max}	220A

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	14km	
Type of Distributed Load	Equality	



Power factor (cosθ)	0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

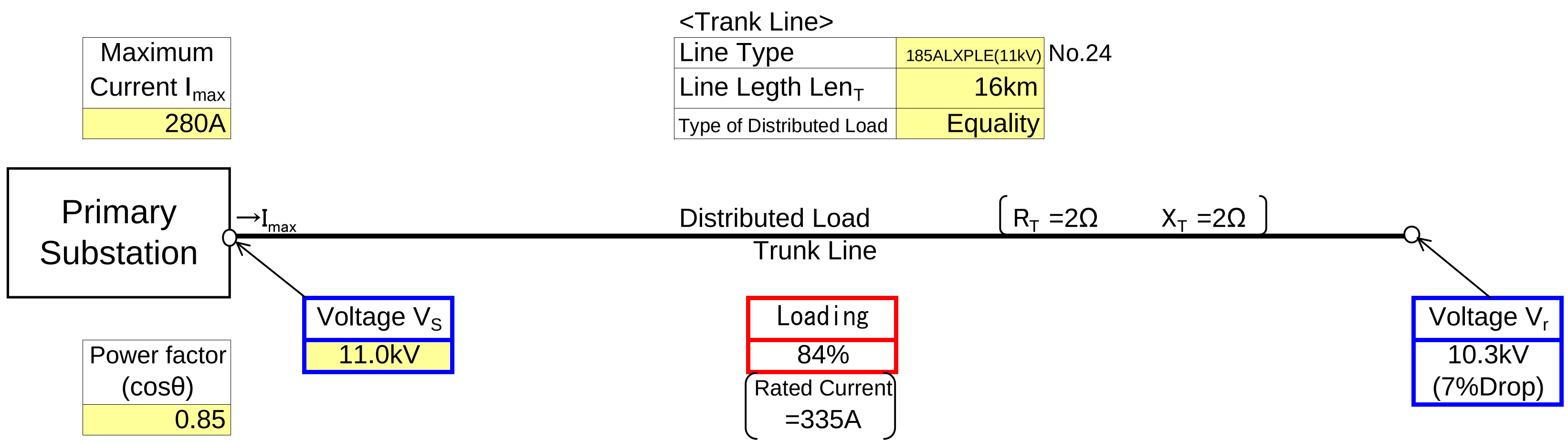
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	JRMA CAMP(MAIN
Feeder Name	L03(L02)

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$

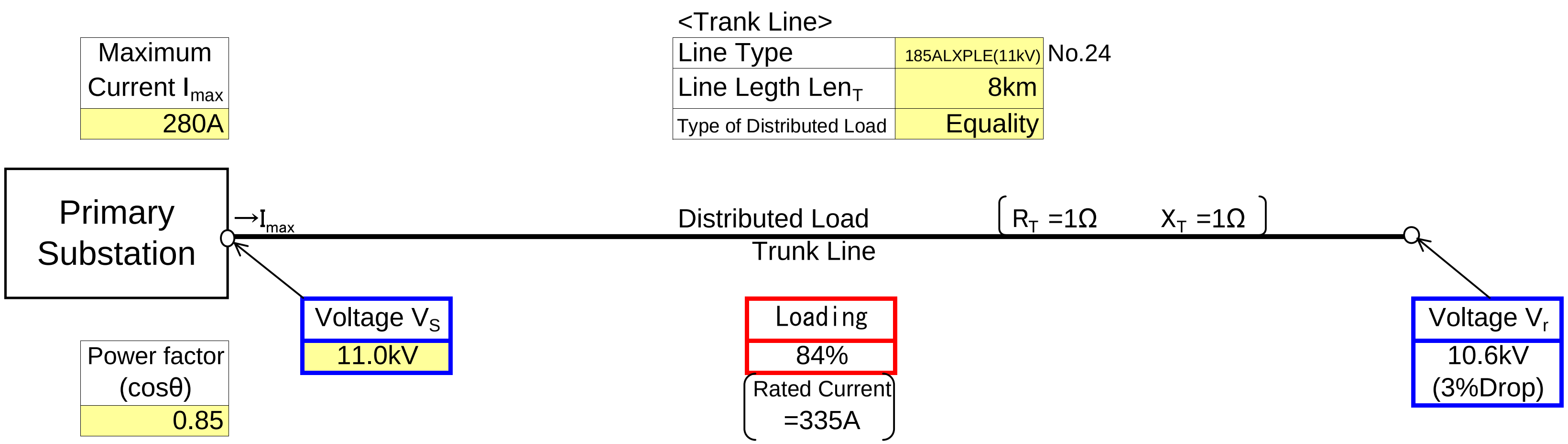
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	LEGON(MAIN M)
Feeder Name	M05(Old legon 2)

: Input data in colored cells

Type-1



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$$

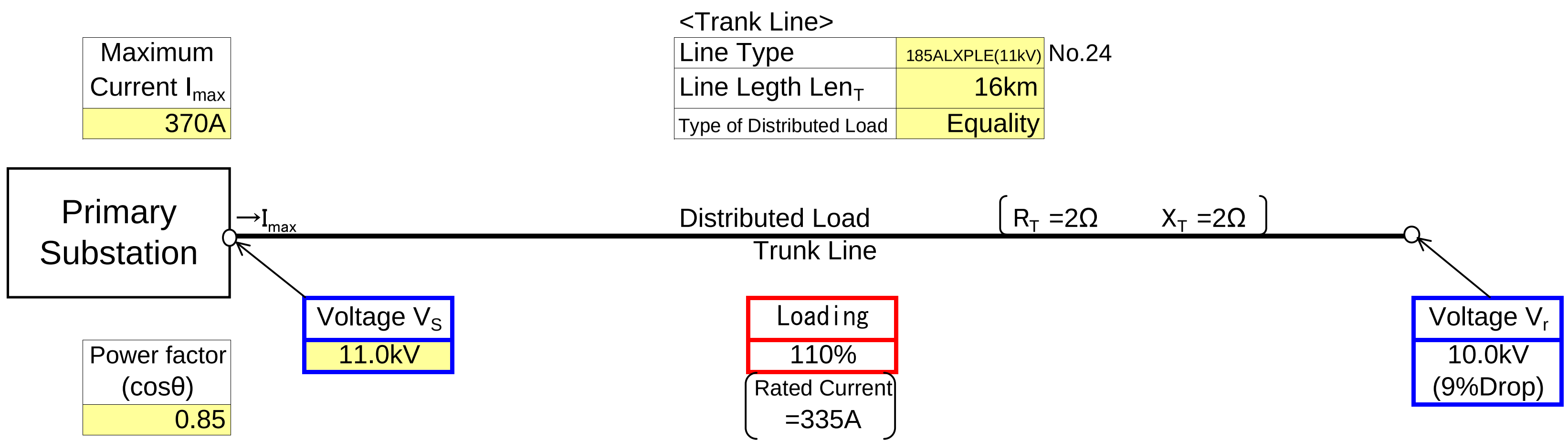
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	LEGON(MAIN M)
Feeder Name	M01(Old legon 1)

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

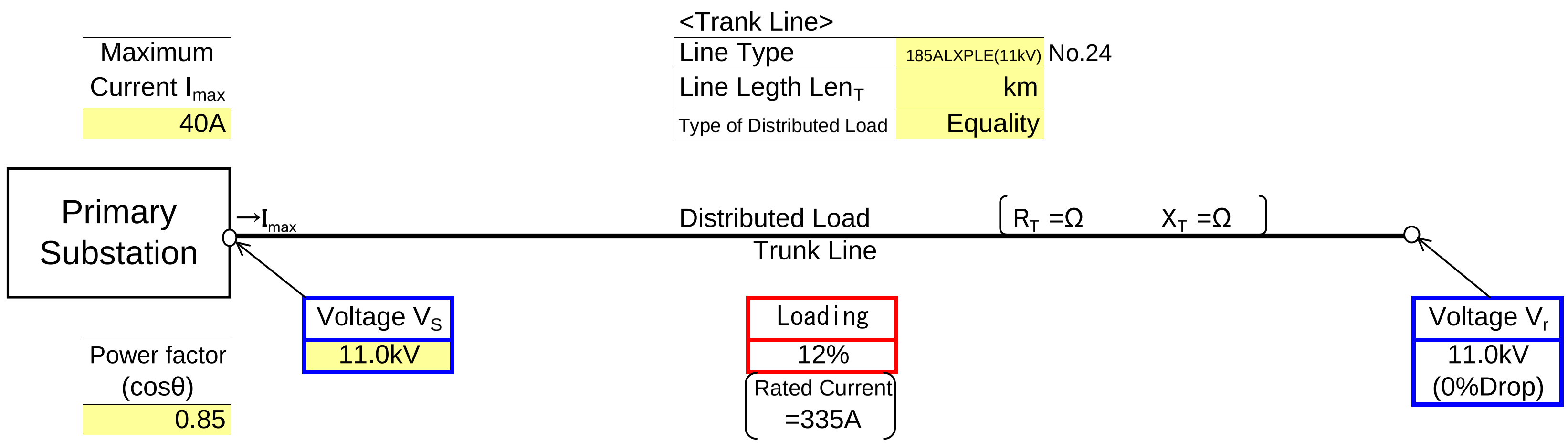
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	LEGON(MAIN M)
Feeder Name	02(Legon worksho

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$

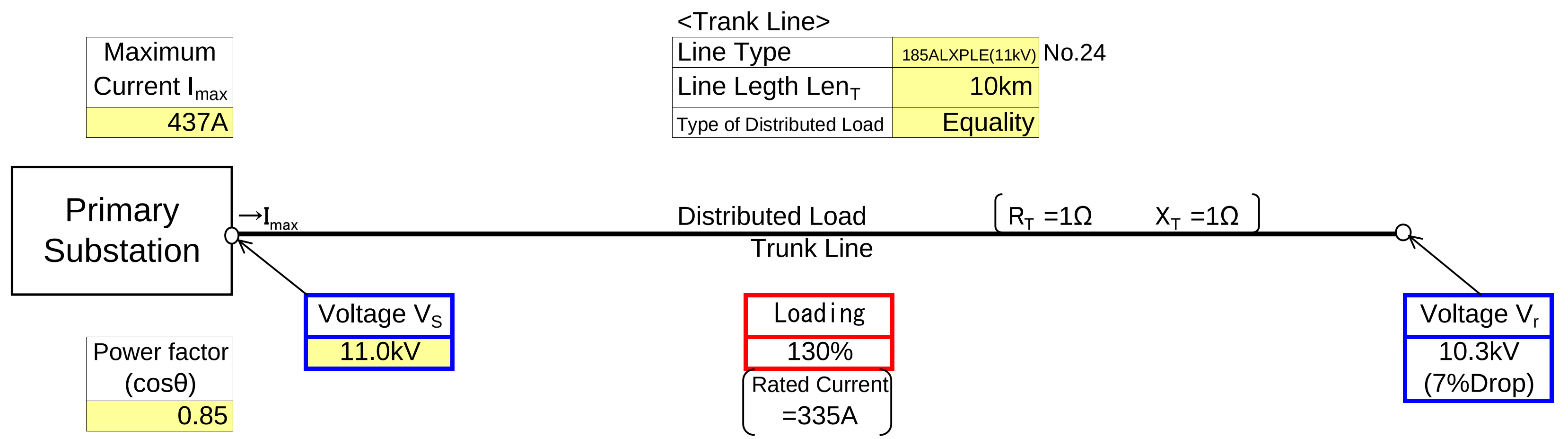
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	LEGON(MAIN M)
Feeder Name	M07(Madina)

: Input data in colored cells

Type-1



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$$

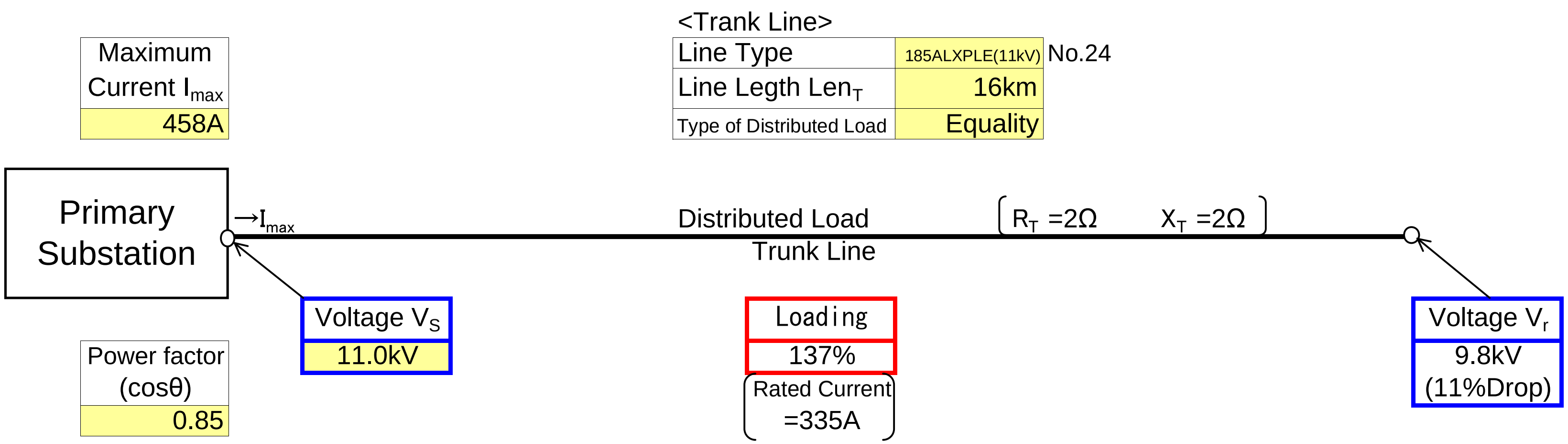
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	LEGON(MAIN M)
Feeder Name	M08(Kwabenya)

: Input data in colored cells

Type-1



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	HIE NUNGUA (MAI
Feeder Name	Q03(Teshie 1)

: Input data in colored cells

Type-2

<Trank Line>

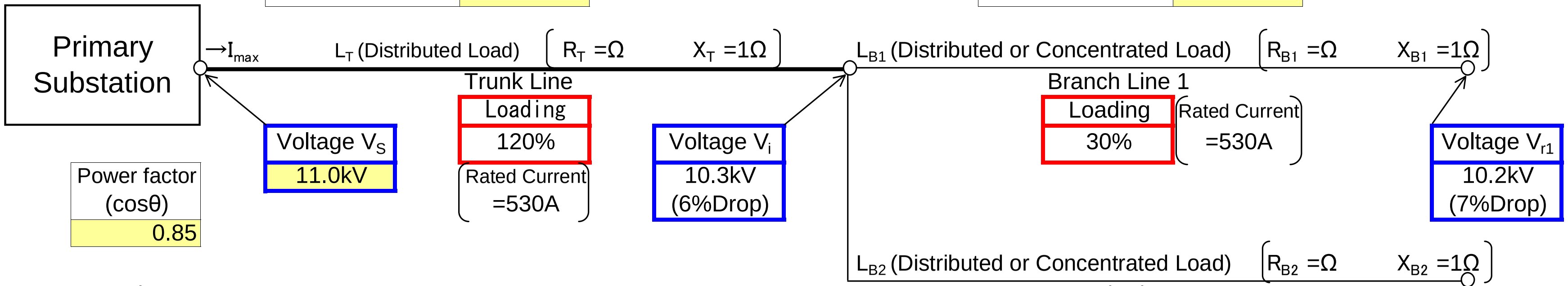
Load L_T	328A
Line Type	AAC150mm2 No.6
Line Legth Len_T	2km
Type of Distributed Load	Equality
Total Transformer Capacity of secondary substations CAP_T	2860kVA

<Branch Line 1>

Load L_{B1}	161A
Line Type	AAC150mm2 No.6
Type of Load	Equality
Line Length Len_{B1}	2km
Total Transformer Capacity of secondary substations CAP_{B1}	1400kVA

Maximum Current I_{max}
638A

Power factor (cosθ)
0.85



<Branch Line 2>

Load L_{B2}	149A
Line Type	AAC150mm2 No.6
Type of Load	Equality
Line Length Len_{B1}	2km
Total Transformer Capacity of secondary substations CAP_{B2}	1300kVA

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor

V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	HIE NUNGUA (MAI
Feeder Name	Q06(Teshie 3)

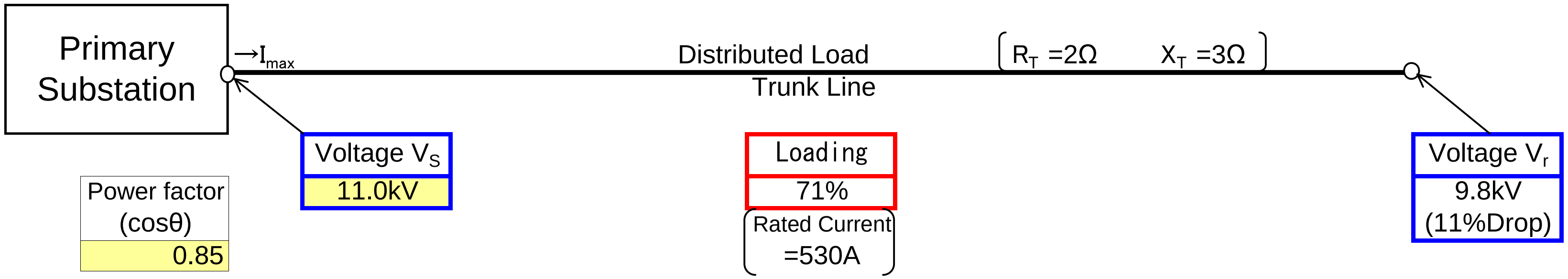
: Input data in colored cells

Type-1

Maximum Current I_{max}
378A

<Trank Line>

Line Type	AAC150mm2	No.6
Line Legth Len_T	10km	
Type of Distributed Load	Equality	



Power factor (cosθ)
0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	HIE NUNGUA (MAI
Feeder Name	001(OLD SPINTEX

: Input data in colored cells

Type-2

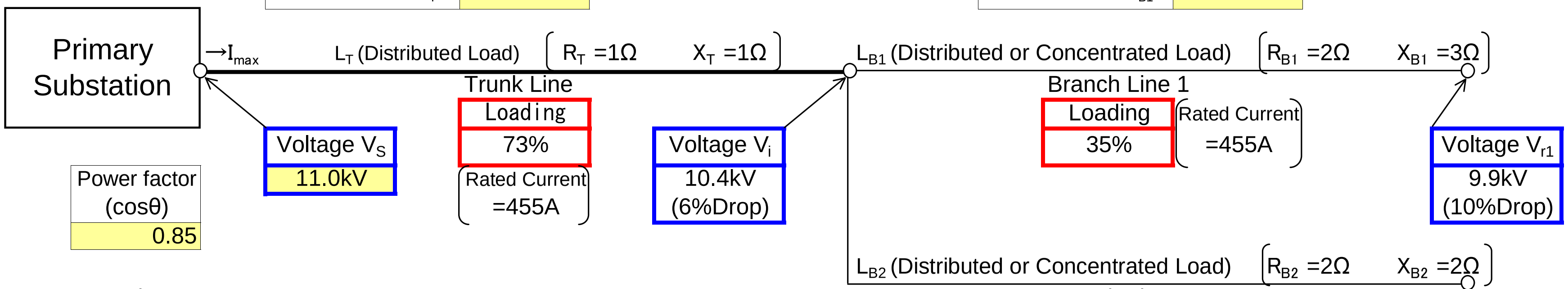
Maximum Current I_{max}
333A

<Trank Line>

Load L_T	103A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	3km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	1315kVA	

<Branch Line 1>

Load L_{B1}	158A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	8km	
Total Transformer Capacity of secondary substations CAP_{B1}	2015kVA	



Power factor (cosθ)
0.85

<Branch Line 2>

Load L_{B2}	72A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	7km	
Total Transformer Capacity of secondary substations CAP_{B2}	915kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage I_{max} : Maximum Current R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage L_T : Load (Trunk line) X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage L_{B1} : Load (Branch Line 1) cosθ : Power Factor
V_{r2} : Received Voltage L_{B2} : Load (Branch Line 2) f_T, f_{B1}, f_{B2} : Dispersal Load Factor $CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	HIE NUNGUA (MAI
Feeder Name	Q07(Teshie 2)

: Input data in colored cells

Type-3

Maximum Current I_{max}
368A

Power factor (cosθ)
0.85

Primary Substation

→I_{max}

Voltage V_S: 11.0kV

<Trank Line 1>

Load L_{T1}	108A	
Line Type	AAC150mm2	No.6
Line Legth Len_{T1}	5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	2330kVA	

L_{T1} (Distributed Load) (R_{T1} =1Ω X_{T1} =2Ω)

Trunk Line 1: Loading 69% (Rated Current =530A)

Voltage V_{i1}: 10.0kV (9%Drop)

<Trank Line 2>

Load L_{T2}	23A	
Line Type	AAC150mm2	No.6
Line Legth Len_{T2}	2km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	500kVA	

L_{T2} (Distributed Load) (R_{T2} =Ω X_{T2} =1Ω)

Trunk Line 2: Loading 26% (Rated Current =530A)

Voltage V_{i2}: 9.9kV (11%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =1Ω X_{B1} =1Ω)

Branch Line 1: Loading 23% (Rated Current =530A)

Voltage V_{r1}: 9.9kV (10%Drop)

<Branch Line 1>

Load L_{B1}	122A	
Line Type	AAC150mm2	No.6
Type of Load	Equality	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B1}	2630kVA	

<Branch Line 2>

Load L_{B2}	38A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B2}	815kVA	

L_{B2} (Distributed or Concentrated Load) (R_{B2} =1Ω X_{B2} =1Ω)

Branch Line 2: Loading 8% (Rated Current =455A)

Voltage V_{r2}: 9.8kV (10%Drop)

L_{B3} (Distributed or Concentrated Load) (R_{B3} =1Ω X_{B3} =1Ω)

Branch Line 3: Loading 17% (Rated Current =455A)

Voltage V_{r3}: 9.8kV (11%Drop)

<Branch Line 3>

Load L_{B3}	76A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B3}	4km	
Total Transformer Capacity of secondary substations CAP_{B3}	1630kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

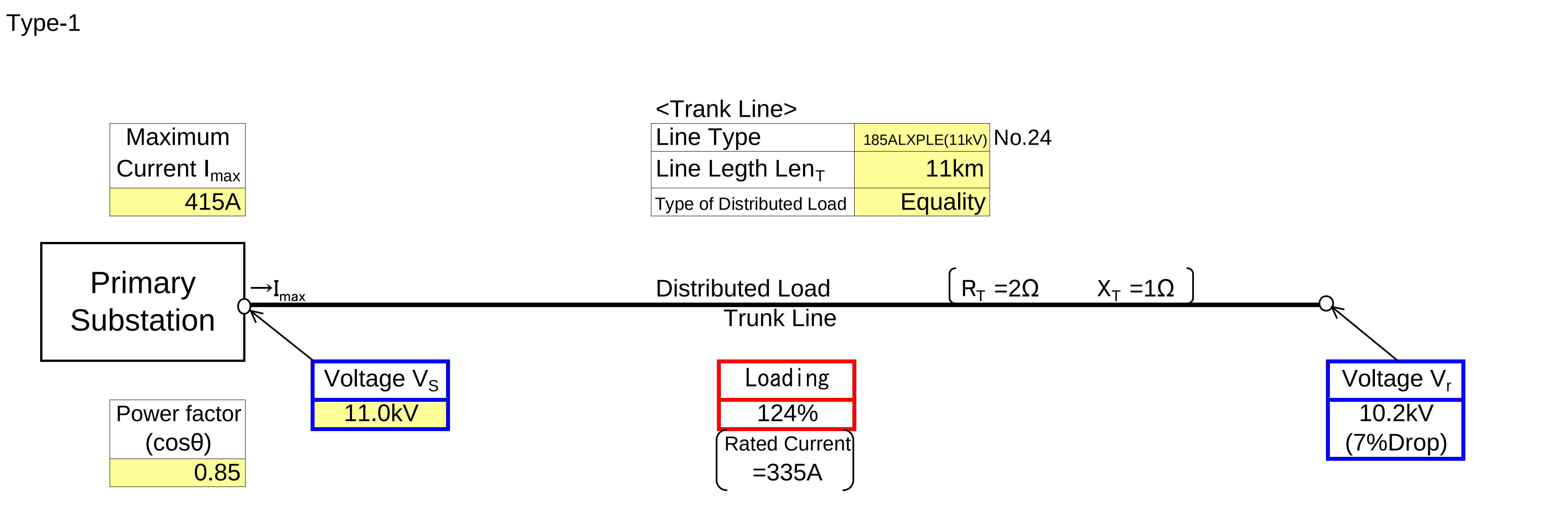
$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ADENTA(MAIN T)
Feeder Name	T03(Adenta Ests 1)

: Input data in colored cells



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

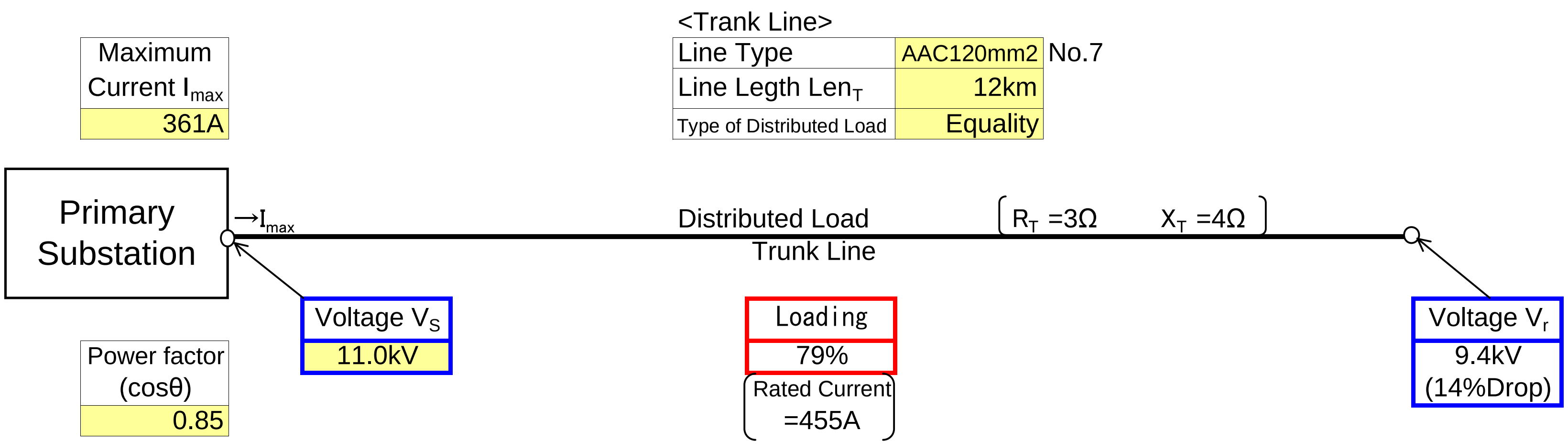
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ADENTA(MAIN T)
Feeder Name	T09(AGBOBGA)

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ADENTA(MAIN T)
Feeder Name	T10(DODOWA)

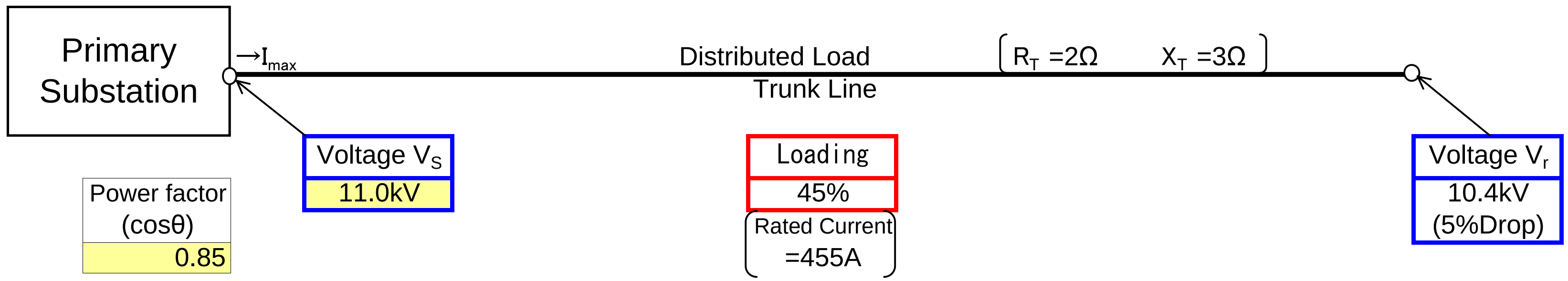
: Input data in colored cells

Type-1

Maximum Current I_{max}
205A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	8km	
Type of Distributed Load	Equality	



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

T11 (PANTANG) (Type-2)

Substation Name	ADENTA (MAIN T)
Feeder Name	T11(PANTANG)

: Input data in colored cells

Type-2

Maximum Current I_{max}
261A

Power factor (cosθ)
0.85

<Trank Line>

Load L_T	23A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	2km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	500kVA	

<Branch Line 1>

Load L_{B1}	161A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	8km	
Total Transformer Capacity of secondary substations CAP_{B1}	3425kVA	

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =1Ω X_T =1Ω)

Trunk Line

Loading
57%

(Rated Current =455A)

Voltage V_S
11.0kV

Voltage V_i
10.6kV (3%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =2Ω X_{B1} =3Ω)

Branch Line 1

Loading
35%

(Rated Current =455A)

Voltage V_{r1}
10.2kV (8%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =2Ω X_{B2} =2Ω)

Branch Line 2

Loading
17%

(Rated Current =455A)

Voltage V_{r2}
10.4kV (5%Drop)

<Branch Line 2>

Load L_{B2}	77A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	7km	
Total Transformer Capacity of secondary substations CAP_{B2}	1640kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage　I_{max} : Maximum Current　R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage　L_T : Load (Trunk line)　X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage　L_{B1} : Load (Branch Line 1)　cosθ : Power Factor

V_{r2} : Received Voltage　L_{B2} : Load (Branch Line 2)　f_T, f_{B1}, f_{B2} : Dispersal Load Factor　CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

T04 (REDCO) (Type-2)

Substation Name	ADENTA (MAIN T)
Feeder Name	T04(REDCO)

: Input data in colored cells

Type-2

Maximum Current I_{max}: 415A

Power factor (cosθ): 0.85

<Trank Line>

Load L_T	197A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	3km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	3525kVA	

<Branch Line 1>

Load L_{B1}	134A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	8km	
Total Transformer Capacity of secondary substations CAP_{B1}	2400kVA	

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =1Ω X_T =1Ω)

Trunk Line

Loading 91%

(Rated Current =455A)

Voltage V_S 11.0kV

Voltage V_i 10.3kV (6%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =2Ω X_{B1} =3Ω)

Branch Line 1

Loading 29%

(Rated Current =455A)

Voltage V_{r1} 9.9kV (10%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =2Ω X_{B2} =2Ω)

Branch Line 2

Loading 18%

(Rated Current =455A)

Voltage V_{r2} 10.1kV (8%Drop)

<Branch Line 2>

Load L_{B2}	84A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	7km	
Total Transformer Capacity of secondary substations CAP_{B2}	1500kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

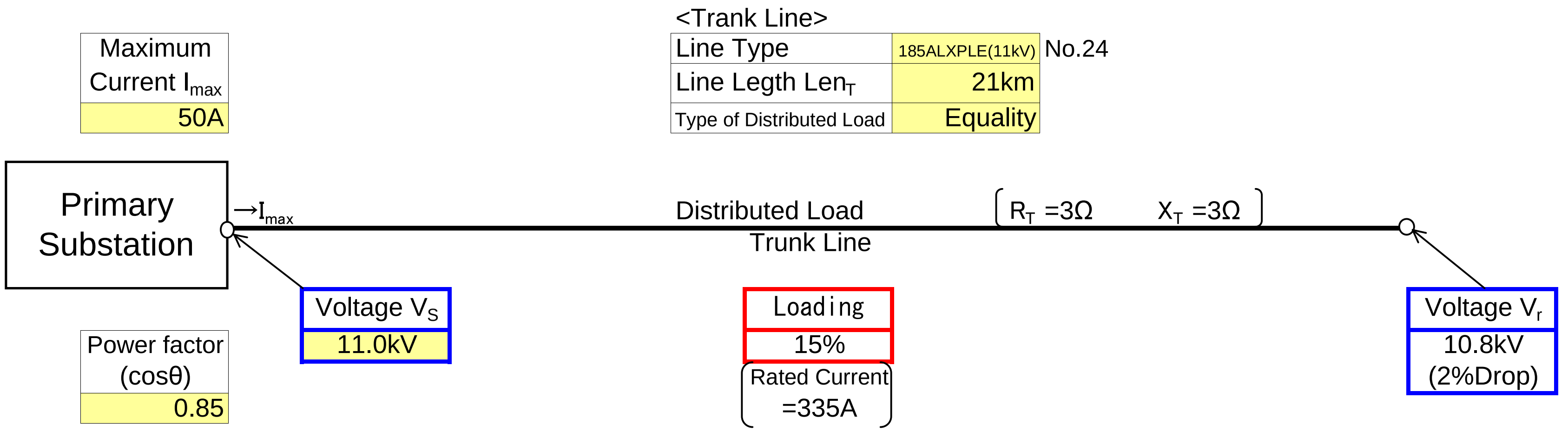
CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	AKWAPIM (MAIN W
Feeder Name	05(T. Q. MEM HOS

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KWAPIM (MAIN W
Feeder Name	PEDUASE

: Input data in colored cells

Type-3

Maximum Current I_{max}
125A

Power factor (cosθ)
0.85

<Trank Line 1>

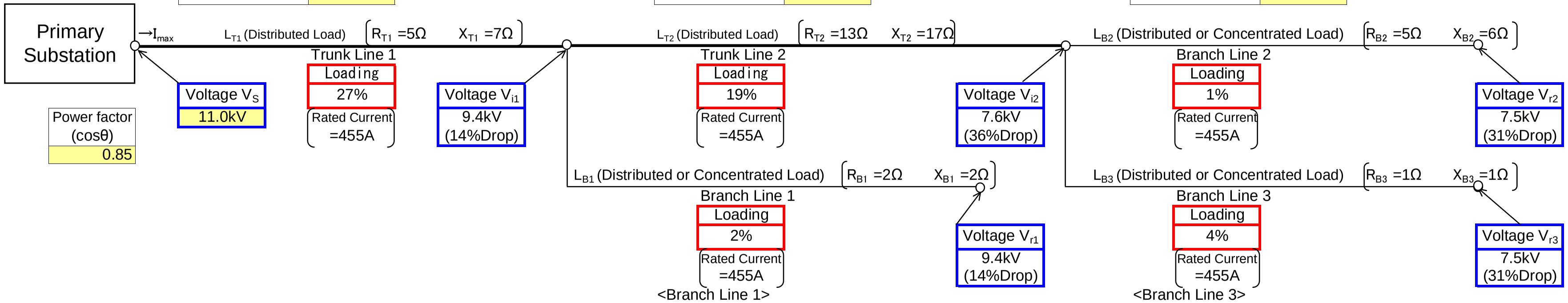
Load L_{T1}	30A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	20km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	1140kVA	

<Trank Line 2>

Load L_{T2}	64A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	47km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	2410kVA	

<Branch Line 2>

Load L_{B2}	5A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	17km	
Total Transformer Capacity of secondary substations CAP_{B2}	200kVA	



<Branch Line 1>

Load L_{B1}	8A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	7km	
Total Transformer Capacity of secondary substations CAP_{B1}	300kVA	

<Branch Line 3>

Load L_{B3}	17A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B3}	4km	
Total Transformer Capacity of secondary substations CAP_{B3}	650kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KWAPIM (MAIN W
Feeder Name	AKROPONG FEE

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	19A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	4km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	600kVA	

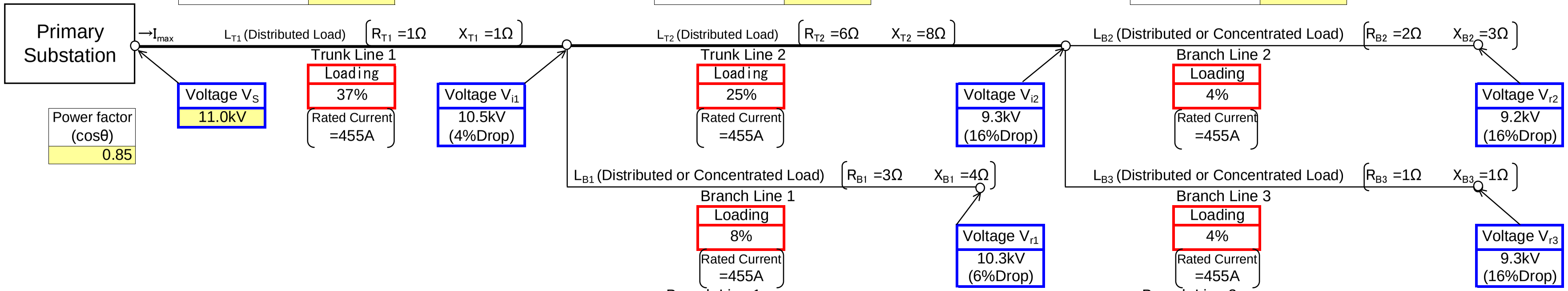
<Trank Line 2>

Load L_{T2}	82A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	23km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	2530kVA	

<Branch Line 2>

Load L_{B2}	16A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	8km	
Total Transformer Capacity of secondary substations CAP_{B2}	500kVA	

Maximum Current I_{max}	170A
Power factor (cosθ)	0.85



<Branch Line 1>

Load L_{B1}	35A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	13km	
Total Transformer Capacity of secondary substations CAP_{B1}	1080kVA	

<Branch Line 3>

Load L_{B3}	18A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B3}	3km	
Total Transformer Capacity of secondary substations CAP_{B3}	550kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	;AATSONA(MAIN Y
Feeder Name	Y09(Coca cola)

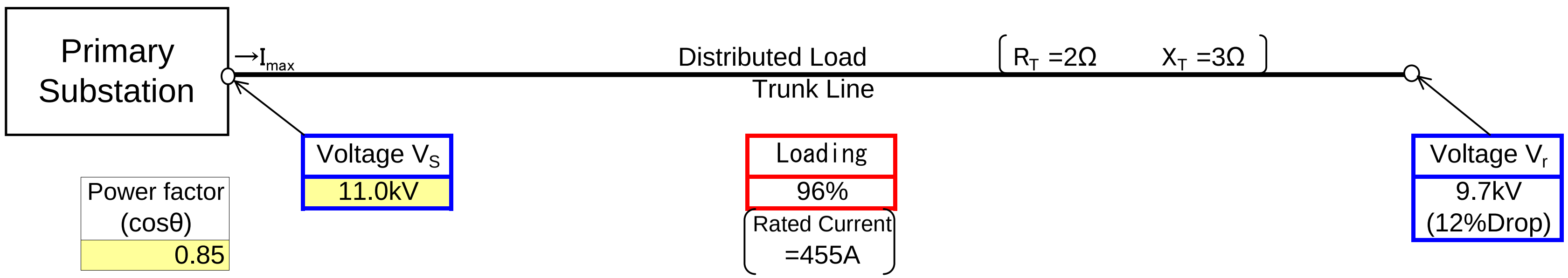
: Input data in colored cells

Type-1

Maximum Current I_{max}
437A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	8km	
Type of Distributed Load	Equality	



Power factor (cosθ)
0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	3AATSONA(MAIN Y
Feeder Name	Y09(Coca cola)

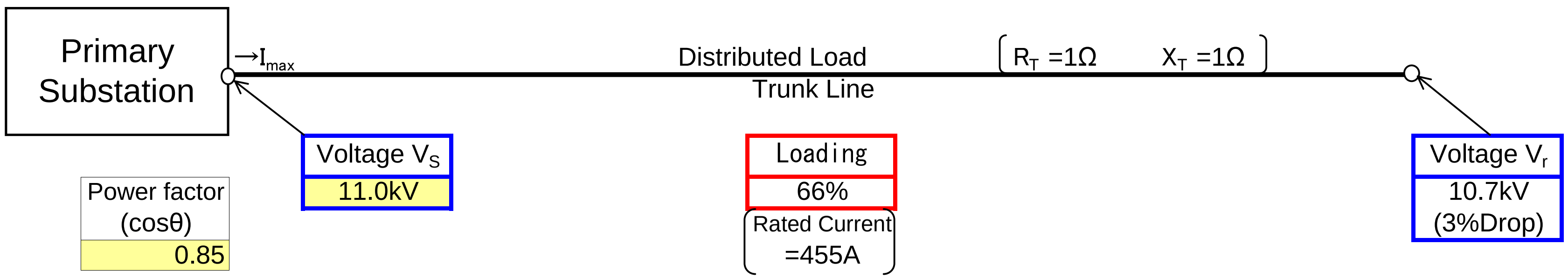
: Input data in colored cells

Type-1

Maximum Current I_{max}
300A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	3km	
Type of Distributed Load	Equality	



Power factor (cosθ)
0.85

=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	3AATSONA(MAIN Y
Feeder Name	Y10(Texpo)

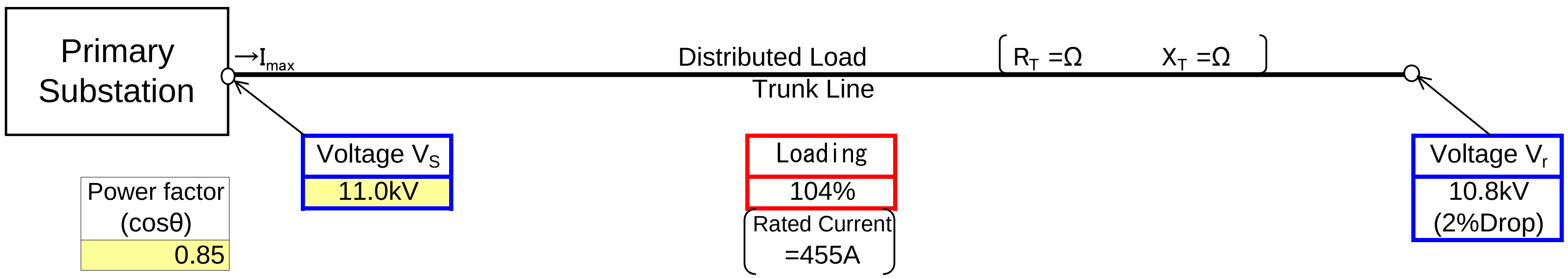
: Input data in colored cells

Type-1

Maximum Current I_{max}	475A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	1km	
Type of Distributed Load	Equality	



Power factor (cosθ)	0.85

=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$$

V_s : Supply Voltage
V_r : Received Voltage
I_{max} : Maximum Current
R_T : Resistance
X_T : Reactance
cosθ : Power Factor
f_T : Dispersal Load Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	AATSONA(MAIN Y
Feeder Name	Y11(Spintex)

: Input data in colored cells

Type-2

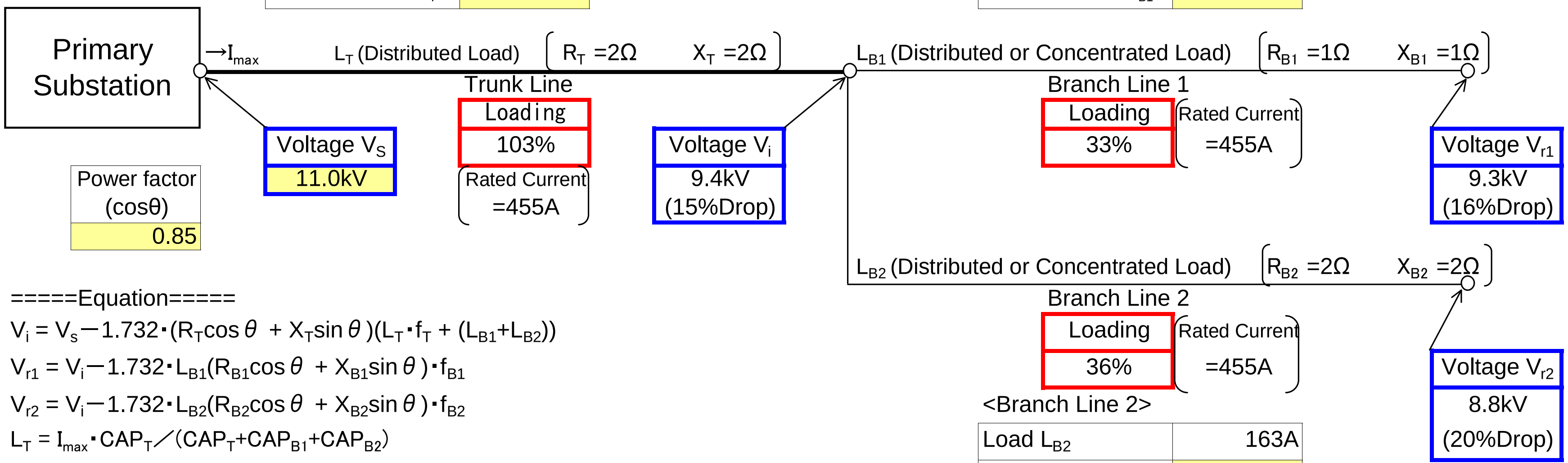
Maximum Current I_{max}
467A

<Trank Line>

Load L_T	152A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	6km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_T	1300kVA	

<Branch Line 1>

Load L_{B1}	152A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B1}	1300kVA	



Power factor (cosθ)
0.85

<Branch Line 2>

Load L_{B2}	163A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	7km	
Total Transformer Capacity of secondary substations CAP_{B2}	1400kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance	
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance	
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor	
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor	CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN H
Feeder Name	ACHIMOTA 1

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	33A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	2km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	415kVA	

<Trank Line 2>

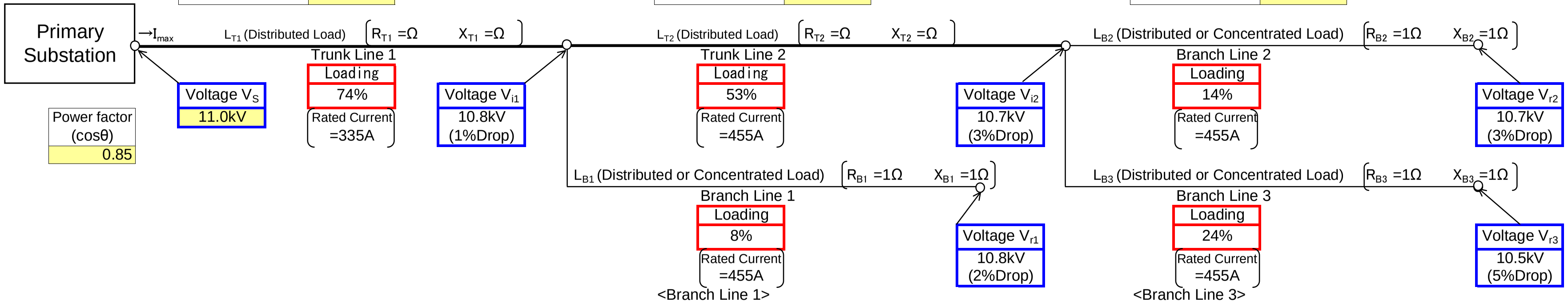
Load L_{T2}	4A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	1km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	50kVA	

<Branch Line 2>

Load L_{B2}	64A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B2}	815kVA	

Maximum Current I_{max}
247A

Power factor (cosθ)
0.85



<Branch Line 1>

Load L_{B1}	36A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B1}	450kVA	

<Branch Line 3>

Load L_{B3}	110A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B3}	4km	
Total Transformer Capacity of secondary substations CAP_{B3}	1400kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

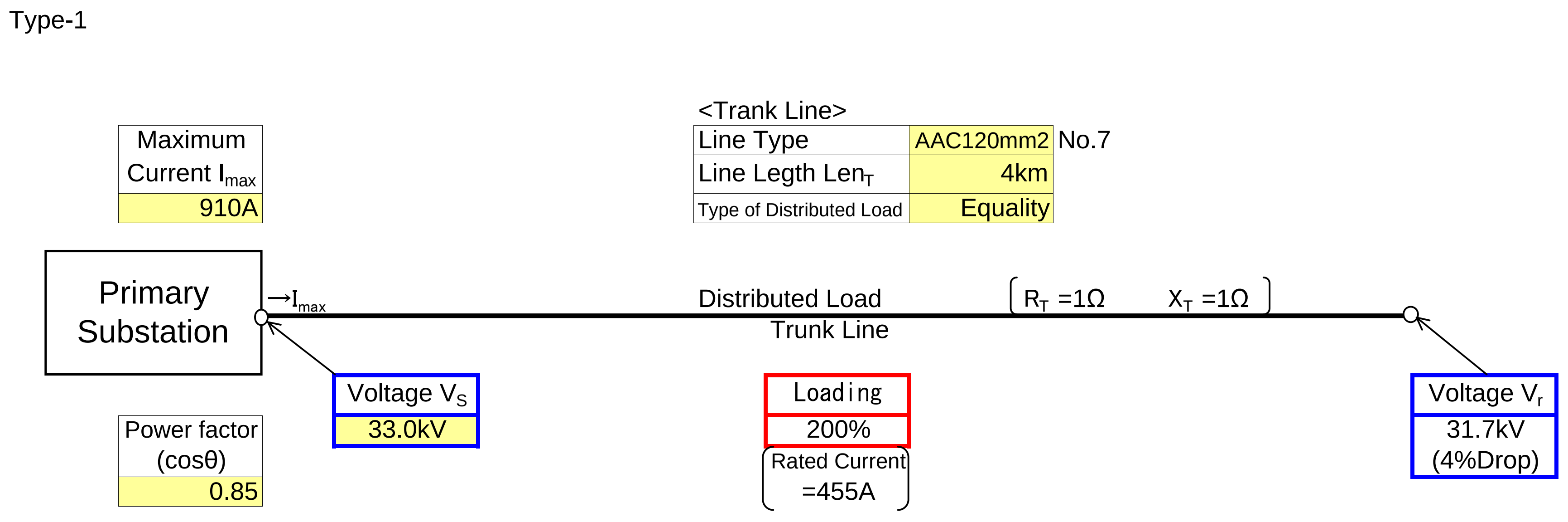
Power System Analysis

- Accra East 33kV -

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN A
Feeder Name	AWOSHIE I

: Input data in colored cells



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN A
Feeder Name	AWOSHIE II

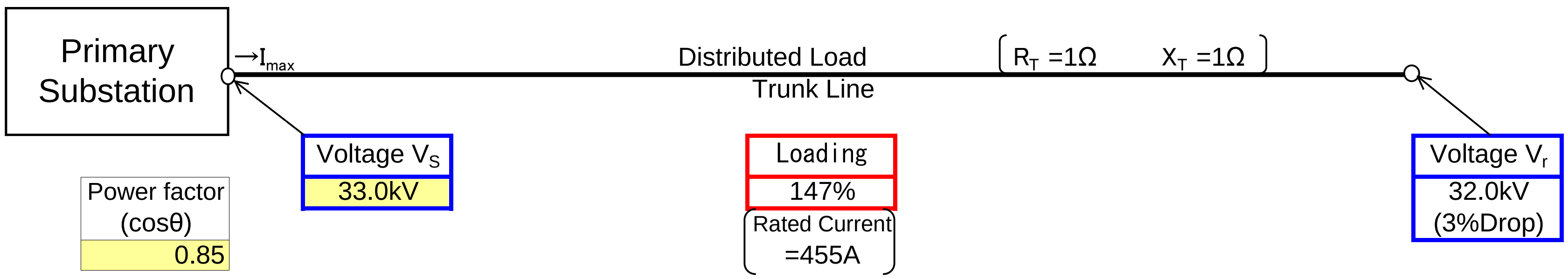
: Input data in colored cells

Type-1

Maximum Current I_{max}
668A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	4km	
Type of Distributed Load	Equality	



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN A - ODORKOR
Feeder Name	DANSOMAN

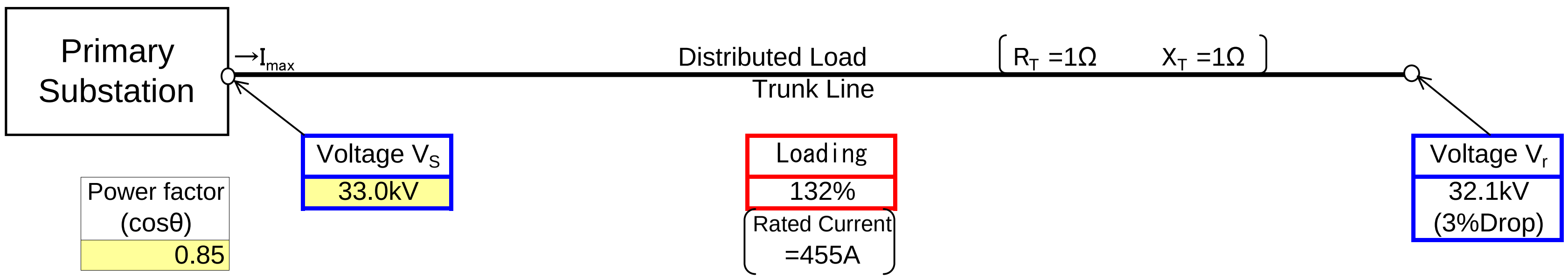
: Input data in colored cells

Type-1

Maximum Current I_{max}
600A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	4km	
Type of Distributed Load	Equality	



Power factor (cosθ)
0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	AATSONA(MAIN Y
Feeder Name	Y04(Johnson wax)

: Input data in colored cells

Type-2

Maximum Current I_{max}: 437A

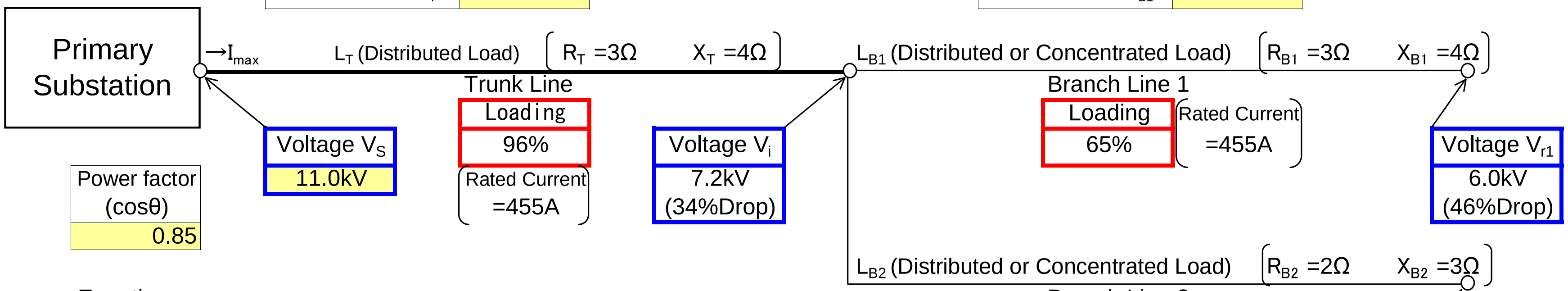
Power factor (cosθ): 0.85

<Trank Line>

Load L_T	16A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	12km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	450kVA	

<Branch Line 1>

Load L_{B1}	295A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	12km	
Total Transformer Capacity of secondary substations CAP_{B1}	8215kVA	



<Branch Line 2>

Load L_{B2}	126A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	8km	
Total Transformer Capacity of secondary substations CAP_{B2}	3525kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage I_{max} : Maximum Current R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage L_T : Load (Trunk line) X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage L_{B1} : Load (Branch Line 1) cosθ : Power Factor
V_{r2} : Received Voltage L_{B2} : Load (Branch Line 2) f_T, f_{B1}, f_{B2} : Dispersal Load Factor CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN H
Feeder Name	ACHIMOTA 1

: Input data in colored cells

Type-3

Maximum Current I_{max}
835A

Power factor (cosθ)
0.85

<Trank Line 1>

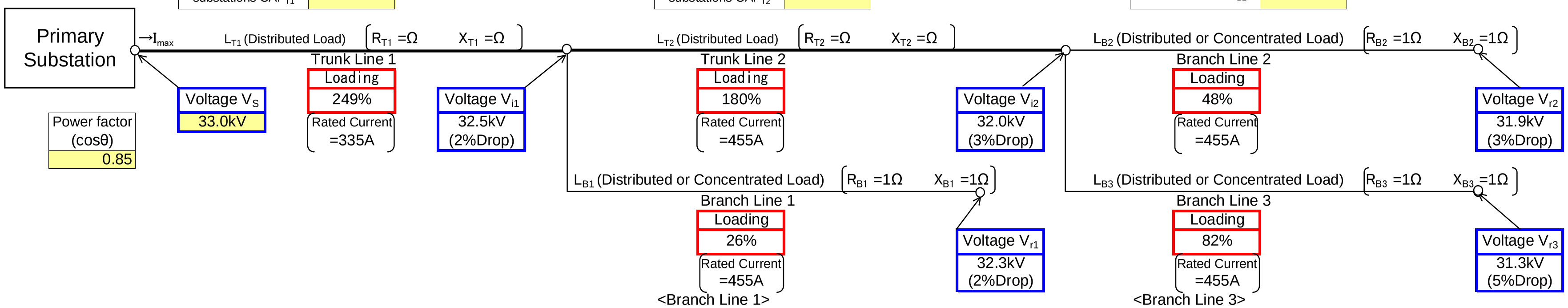
Load L_{T1}	111A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	2km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	415kVA	

<Trank Line 2>

Load L_{T2}	13A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	1km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	50kVA	

<Branch Line 2>

Load L_{B2}	217A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B2}	815kVA	



<Branch Line 1>

Load L_{B1}	120A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B1}	450kVA	

<Branch Line 3>

Load L_{B3}	373A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B3}	4km	
Total Transformer Capacity of secondary substations CAP_{B3}	1400kVA	

=====Equation=====

$V_{i1} = V_s - 1.732\cdot(R_{T1}\cos\theta + X_{T1}\sin\theta)\cdot(L_{T1}\cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732\cdot(R_{T2}\cos\theta + X_{T2}\sin\theta)\cdot(L_{T2}\cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732\cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta)\cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732\cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta)\cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732\cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta)\cdot f_{B3}$

$L_{T1} = I_{max}\cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max}\cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max}\cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max}\cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max}\cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN B
Feeder Name	MATAHEKO

: Input data in colored cells

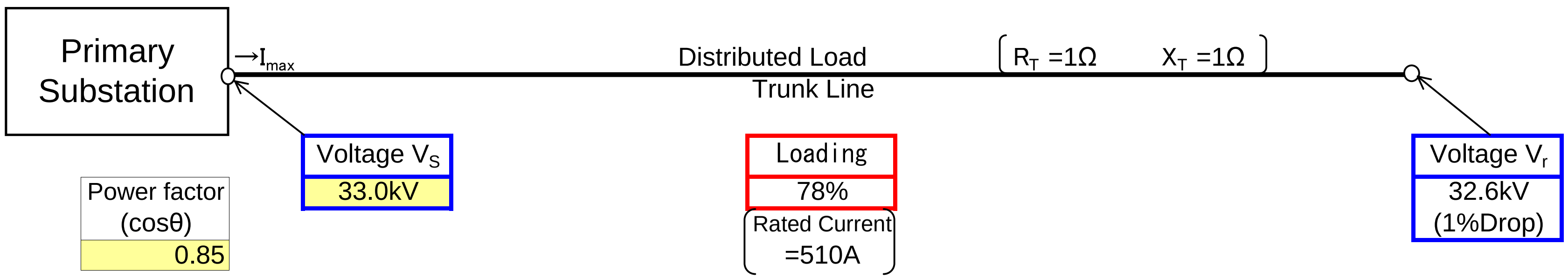
Type-1

Maximum Current I_{max}
396A

<Trank Line>

Line Type	240ALXLPE(33kV)	No.29
Line Legth Len_T	5km	
Type of Distributed Load	Equality	

Power factor (cosθ)
0.85



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

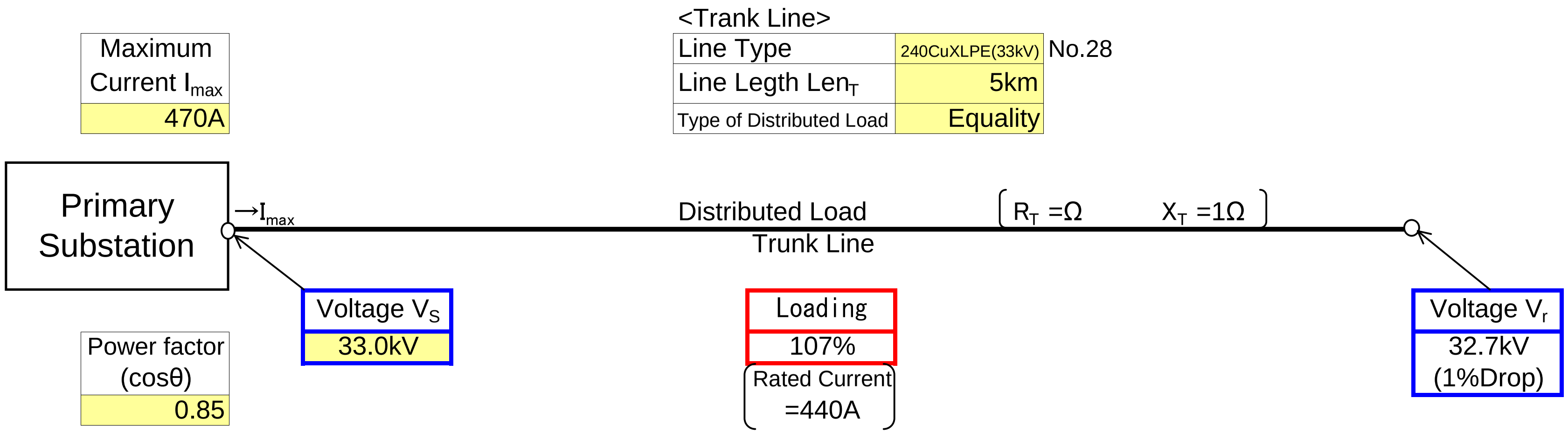
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN B
Feeder Name	ATERBIOKORSHI

: Input data in colored cells

Type-1



=====Equation=====

$$V_r = V_s - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN B
Feeder Name	KORLE BU

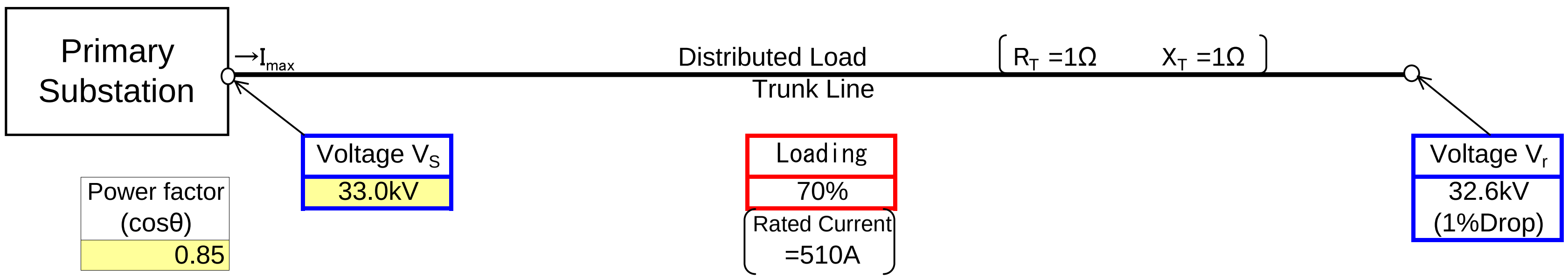
: Input data in colored cells

Type-1

Maximum Current I_{max}	359A
Power factor ($\cos\theta$)	0.85

<Trank Line>

Line Type	240ALXLPE(33kV)	No.29
Line Legth Len_T	6km	
Type of Distributed Load	Equality	



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	$\cos\theta$	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN C
Feeder Name	QUARRY I

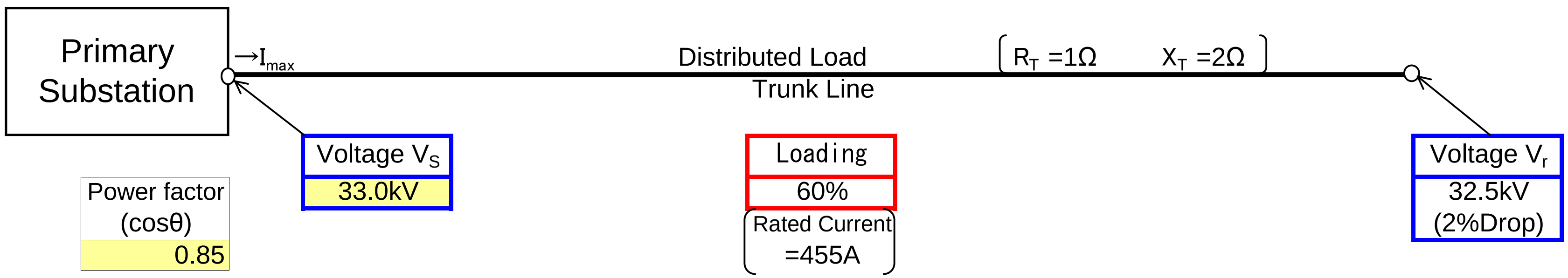
: Input data in colored cells

Type-1

Maximum Current I_{max}	275A
Power factor ($\cos\theta$)	0.85

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	5km	
Type of Distributed Load	Equality	



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$$

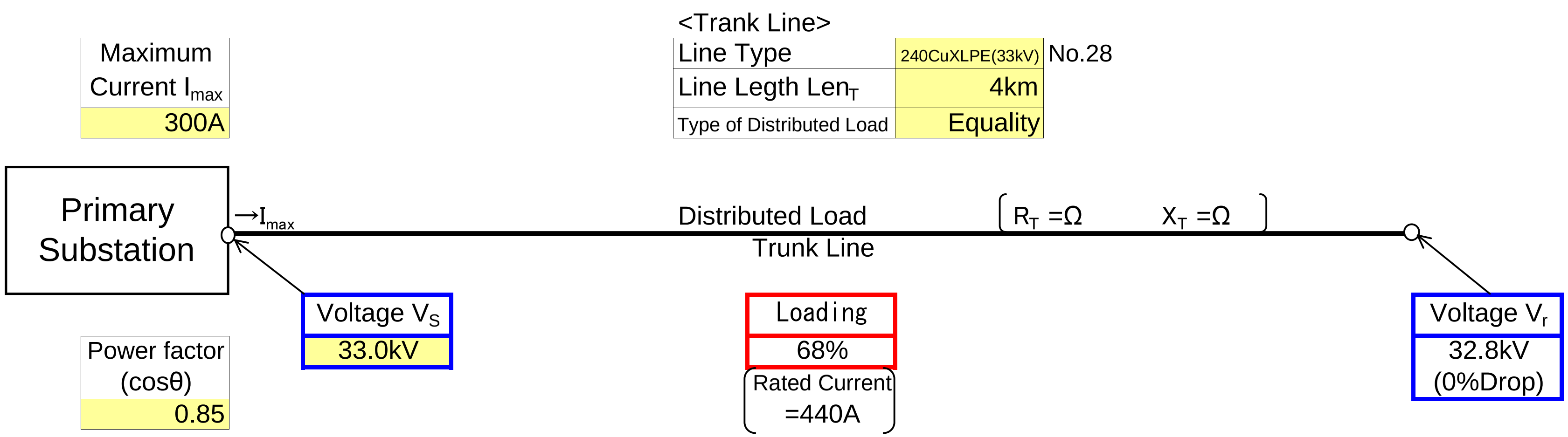
V_S	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	$\cos\theta$	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN C
Feeder Name	NSAWAM

: Input data in colored cells

Type-1



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$$

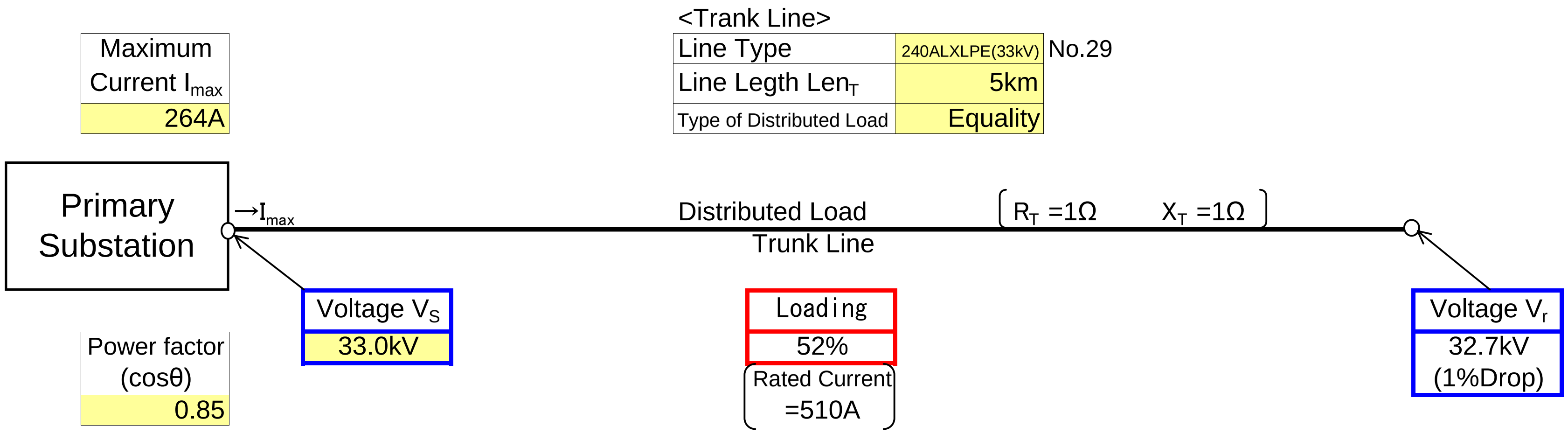
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN C
Feeder Name	QUARRY II

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

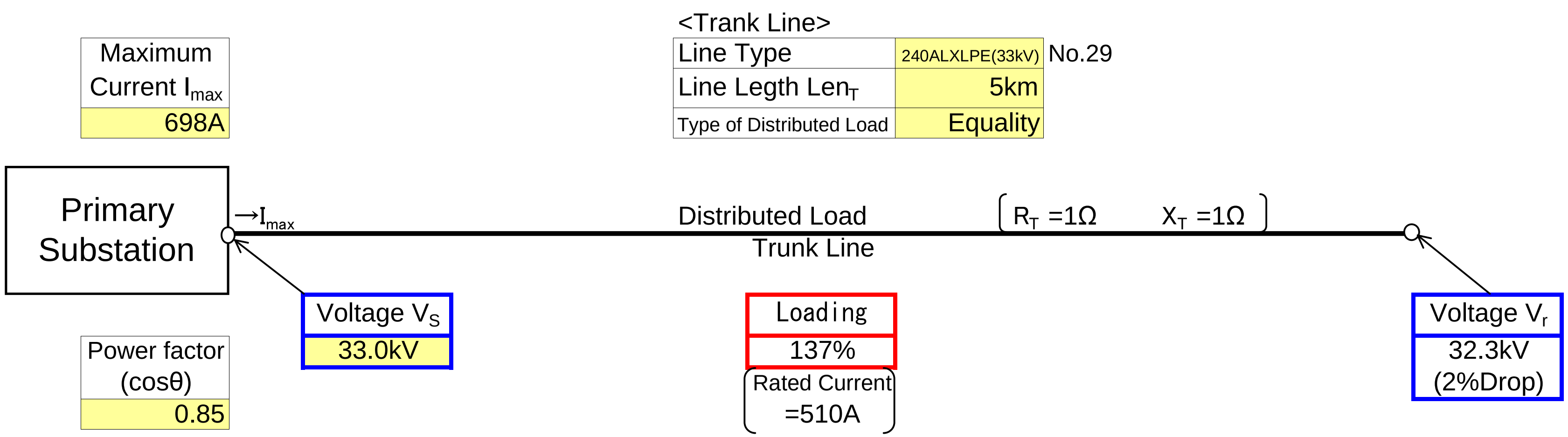
V_S	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN C
Feeder Name	ACHIMOTA I

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN C
Feeder Name	ACHIMOTA II

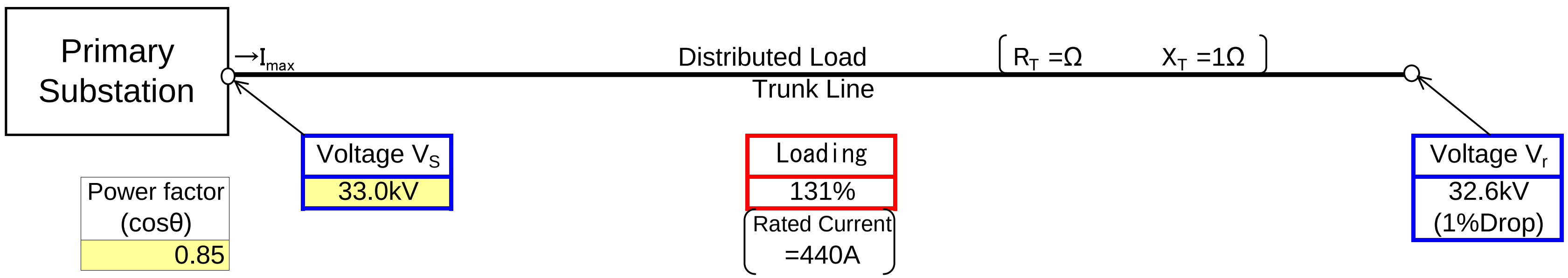
: Input data in colored cells

Type-1

Maximum Current I_{max}
576A

<Trank Line>

Line Type	240CuXLPE(33kV)	No.28
Line Legth Len_T	5km	
Type of Distributed Load	Equality	



Power factor (cosθ)
0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	AIN D- RING ROAI
Feeder Name	KOKOMLEMLE

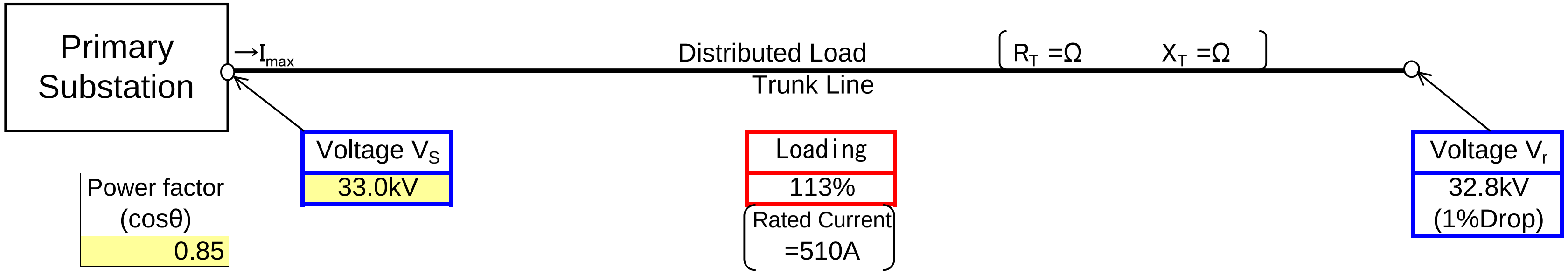
: Input data in colored cells

Type-1

Maximum Current I_{max}	576A

<Trank Line>

Line Type	240ALXLPE(33kV)	No.29
Line Legth Len_T	2km	
Type of Distributed Load	Equality	



Power factor (cosθ)	0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

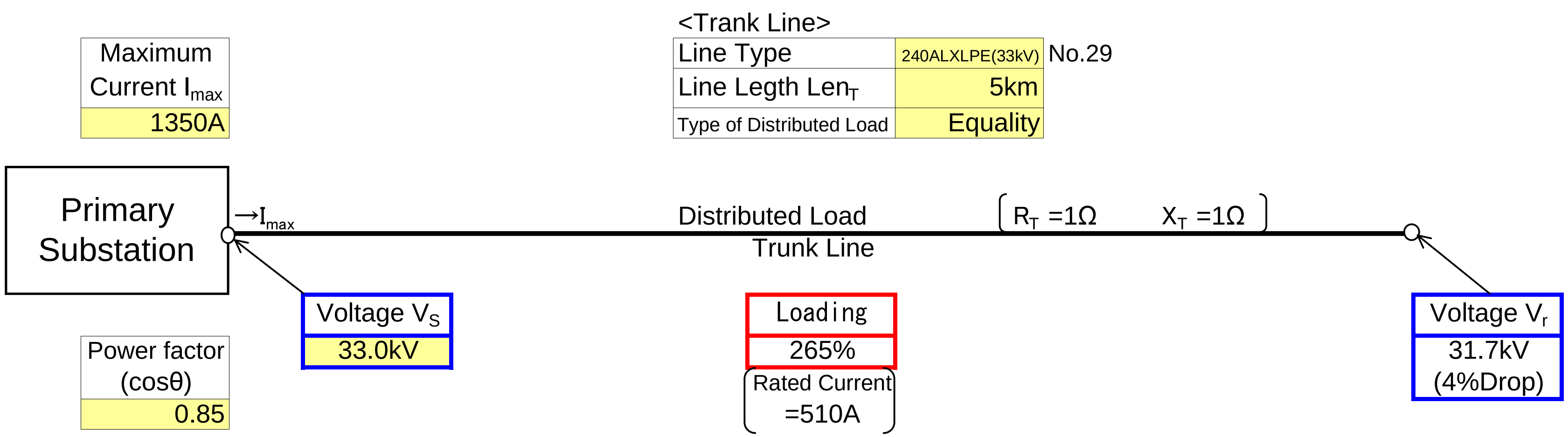
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	AIN D- RING ROAI
Feeder Name	ALAJO II

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

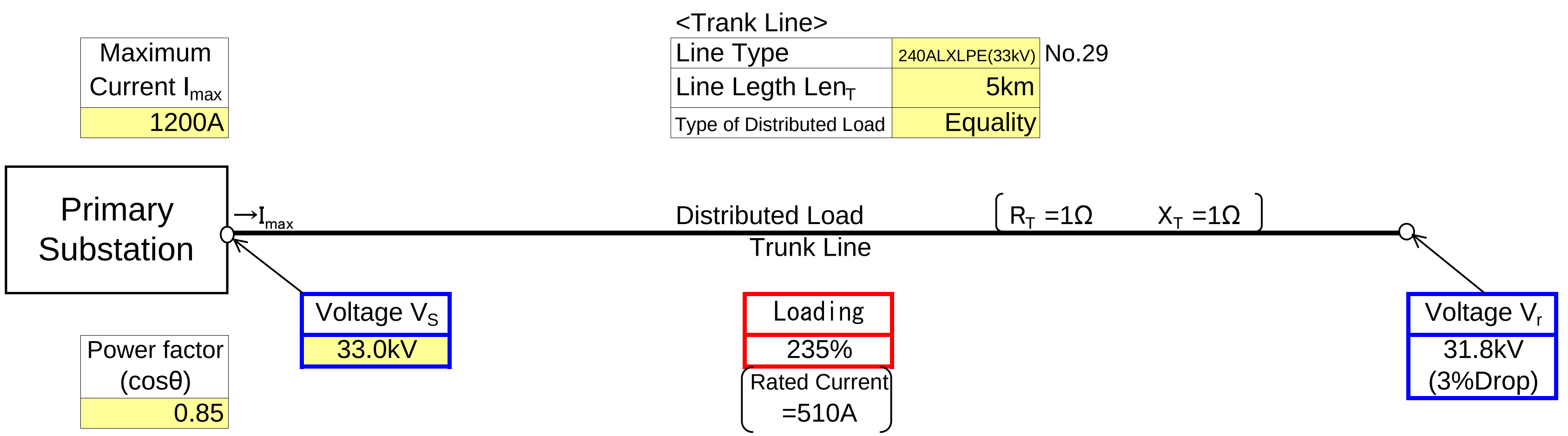
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	AIN D- RING ROAI
Feeder Name	ALAJO I

: Input data in colored cells

Type-1



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	AIN D- RING ROAI
Feeder Name	AVENOR I

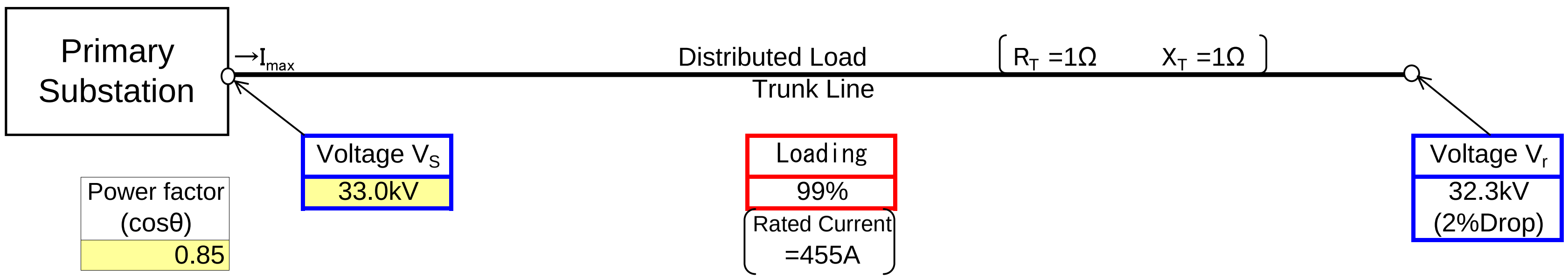
: Input data in colored cells

Type-1

Maximum Current I_{max}
450A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	4km	
Type of Distributed Load	Equality	



Power factor (cosθ)
0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

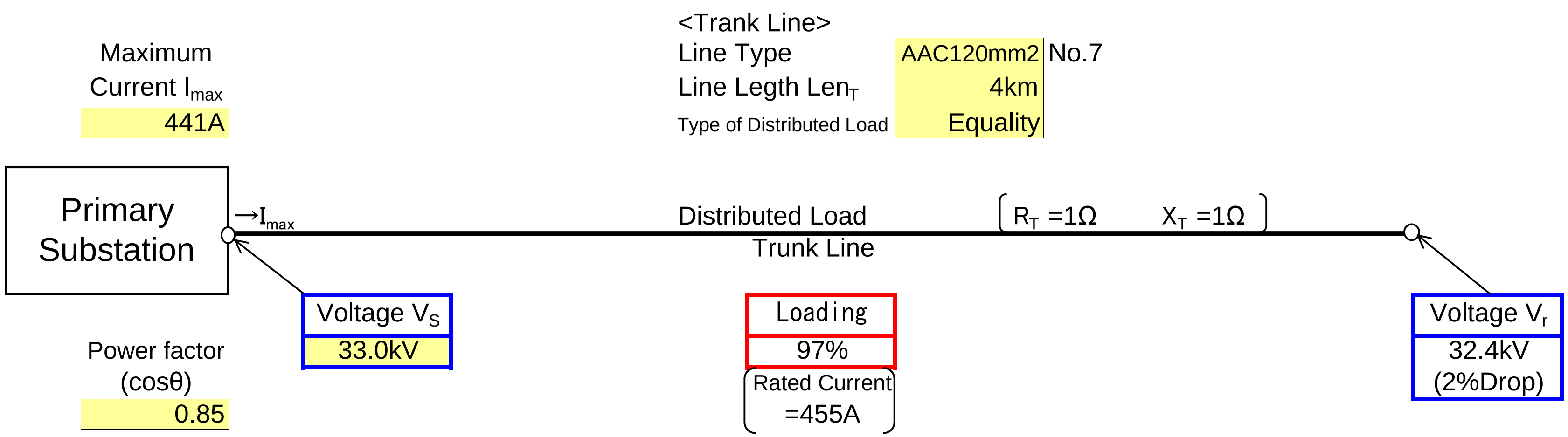
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	AIN D- RING ROAI
Feeder Name	AVENOR II

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_S	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	IN E- GRAPHIC RC
Feeder Name	OKAISHIE II

: Input data in colored cells

Type-1

Maximum Current I_{max}	399A

Power factor (cosθ)	0.85

<Trank Line>

Line Type	240CuXLPE(33kV)	No.28
Line Legth Len_T	4km	
Type of Distributed Load	Equality	

Primary Substation

$\rightarrow I_{max}$

Distributed Load

Trunk Line

R_T =Ω X_T =Ω

Voltage V_S
33.0kV

Loading
91%

Rated Current =440A

Voltage V_r
32.8kV (1%Drop)

=====Equation=====

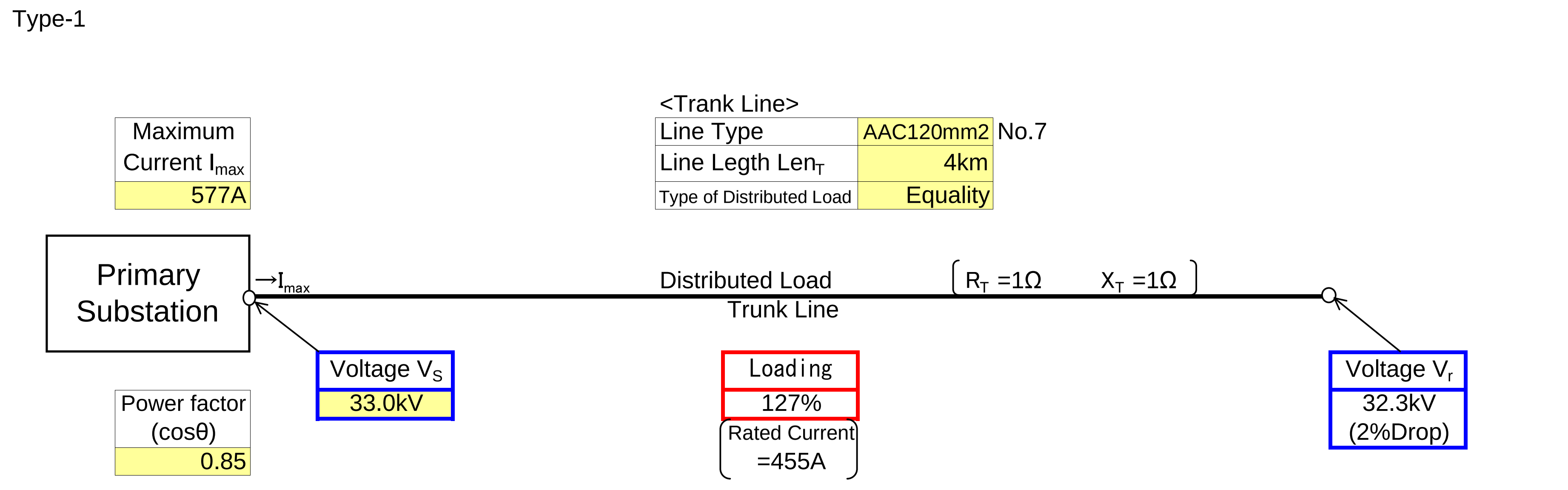
$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	IN E- GRAPHIC RC
Feeder Name	AVENOR II

: Input data in colored cells



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$$

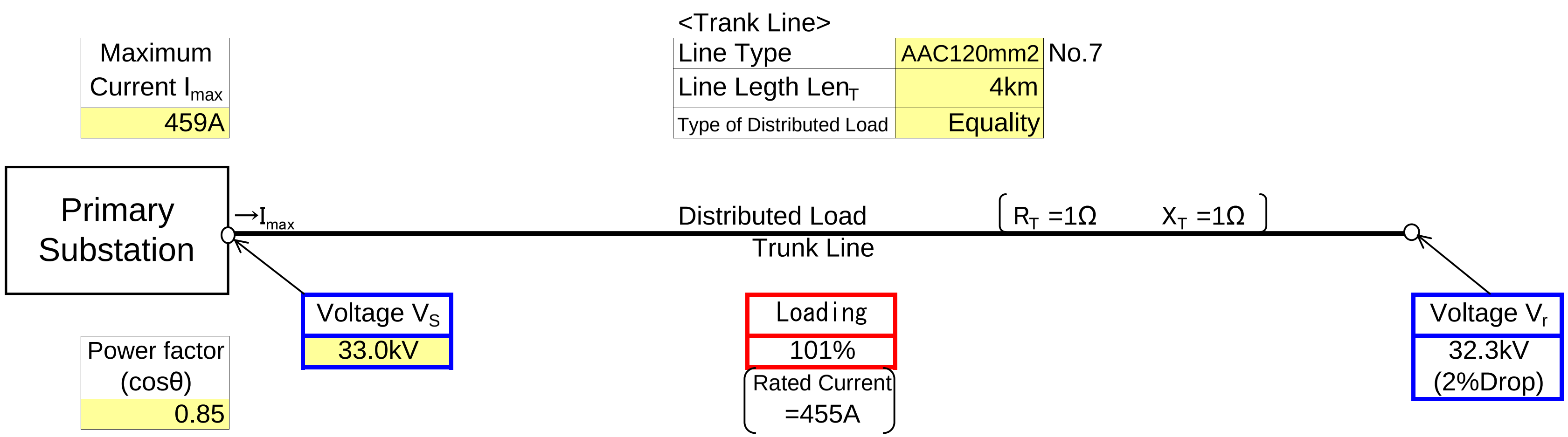
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	IN E-GRAPHIC RC
Feeder Name	AVENOR I

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

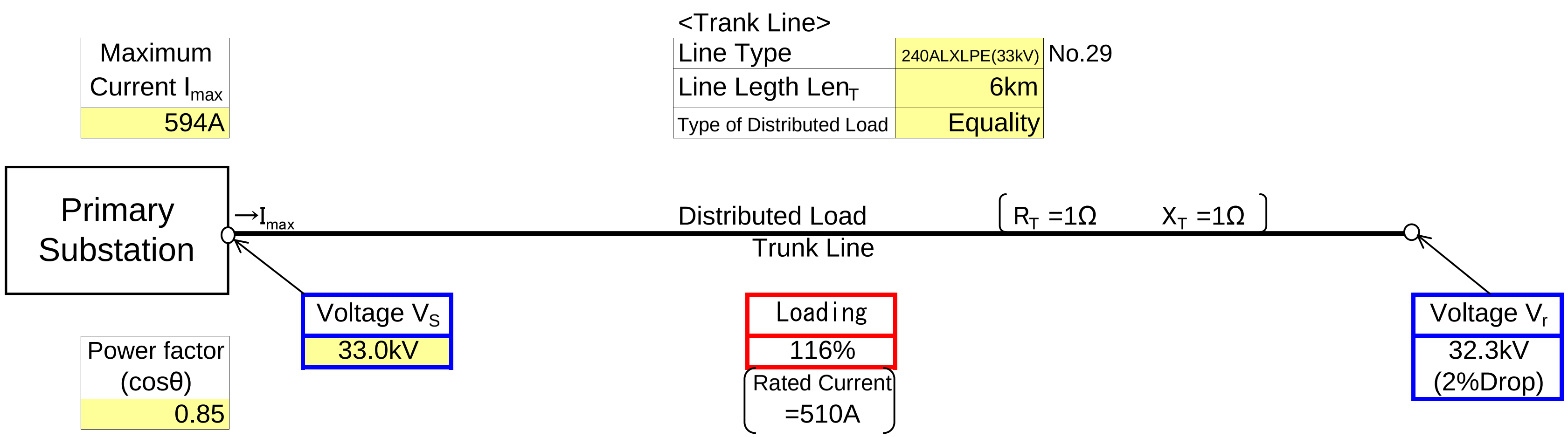
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	IN E-GRAPHIC RC
Feeder Name	KOTOBABI I

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

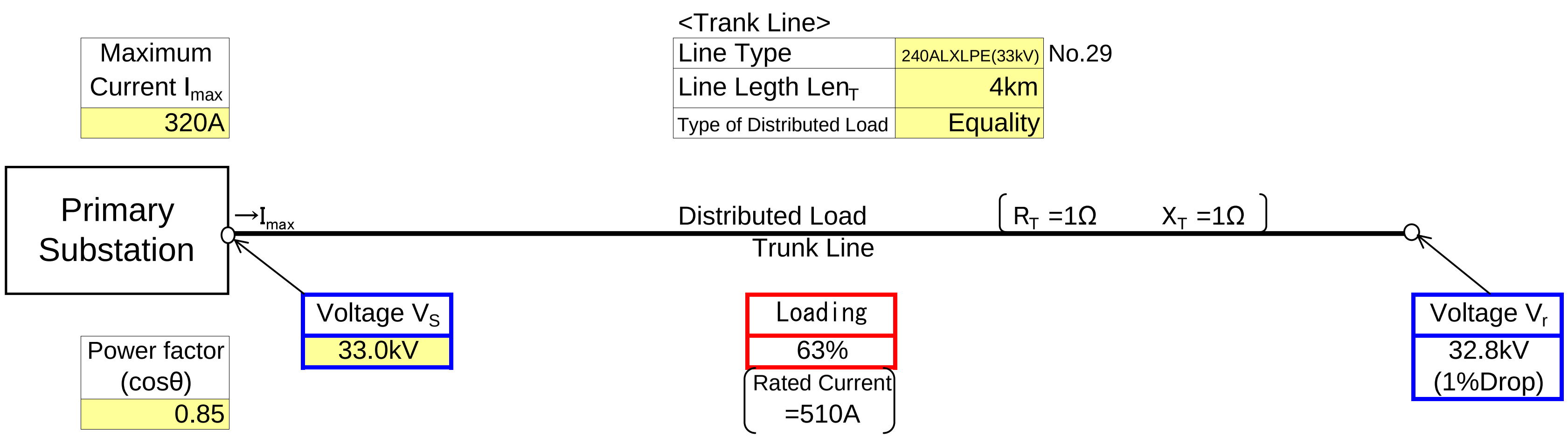
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	IN E-GRAPHIC RC
Feeder Name	OKAISHIE I

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

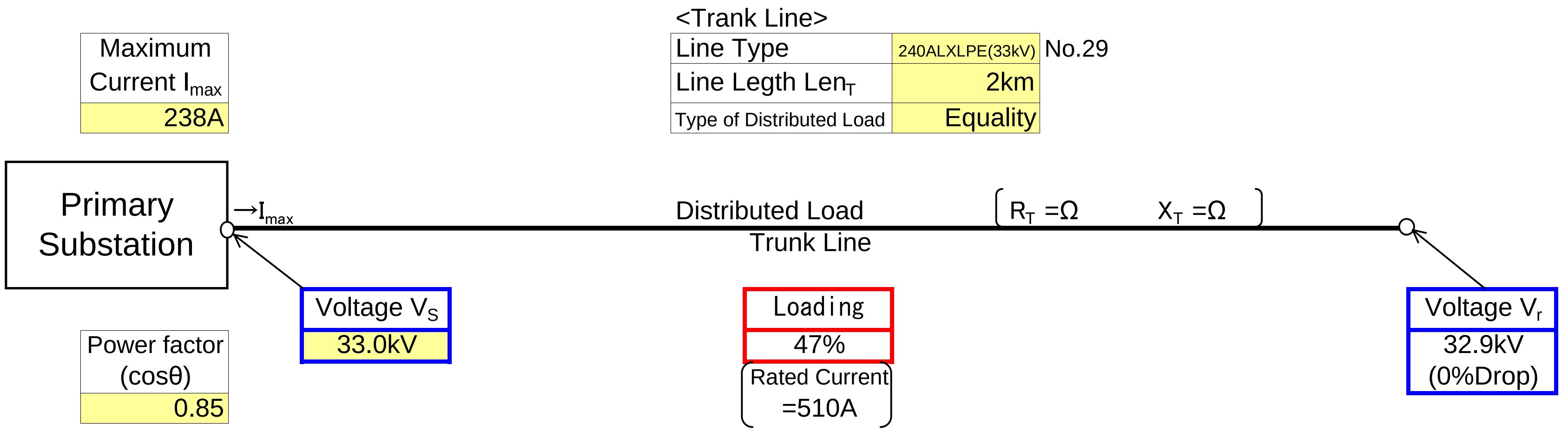
V_S	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	IN E-GRAPHIC RC
Feeder Name	ADABRAKA

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

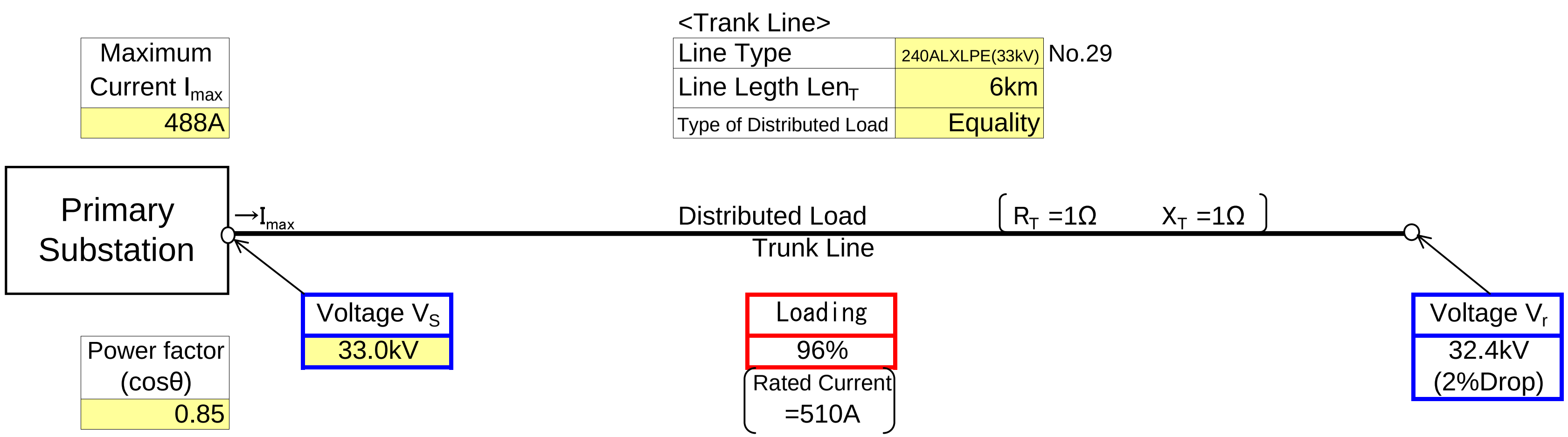
V_S	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	IN E- GRAPHIC RC
Feeder Name	KOTOBABI II

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

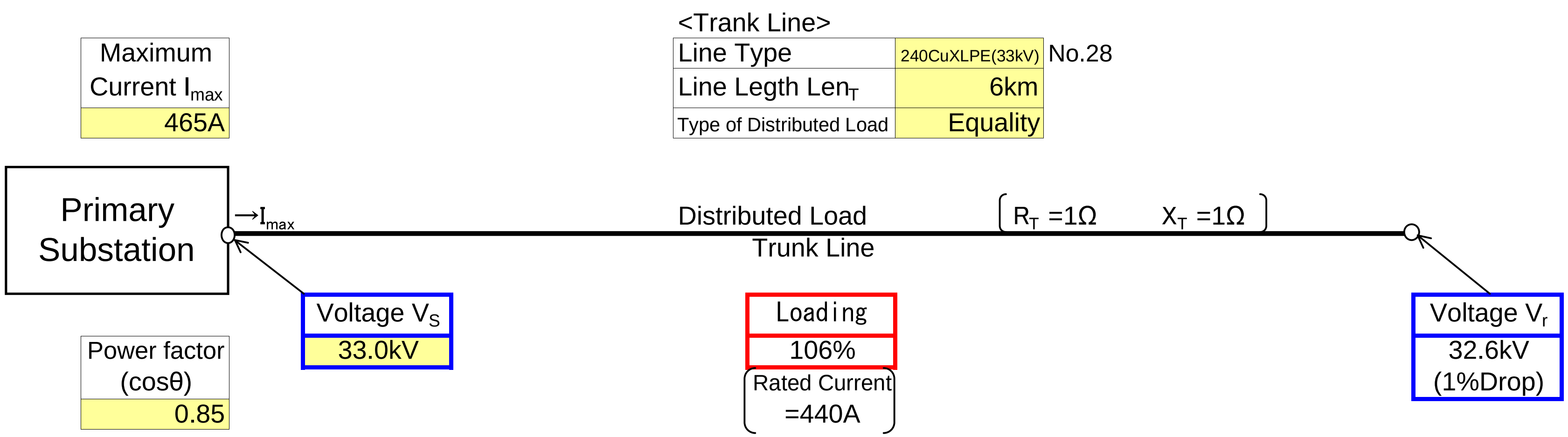
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	N E - GRAPHIC RO
Feeder Name	ATERBIOKORSHI

: Input data in colored cells

Type-1



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	AIN F- KOKOMLEM
Feeder Name	ADABRAKA

: Input data in colored cells

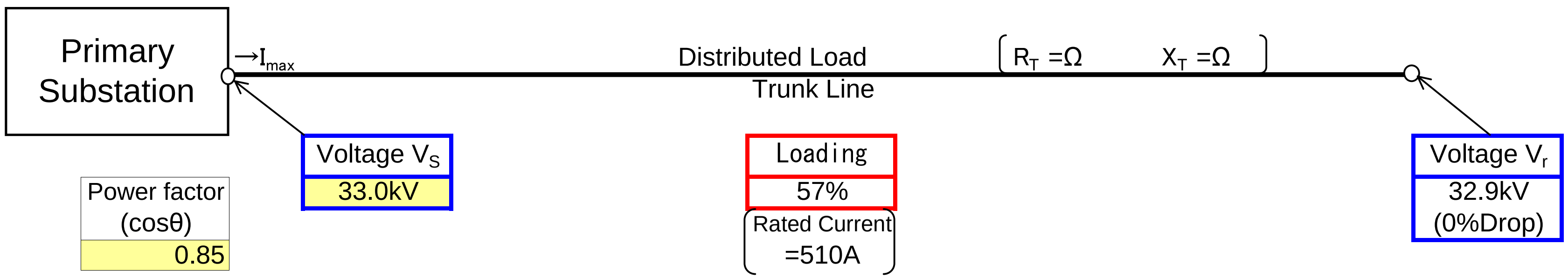
Type-1

<Trank Line>

Line Type	240ALXLPE(33kV)	No.29
Line Legth Len_T	2km	
Type of Distributed Load	Equality	

Maximum Current I_{max}
289A

Power factor (cosθ)
0.85



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

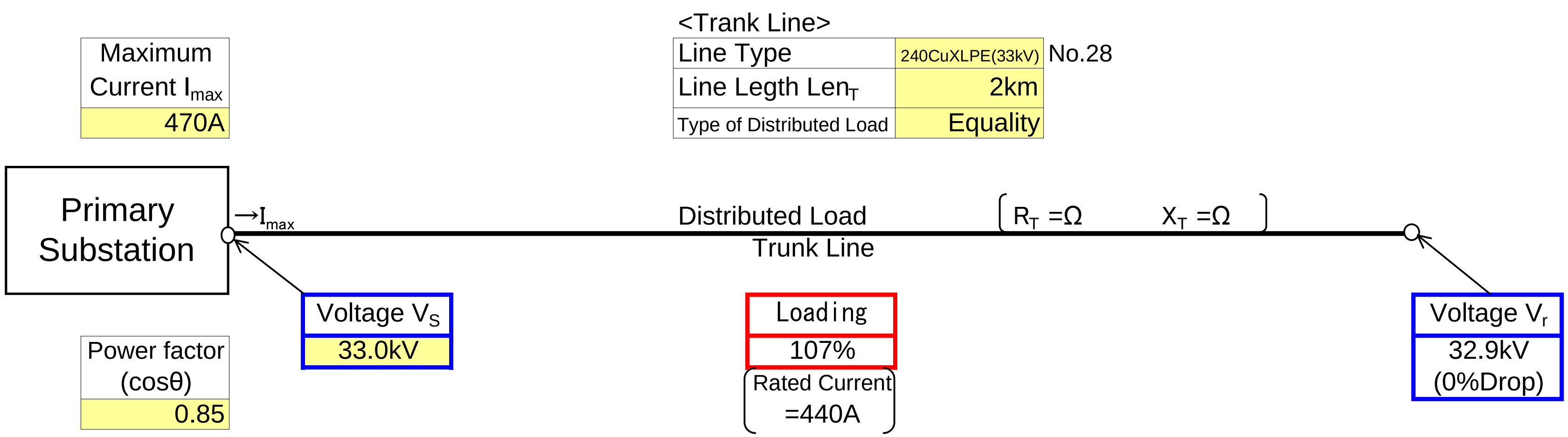
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	AIN F- KOKOMLEM
Feeder Name	KOKOMLEMLE

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

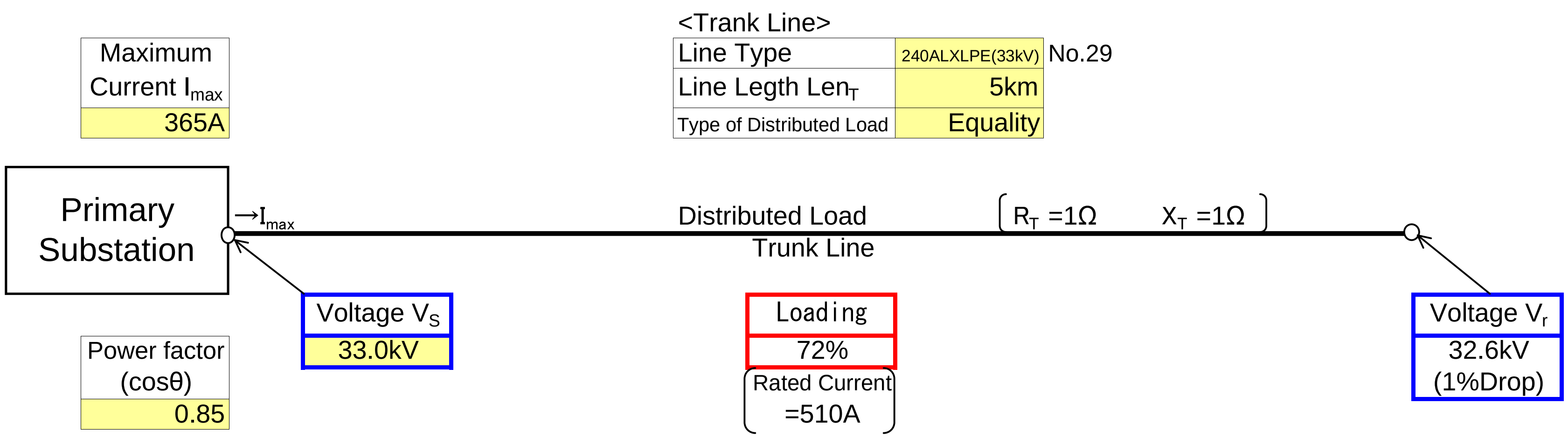
V_S	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN G-MAKOLA
Feeder Name	KORLE BU

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

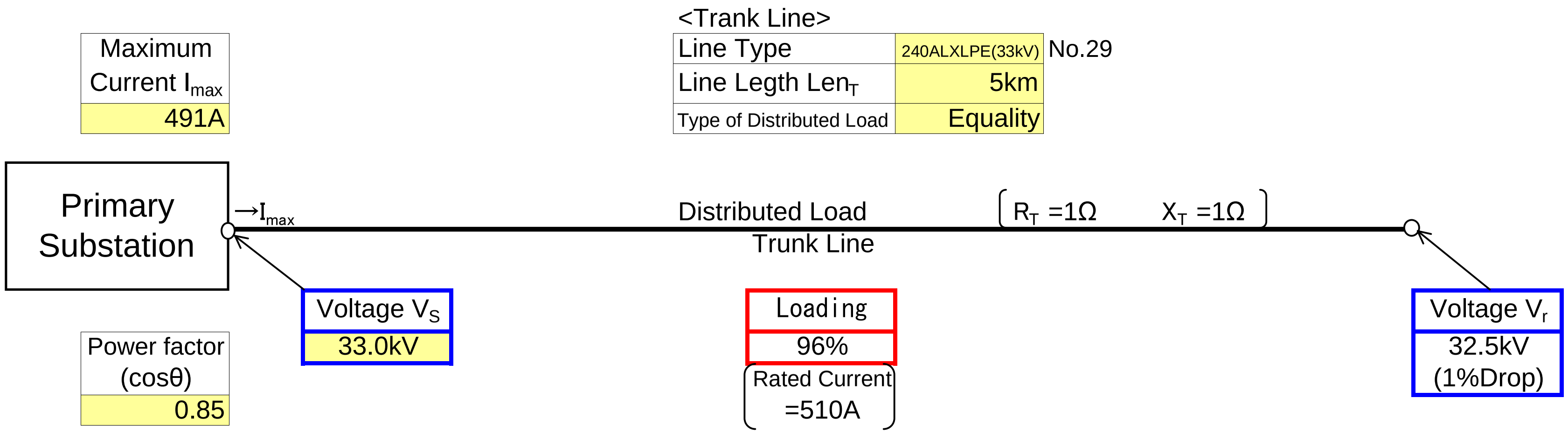
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN G-MAKOLA
Feeder Name	RINGWAY

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

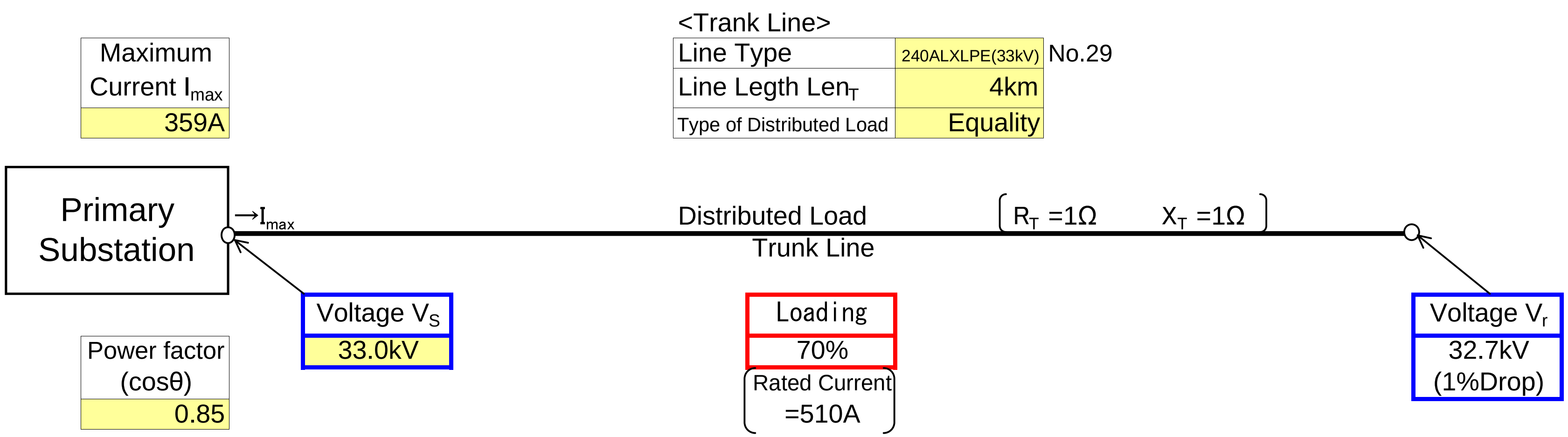
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN G-MAKOLA
Feeder Name	KINBU

: Input data in colored cells

Type-1



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$$

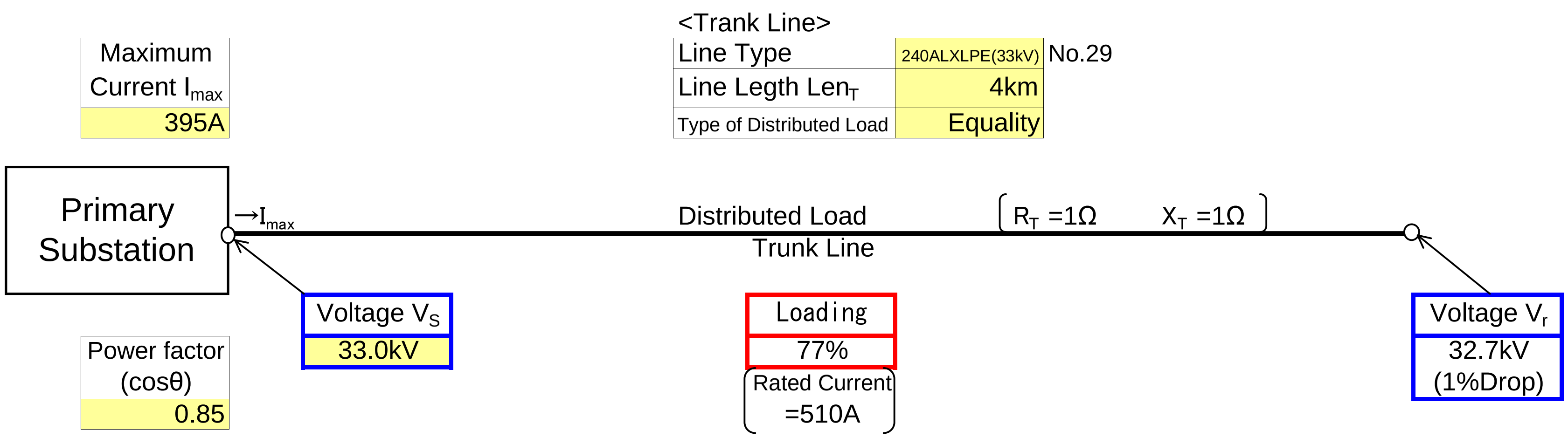
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN G-MAKOLA
Feeder Name	OKAISHIE II

: Input data in colored cells

Type-1



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$$

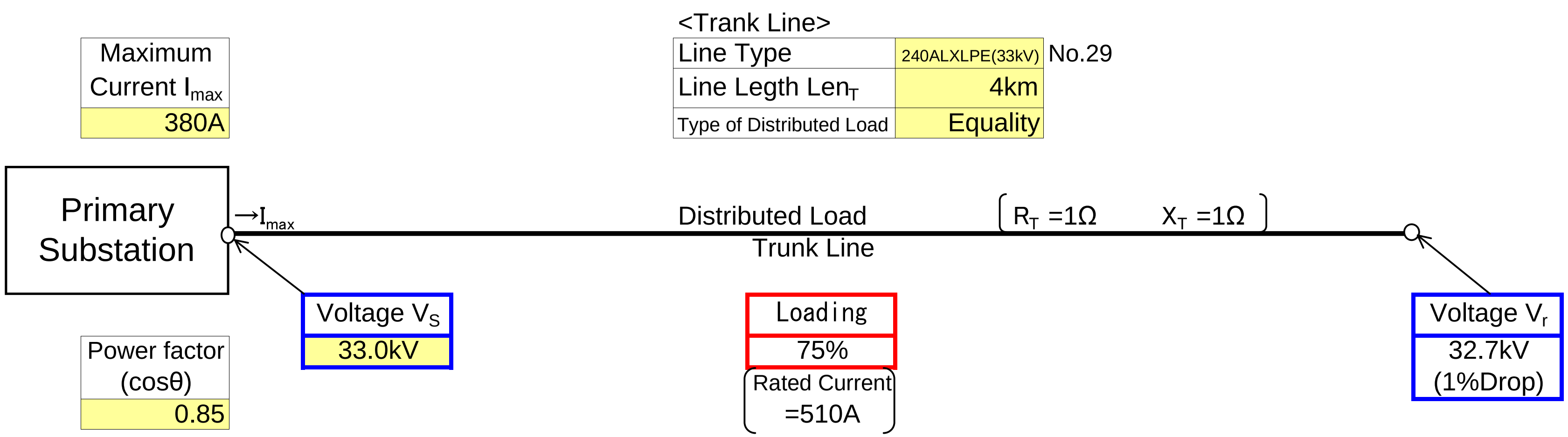
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN G-MAKOLA
Feeder Name	OKAISHIE I

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ACHIMOTA(MAIN H
Feeder Name	LEGON

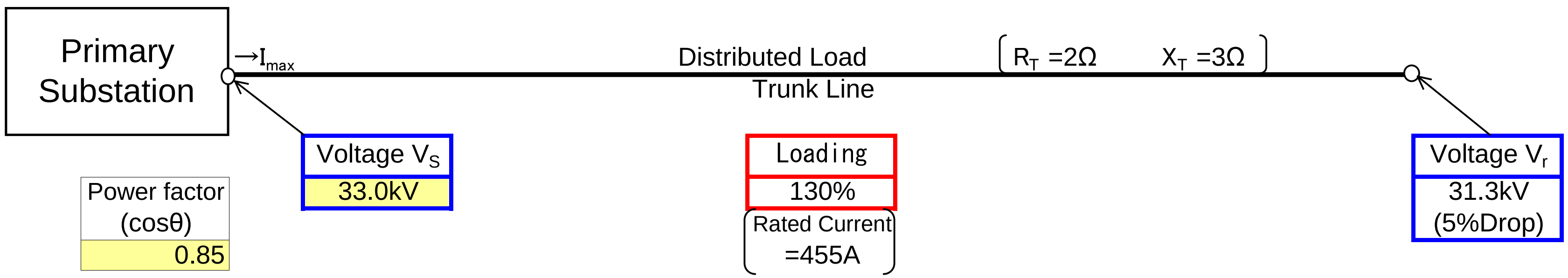
: Input data in colored cells

Type-1

Maximum Current I_{max}	592A
Power factor ($\cos\theta$)	0.85

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	8km	
Type of Distributed Load	Equality	



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	$\cos\theta$	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ACHIMOTA(MAIN H
Feeder Name	ADENTA

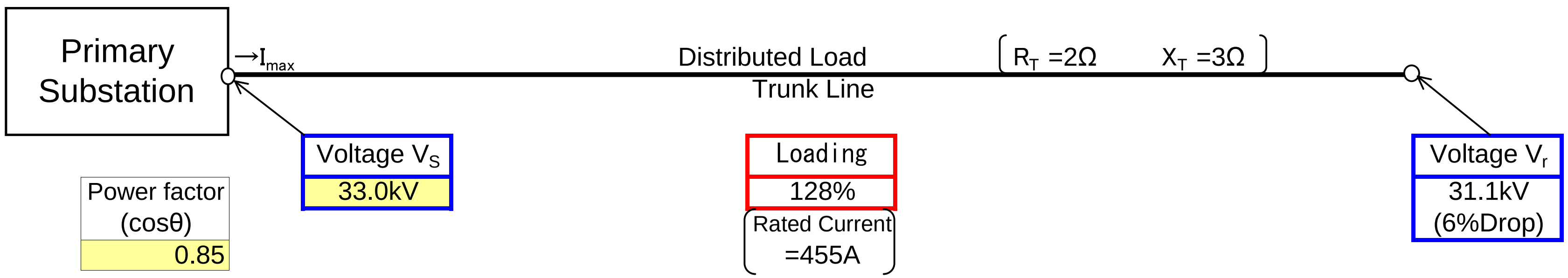
: Input data in colored cells

Type-1

Maximum Current I_{max}	582A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	9km	
Type of Distributed Load	Equality	



Power factor (cosθ)	0.85

=====Equation=====

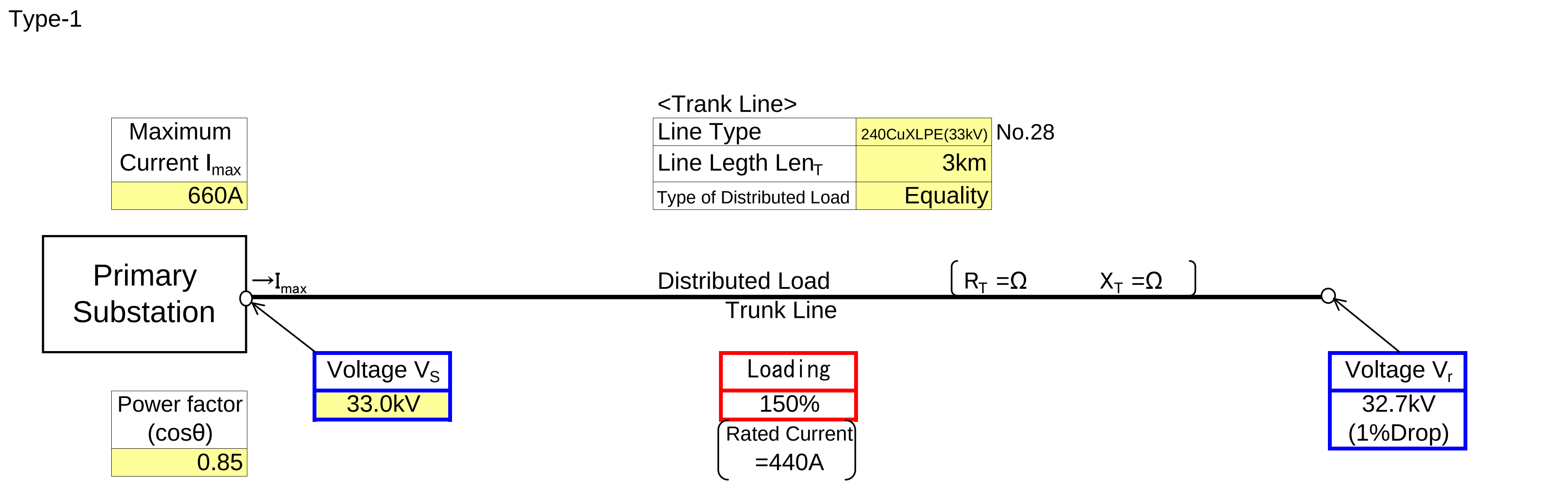
$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ACHIMOTA(MAIN H
Feeder Name	AIRPORT CITY II

: Input data in colored cells



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ACHIMOTA(MAIN H
Feeder Name	AIRPORT CITY 1

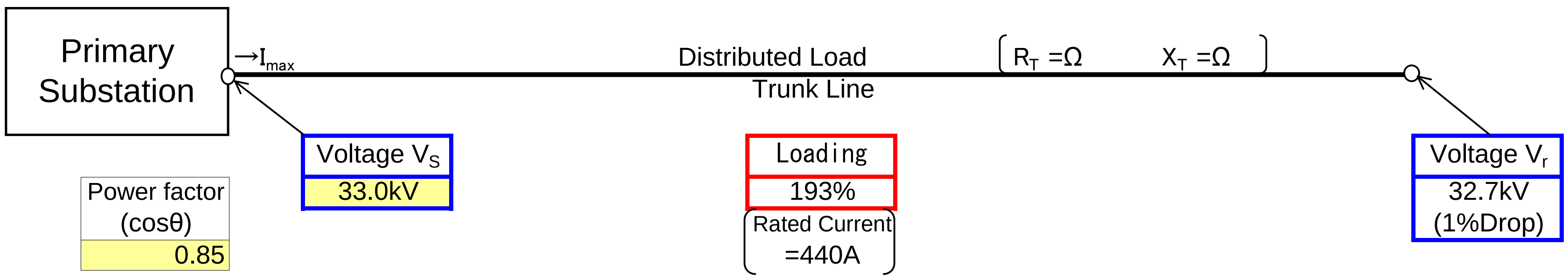
: Input data in colored cells

Type-1

Maximum Current I_{max}
850A

<Trank Line>

Line Type	240CuXLPE(33kV)	No.28
Line Legth Len_T	3km	
Type of Distributed Load	Equality	



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$$

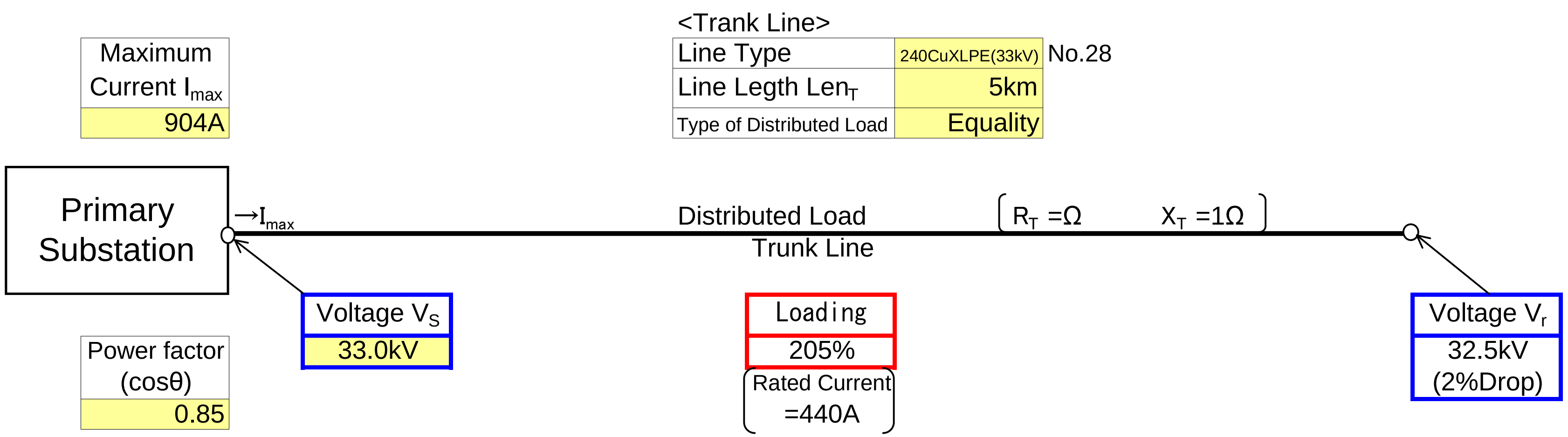
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ACHIMOTA(MAIN H
Feeder Name	MAMOBI 1

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

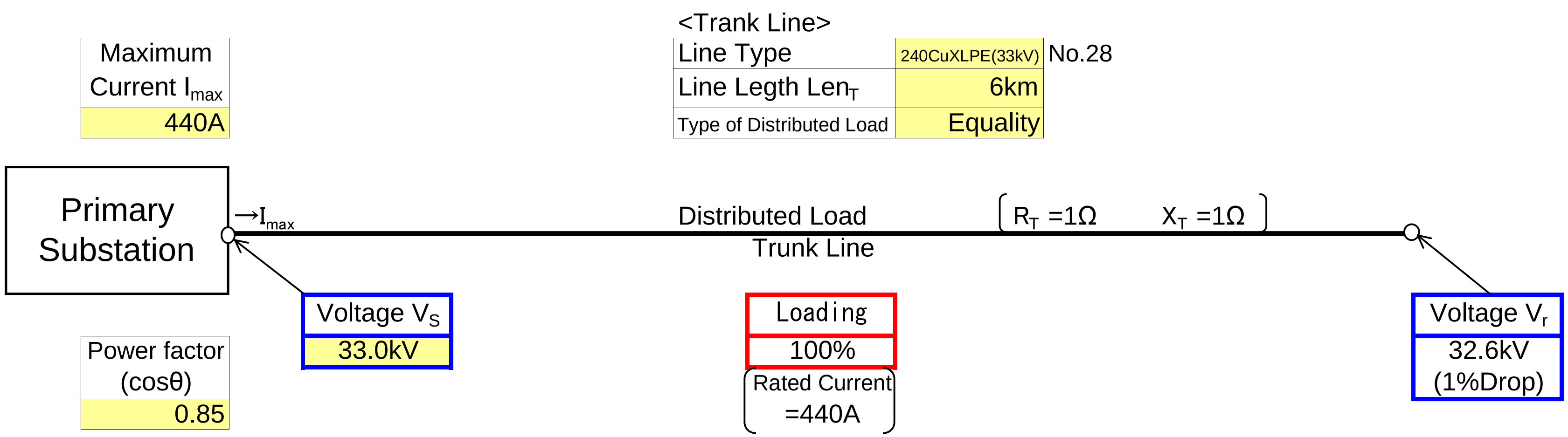
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ACHIMOTA(MAIN H
Feeder Name	KOTOBABI II

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

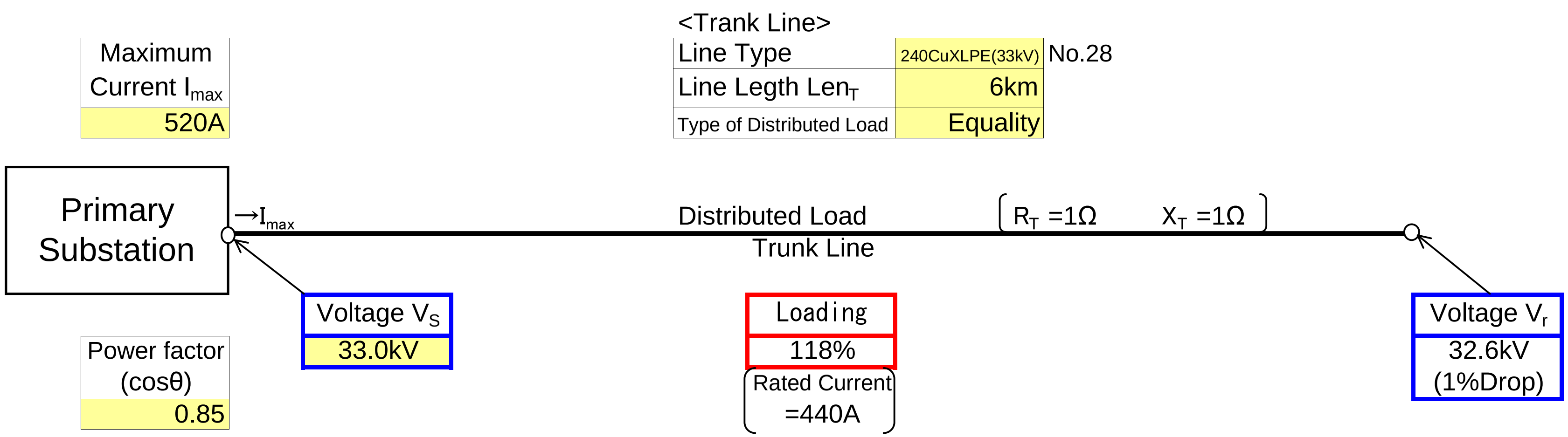
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ACHIMOTA(MAIN H
Feeder Name	KOTOBABI 1

: Input data in colored cells

Type-1



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ACHIMOTA(MAIN H
Feeder Name	ALAJO I

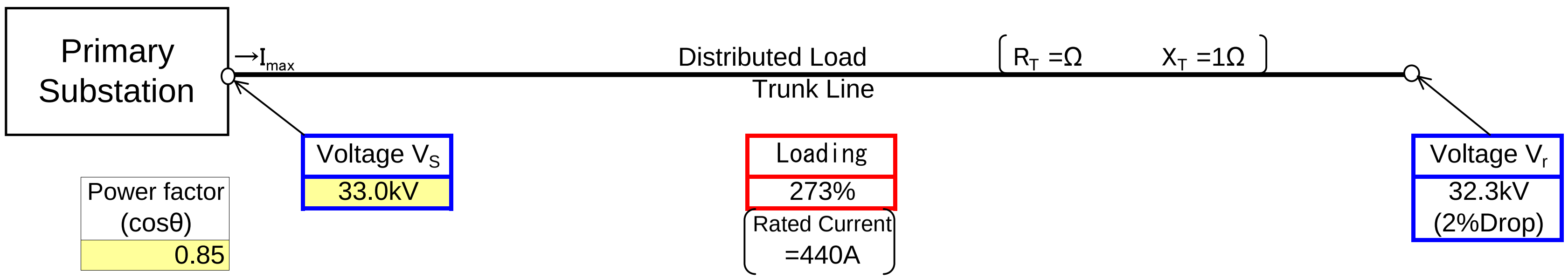
: Input data in colored cells

Type-1

Maximum Current I_{max}	
1200A	

<Trank Line>

Line Type	240CuXLPE(33kV)	No.28
Line Legth Len_T	5km	
Type of Distributed Load	Equality	



Power factor (cosθ)	
0.85	

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ACHIMOTA(MAIN H
Feeder Name	ALAJO II

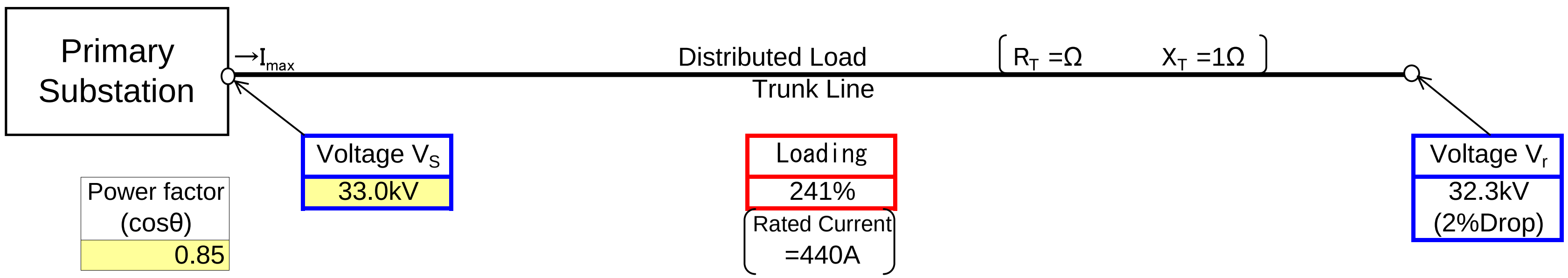
: Input data in colored cells

Type-1

Maximum Current I_{max}
1060A

<Trank Line>

Line Type	240CuXLPE(33kV)	No.28
Line Legth Len_T	5km	
Type of Distributed Load	Equality	



Power factor (cosθ)
0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

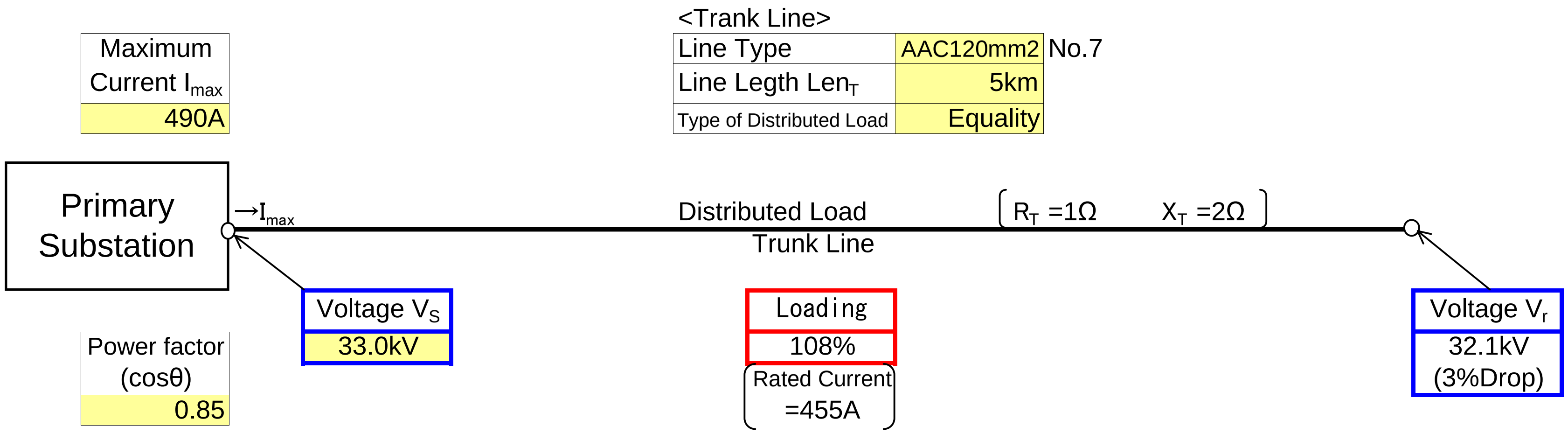
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ACHIMOTA(MAIN H
Feeder Name	ACHIMOTA II

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN H
Feeder Name	ACHIMOTA 1

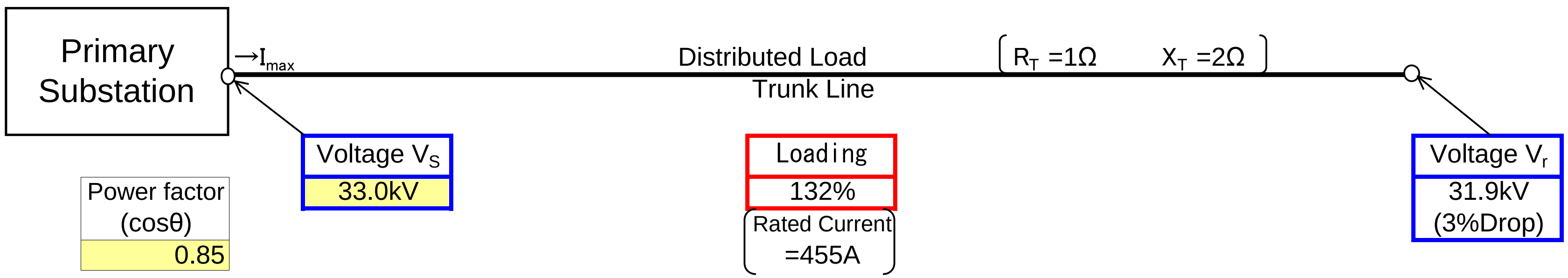
: Input data in colored cells

Type-1

Maximum Current I_{max}
600A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	5km	
Type of Distributed Load	Equality	



Power factor (cosθ)
0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

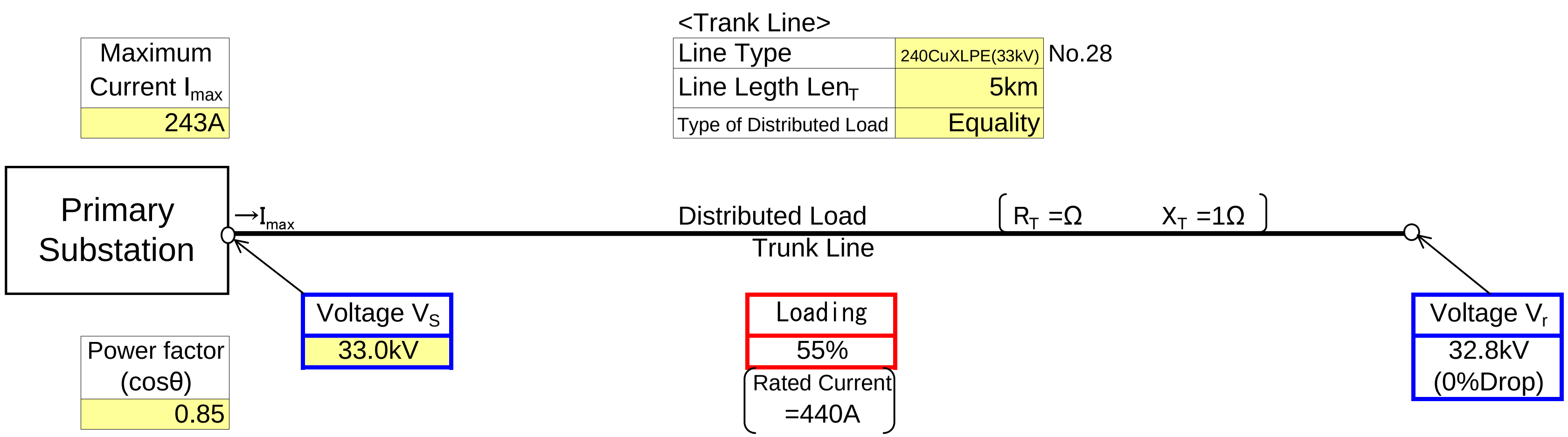
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	VITCHBACK(MAIN
Feeder Name	RINGWAY

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

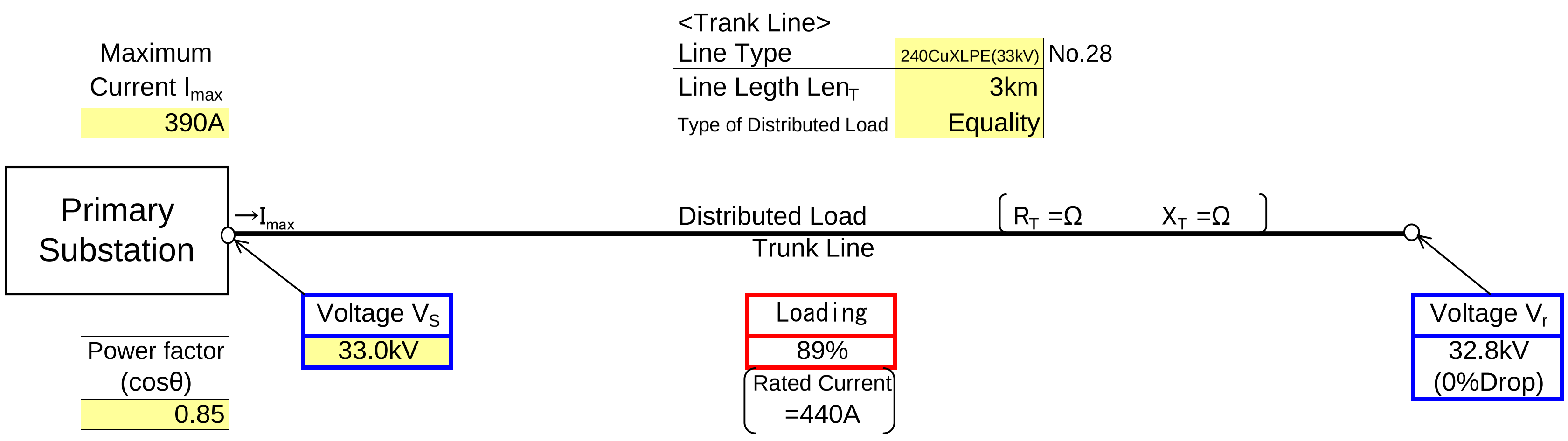
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	WITCHBACK(MAIN
Feeder Name	RIDGE

: Input data in colored cells

Type-1



=====Equation=====

$$V_r = V_s - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$$

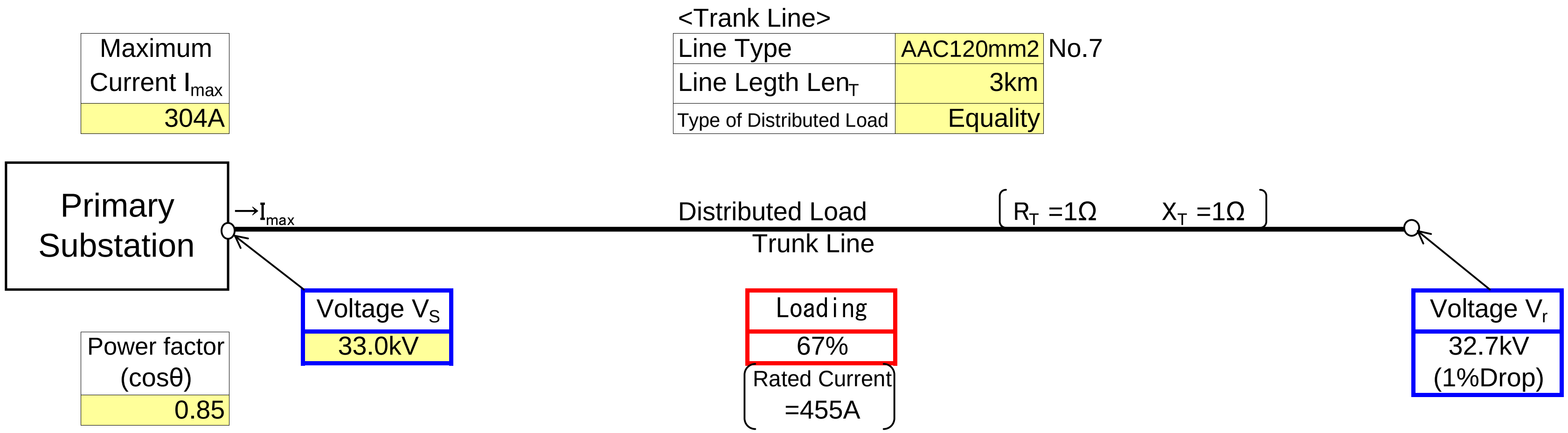
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	VITCHBACK(MAIN
Feeder Name	CANTONMENT I

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	VITCHBACK(MAIN
Feeder Name	CANTONMENT II

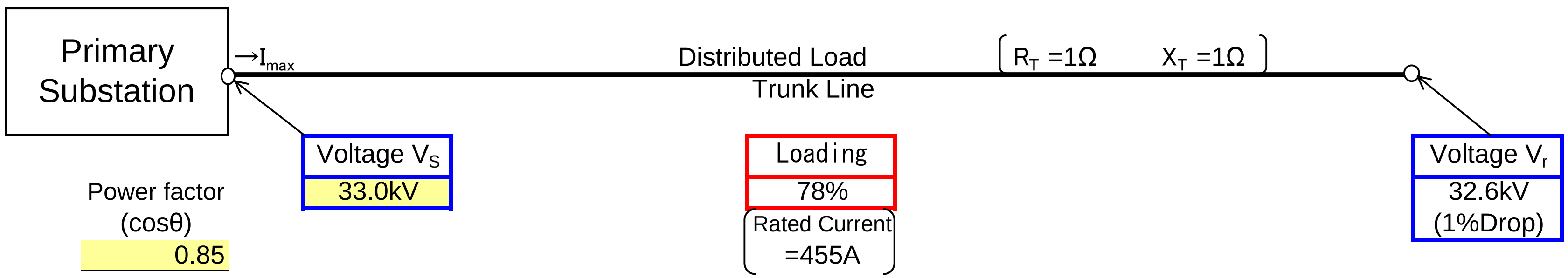
: Input data in colored cells

Type-1

Maximum Current I_{max}	354A
Power factor (cosθ)	0.85

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	3km	
Type of Distributed Load	Equality	



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_S	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN L
Feeder Name	T-NUNGUA II

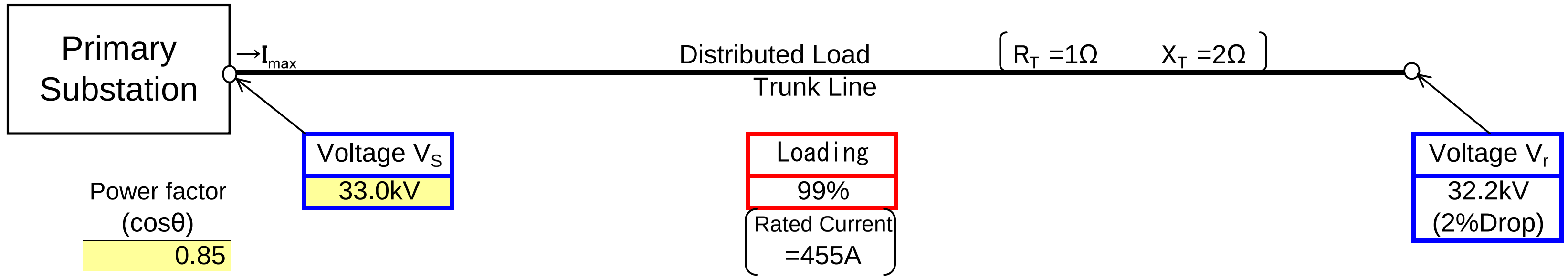
: Input data in colored cells

Type-1

Maximum Current I_{max}	450A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	5km	
Type of Distributed Load	Equality	



Power factor (cosθ)	0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

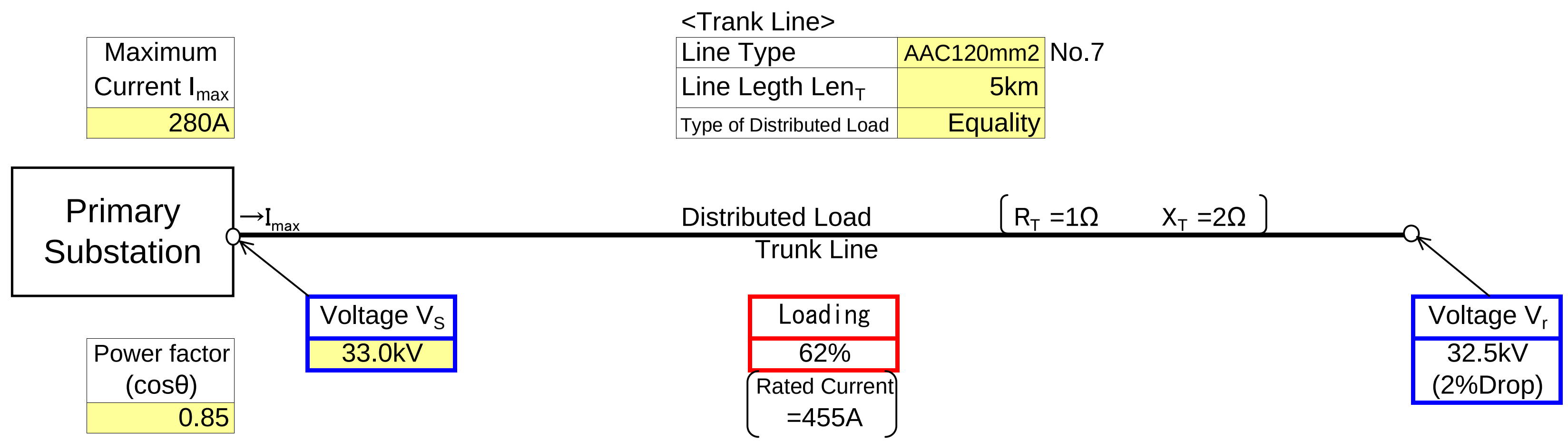
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN L
Feeder Name	T-NUNGUA II

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN L
Feeder Name	T-NUNGUA II

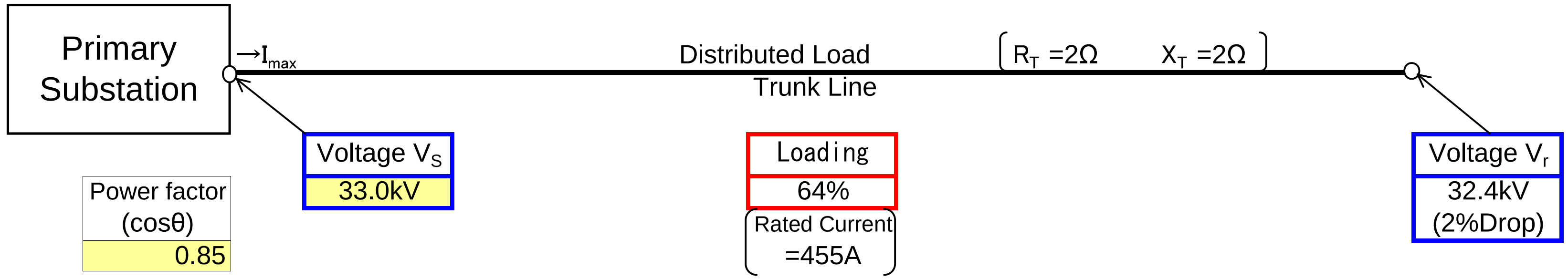
: Input data in colored cells

Type-1

Maximum Current I_{max}
290A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	6km	
Type of Distributed Load	Equality	



Power factor (cosθ)
0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN L
Feeder Name	T-NUNGUA II

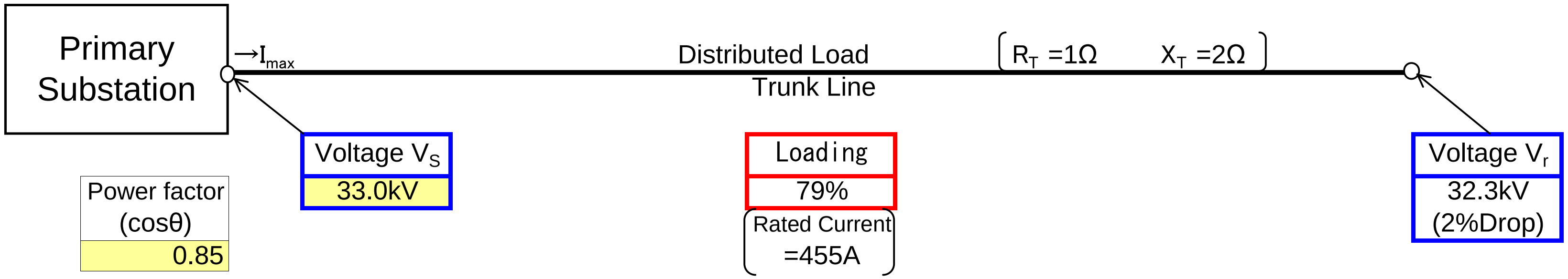
: Input data in colored cells

Type-1

Maximum Current I_{max}	360A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	5km	
Type of Distributed Load	Equality	



Power factor (cosθ)	0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$

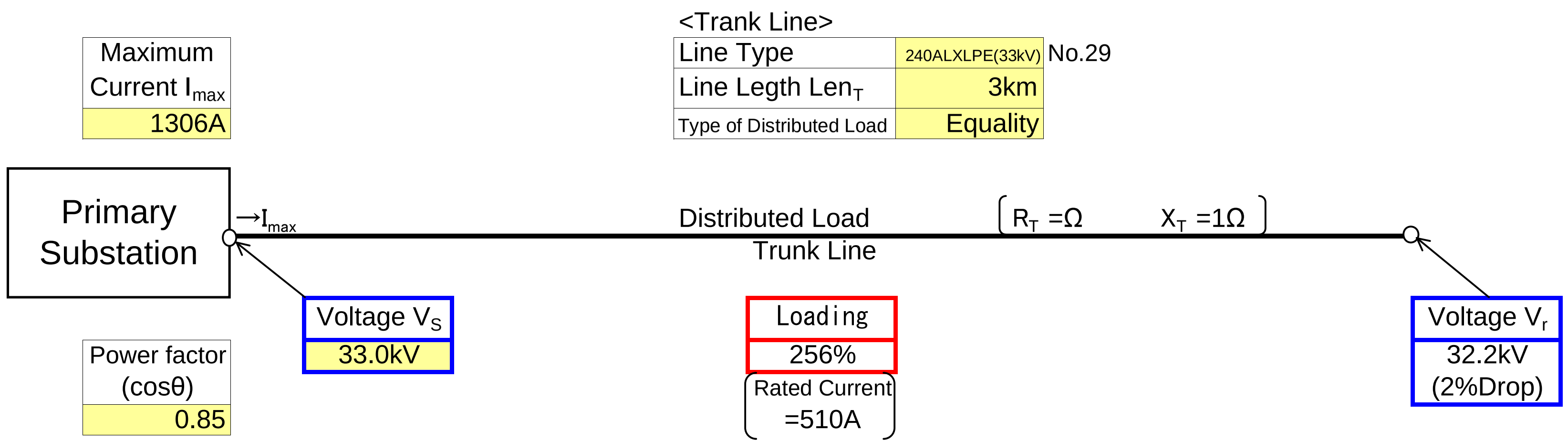
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN M - LEGON
Feeder Name	LEGON

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

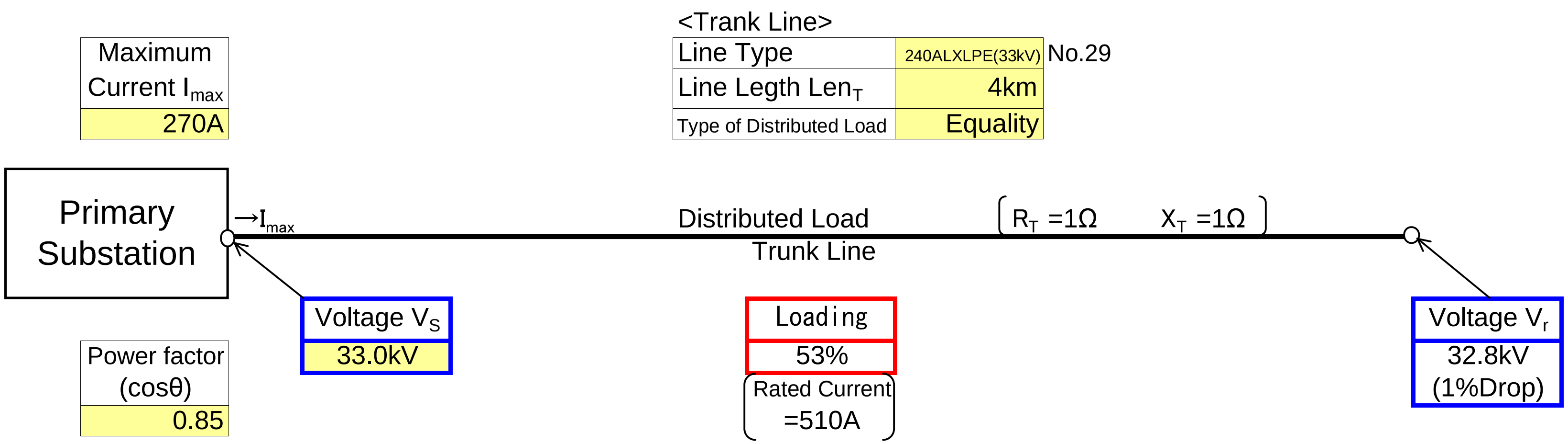
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN R-RIDGE
Feeder Name	KINBU

: Input data in colored cells

Type-1



=====Equation=====

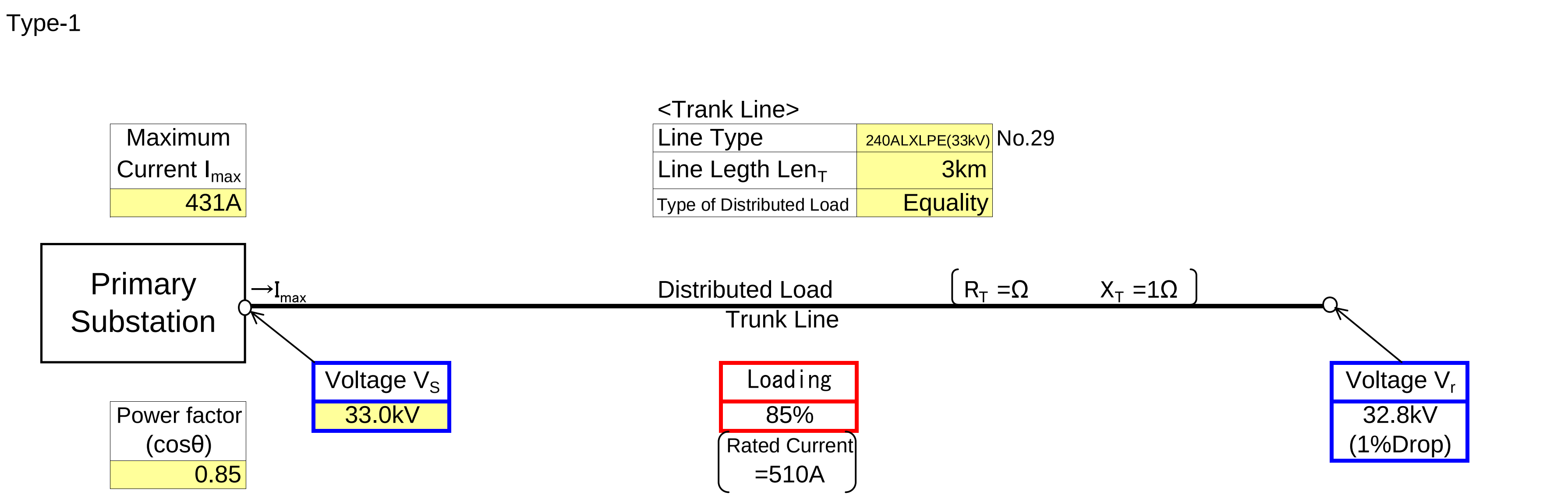
$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN R-RIDGE
Feeder Name	RIDGE

: Input data in colored cells



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$$

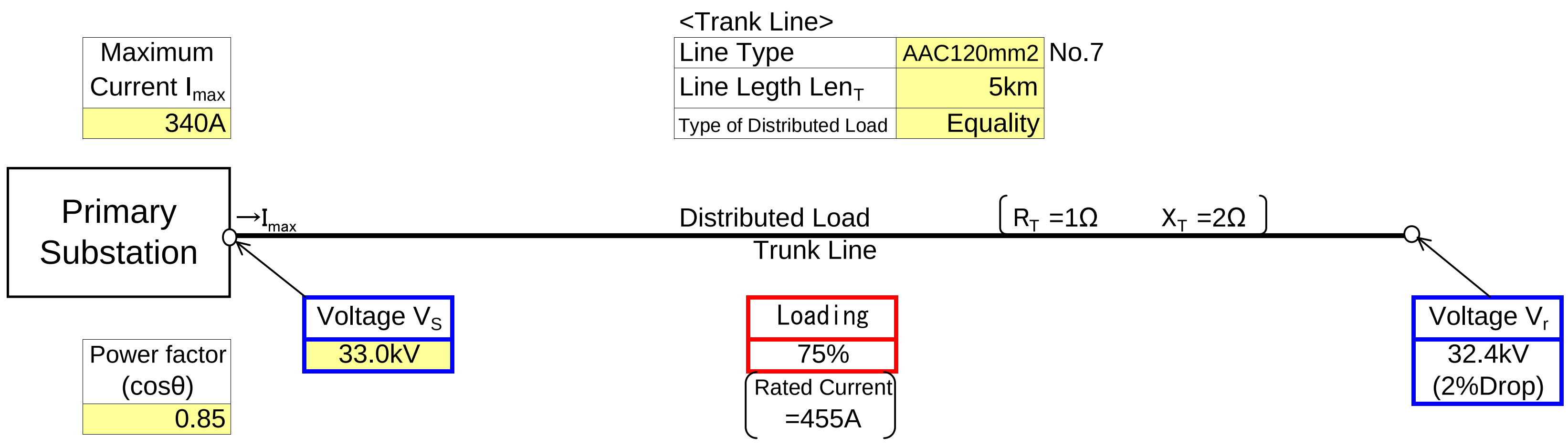
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	AIN S-KWASHIEMA
Feeder Name	QUARY 2

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	AIN S-KWASHIEMA
Feeder Name	QUARY 1

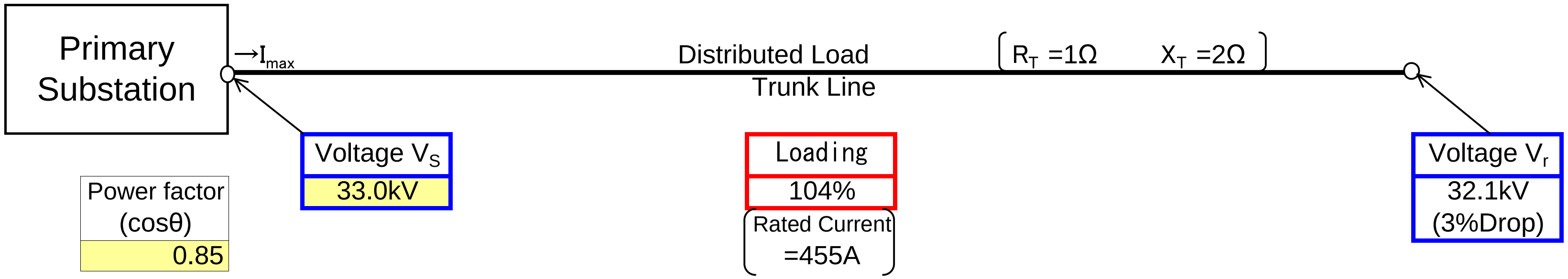
: Input data in colored cells

Type-1

Maximum Current I_{max}
475A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	5km	
Type of Distributed Load	Equality	



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	AIN S-KWASHIEMA
Feeder Name	KWASHIEMAN 1

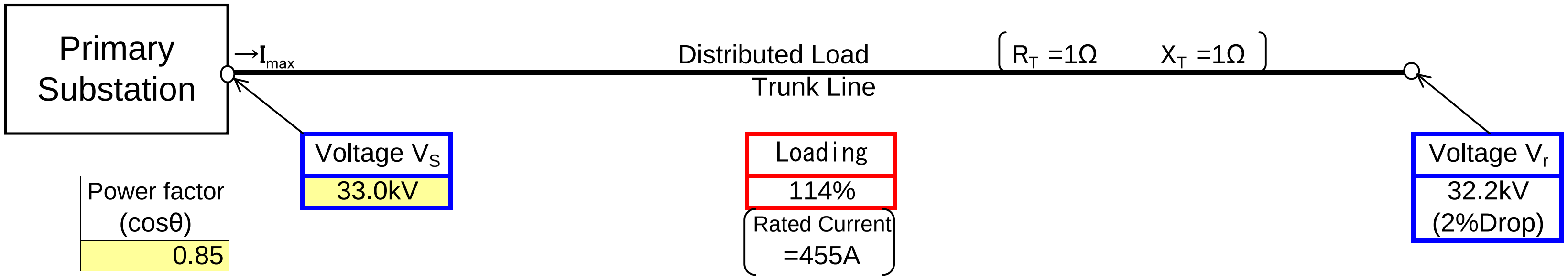
: Input data in colored cells

Type-1

Maximum Current I_{max}
520A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	4km	
Type of Distributed Load	Equality	



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$$

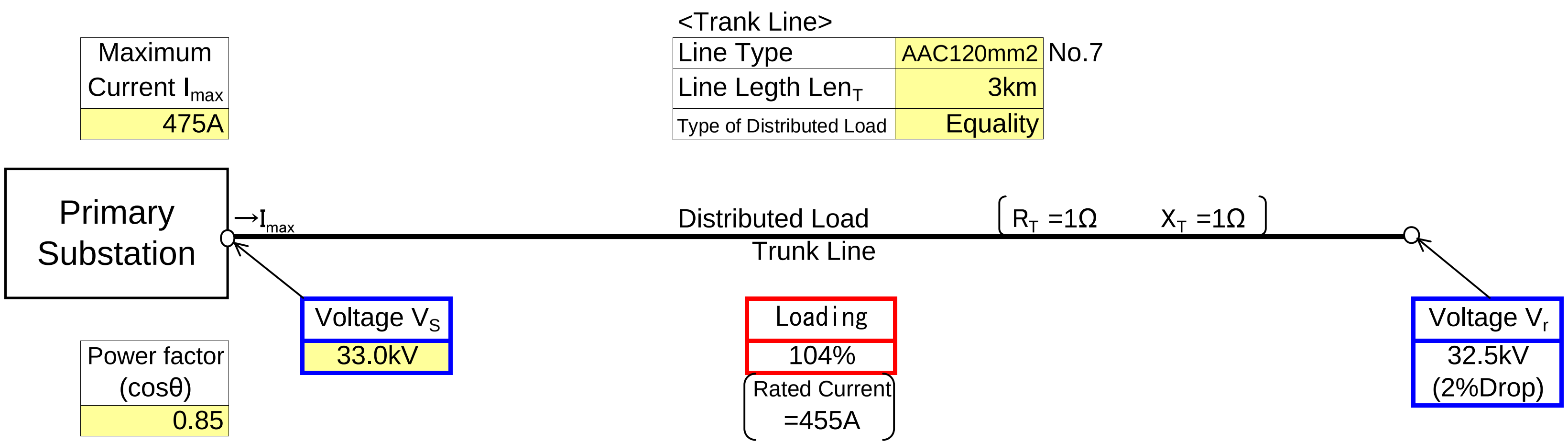
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	AIN S-KWASHIEMA
Feeder Name	KWASHIEMAN 2

: Input data in colored cells

Type-1



=====Equation=====

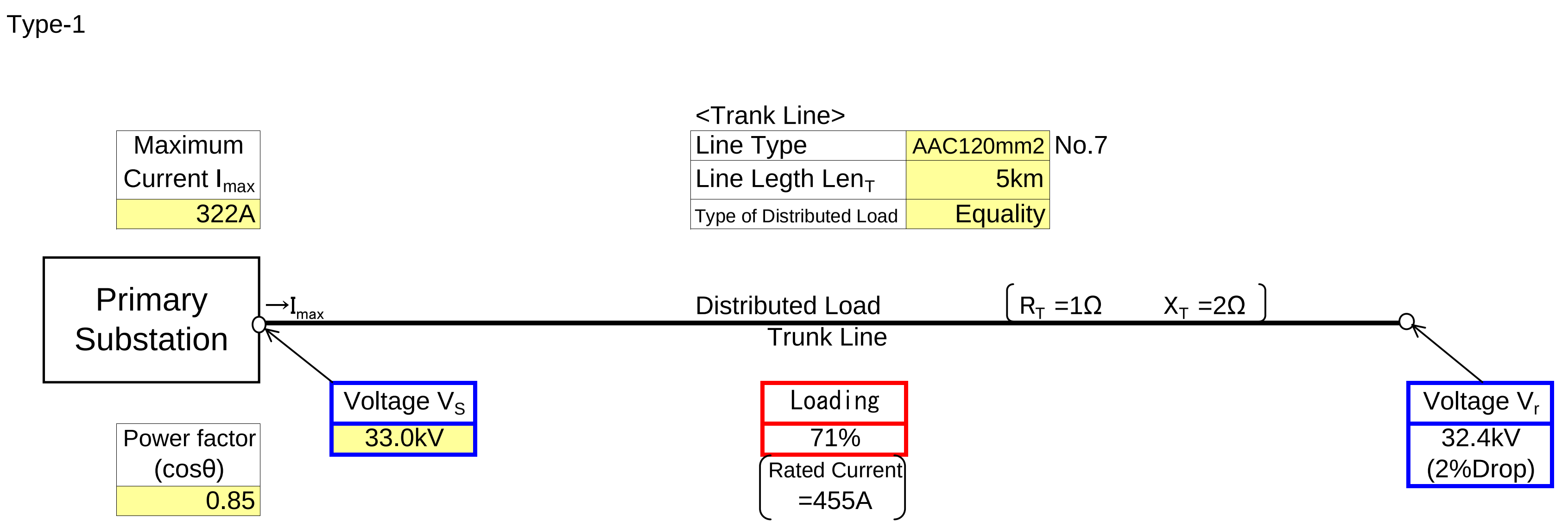
$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN T-ADENTA
Feeder Name	MAMPONG

: Input data in colored cells



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN V-DANSOMAN
Feeder Name	DANSOMAN

: Input data in colored cells

Type-1

Maximum Current I_{max}	437A
Power factor (cosθ)	0.85

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	5km	
Type of Distributed Load	Equality	

Primary Substation →I_{max}

Distributed Load Trunk Line (R_T =1Ω X_T =2Ω)

Voltage V_S: 33.0kV

Loading: 96%

Rated Current =455A

Voltage V_r: 32.2kV (2%Drop)

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

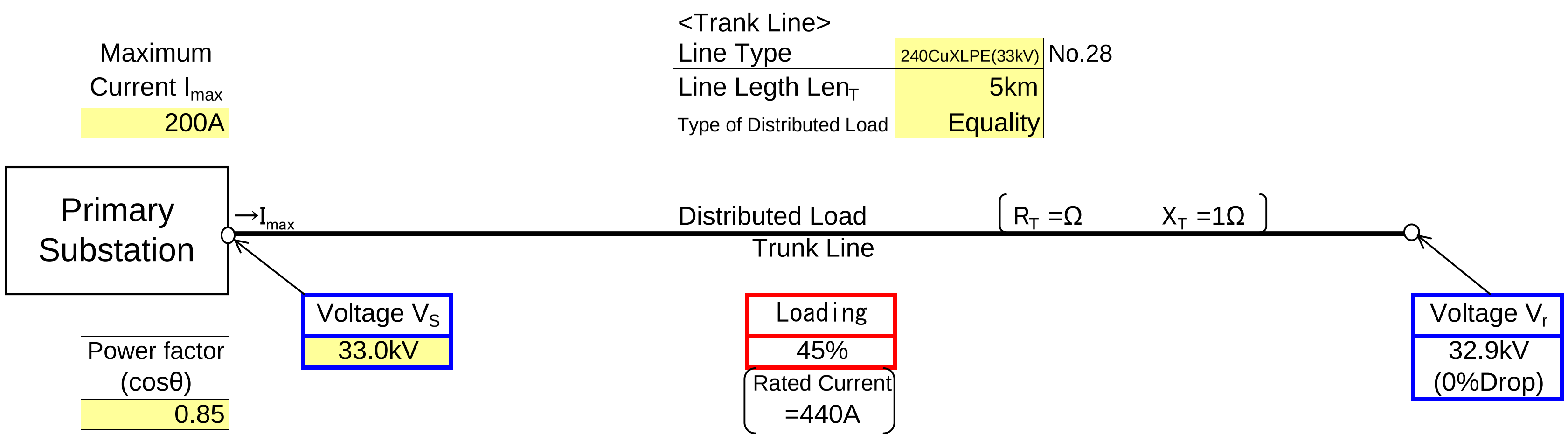
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN V-DANSOMAN
Feeder Name	MATAHEKO

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	IAIN Y-BAATSONA
Feeder Name	TEMA II

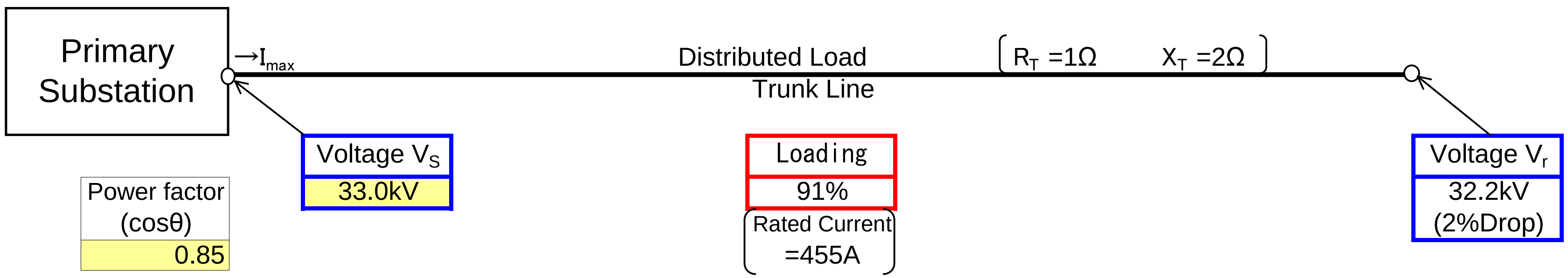
: Input data in colored cells

Type-1

Maximum Current I_{max}
413A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	5km	
Type of Distributed Load	Equality	



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

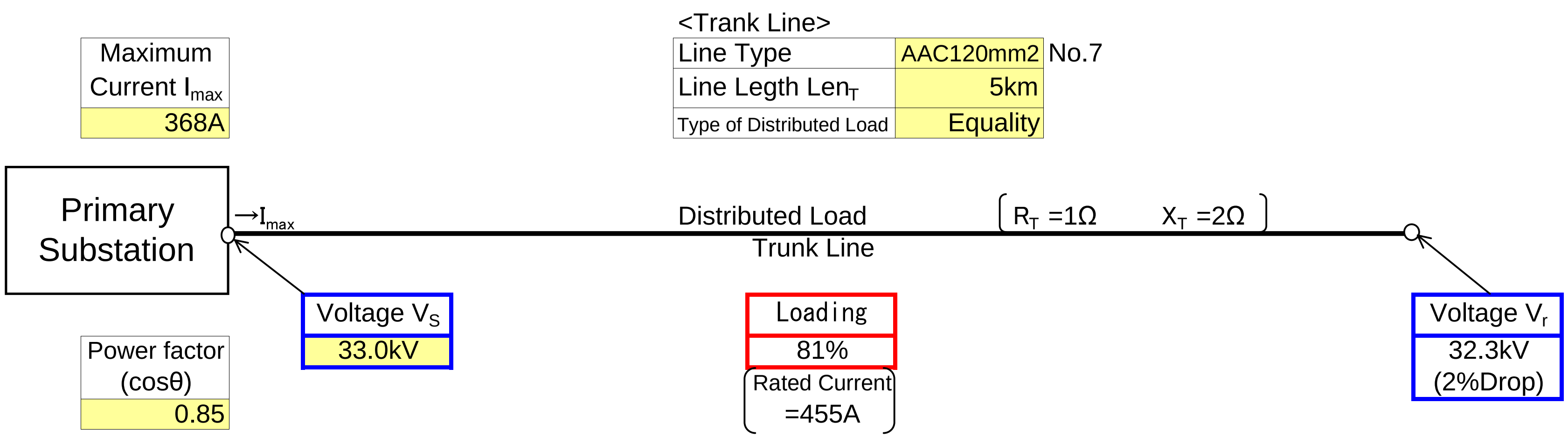
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	IAIN Y-BAATSONA
Feeder Name	TEMA I

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

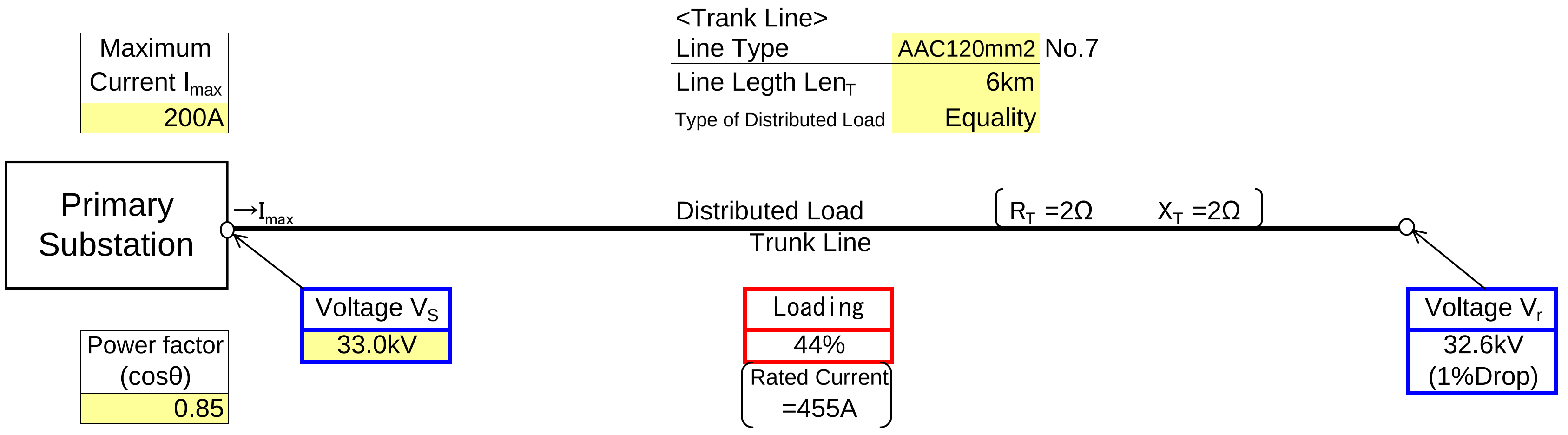
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MAIN Z-TOKUSE
Feeder Name	KASOA

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

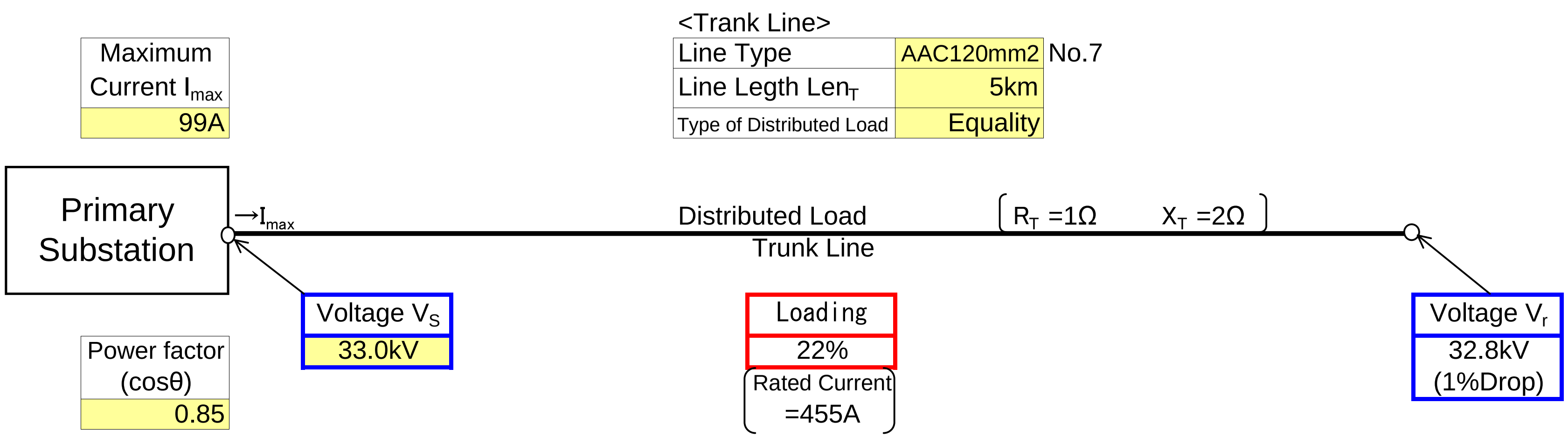
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MALLAM BSP
Feeder Name	WEIJA II

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MALLAM BSP
Feeder Name	WEIJA I

: Input data in colored cells

Type-1

Maximum Current I_{max}
339A

Power factor (cosθ)
0.85

Primary Substation

→I_{max}

Voltage V_S
33.0kV

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	5km	
Type of Distributed Load	Equality	

Distributed Load

Trunk Line

R_T =1Ω X_T =2Ω

Loading
75%

Rated Current =455A

Voltage V_r
32.4kV (2%Drop)

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

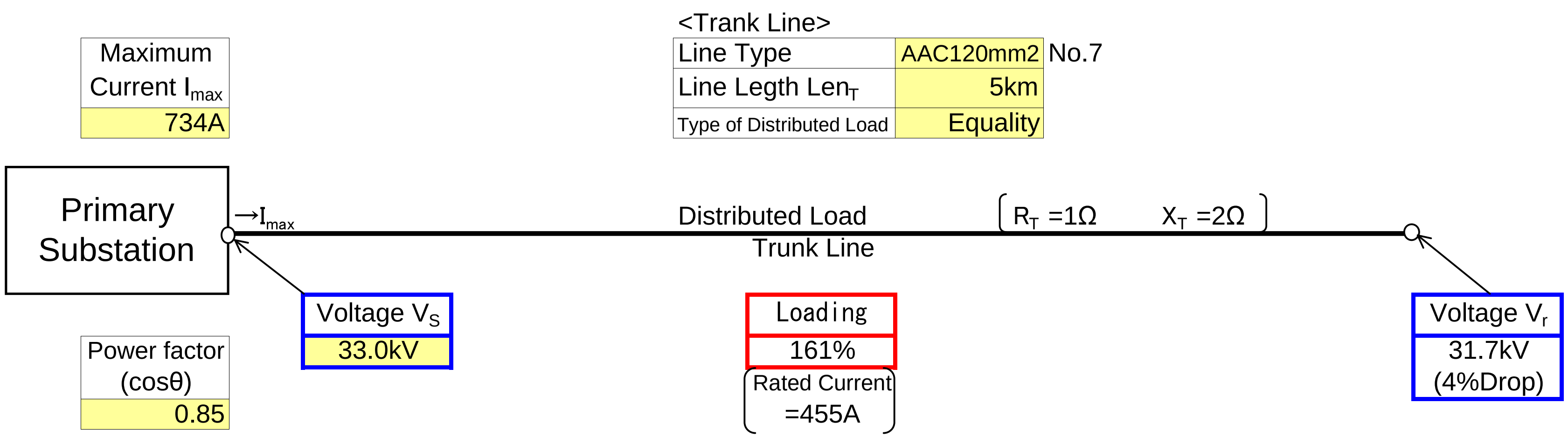
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MALLAM BSP
Feeder Name	KWASHEMAN II

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MALLAM BSP
Feeder Name	KWASHEMAN I

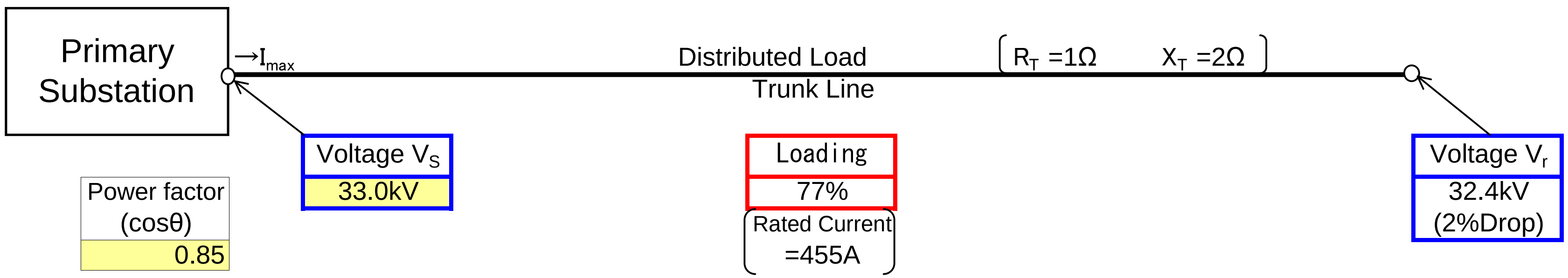
: Input data in colored cells

Type-1

Maximum Current I_{max}	352A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	5km	
Type of Distributed Load	Equality	



Power factor (cosθ)	0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MALLAM BSP
Feeder Name	AWOSHIE II

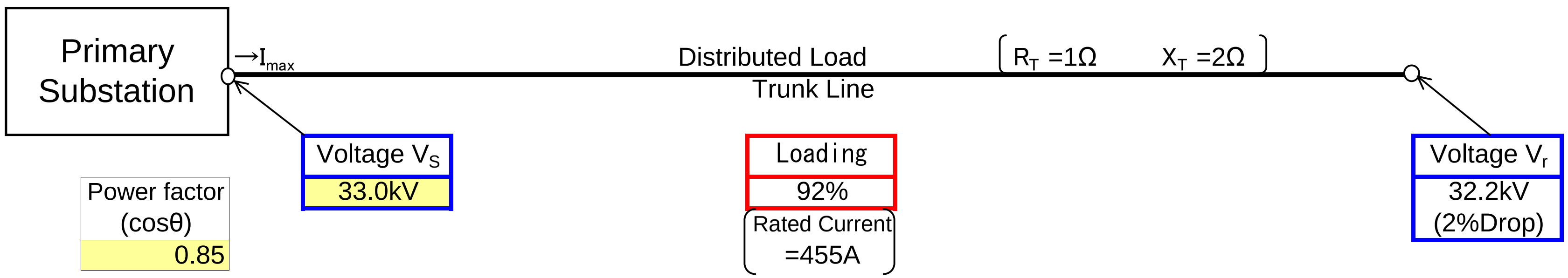
: Input data in colored cells

Type-1

Maximum Current I_{max}	420A
Power factor (cosθ)	0.85

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	5km	
Type of Distributed Load	Equality	



=====Equation=====

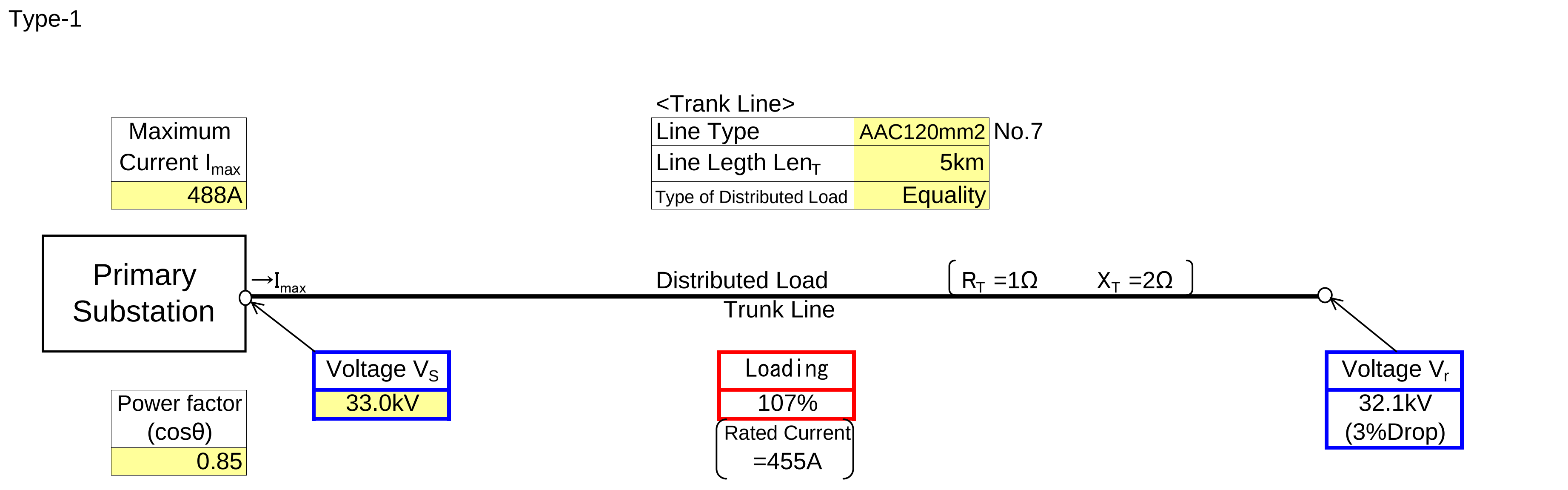
$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_S	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	MALLAM BSP
Feeder Name	AWOSHIE I

: Input data in colored cells



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis

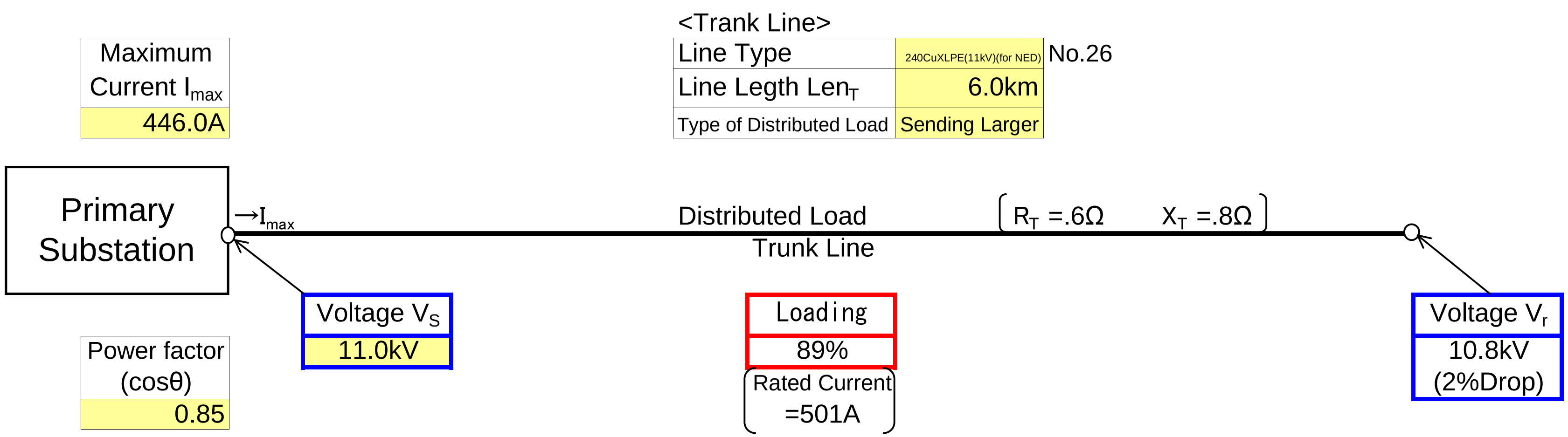
- Tema -

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	A
Feeder Name	A31

: Input data in colored cells

Type-1



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	A
Feeder Name	A21

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	18A	
Line Type	240CuXLPE(11kV)(for NED)	No.26
Line Legth Len_T	2.0km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_T	315kVA	

<Branch Line 1>

Load L_{B1}	184A	
Line Type	120CuPILC(11kV)	No.22
Line Length Len_{B1}	6.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	3195kVA	

Maximum Current I_{max}
286.0A

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =.2Ω X_T =.3Ω)

Trunk Line

Loading
57%

(Rated Current =501A)

Voltage V_S
11.0kV

Voltage V_i
10.8kV (1%Drop)

Power factor (cosθ)
0.85

L_{B1} (Distributed or Concentrated Load) (R_{B1} =1.2Ω X_{B1} =.7Ω)

Branch Line 1

Loading
62%

(Rated Current =295A)

Voltage V_{r1}
10.6kV (3%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =.6Ω X_{B2} =.4Ω)

Branch Line 2

Loading
28%

(Rated Current =295A)

Voltage V_{r2}
10.8kV (2%Drop)

<Branch Line 2>

Load L_{B2}	84A	
Line Type	120CuPILC(11kV)	No.22
Line Length Len_{B1}	3.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1450kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance	
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance	
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor	
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor	CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	JUAPONG
Feeder Name	Juapong

: Input data in colored cells

Type-3

Maximum Current I_{max}	255.0A
Power factor (cosθ)	0.90

<Trank Line 1>

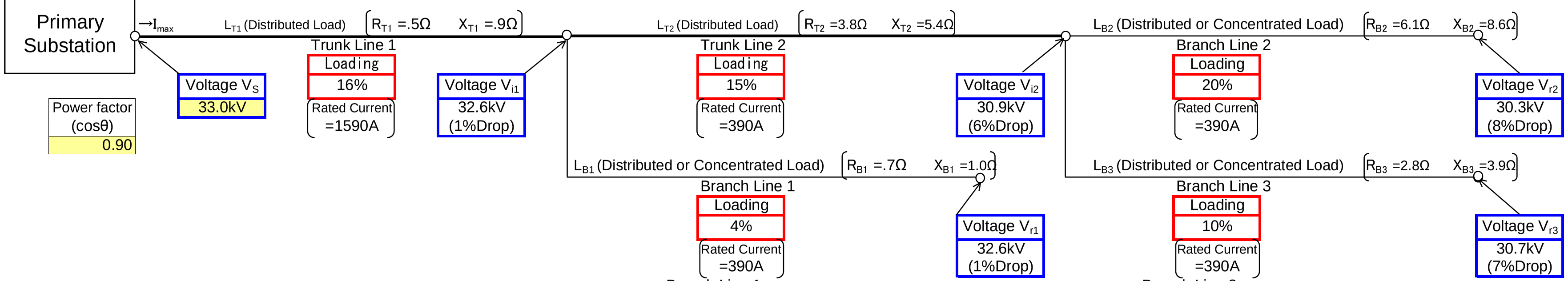
Load L_{T1}	8A	
Line Type	6x1x500CUXLPE	No.55
Line Legth Len_{T1}	10.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	100kVA	

<Trank Line 2>

Load L_{T2}	112A	
Line Type	120ALBARE	No.37
Line Legth Len_{T2}	15.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	1400kVA	

<Branch Line 2>

Load L_{B2}	80A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	24.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1000kVA	



<Branch Line 1>

Load L_{B1}	16A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	2.8km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	200kVA	

<Branch Line 3>

Load L_{B3}	40A	
Line Type	120ALBARE	No.37
Line Length Len_{B3}	11.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	500kVA	

=====Equation=====

$V_{i1} = V_s - 1.732\cdot(R_{T1}\cos\theta + X_{T1}\sin\theta)\cdot(L_{T1}\cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732\cdot(R_{T2}\cos\theta + X_{T2}\sin\theta)\cdot(L_{T2}\cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732\cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta)\cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732\cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta)\cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732\cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta)\cdot f_{B3}$

$L_{T1} = I_{max}\cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max}\cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max}\cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max}\cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max}\cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	A
Feeder Name	A61

: Input data in colored cells

Type-2

Maximum Current I_{max}
250.0A

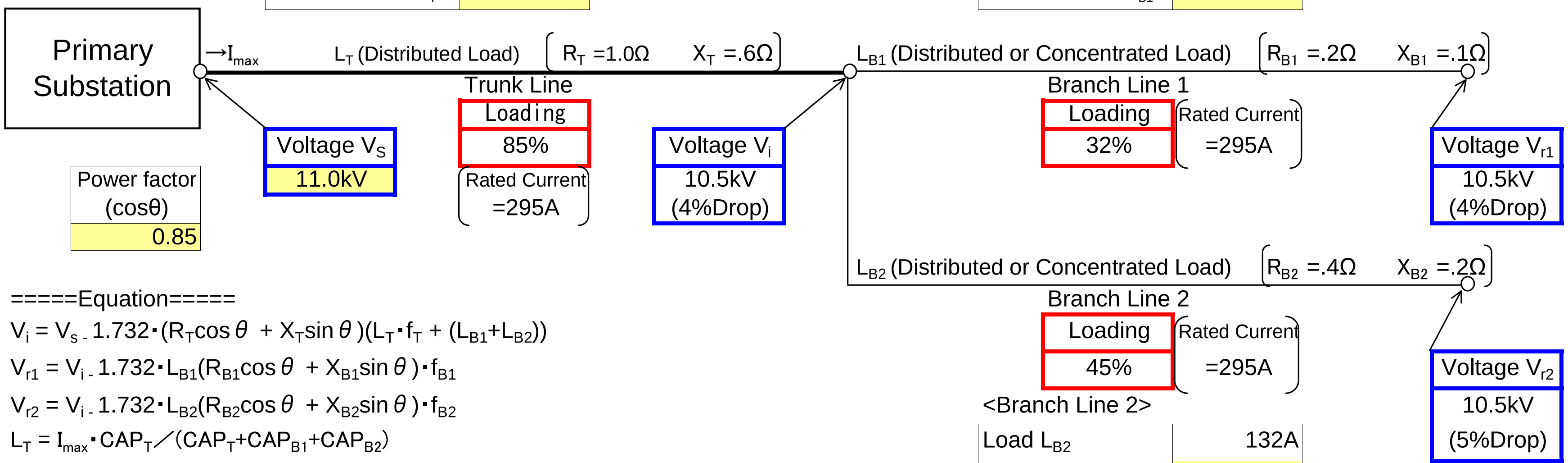
Power factor (cosθ)
0.85

<Trank Line>

Load L_T	23A	
Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	5.0km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_T	315kVA	

<Branch Line 1>

Load L_{B1}	95A	
Line Type	120CuPILC(11kV)	No.22
Line Length Len_{B1}	1.0km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	1315kVA	



<Branch Line 2>

Load L_{B2}	132A	
Line Type	120CuPILC(11kV)	No.22
Line Length Len_{B1}	2.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1815kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_T, R_{B1}, R_{B2}	: Resistance
V_i	: Interim Voltage	L_T	: Load (Trunk line)	X_T, X_{B1}, X_{B2}	: Reactance
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	cosθ	: Power Factor
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	f_T, f_{B1}, f_{B2}	: Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	A
Feeder Name	A91

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	44A	
Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	.1km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_T	1880kVA	

<Branch Line 1>

Load L_{B1}	71A	
Line Type	120CuPILC(11kV)	No.22
Line Length Len_{B1}	7.0km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	3010kVA	

Maximum Current I_{max}	120.0A
Power factor (cosθ)	0.85

Primary Substation

→I_{max}

L_T (Distributed Load) (R_T =.0Ω X_T =.0Ω)

Trunk Line

Loading
41%

(Rated Current =295A)

Voltage V_S
11.0kV

Voltage V_i
11.0kV (0%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =1.4Ω X_{B1} =.8Ω)

Branch Line 1

Loading
24%

(Rated Current =295A)

Voltage V_{r1}
10.9kV (1%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =.2Ω X_{B2} =.1Ω)

Branch Line 2

Loading
2%

(Rated Current =295A)

Voltage V_{r2}
11.0kV (0%Drop)

<Branch Line 2>

Load L_{B2}	5A	
Line Type	120CuPILC(11kV)	No.22
Line Length Len_{B1}	1.1km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	200kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance	
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance	
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor	
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor	CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	JUAPONG
Feeder Name	AKWAMUFIE

: Input data in colored cells

Type-3

Maximum Current I_{max}
107.0A

Power factor (cosθ)
0.90

<Trank Line 1>

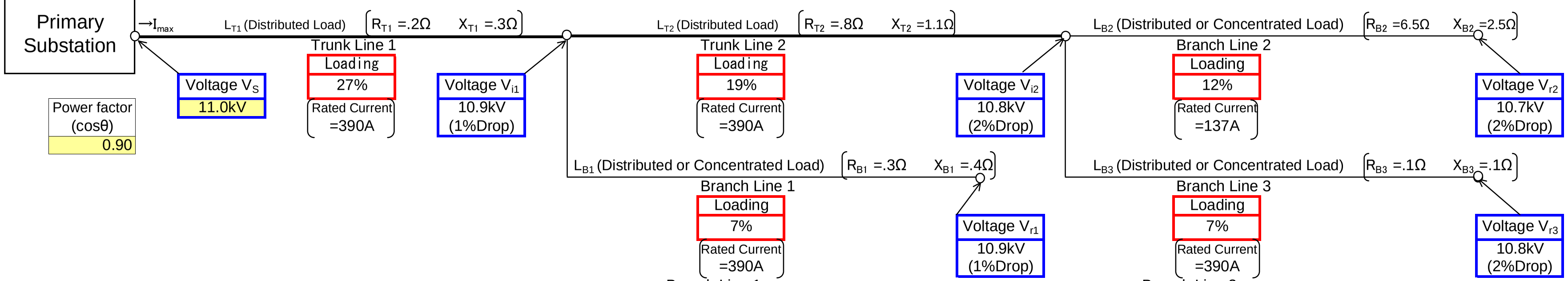
Load L_{T1}	6A	
Line Type	120ALBARE	No.37
Line Legth Len_{T1}	.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	100kVA	

<Trank Line 2>

Load L_{T2}	28A	
Line Type	120ALBARE	No.37
Line Legth Len_{T2}	3.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	500kVA	

<Branch Line 2>

Load L_{B2}	17A	
Line Type	Cu16mm2	No.16
Line Length Len_{B1}	5.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	300kVA	



<Branch Line 1>

Load L_{B1}	28A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	1.2km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	500kVA	

<Branch Line 3>

Load L_{B3}	28A	
Line Type	120ALBARE	No.37
Line Length Len_{B3}	.2km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B3}	500kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	B
Feeder Name	B101

: Input data in colored cells

Type-2

Maximum Current I_{max}
178.0A

Power factor (cosθ)
0.85

<Trank Line>

Load L_T	80A	
Line Type	240CuXLPE(11kV)(for NED)	No.26
Line Legth Len_T	1.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	1000kVA	

<Branch Line 1>

Load L_{B1}	16A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	8.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	200kVA	

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =.2Ω X_T =.3Ω)

Trunk Line

Loading
36%

(Rated Current =501A)

Voltage V_S
11.0kV

Voltage V_i
10.9kV (1%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =2.2Ω X_{B1} =2.9Ω)

Branch Line 1

Loading
4%

(Rated Current =455A)

Voltage V_{r1}
10.9kV (1%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =.2Ω X_{B2} =.3Ω)

Branch Line 2

Loading
18%

(Rated Current =455A)

Voltage V_{r2}
10.9kV (1%Drop)

<Branch Line 2>

Load L_{B2}	82A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	.9km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	1015kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor
V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — $CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	B
Feeder Name	B101

: Input data in colored cells

Type-2

Maximum Current I_{max}
235.0A

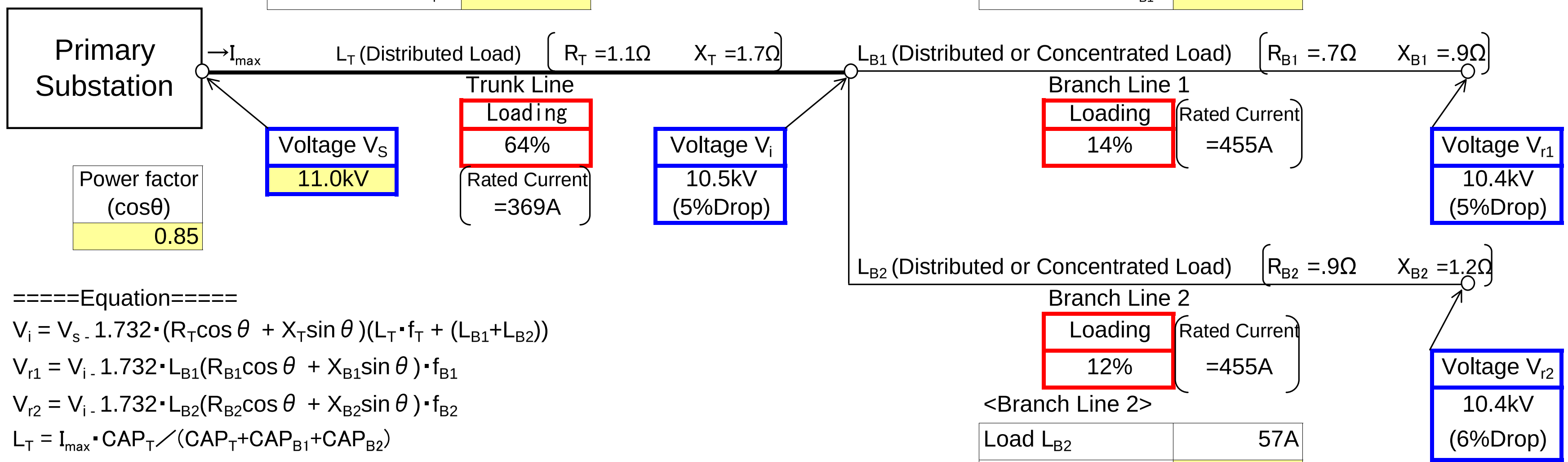
Power factor ($\cos\theta$)
0.85

<Trank Line>

Load L_T	116A	
Line Type	Cu70mm2	No.14
Line Legth Len_T	3.9km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_T	3780kVA	

<Branch Line 1>

Load L_{B1}	63A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	2.6km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	2050kVA	



<Branch Line 2>

Load L_{B2}	57A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	3.4km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	1850kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_T, R_{B1}, R_{B2}	: Resistance
V_i	: Interim Voltage	L_T	: Load (Trunk line)	X_T, X_{B1}, X_{B2}	: Reactance
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	cosθ	: Power Factor
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	f_T, f_{B1}, f_{B2}	: Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	B
Feeder Name	B51

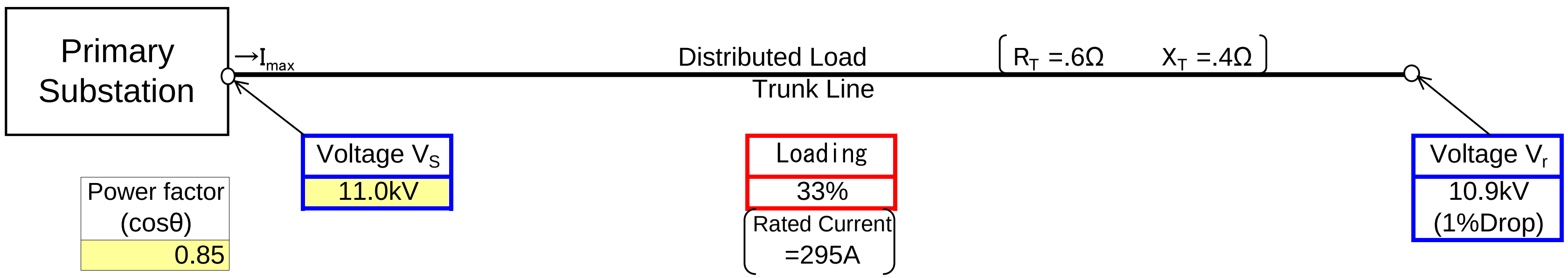
: Input data in colored cells

Type-1

Maximum Current I_{max}
98.0A

<Trank Line>

Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	3.2km	
Type of Distributed Load	Equality	



Power factor (cosθ)
0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	B
Feeder Name	B41&B71

: Input data in colored cells

Type-2

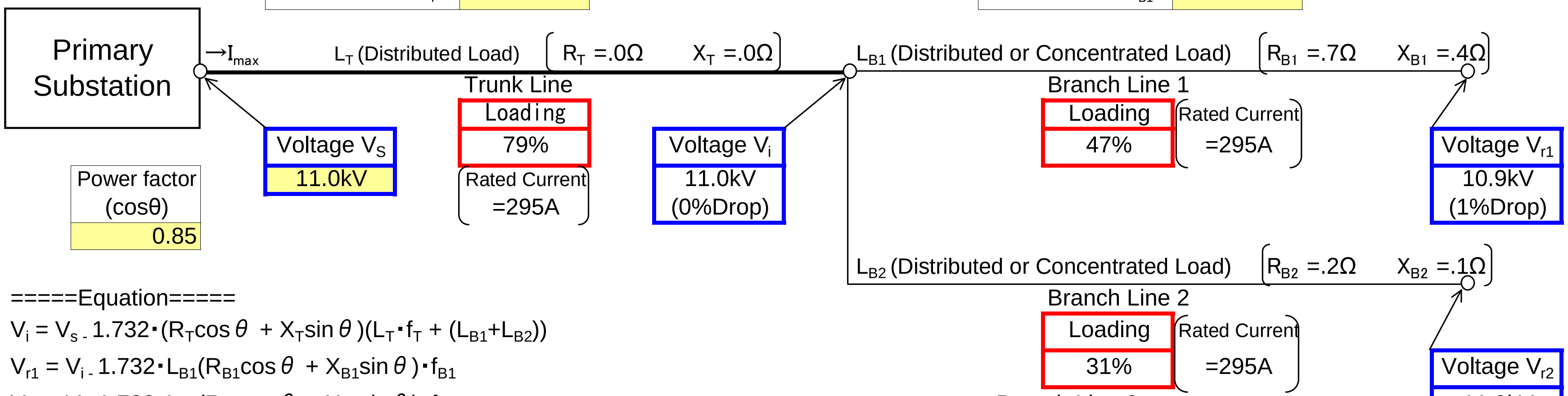
<Trank Line>

Load L_T	A	
Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	.0km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_T	kVA	

<Branch Line 1>

Load L_{B1}	140A	
Line Type	120CuPILC(11kV)	No.22
Line Length Len_{B1}	3.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	2000kVA	

Maximum Current I_{max}	232.0A
Power factor (cosθ)	0.85



<Branch Line 2>

Load L_{B2}	92A	
Line Type	120CuPILC(11kV)	No.22
Line Length Len_{B1}	1.1km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	1315kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage　I_{max} : Maximum Current　R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage　L_T : Load (Trunk line)　X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage　L_{B1} : Load (Branch Line 1)　cosθ : Power Factor
V_{r2} : Received Voltage　L_{B2} : Load (Branch Line 2)　f_T, f_{B1}, f_{B2} : Dispersal Load Factor　$CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	B
Feeder Name	B31

: Input data in colored cells

Type-3

Maximum Current I_{max}
393.0A

<Trank Line 1>

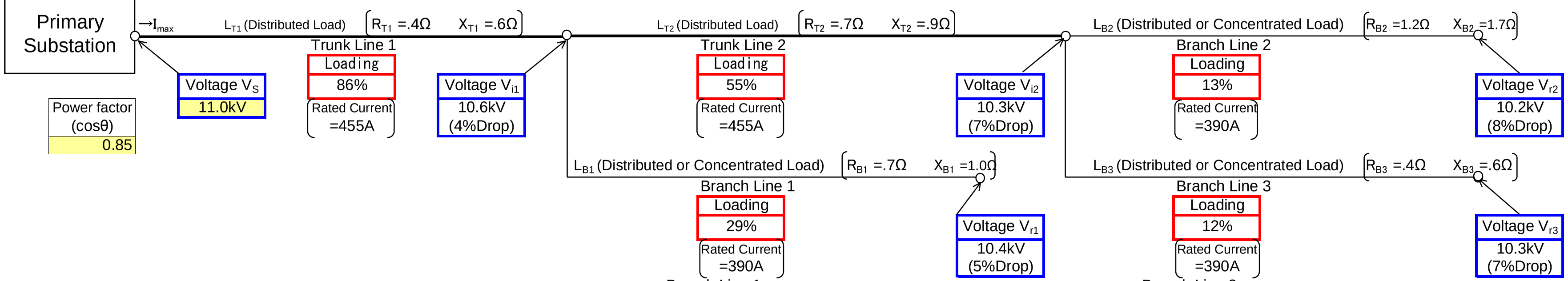
Load L_{T1}	27A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	1.6km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	850kVA	

<Trank Line 2>

Load L_{T2}	153A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	2.5km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	4895kVA	

<Branch Line 2>

Load L_{B2}	50A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	4.9km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	1600kVA	



Power factor (cosθ)
0.85

<Branch Line 1>

Load L_{B1}	115A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	2.8km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	3665kVA	

<Branch Line 3>

Load L_{B3}	48A	
Line Type	120ALBARE	No.37
Line Length Len_{B3}	1.7km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{B3}	1530kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	B
Feeder Name	51

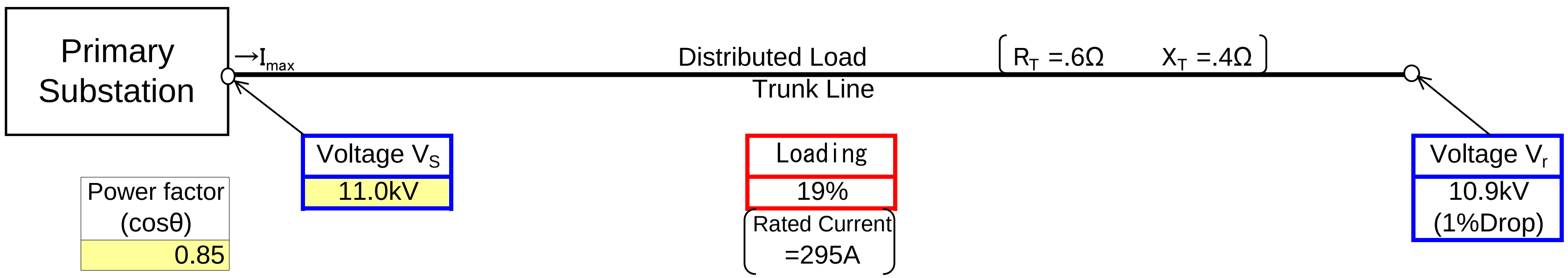
: Input data in colored cells

Type-1

Maximum Current I_{max}
55.0A

<Trank Line>

Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	3.2km	
Type of Distributed Load		



Power factor (cosθ)
0.85

=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	B
Feeder Name	B81

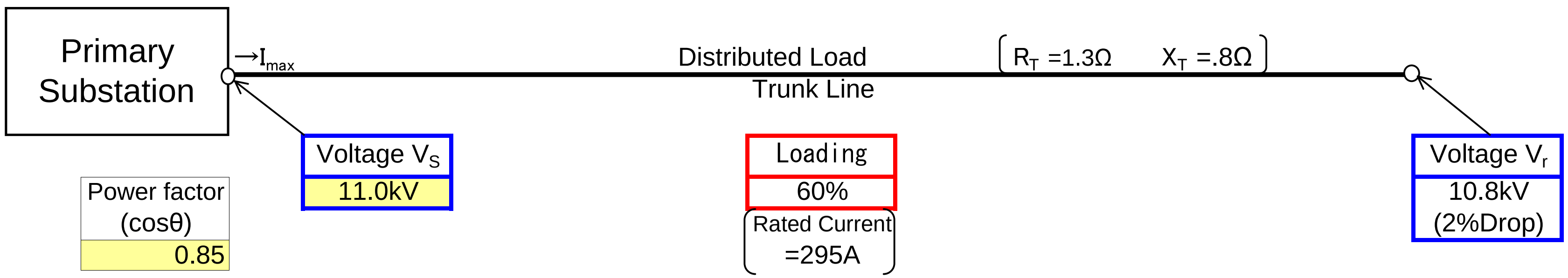
: Input data in colored cells

Type-1

Maximum Current I_{max}
178.0A

<Trank Line>

Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	6.6km	
Type of Distributed Load	Middle Larger	



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	B
Feeder Name	B91

: Input data in colored cells

Type-2

Maximum Current I_{max}
357.0A

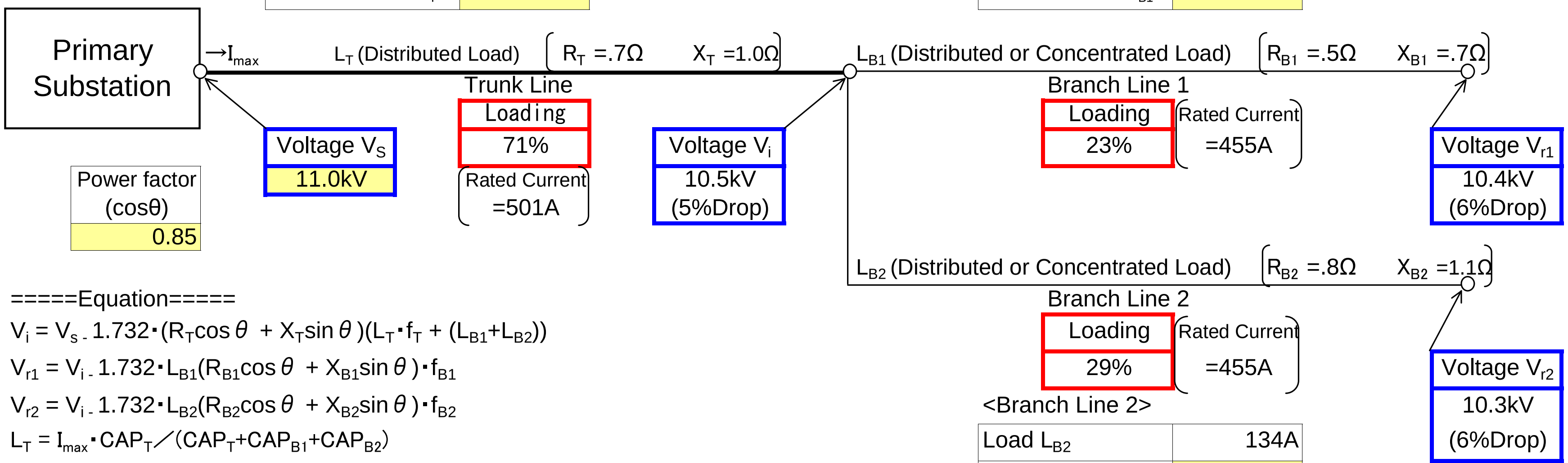
Power factor (cosθ)
0.85

<Trank Line>

Load L_T	120A	
Line Type	240CuXLPE(11kV)(for NED)	No.26
Line Legth Len_T	6.9km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_T	2100kVA	

<Branch Line 1>

Load L_{B1}	104A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	1.9km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	1815kVA	



<Branch Line 2>

Load L_{B2}	134A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	3.0km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	2345kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor
V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — $CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	E
Feeder Name	E11

: Input data in colored cells

Type-2

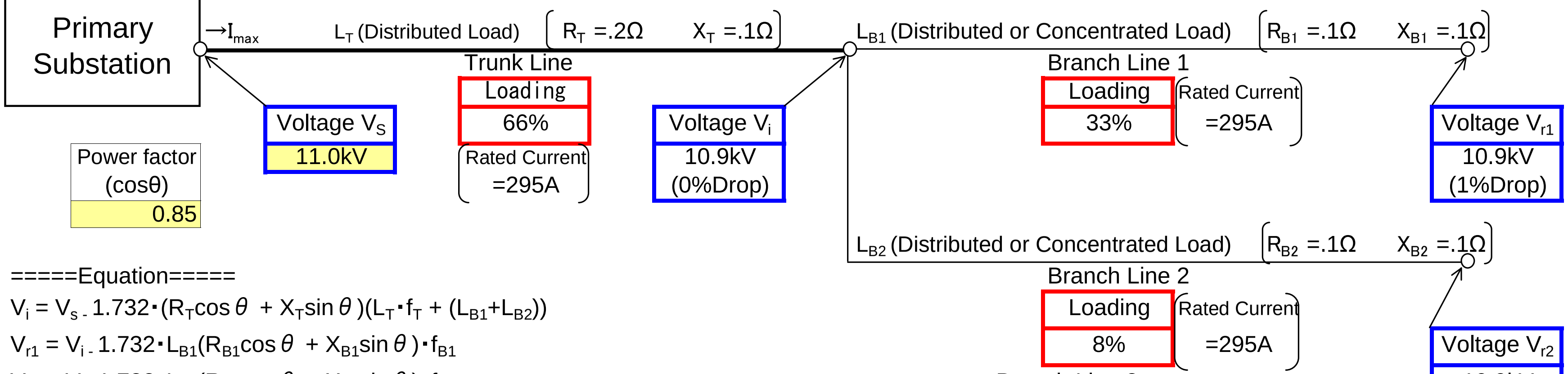
Maximum Current I_{max}	196.0A
Power factor (cosθ)	0.85

<Trank Line>

Load L_T	76A	
Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	.8km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	2550kVA	

<Branch Line 1>

Load L_{B1}	97A	
Line Type	120CuPILC(11kV)	No.22
Line Length Len_{B1}	.7km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	3250kVA	



<Branch Line 2>

Load L_{B2}	24A	
Line Type	120CuPILC(11kV)	No.22
Line Length Len_{B1}	.5km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	800kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

- V_s : Supply Voltage
- V_i : Interim Voltage
- V_{r1} : Received Voltage
- V_{r2} : Received Voltage
- I_{max} : Maximum Current
- L_T : Load (Trunk line)
- L_{B1} : Load (Branch Line 1)
- L_{B2} : Load (Branch Line 2)
- R_T, R_{B1}, R_{B2} : Resistance
- X_T, X_{B1}, X_{B2} : Reactance
- cosθ : Power Factor
- f_T, f_{B1}, f_{B2} : Dispersal Load Factor
- CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	H
Feeder Name	Ernest Chemist

: Input data in colored cells

Type-2

Maximum Current I_{max}
240.0A

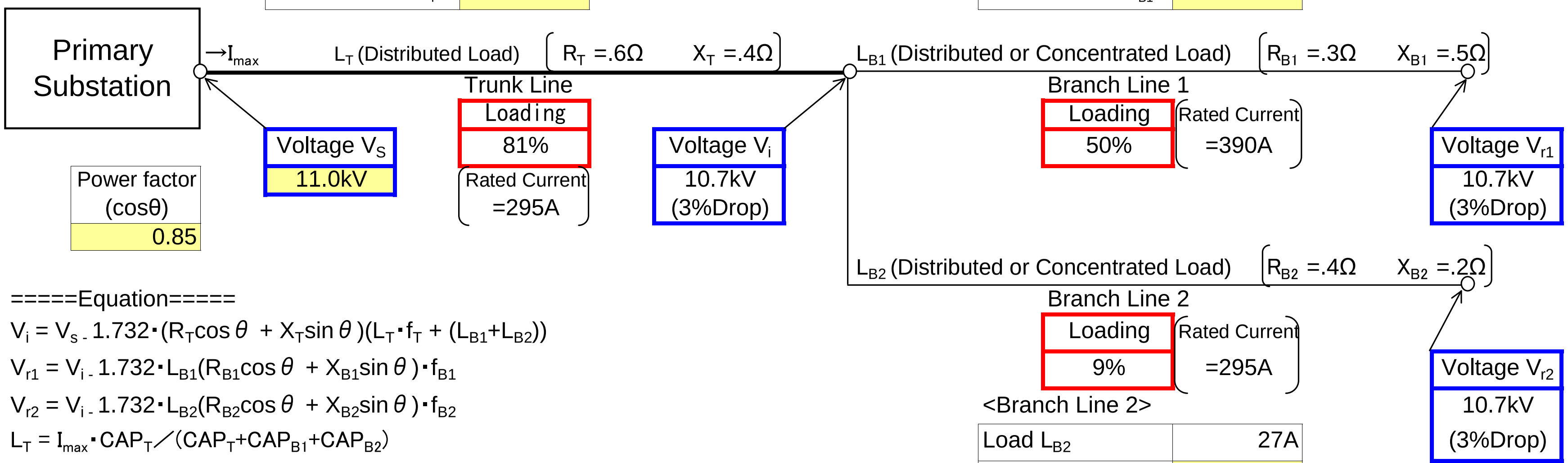
Power factor (cosθ)
0.85

<Trank Line>

Load L_T	19A	
Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	3.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	565kVA	

<Branch Line 1>

Load L_{B1}	194A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	1.3km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	5800kVA	



<Branch Line 2>

Load L_{B2}	27A	
Line Type	120CuPILC(11kV)	No.22
Line Length Len_{B1}	2.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	800kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage; I_{max} : Maximum Current; R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage; L_T : Load (Trunk line); X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage; L_{B1} : Load (Branch Line 1); cosθ : Power Factor
V_{r2} : Received Voltage; L_{B2} : Load (Branch Line 2); f_T, f_{B1}, f_{B2} : Dispersal Load Factor; CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	D
Feeder Name	F/H#1

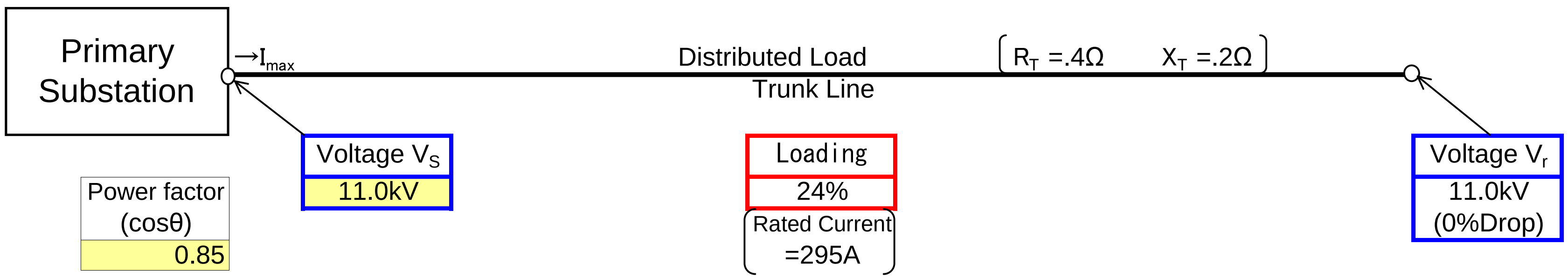
: Input data in colored cells

Type-1

Maximum Current I_{max}	70.0A

<Trank Line>

Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	1.9km	
Type of Distributed Load	Equality	



Power factor (cosθ)	0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	D
Feeder Name	ASASUA

: Input data in colored cells

Type-2

Maximum Current I_{max}
125.0A

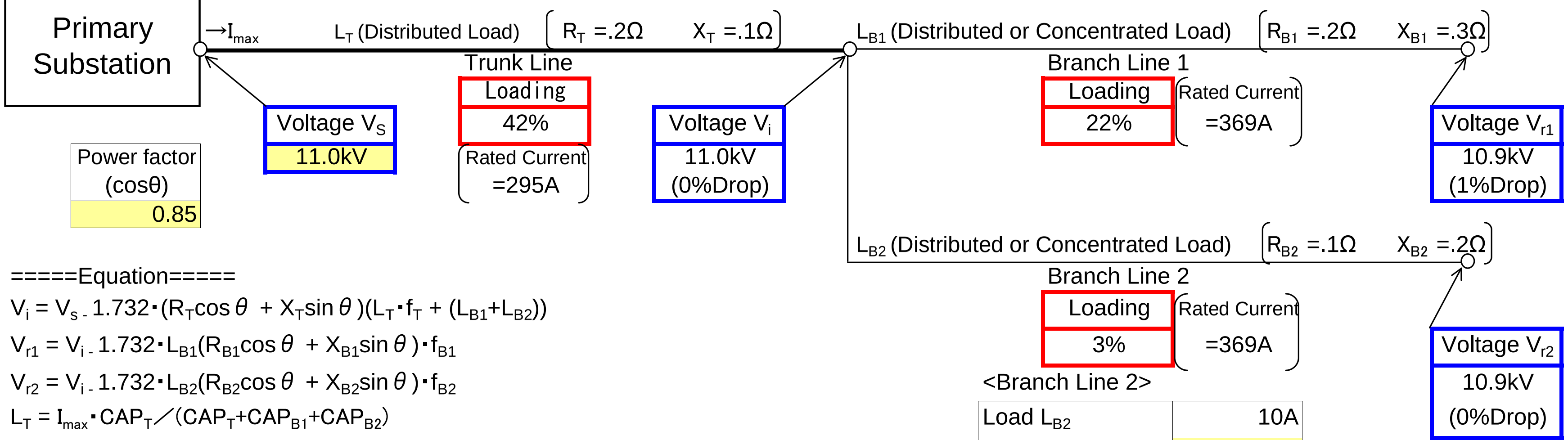
Power factor (cosθ)
0.85

<Trank Line>

Load L_T	33A	
Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	1.1km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_T	2015kVA	

<Branch Line 1>

Load L_{B1}	81A	
Line Type	Cu70mm2	No.14
Line Length Len_{B1}	.7km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	4930kVA	



<Branch Line 2>

Load L_{B2}	10A	
Line Type	Cu70mm2	No.14
Line Length Len_{B1}	.5km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	630kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

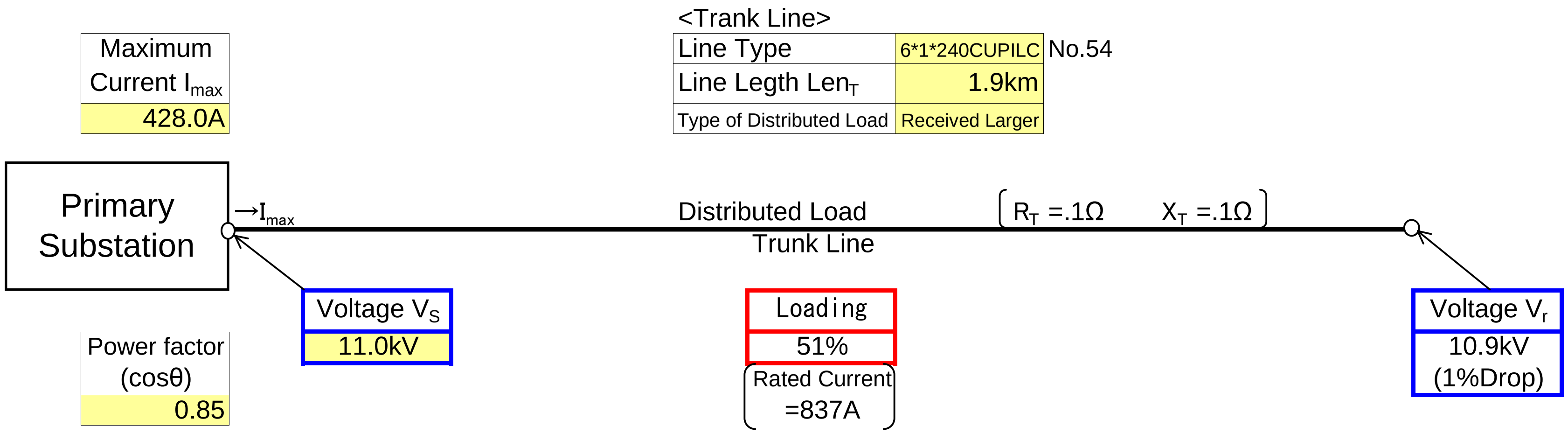
V_s : Supply Voltage　I_{max} : Maximum Current　R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage　L_T : Load (Trunk line)　X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage　L_{B1} : Load (Branch Line 1)　cosθ : Power Factor
V_{r2} : Received Voltage　L_{B2} : Load (Branch Line 2)　f_T, f_{B1}, f_{B2} : Dispersal Load Factor　CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	D
Feeder Name	GHACEM

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	D
Feeder Name	AGRONA

: Input data in colored cells

Type-2

<Trank Line>

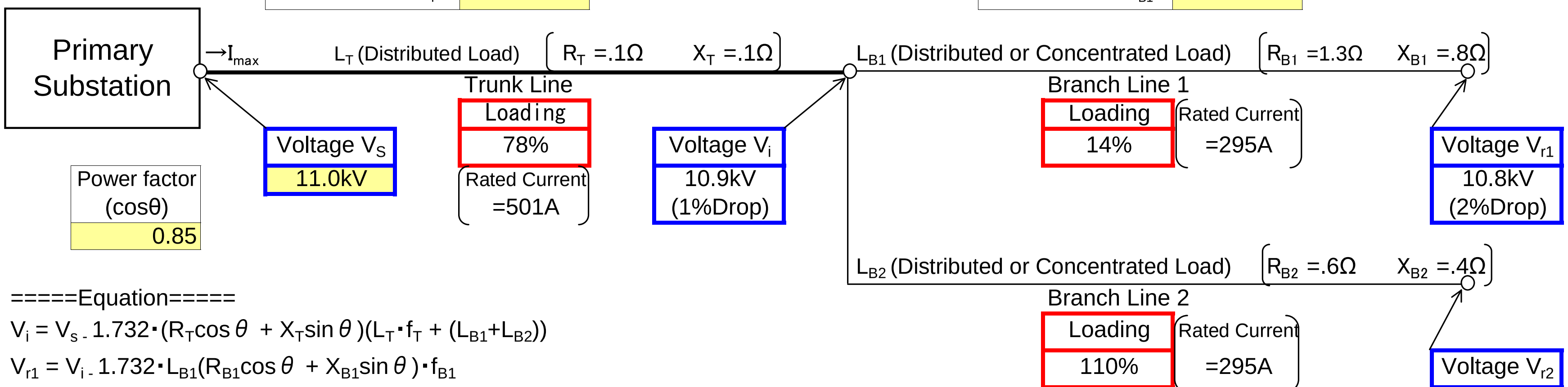
Load L_T	27A	
Line Type	240CuXLPE(11kV)(for NED)	No.26
Line Legth Len_T	1.0km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_T	500kVA	

<Branch Line 1>

Load L_{B1}	41A	
Line Type	120CuPILC(11kV)	No.22
Line Length Len_{B1}	6.4km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	750kVA	

Maximum Current I_{max}	393.0A

Power factor (cosθ)	0.85



<Branch Line 2>

Load L_{B2}	325A	
Line Type	120CuPILC(11kV)	No.22
Line Length Len_{B1}	3.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	6000kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance	
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance	
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor	
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor	CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	LASHIBI
Feeder Name	VIVIAN FARM

: Input data in colored cells

Type-2

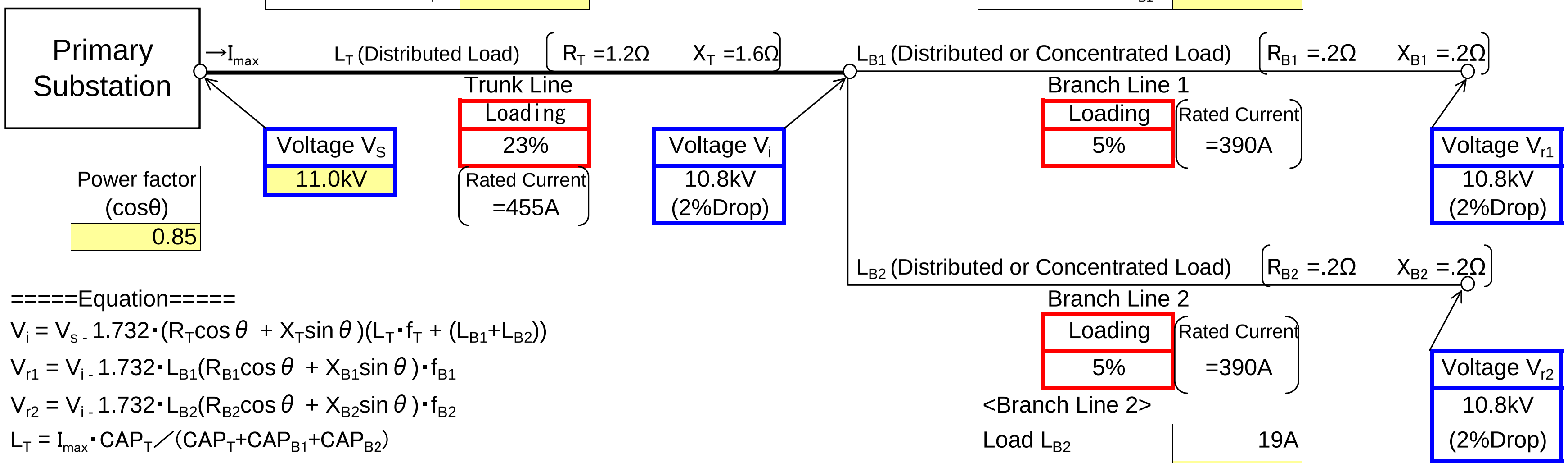
<Trank Line>

Load L_T	68A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	4.4km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_T	3550kVA	

<Branch Line 1>

Load L_{B1}	19A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	.6km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	1000kVA	

Maximum Current I_{max}	106.0A
Power factor (cosθ)	0.85



<Branch Line 2>

Load L_{B2}	19A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	.7km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	1000kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_T, R_{B1}, R_{B2}	: Resistance
V_i	: Interim Voltage	L_T	: Load (Trunk line)	X_T, X_{B1}, X_{B2}	: Reactance
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	cosθ	: Power Factor
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	f_T, f_{B1}, f_{B2}	: Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	LASHIBI
Feeder Name	KLAGON

: Input data in colored cells

Type-2

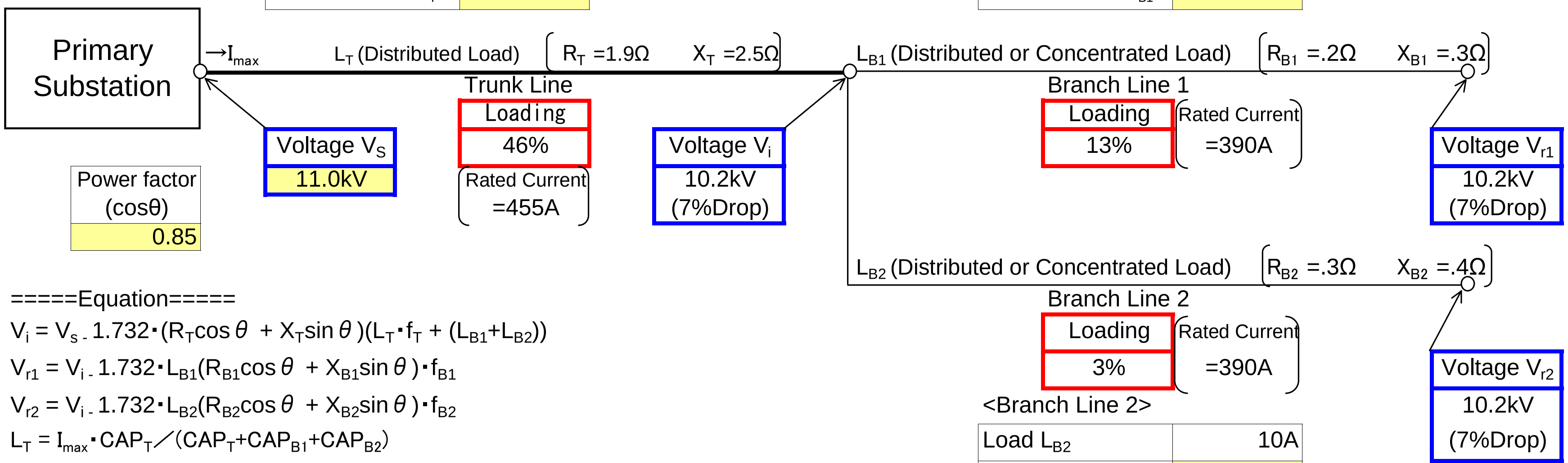
<Trank Line>

Load L_T	149A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	6.9km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	4545kVA	

<Branch Line 1>

Load L_{B1}	49A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1500kVA	

Maximum Current I_{max}	209.0A
Power factor (cosθ)	0.85



<Branch Line 2>

Load L_{B2}	10A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	1.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	315kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage I_{max} : Maximum Current R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage L_T : Load (Trunk line) X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage L_{B1} : Load (Branch Line 1) cosθ : Power Factor
V_{r2} : Received Voltage L_{B2} : Load (Branch Line 2) f_T, f_{B1}, f_{B2} : Dispersal Load Factor CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	LASHIBI
Feeder Name	COMM.20(L91)

: Input data in colored cells

Type-3

Maximum Current I_{max}
286.0A

Power factor (cosθ)
0.90

<Trank Line 1>

Load L_{T1}	76A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	5.5km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	2645kVA	

<Trank Line 2>

Load L_{T2}	A	
Line Type	120ALBARE	No.37
Line Legth Len_{T2}	1.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	kVA	

<Branch Line 2>

Load L_{B2}	113A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	1.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	3945kVA	

Primary Substation →I_{max}

L_{T1} (Distributed Load) (R_{T1} =1.5Ω X_{T1} =2.0Ω)

Trunk Line 1: Loading 63% (Rated Current =455A)

Voltage V_S: 11.0kV

Voltage V_{i1}: 10.0kV (9%Drop)

L_{T2} (Distributed Load) (R_{T2} =.3Ω X_{T2} =.4Ω)

Trunk Line 2: Loading 38% (Rated Current =390A)

Voltage V_{i2}: 9.9kV (10%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =.4Ω X_{B2} =.6Ω)

Branch Line 2: Loading 29% (Rated Current =390A)

Voltage V_{r2}: 9.9kV (10%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =.3Ω X_{B1} =.4Ω)

Branch Line 1: Loading 10% (Rated Current =390A)

Voltage V_{r1}: 10.0kV (9%Drop)

L_{B3} (Distributed or Concentrated Load) (R_{B3} =.5Ω X_{B3} =.6Ω)

Branch Line 3: Loading 15% (Rated Current =390A)

Voltage V_{r3}: 9.9kV (10%Drop)

<Branch Line 1>

Load L_{B1}	38A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	1.1km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	1315kVA	

<Branch Line 3>

Load L_{B3}	60A	
Line Type	120ALBARE	No.37
Line Length Len_{B3}	1.8km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B3}	2100kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

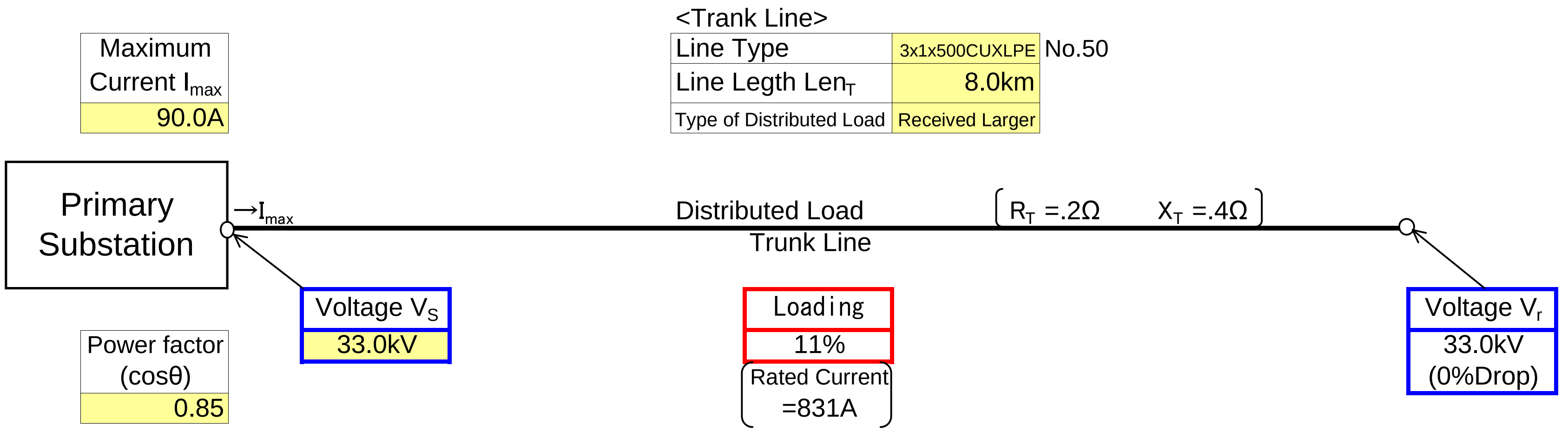
V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	A
Feeder Name	A1-Lashibi

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_S	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	D
Feeder Name	LUBE OIL

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	164A	
Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	2.9km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_T	3715kVA	

<Branch Line 1>

Load L_{B1}	22A	
Line Type	120CuPILC(11kV)	No.22
Line Length Len_{B1}	.4km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	500kVA	

Maximum Current I_{max}	200.0A

Power factor (cosθ)	0.85

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =.6Ω X_T =.4Ω)

Trunk Line

Loading	68%

(Rated Current =295A)

Voltage V_S	11.0kV

Voltage V_i	10.9kV (1%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =.1Ω X_{B1} =.0Ω)

Branch Line 1

Loading	7%

(Rated Current =295A)

Voltage V_{r1}	10.9kV (1%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =.1Ω X_{B2} =.1Ω)

Branch Line 2

Loading	5%

(Rated Current =295A)

Voltage V_{r2}	10.9kV (1%Drop)

<Branch Line 2>

Load L_{B2}	14A	
Line Type	120CuPILC(11kV)	No.22
Line Length Len_{B1}	.5km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	315kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage I_{max} : Maximum Current R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage L_T : Load (Trunk line) X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage L_{B1} : Load (Branch Line 1) cosθ : Power Factor
V_{r2} : Received Voltage L_{B2} : Load (Branch Line 2) f_T, f_{B1}, f_{B2} : Dispersal Load Factor $CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	H
Feeder Name	NESTLE

: Input data in colored cells

Type-3

Maximum Current I_{max}
250.0A

Power factor ($\cos\theta$)
0.85

Primary Substation $\rightarrow I_{max}$

Voltage V_S
11.0kV

<Trank Line 1>

Load L_{T1}	64A	
Line Type	Cu70mm2	No.14
Line Legth Len_{T1}	2.6km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	4300kVA	

L_{T1} (Distributed Load) R_{T1} =.8Ω X_{T1} =1.2Ω

Trunk Line 1

Loading
68%

Rated Current =369A

Voltage V_{i1}
10.5kV (4%Drop)

<Trank Line 2>

Load L_{T2}	69A	
Line Type	Cu70mm2	No.14
Line Legth Len_{T2}	.7km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	4650kVA	

L_{T2} (Distributed Load) R_{T2} =.2Ω X_{T2} =.3Ω

Trunk Line 2

Loading
50%

Rated Current =369A

Voltage V_{i2}
10.4kV (5%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} =.4Ω X_{B1} =.6Ω

Branch Line 1

Loading
1%

Rated Current =369A

Voltage V_{r1}
10.5kV (5%Drop)

<Branch Line 1>

Load L_{B1}	2A	
Line Type	Cu70mm2	No.14
Line Length Len_{B1}	1.3km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	150kVA	

<Branch Line 2>

Load L_{B2}	34A	
Line Type	Cu70mm2	No.14
Line Length Len_{B1}	.7km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	2300kVA	

L_{B2} (Distributed or Concentrated Load) R_{B2} =.2Ω X_{B2} =.3Ω

Branch Line 2

Loading
9%

Rated Current =369A

Voltage V_{r2}
10.4kV (5%Drop)

L_{B3} (Distributed or Concentrated Load) R_{B3} =.5Ω X_{B3} =.7Ω

Branch Line 3

Loading
18%

Rated Current =455A

Voltage V_{r3}
10.4kV (6%Drop)

<Branch Line 3>

Load L_{B3}	81A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	2.0km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{B3}	5500kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	$\cos\theta$	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	LASHIBI
Feeder Name	VIVIAN FARM

: Input data in colored cells

Type-2

Maximum Current I_{max}
189.0A

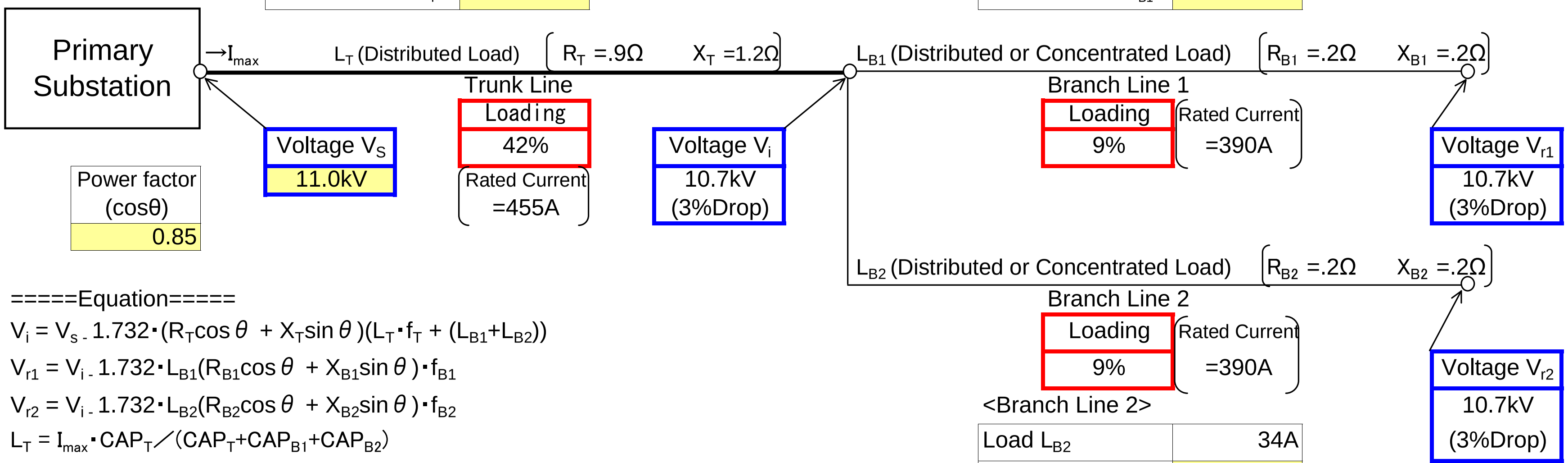
Power factor ($\cos\theta$)
0.85

<Trank Line>

Load L_T	122A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	3.4km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	3600kVA	

<Branch Line 1>

Load L_{B1}	34A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	.7km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	1000kVA	



<Branch Line 2>

Load L_{B2}	34A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	.6km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	1000kVA	

=====Equation=====

$V_i = V_s - 1.732\cdot(R_T\cos\theta + X_T\sin\theta)(L_T\cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732\cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta)\cdot f_{B1}$

$V_{r2} = V_i - 1.732\cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta)\cdot f_{B2}$

$L_T = I_{max}\cdot CAP_T/(CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max}\cdot CAP_{B1}/(CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max}\cdot CAP_{B2}/(CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage; I_{max} : Maximum Current; R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage; L_T : Load (Trunk line); X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage; L_{B1} : Load (Branch Line 1); $\cos\theta$: Power Factor

V_{r2} : Received Voltage; L_{B2} : Load (Branch Line 2); f_T, f_{B1}, f_{B2} : Dispersal Load Factor; $CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	LASHIBI
Feeder Name	NUNGUA

: Input data in colored cells

Type-3

Maximum Current I_{max}	
523.0A	

Power factor (cosθ)	
0.90	

Primary Substation →I_{max}

Voltage V_S: 11.0kV

<Trank Line 1>

Load L_{T1}	85A	
Line Type	120ALBARE	No.37
Line Legth Len_{T1}	2.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	1025kVA	

L_{T1} (Distributed Load) (R_{T1} =.5Ω X_{T1} =.7Ω)

Trunk Line 1: Loading 134% (Rated Current =390A)

Voltage V_{i1}: 10.3kV (6%Drop)

<Trank Line 2>

Load L_{T2}	255A	
Line Type	120ALBARE	No.37
Line Legth Len_{T2}	2.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	3065kVA	

L_{T2} (Distributed Load) (R_{T2} =.5Ω X_{T2} =.7Ω)

Trunk Line 2: Loading 87% (Rated Current =390A)

Voltage V_{i2}: 10.1kV (8%Drop)

<Branch Line 2>

Load L_{B2}	42A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	500kVA	

L_{B2} (Distributed or Concentrated Load) (R_{B2} =.2Ω X_{B2} =.3Ω)

Branch Line 2: Loading 11% (Rated Current =390A)

Voltage V_{r2}: 10.1kV (9%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =.3Ω X_{B1} =.4Ω)

Branch Line 1: Loading 26% (Rated Current =390A)

Voltage V_{r1}: 10.3kV (6%Drop)

<Branch Line 1>

Load L_{B1}	100A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	1.1km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	1200kVA	

L_{B3} (Distributed or Concentrated Load) (R_{B3} =1.0Ω X_{B3} =1.4Ω)

Branch Line 3: Loading 11% (Rated Current =390A)

Voltage V_{r3}: 10.0kV (9%Drop)

<Branch Line 3>

Load L_{B3}	42A	
Line Type	120ALBARE	No.37
Line Length Len_{B3}	4.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	500kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPONG
Feeder Name	OKWENYA

: Input data in colored cells

Type-2

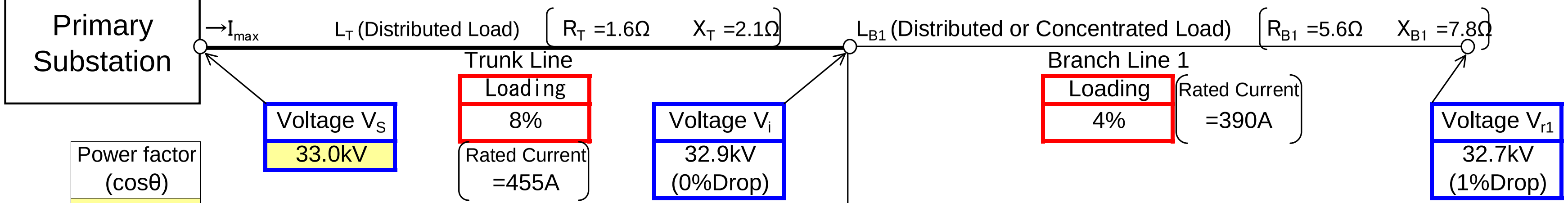
Maximum Current I_{max}	36.0A
Power factor (cosθ)	0.90

<Trank Line>

Load L_T	3A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	6.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	250kVA	

<Branch Line 1>

Load L_{B1}	17A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	22.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1250kVA	



<Branch Line 2>

Load L_{B2}	16A	
Line Type	50ALBARE	No.34
Line Length Len_{B1}	18.1km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	1150kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage　I_{max} : Maximum Current　R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage　L_T : Load (Trunk line)　X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage　L_{B1} : Load (Branch Line 1)　cosθ : Power Factor

V_{r2} : Received Voltage　L_{B2} : Load (Branch Line 2)　f_T, f_{B1}, f_{B2} : Dispersal Load Factor　CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPONG
Feeder Name	Juapong

: Input data in colored cells

Type-3

Maximum Current I_{max}
57.0A

<Trank Line 1>

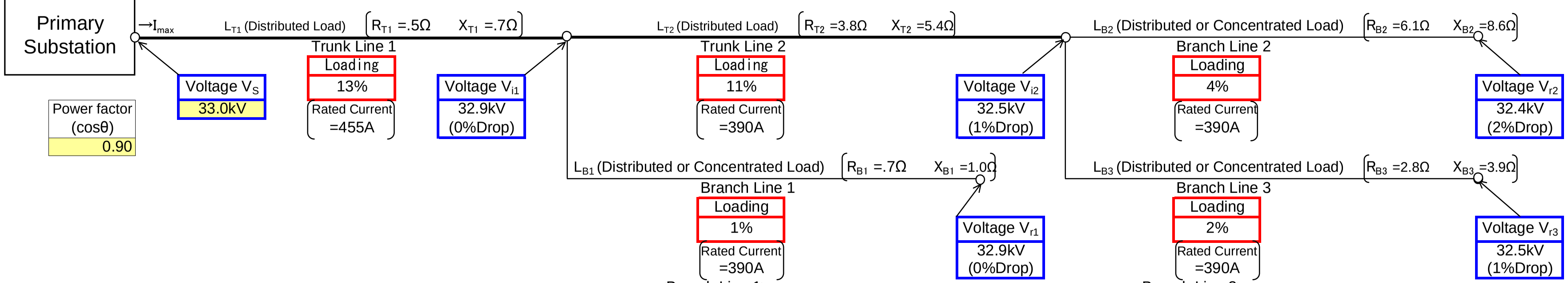
Load L_{T1}	3A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	2.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	200kVA	

<Trank Line 2>

Load L_{T2}	24A	
Line Type	120ALBARE	No.37
Line Legth Len_{T2}	15.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	1400kVA	

<Branch Line 2>

Load L_{B2}	17A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	24.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1000kVA	



<Branch Line 1>

Load L_{B1}	3A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	2.8km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	200kVA	

<Branch Line 3>

Load L_{B3}	9A	
Line Type	120ALBARE	No.37
Line Length Len_{B3}	11.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	500kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	D
Feeder Name	PFC

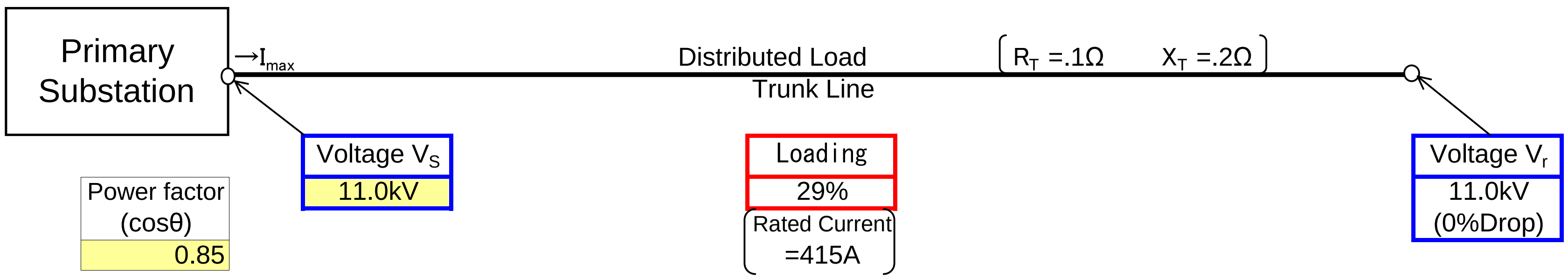
: Input data in colored cells

Type-1

Maximum Current I_{max}
120.0A

<Trank Line>

Line Type	240CuPILC(11kV)(for NED)	No.25
Line Legth Len_T	1.4km	
Type of Distributed Load	Middle Larger	



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	D
Feeder Name	AGRONA

: Input data in colored cells

Type-2

Maximum Current I_{max}
220.0A

Power factor (cosθ)
0.85

<Trank Line>

Load L_T	15A	
Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	1.0km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_T	500kVA	

<Branch Line 1>

Load L_{B1}	23A	
Line Type	120CuPILC(11kV)	No.22
Line Length Len_{B1}	6.4km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	750kVA	

Primary Substation

$\rightarrow I_{max}$

Voltage V_S: 11.0kV

L_T (Distributed Load) (R_T =.2Ω X_T =.1Ω)

Trunk Line

Loading
75%

(Rated Current =295A)

Voltage V_i: 10.9kV (1%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =1.3Ω X_{B1} =.8Ω)

Branch Line 1

Loading
8%

(Rated Current =295A)

Voltage V_{r1}: 10.9kV (1%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =.1Ω X_{B2} =.0Ω)

Branch Line 2

Loading
62%

(Rated Current =295A)

Voltage V_{r2}: 10.9kV (1%Drop)

<Branch Line 2>

Load L_{B2}	182A	
Line Type	120CuPILC(11kV)	No.22
Line Length Len_{B1}	.3km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	6000kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage; I_{max} : Maximum Current; R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage; L_T : Load (Trunk line); X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage; L_{B1} : Load (Branch Line 1); cosθ : Power Factor

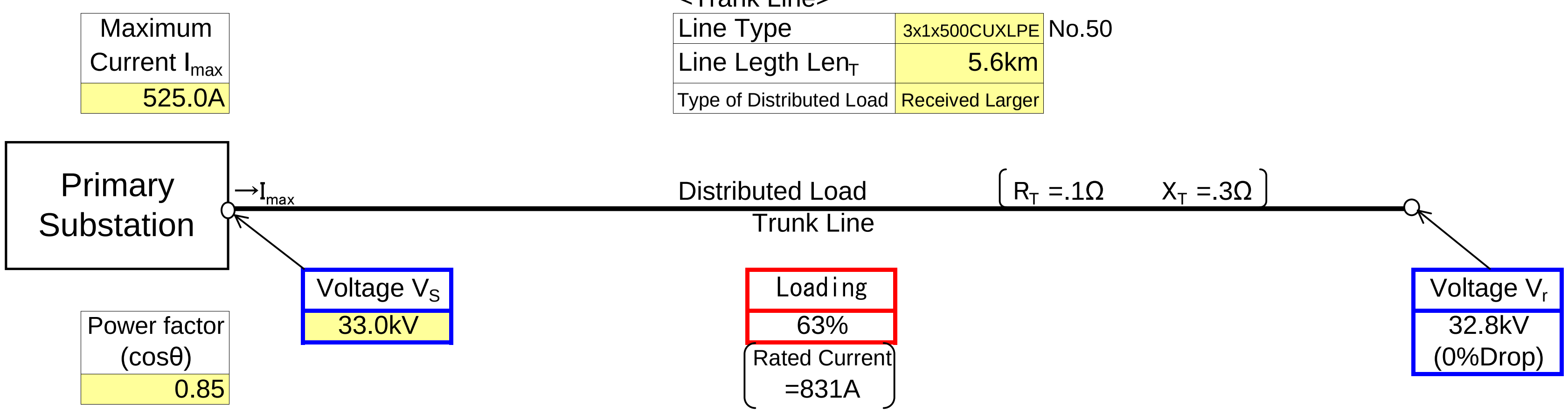
V_{r2} : Received Voltage; L_{B2} : Load (Branch Line 2); f_T, f_{B1}, f_{B2} : Dispersal Load Factor; $CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	H
Feeder Name	H-A1

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_S	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPONG
Feeder Name	Old Works

: Input data in colored cells

Type-2

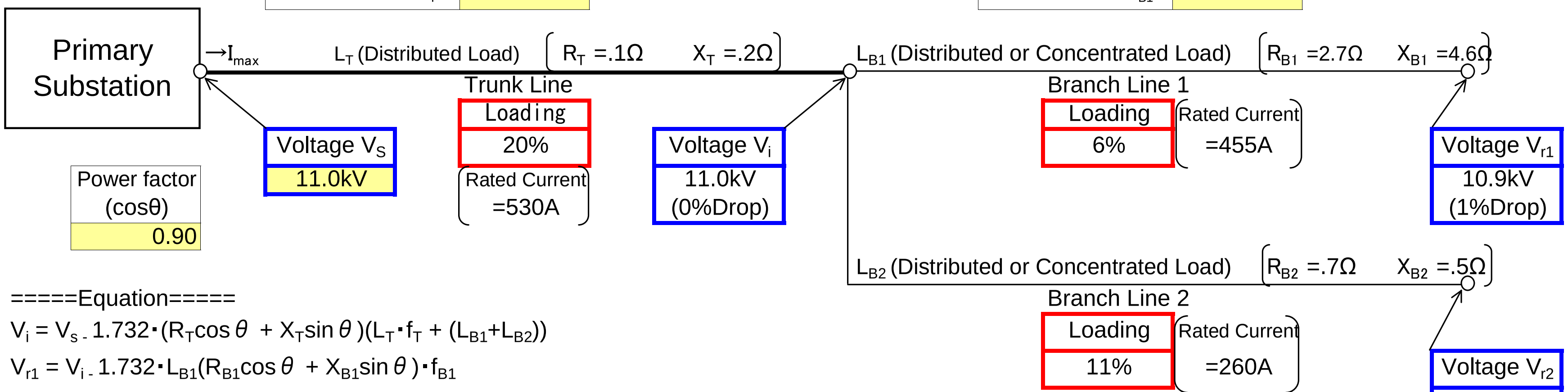
<Trank Line>

Load L_T	51A	
Line Type	AAC150mm2	No.6
Line Legth Len_T	.5km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_T	550kVA	

<Branch Line 1>

Load L_{B1}	28A	
Line Type	150ALBARE	No.38
Line Length Len_{B1}	13.3km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	300kVA	

Maximum Current I_{max}	107.0A
Power factor (cosθ)	0.90



<Branch Line 2>

Load L_{B2}	29A	
Line Type	50ALBARE	No.34
Line Length Len_{B1}	1.2km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	315kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance	
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance	
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor	
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor	CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	H
Feeder Name	Prampram

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	A	
Line Type	120CuPILC(11kV)	No.22
Line Legth Len_{T1}	2.0km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	kVA	

<Trank Line 2>

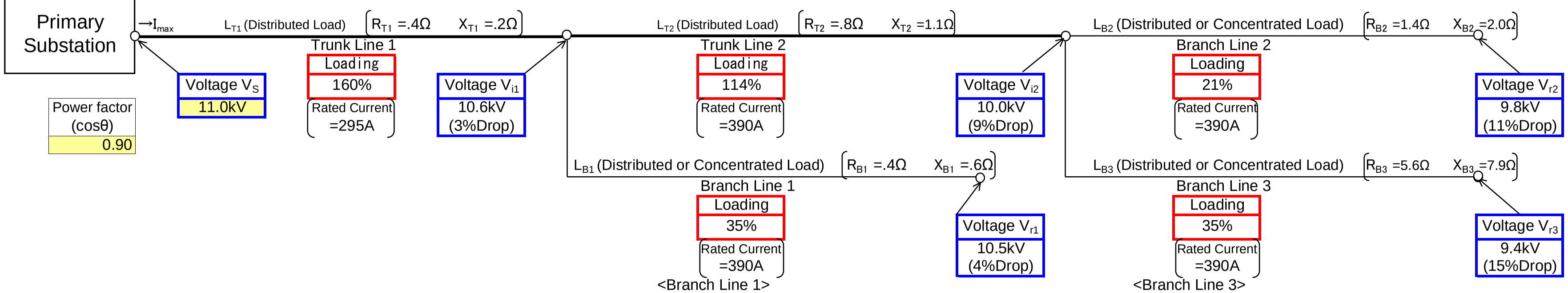
Load L_{T2}	118A	
Line Type	120ALBARE	No.37
Line Legth Len_{T2}	3.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	3550kVA	

<Branch Line 2>

Load L_{B2}	83A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	5.7km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	2480kVA	

Maximum Current I_{max}
473.0A

Power factor (cosθ)
0.90



<Branch Line 1>

Load L_{B1}	135A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	1.7km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	4065kVA	

<Branch Line 3>

Load L_{B3}	137A	
Line Type	120ALBARE	No.37
Line Length Len_{B3}	22.2km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{B3}	4105kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	H
Feeder Name	T.O.R

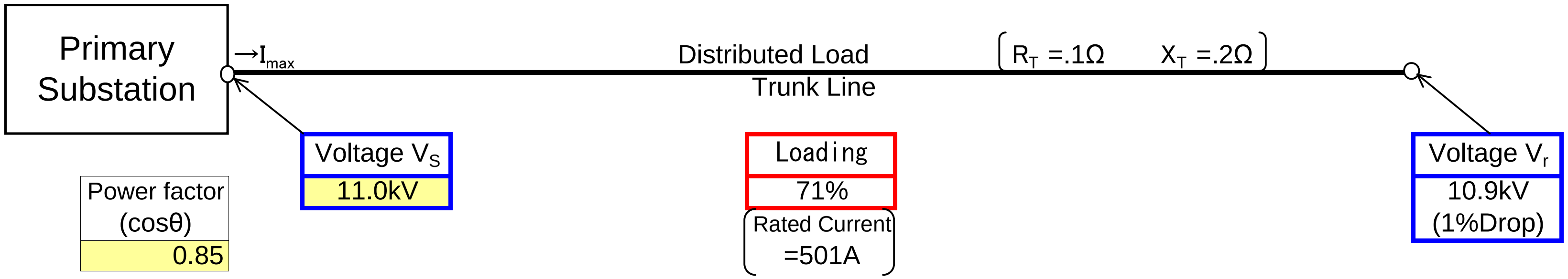
: Input data in colored cells

Type-1

Maximum Current I_{max}	
357.0A	

<Trank Line>

Line Type	240CuXLPE(11kV)(for NED)	No.26
Line Legth Len_T	1.2km	
Type of Distributed Load	Received Larger	



Power factor (cosθ)	
0.85	

=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	H
Feeder Name	Kpone Garages

: Input data in colored cells

Type-2

Maximum Current I_{max}
268.0A

Power factor (cosθ)
0.85

<Trank Line>

Load L_T	83A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	1.7km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_T	2550kVA	

<Branch Line 1>

Load L_{B1}	109A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	1.9km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	3345kVA	

Primary Substation

→I_{max}

L_T (Distributed Load) (R_T =.5Ω X_T =.6Ω)

Trunk Line

Loading
59%

(Rated Current =455A)

Voltage V_S
11.0kV

Voltage V_i
10.7kV (3%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =.5Ω X_{B1} =.7Ω)

Branch Line 1

Loading
24%

(Rated Current =455A)

Voltage V_{r1}
10.6kV (3%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =.5Ω X_{B2} =.6Ω)

Branch Line 2

Loading
19%

(Rated Current =390A)

Voltage V_{r2}
10.7kV (3%Drop)

<Branch Line 2>

Load L_{B2}	76A	
Line Type	120ALBARE	No.37
Line Length Len_{B1}	1.8km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	2330kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage I_{max} : Maximum Current R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage L_T : Load (Trunk line) X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage L_{B1} : Load (Branch Line 1) cosθ : Power Factor

V_{r2} : Received Voltage L_{B2} : Load (Branch Line 2) f_T, f_{B1}, f_{B2} : Dispersal Load Factor $CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	H
Feeder Name	Slaughter Hse

: Input data in colored cells

Type-3

Maximum Current I_{max}: 60.0A

Power factor (cosθ): 0.85

Primary Substation →I_{max}

Voltage V_s: 11.0kV

<Trank Line 1>

Load L_{T1}	A	
Line Type	120CuPILC(11kV)	No.22
Line Legth Len_{T1}	.7km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	kVA	

L_{T1} (Distributed Load) (R_{T1} =.1Ω X_{T1} =.1Ω)

Trunk Line 1: Loading 20%, Rated Current =295A

Voltage V_{i1}: 11.0kV (0%Drop)

<Trank Line 2>

Load L_{T2}	11A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	1.1km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	2350kVA	

L_{T2} (Distributed Load) (R_{T2} =.3Ω X_{T2} =.4Ω)

Trunk Line 2: Loading 14%, Rated Current =455A

Voltage V_{i2}: 11.0kV (0%Drop)

<Branch Line 2>

Load L_{B2}	13A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	.9km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	2800kVA	

L_{B2} (Distributed or Concentrated Load) (R_{B2} =.2Ω X_{B2} =.3Ω)

Branch Line 2: Loading 3%, Rated Current =455A

Voltage V_{r2}: 11.0kV (0%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =.3Ω X_{B1} =.4Ω)

Branch Line 1: Loading 4%, Rated Current =455A

Voltage V_{r1}: 11.0kV (0%Drop)

<Branch Line 1>

Load L_{B1}	19A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	1.1km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	4025kVA	

L_{B3} (Distributed or Concentrated Load) (R_{B3} =.2Ω X_{B3} =.3Ω)

Branch Line 3: Loading 4%, Rated Current =455A

Voltage V_{r3}: 11.0kV (0%Drop)

<Branch Line 3>

Load L_{B3}	16A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	.8km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B3}	3350kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis

- Volta 2017 -

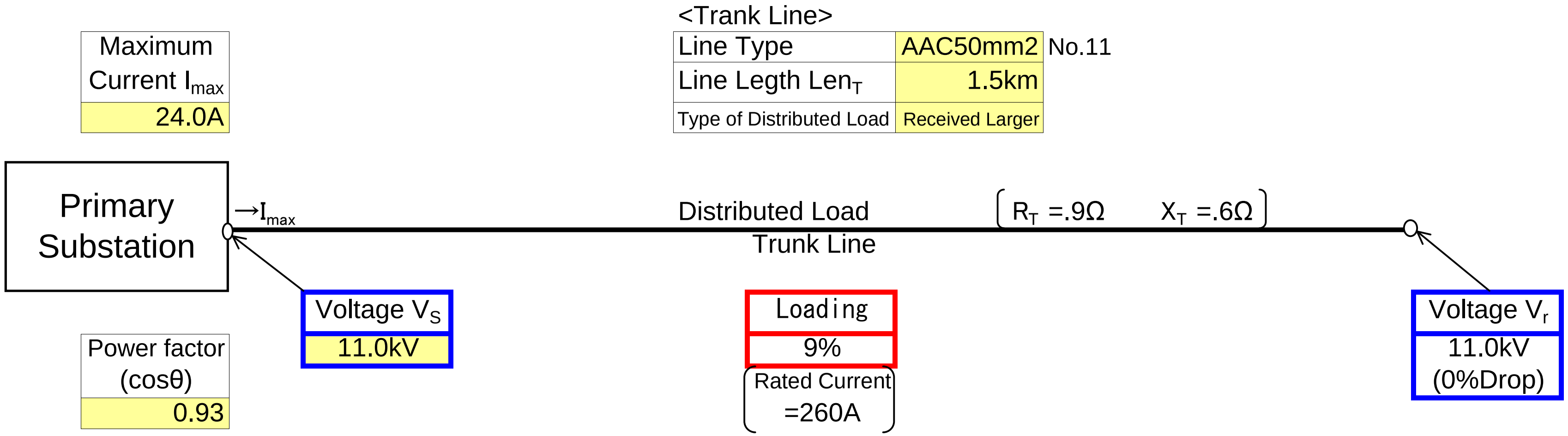
Step A (Type-1)

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	AFLAO
Feeder Name	DENU

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	AFLAO
Feeder Name	AFLAO

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	4A	
Line Type	Cu35mm2	No.15
Line Legth Len_T	.2km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	315kVA	

<Branch Line 1>

Load L_{B1}	28A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	4.4km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	2130kVA	

Maximum Current I_{max}: 69.0A

Power factor ($\cos\theta$): 0.86

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =.1Ω X_T =.1Ω)

Trunk Line

Loading 29%

Rated Current =236A

Voltage V_S 11.0kV

Voltage V_i 11.0kV (0%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =.7Ω X_{B1} =.6Ω)

Branch Line 1

Loading 8%

Rated Current =335A

Voltage V_{r1} 11.0kV (0%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =.4Ω X_{B2} =.4Ω)

Branch Line 2

Loading 11%

Rated Current =335A

Voltage V_{r2} 11.0kV (0%Drop)

<Branch Line 2>

Load L_{B2}	37A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	2.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	2760kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage; I_{max} : Maximum Current; R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage; L_T : Load (Trunk line); X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage; L_{B1} : Load (Branch Line 1); $\cos\theta$: Power Factor

V_{r2} : Received Voltage; L_{B2} : Load (Branch Line 2); f_T, f_{B1}, f_{B2} : Dispersal Load Factor; $CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	AFLAO
Feeder Name	DENU

: Input data in colored cells

Type-2

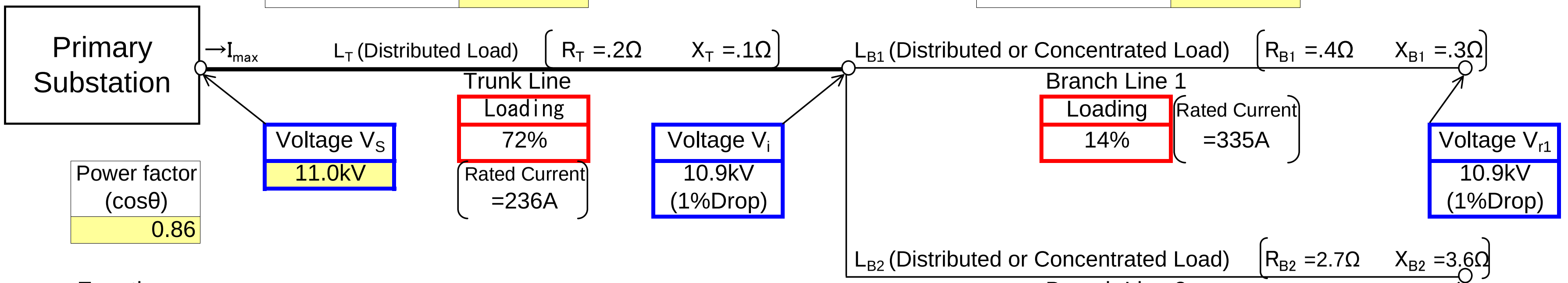
<Trank Line>

Load L_T	12A	
Line Type	Cu35mm2	No.15
Line Legth Len_T	.3km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	315kVA	

<Branch Line 1>

Load L_{B1}	48A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	2.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1260kVA	

Maximum Current I_{max}	171.0A
Power factor (cosθ)	0.86



<Branch Line 2>

Load L_{B2}	111A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	10.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	2930kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor
V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	AFLAO
Feeder Name	ABOR

: Input data in colored cells

Type-3

Maximum Current I_{max}
83.0A

Power factor (cosθ)
0.86

<Trank Line 1>

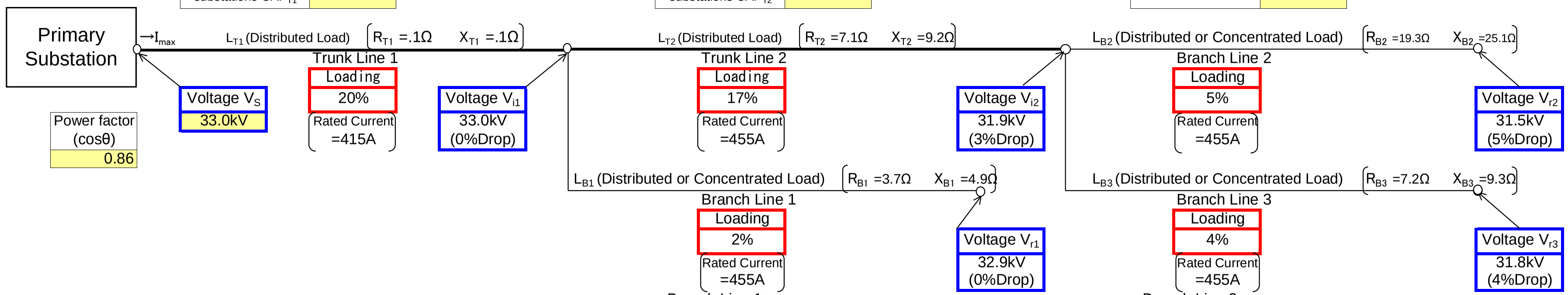
Load L_{T1}	A	
Line Type	240CuPILC(11kV)	No.25
Line Legth Len_{T1}	1.0km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	50kVA	

<Trank Line 2>

Load L_{T2}	28A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	25.8km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	3050kVA	

<Branch Line 2>

Load L_{B2}	24A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	70.3km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	2600kVA	



<Branch Line 1>

Load L_{B1}	10A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	13.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1100kVA	

<Branch Line 3>

Load L_{B3}	20A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	26.2km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{B3}	2125kVA	

=====Equation=====

$V_{i1} = V_{s} - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	HO
Feeder Name	CENTRAL FEEDER

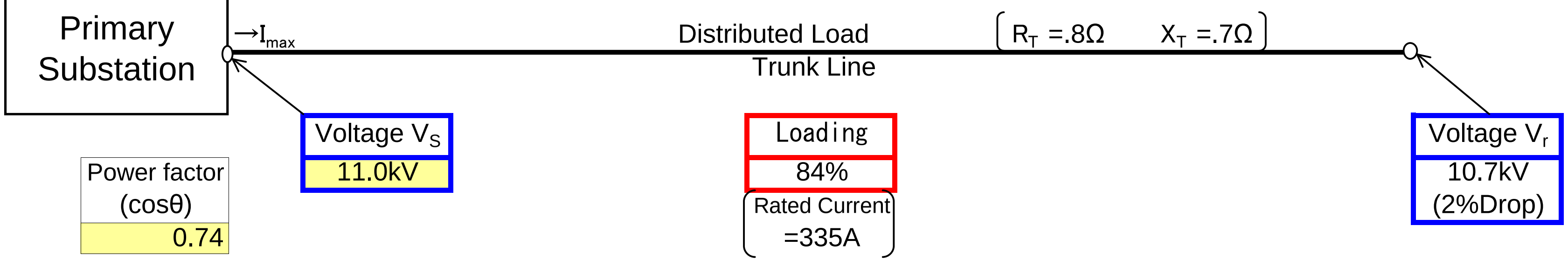
: Input data in colored cells

Type-1

Maximum Current I_{max}	282.0A

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	5.3km	
Type of Distributed Load	Equality	



Power factor (cosθ)	0.74

=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	HO
Feeder Name	SOKODE

: Input data in colored cells

Type-2

Maximum Current I_{max}: 204.0A

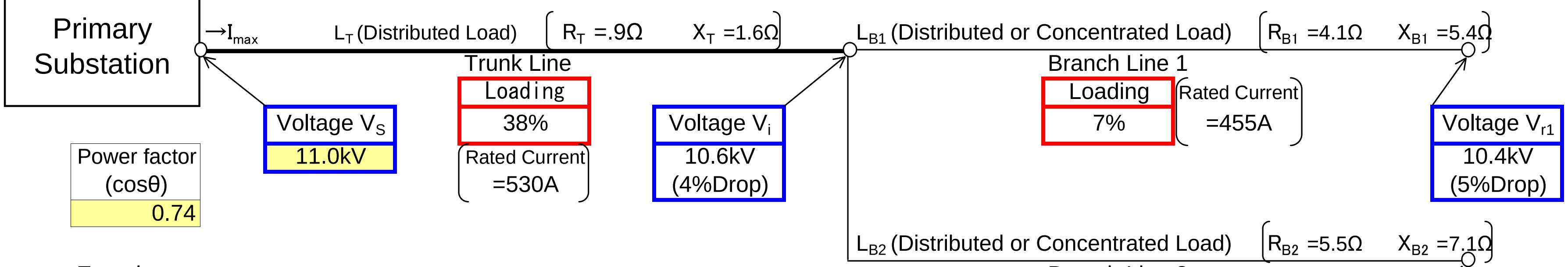
Power factor (cosθ): 0.74

<Trank Line>

Load L_T	141A	
Line Type	AAC150mm2	No.6
Line Legth Len_T	4.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	5390kVA	

<Branch Line 1>

Load L_{B1}	30A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	15.0km	
Type of Distributed Load	Middle Smaller	
Total Transformer Capacity of secondary substations CAP_{B1}	1150kVA	



<Branch Line 2>

Load L_{B2}	33A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	20.0km	
Type of Distributed Load	Middle Smaller	
Total Transformer Capacity of secondary substations CAP_{B2}	1240kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor

V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — $CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	HO
Feeder Name	TANYIGBE

: Input data in colored cells

Type-3

Maximum Current I_{max}
185.0A

Power factor (cosθ)
0.74

<Trank Line 1>

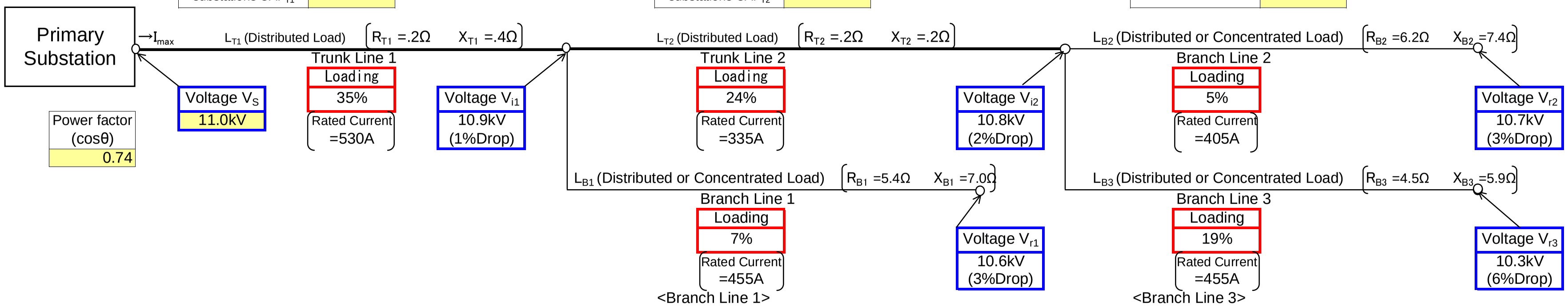
Load L_{T1}	26A	
Line Type	AAC150mm2	No.6
Line Legth Len_{T1}	1.1km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	1395kVA	

<Trank Line 2>

Load L_{T2}	21A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T2}	1.2km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	1130kVA	

<Branch Line 2>

Load L_{B2}	19A	
Line Type	AAC100mm2	No.8
Line Length Len_{B1}	20.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1000kVA	



<Branch Line 1>

Load L_{B1}	33A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	19.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1750kVA	

<Branch Line 3>

Load L_{B3}	85A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	16.5km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{B3}	4500kVA	

=====Equation=====

$V_{i1} = V_s - 1.732\cdot(R_{T1}\cos\theta + X_{T1}\sin\theta)\cdot(L_{T1}\cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732\cdot(R_{T2}\cos\theta + X_{T2}\sin\theta)\cdot(L_{T2}\cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732\cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta)\cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732\cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta)\cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732\cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta)\cdot f_{B3}$

$L_{T1} = I_{max}\cdot CAP_{T1}/(CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max}\cdot CAP_{T2}/(CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max}\cdot CAP_{B1}/(CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max}\cdot CAP_{B2}/(CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max}\cdot CAP_{B3}/(CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage
V_{i1} : Interim Voltage
V_{i2} : Interim Voltage
V_{r1} : Received Voltage
V_{r2} : Received Voltage
V_{r3} : Received Voltage

I_{max} : Maximum Current
L_{T1} : Load (Trunk line 1)
L_{T2} : Load (Trunk line 2)
L_{B1} : Load (Branch Line 1)
L_{B2} : Load (Branch Line 2)
L_{B3} : Load (Branch Line 3)

$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$: Resistance
$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$: Reactance
$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$: Dispersal Load Factor
$CAP_{T1}, CAP_{T2}, CAP_{B1}, CAP_{B2}, CAP_{B3}$: Total Transformer Capacity of secondary substations
cosθ : Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	HOHOE
Feeder Name	ST FRANCIS

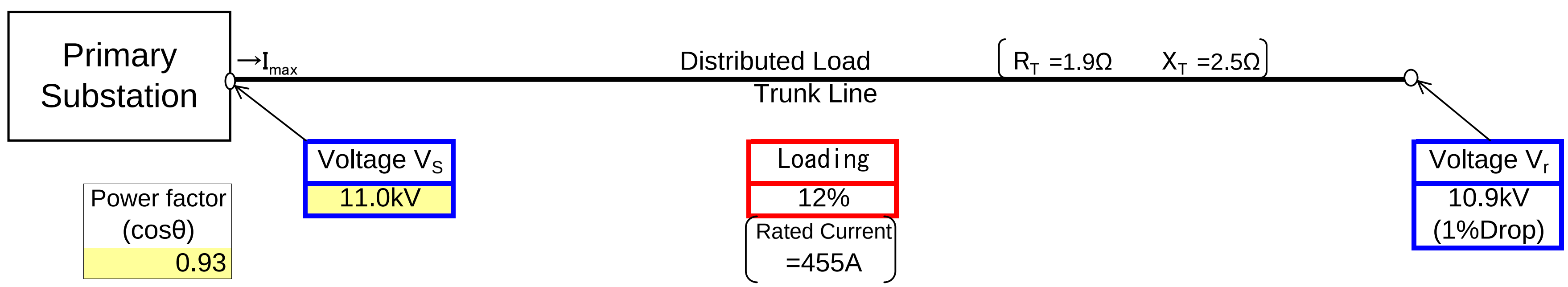
: Input data in colored cells

Type-1

Maximum Current I_{max}	54.0A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	7.1km	
Type of Distributed Load	Equality	



Power factor (cosθ)	0.93

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	HOHOE
Feeder Name	HOPITAL

: Input data in colored cells

Type-2

Maximum Current I_{max}: 134.0A

Power factor ($\cos\theta$): 0.93

<Trank Line>

Load L_T	11A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	.1km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_T	200kVA	

<Branch Line 1>

Load L_{B1}	22A	
Line Type	95ALXPLE(11kV)	No.21
Line Length Len_{B1}	.5km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	415kVA	

Primary Substation $\rightarrow I_{max}$

L_T (Distributed Load) R_T =.0Ω X_T =.0Ω

Trunk Line: Loading 29% (Rated Current =455A)

Voltage V_S: 11.0kV

Voltage V_i: 11.0kV (0%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} =.1Ω X_{B1} =.1Ω

Branch Line 1: Loading 10% (Rated Current =225A)

Voltage V_{r1}: 11.0kV (0%Drop)

L_{B2} (Distributed or Concentrated Load) R_{B2} =.8Ω X_{B2} =1.0Ω

Branch Line 2: Loading 22% (Rated Current =455A)

Voltage V_{r2}: 10.9kV (1%Drop)

<Branch Line 2>

Load L_{B2}	101A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	2.9km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	1915kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage I_{max} : Maximum Current R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage L_T : Load (Trunk line) X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage L_{B1} : Load (Branch Line 1) $\cos\theta$: Power Factor

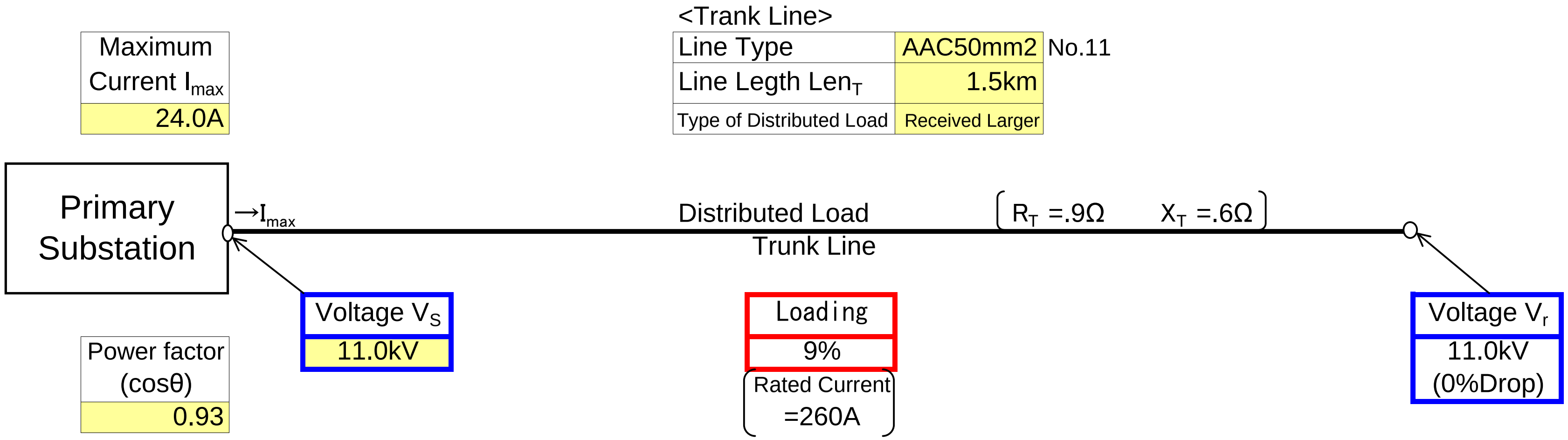
V_{r2} : Received Voltage L_{B2} : Load (Branch Line 2) f_T, f_{B1}, f_{B2} : Dispersal Load Factor CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ANLOGA
Feeder Name	ANTECH

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ANLOGA
Feeder Name	KETA

: Input data in colored cells

Type-2

Maximum Current I_{max}
24.0A

Power factor (cosθ)
0.93

<Trank Line>

Load L_T	14A	
Line Type	Cu35mm2	No.15
Line Legth Len_T	33.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	3815kVA	

<Branch Line 1>

Load L_{B1}	6A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	.3km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	1600kVA	

Primary Substation

$\rightarrow I_{max}$ L_T (Distributed Load) (R_T =23.8Ω X_T =15.8Ω)

Trunk Line

Loading
10%

(Rated Current =236A)

Voltage V_S
11.0kV

Voltage V_i
10.2kV (8%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =.0Ω X_{B1} =.0Ω)

Branch Line 1

Loading
2%

(Rated Current =335A)

Voltage V_{r1}
10.2kV (8%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =2.2Ω X_{B2} =.9Ω)

Branch Line 2

Loading
3%

(Rated Current =137A)

Voltage V_{r2}
10.2kV (8%Drop)

<Branch Line 2>

Load L_{B2}	4A	
Line Type	Cu16mm2	No.16
Line Length Len_{B1}	1.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1215kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor

V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — $CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPANDO
Feeder Name	KPANDO TOWN

: Input data in colored cells

Type-2

Maximum Current I_{max}	125.0A
Power factor (cosθ)	0.93

<Trank Line>

Load L_T	14A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	1.4km	
Type of Distributed Load	Middle Smaller	
Total Transformer Capacity of secondary substations CAP_T	400kVA	

<Branch Line 1>

Load L_{B1}	57A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	6.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1580kVA	

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =.4Ω X_T =.5Ω)

Trunk Line

Loading
27%

(Rated Current =455A)

Voltage V_S
11.0kV

Voltage V_i
10.9kV (1%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =1.6Ω X_{B1} =2.1Ω)

Branch Line 1

Loading
12%

(Rated Current =455A)

Voltage V_{r1}
10.8kV (2%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =.7Ω X_{B2} =.9Ω)

Branch Line 2

Loading
12%

(Rated Current =455A)

Voltage V_{r2}
10.8kV (1%Drop)

<Branch Line 2>

Load L_{B2}	54A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	2.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1515kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPANDO
Feeder Name	SOVIE-VAKPO

: Input data in colored cells

Type-3

Maximum Current I_{max}	
	61.0A

Power factor (cosθ)	
	0.93

Primary Substation

<Trank Line 1>

Load L_{T1}	13A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	20.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	850kVA	

<Trank Line 2>

Load L_{T2}	2A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	3.6km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	100kVA	

<Branch Line 2>

Load L_{B2}	24A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	21.3km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1525kVA	

$\rightarrow I_{max}$

Voltage V_S: 11.0kV

L_{T1} (Distributed Load) (R_{T1} =5.7Ω X_{T1} =7.4Ω)

Trunk Line 1 — Loading 13% — Rated Current =455A

Voltage V_{i1}: 10.2kV (7%Drop)

L_{T2} (Distributed Load) (R_{T2} =1.0Ω X_{T2} =1.3Ω)

Trunk Line 2 — Loading 8% — Rated Current =455A

Voltage V_{i2}: 10.2kV (8%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =5.8Ω X_{B2} =7.6Ω)

Branch Line 2 — Loading 5% — Rated Current =455A

Voltage V_{r2}: 10.0kV (9%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =3.9Ω X_{B1} =5.0Ω)

Branch Line 1 — Loading 3% — Rated Current =455A

Voltage V_{r1}: 10.2kV (7%Drop)

L_{B3} (Distributed or Concentrated Load) (R_{B3} =2.7Ω X_{B3} =3.5Ω)

Branch Line 3 — Loading 2% — Rated Current =455A

Voltage V_{r3}: 10.1kV (8%Drop)

<Branch Line 1>

Load L_{B1}	13A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	14.1km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	850kVA	

<Branch Line 3>

Load L_{B3}	9A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	9.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	550kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPEVE
Feeder Name	GWCL

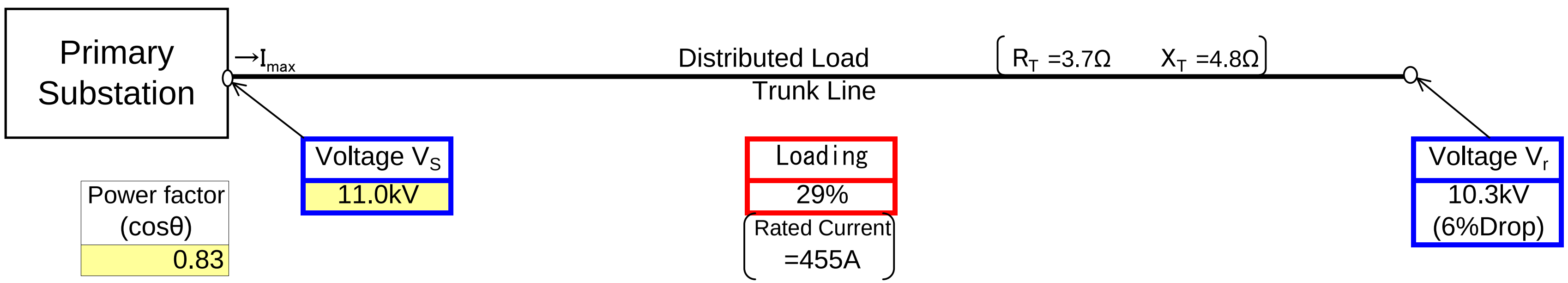
: Input data in colored cells

Type-1

Maximum Current I_{max}	133.0A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	13.5km	
Type of Distributed Load	Equality	



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPEVE
Feeder Name	HAVE

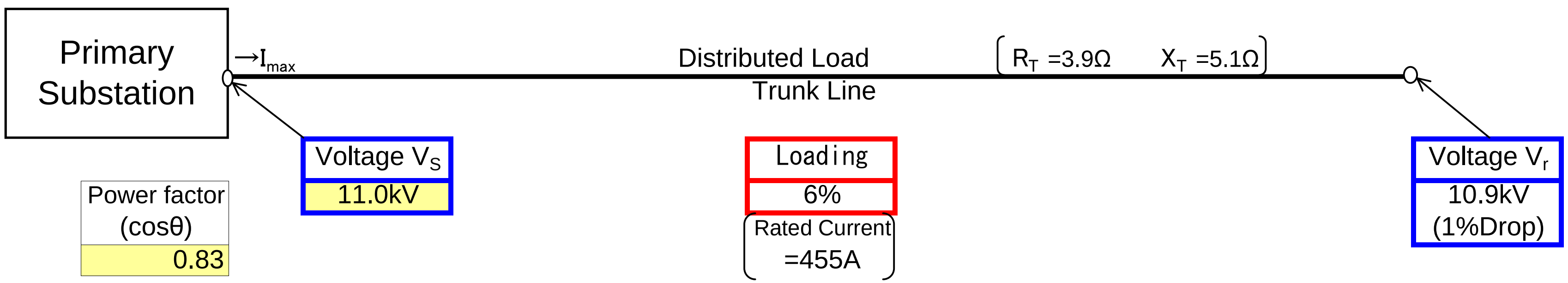
: Input data in colored cells

Type-1

Maximum Current I_{max}	28.0A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	14.4km	
Type of Distributed Load	Equality	



Power factor (cosθ)	0.83

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s : Supply Voltage
V_r : Received Voltage
I_{max} : Maximum Current
R_T : Resistance
X_T : Reactance
cosθ : Power Factor
f_T : Dispersal Load Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPEVE
Feeder Name	KPEVE TOWNSHIP

: Input data in colored cells

Type-2

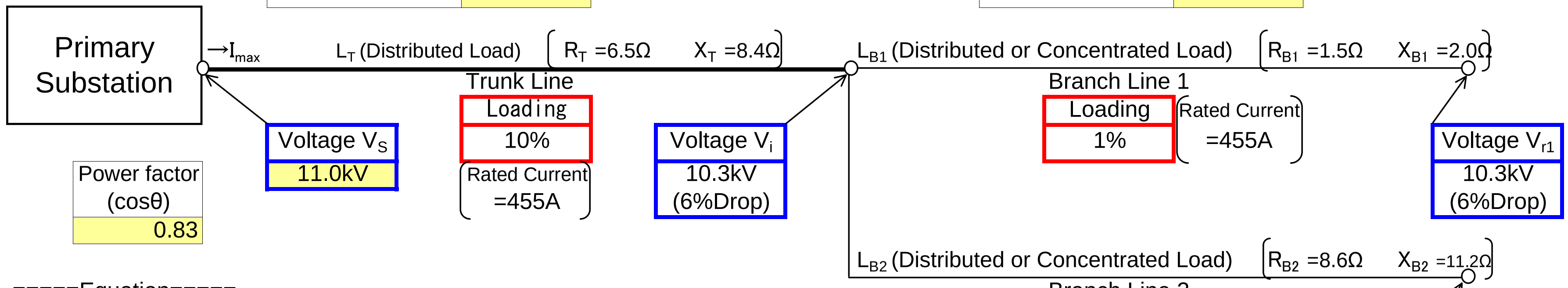
<Trank Line>

Load L_T	11A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	23.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	1050kVA	

<Branch Line 1>

Load L_{B1}	5A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	5.5km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	450kVA	

Maximum Current I_{max}	44.0A
Power factor (cosθ)	0.83



<Branch Line 2>

Load L_{B2}	29A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	31.3km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	2765kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor

V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPEVE
Feeder Name	NEW HAVE FDR

: Input data in colored cells

Type-2

<Trank Line>

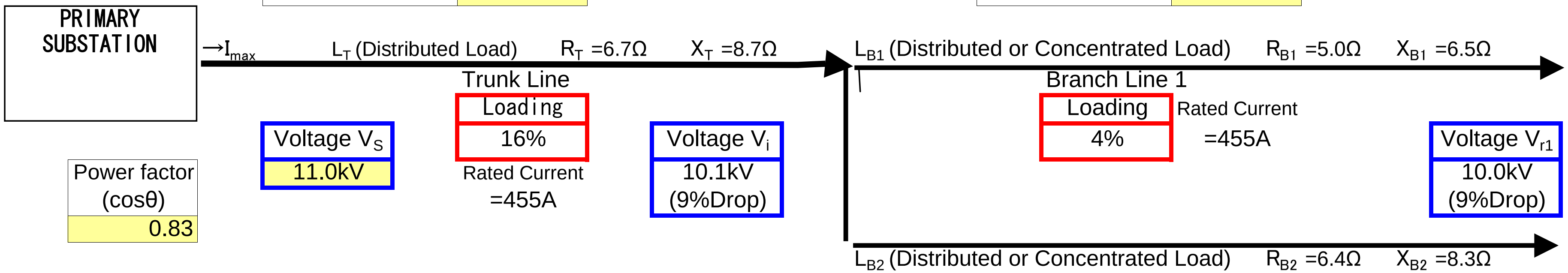
Load L_T	37A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	24.4km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	1650kVA	

<Branch Line 1>

Load L_{B1}	20A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	18.2km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	900kVA	

Maximum Current I_{max}: 71.0A

Power factor (cosθ): 0.83



<Branch Line 2>

Load L_{B2}	14A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	23.3km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	650kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage | I_{max} : Maximum Current | R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage | L_T : Load (Trunk line) | X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage | L_{B1} : Load (Branch Line 1) | cosθ : Power Factor

V_{r2} : Received Voltage | L_{B2} : Load (Branch Line 2) | f_T, f_{B1}, f_{B2} : Dispersal Load Factor | CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPEVE
Feeder Name	TSITO-AMEDZOPE

: Input data in colored cells

Type-3

Maximum Current I_{max}
83.0A

Power factor (cosθ)
0.83

<Trank Line 1>

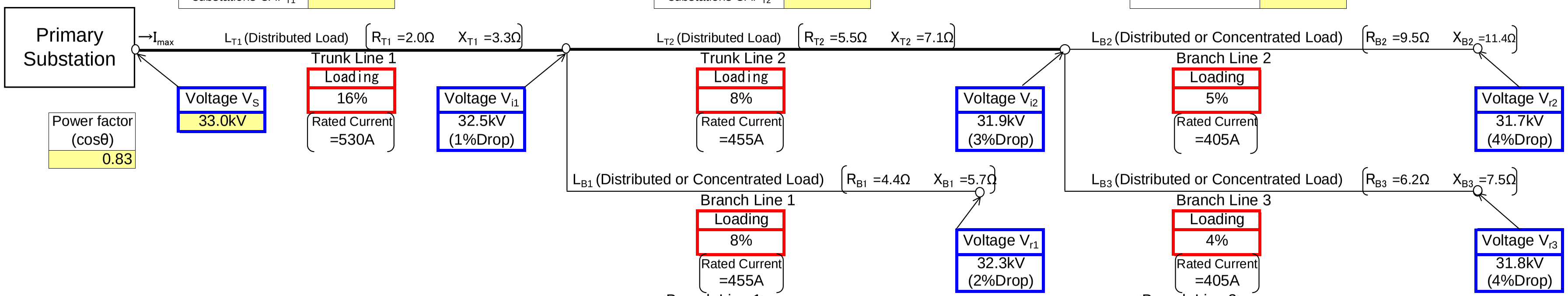
Load L_{T1}	2A	
Line Type	AAC150mm2	No.6
Line Legth Len_{T1}	9.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	200kVA	

<Trank Line 2>

Load L_{T2}	9A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	20.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	700kVA	

<Branch Line 2>

Load L_{B2}	20A	
Line Type	AAC100mm2	No.8
Line Length Len_{B1}	31.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1600kVA	



<Branch Line 1>

Load L_{B1}	36A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	15.9km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	2900kVA	

<Branch Line 3>

Load L_{B3}	17A	
Line Type	AAC100mm2	No.8
Line Length Len_{B3}	20.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	1350kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

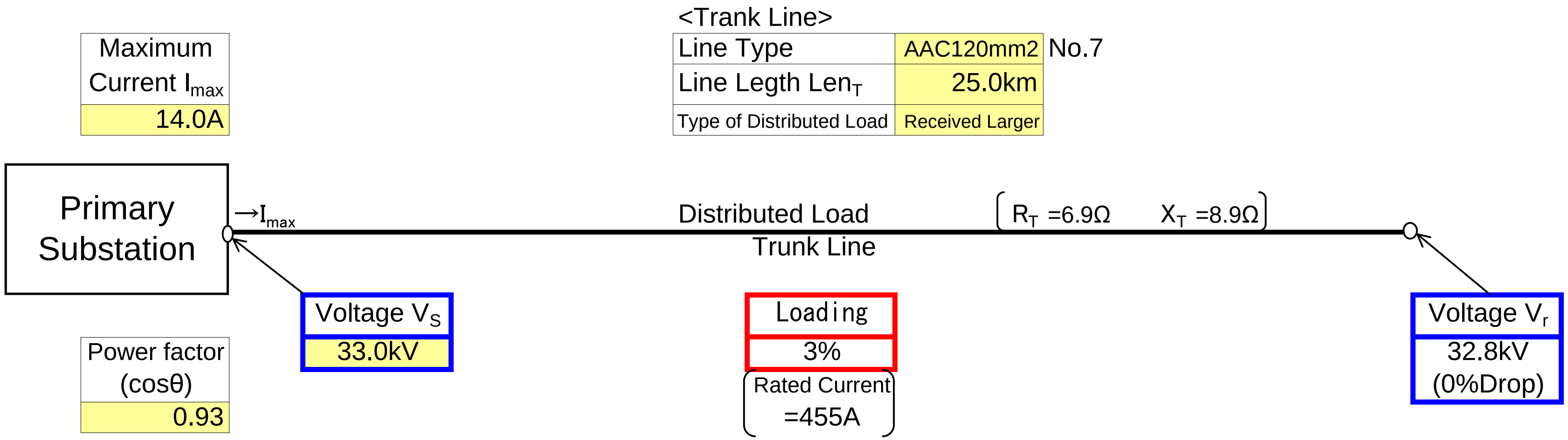
V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	SOGAKOPE
Feeder Name	ADIDOME

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	SOGAKOPE
Feeder Name	SOGA-AKATSI

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	28A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	22.5km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_T	1315kVA	

<Branch Line 1>

Load L_{B1}	36A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	36.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1700kVA	

Maximum Current I_{max}
172.0A

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =6.2Ω X_T =8.0Ω)

Trunk Line

Loading
38%

(Rated Current =455A)

Voltage V_S
34.0kV

Voltage V_i
31.7kV (7%Drop)

Power factor (cosθ)
0.93

L_{B1} (Distributed or Concentrated Load) (R_{B1} =9.9Ω X_{B1} =12.8Ω)

Branch Line 1

Loading
8%

(Rated Current =455A)

Voltage V_{r1}
31.3kV (8%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =6.9Ω X_{B2} =8.9Ω)

Branch Line 2

Loading
24%

(Rated Current =455A)

Voltage V_{r2}
30.8kV (9%Drop)

<Branch Line 2>

Load L_{B2}	107A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	25.0km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	5000kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	SOGAKOPE
Feeder Name	SOGA-AKATSI

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	28A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	22.5km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	1315kVA	

<Trank Line 2>

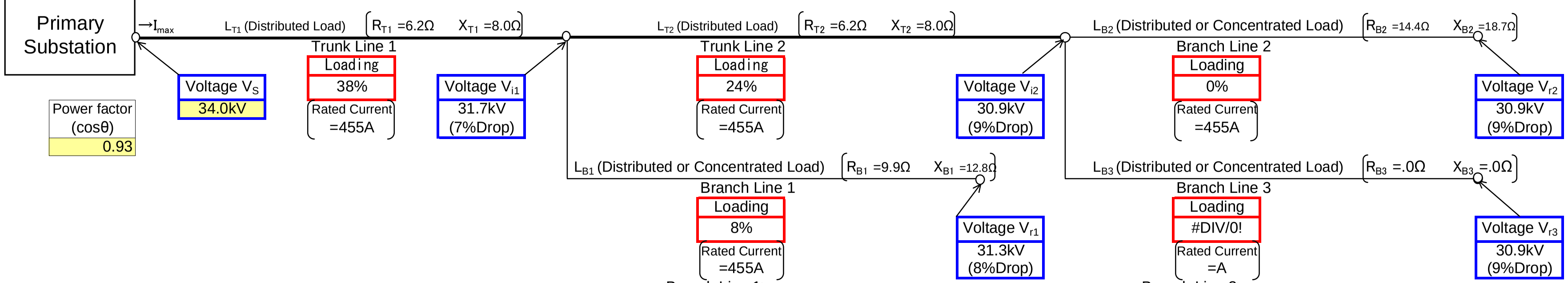
Load L_{T2}	107A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	22.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	5000kVA	

<Branch Line 2>

Load L_{B2}	A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	52.5km	
Type of Distributed Load	Middle Smaller	
Total Transformer Capacity of secondary substations CAP_{B2}		

Maximum Current I_{max}
172.0A

Power factor (cosθ)
0.93



<Branch Line 1>

Load L_{B1}	36A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	36.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1700kVA	

<Branch Line 3>

Load L_{B3}	A	
Line Type	None	No.33
Line Length Len_{B3}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B3}		

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

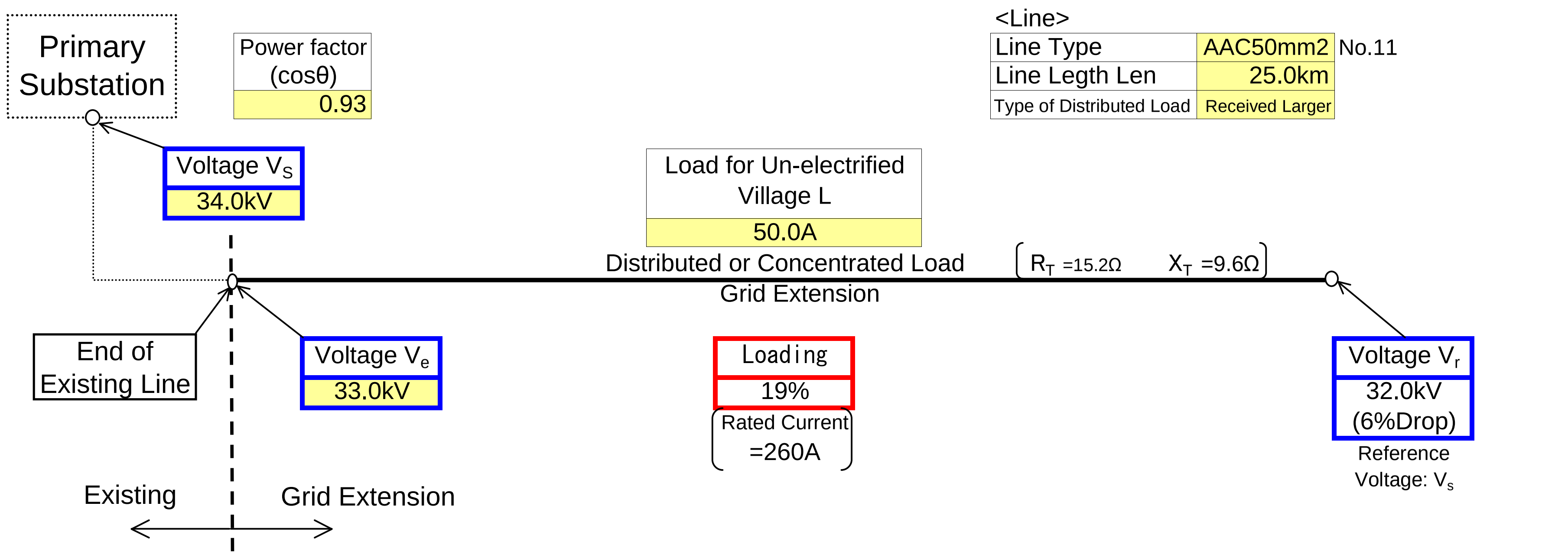
$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step B *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	SOGAKOPE
Feeder Name	ADIDOME

: Input data in colored cells



=====Equation=====

V_r = Ve - 1.732･L(Rcos θ + Xsin θ)･f

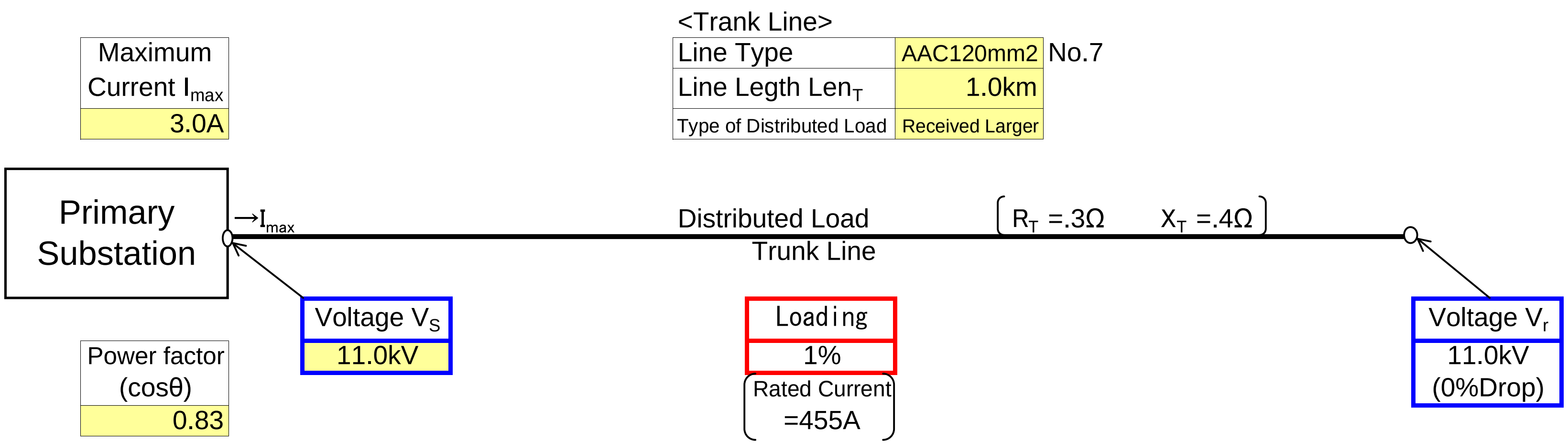
V_s	: Supply Voltage	L	: Load for Un-electrified Village	f	: Dispersal Load Factor
V_e	: Voltage at the end of Existing Line	R	: Resistance		
		X	: Reactance		
V_r	: Received Voltage	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	TSITO
Feeder Name	ADULT COLLEGE

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Substation Name	ANLOGA
Feeder Name	TOWNSHIP

: Input data in colored cells

Type-2

Maximum Current I_{max}
24.0A

Power factor (cosθ)
0.83

Primary Substation TSITO

<Trank Line>

Load L_T	11A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	1.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	250kVA	

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =.3Ω X_T =.4Ω)

Trunk Line

Loading
5%

(Rated Current =455A)

Voltage V_S
11.0kV

Voltage V_i
11.0kV (0%Drop)

<Branch Line 1>

Load L_{B1}	4A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	1.7km	
Type of Distributed Load	Middle Smaller	
Total Transformer Capacity of secondary substations CAP_{B1}	100kVA	

L_{B1} (Distributed or Concentrated Load) (R_{B1} =.5Ω X_{B1} =.6Ω)

Branch Line 1

Loading
1%

(Rated Current =455A)

Voltage V_{r1}
11.0kV (0%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =.1Ω X_{B2} =.2Ω)

Branch Line 2

Loading
2%

(Rated Current =455A)

Voltage V_{r2}
11.0kV (0%Drop)

<Branch Line 2>

Load L_{B2}	9A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	.5km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	200kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor

V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Substation Name	TSITO
Feeder Name	PEKI

: Input data in colored cells

Type-3

Maximum Current I_{max}
70.0A

Power factor ($\cos\theta$)
0.83

<Trank Line 1>

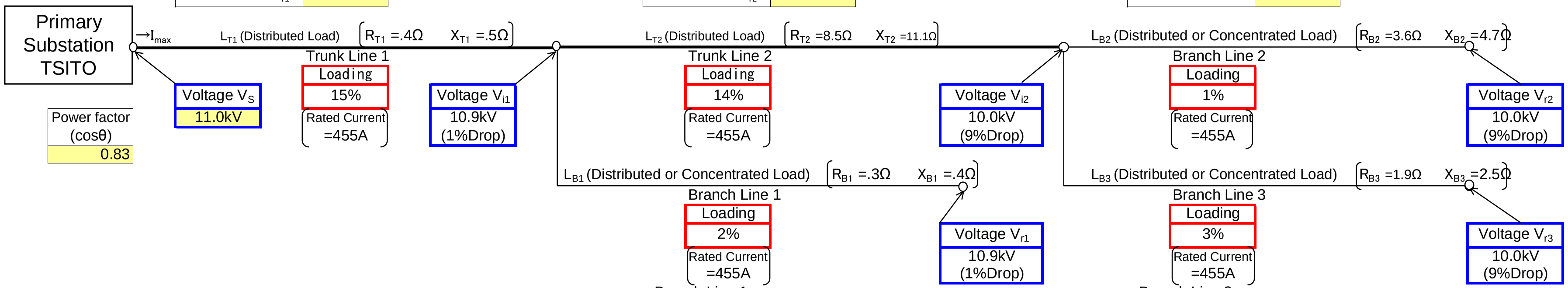
Load L_{T1}	A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	1.3km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	kVA	

<Trank Line 2>

Load L_{T2}	44A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	31.1km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	2065kVA	

<Branch Line 2>

Load L_{B2}	5A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	13.2km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	225kVA	



<Branch Line 1>

Load L_{B1}	7A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	1.1km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	350kVA	

<Branch Line 3>

Load L_{B3}	14A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	7.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	675kVA	

=====Equation=====

$V_{i1} = V_s - 1.732\cdot(R_{T1}\cos\theta + X_{T1}\sin\theta)\cdot(L_{T1}\cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732\cdot(R_{T2}\cos\theta + X_{T2}\sin\theta)\cdot(L_{T2}\cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732\cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta)\cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732\cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta)\cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732\cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta)\cdot f_{B3}$

$L_{T1} = I_{max}\cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max}\cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ANLOGA
Feeder Name	WIND FARM

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	30A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	40.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	4000kVA	

<Branch Line 1>

Load L_{B1}	111A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	12.5km	
Type of Distributed Load	Middle Smaller	
Total Transformer Capacity of secondary substations CAP_{B1}	15000kVA	

Maximum Current I_{max}
260.0A

Power factor (cosθ)
0.94

Primary Substation ANLOGA

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =11.0Ω X_T =14.3Ω)

Trunk Line

Loading
57%

(Rated Current =455A)

Voltage V_S
34.0kV

Voltage V_i
27.5kV (19%Drop)

DABALA

L_{B1} (Distributed or Concentrated Load) (R_{B1} =3.4Ω X_{B1} =4.5Ω) ***SOGA BSP***

Branch Line 1

Loading
24%

(Rated Current =455A)

Voltage V_{r1}
27.0kV (20%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =17.8Ω X_{B2} =23.2Ω) ***AFLAO BSP***

Branch Line 2

Loading
26%

(Rated Current =455A)

Voltage V_{r2}
24.9kV (27%Drop)

<Branch Line 2>

Load L_{B2}	119A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	65.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	16000kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage I_{max} : Maximum Current R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage L_T : Load (Trunk line) X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage L_{B1} : Load (Branch Line 1) cosθ : Power Factor

V_{r2} : Received Voltage L_{B2} : Load (Branch Line 2) f_T, f_{B1}, f_{B2} : Dispersal Load Factor CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ANLOGA
Feeder Name	WIND FARM

: Input data in colored cells

Type-3

<Trank Line 1>

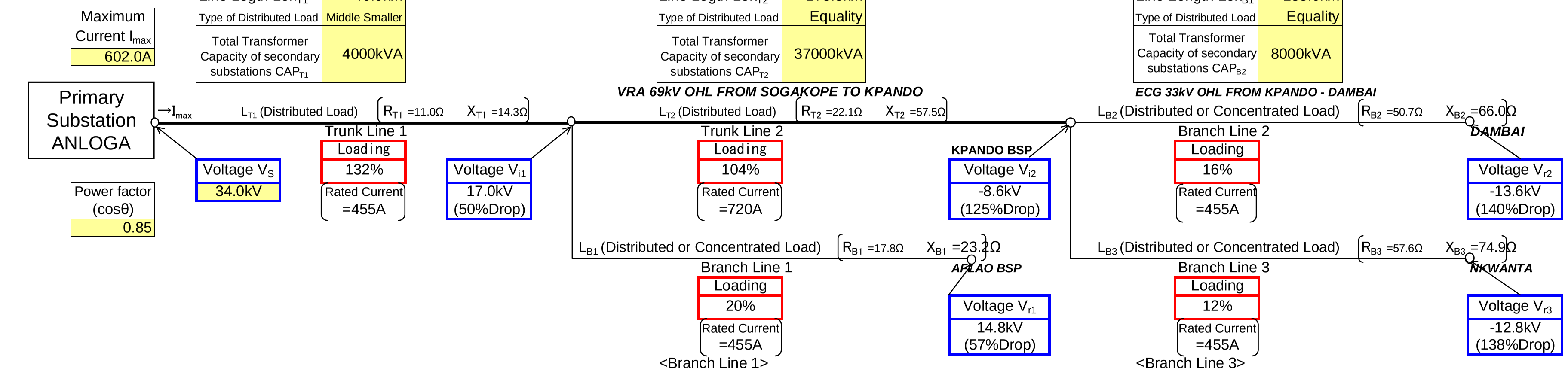
Load L_{T1}	37A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	40.0km	
Type of Distributed Load	Middle Smaller	
Total Transformer Capacity of secondary substations CAP_{T1}	4000kVA	

<Trank Line 2>

Load L_{T2}	343A	
Line Type	AAC240mm2	No.4
Line Legth Len_{T2}	173.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	37000kVA	

<Branch Line 2>

Load L_{B2}	74A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	185.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	8000kVA	



<Branch Line 1>

Load L_{B1}	93A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	65.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	10000kVA	

<Branch Line 3>

Load L_{B3}	56A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	210.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	6000kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPANDO
Feeder Name	NKONYA

: Input data in colored cells

Type-3

Maximum Current I_{max}
31.0A

Power factor (cosθ)
0.93

Primary Substation

→I_{max}

<Trank Line 1>

Load L_{T1}	3A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	56.9km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	1500kVA	

L_{T1} (Distributed Load) R_{T1} =15.6Ω X_{T1} =20.3Ω

Trunk Line 1: Loading 7%, Rated Current =455A

Voltage V_S: 31.1kV

Voltage V_{i1}: 30.0kV (4%Drop)

<Trank Line 2>

Load L_{T2}	3A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	33.4km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	1800kVA	

L_{T2} (Distributed Load) R_{T2} =9.2Ω X_{T2} =11.9Ω

Trunk Line 2: Loading 6%, Rated Current =455A

Voltage V_{i2}: 29.4kV (5%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} =3.8Ω X_{B1} =4.9Ω

Branch Line 1: Loading 0%, Rated Current =455A

Voltage V_{r1}: 30.0kV (4%Drop)

<Branch Line 1>

Load L_{B1}	2A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	13.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	825kVA	

<Branch Line 2>

Load L_{B2}	11A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	101.4km	
Type of Distributed Load	Middle Smaller	
Total Transformer Capacity of secondary substations CAP_{B2}	5700kVA	

L_{B2} (Distributed or Concentrated Load) R_{B2} =27.8Ω X_{B2} =36.2Ω

Branch Line 2: Loading 2%, Rated Current =455A

Voltage V_{r2}: 29.1kV (7%Drop)

L_{B3} (Distributed or Concentrated Load) R_{B3} =36.5Ω X_{B3} =47.5Ω

Branch Line 3: Loading 3%, Rated Current =455A

Voltage V_{r3}: 28.9kV (7%Drop)

<Branch Line 3>

Load L_{B3}	12A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	133.2km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	6550kVA	

=====Equation=====

$V_{i1} = V_{s} - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPANDO
Feeder Name	NKONYA

: Input data in colored cells

Type-2

Maximum Current I_{max}
19.0A

Power factor (cosθ)
0.93

<Trank Line>

Load L_T	9A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	56.9km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	1550kVA	

<Branch Line 1>

Load L_{B1}	5A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	26.3km	
Type of Distributed Load	Middle Smaller	
Total Transformer Capacity of secondary substations CAP_{B1}	960kVA	

→I_{max} L_T (Distributed Load) R_T =15.6Ω X_T =20.3Ω

Voltage V_S: 33.0kV

Trunk Line Loading: 4%, Rated Current =455A

Voltage V_i: 32.4kV (2%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} =7.2Ω X_{B1} =9.4Ω

Branch Line 1 Loading: 1%, Rated Current =455A

Voltage V_{r1}: 32.4kV (2%Drop)

L_{B2} (Distributed or Concentrated Load) R_{B2} =3.8Ω X_{B2} =4.9Ω

Branch Line 2 Loading: 1%, Rated Current =455A

Voltage V_{r2}: 32.4kV (2%Drop)

<Branch Line 2>

Load L_{B2}	5A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	13.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	825kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage; I_{max} : Maximum Current; R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage; L_T : Load (Trunk line); X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage; L_{B1} : Load (Branch Line 1); cosθ : Power Factor

V_{r2} : Received Voltage; L_{B2} : Load (Branch Line 2); f_T, f_{B1}, f_{B2} : Dispersal Load Factor; CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPANDO
Feeder Name	HOHOE

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	3A
Line Type	AAC150mm2 No.6
Line Legth Len_T	13.0km
Type of Distributed Load	Received Larger
Total Transformer Capacity of secondary substations CAP_T	100kVA

<Branch Line 1>

Load L_{B1}	87A
Line Type	AAC150mm2 No.6
Line Length Len_{B1}	28.0km
Type of Distributed Load	Received Larger
Total Transformer Capacity of secondary substations CAP_{B1}	3250kVA

Maximum Current I_{max}	134.0A
Power factor (cosθ)	0.93

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) R_T =2.7Ω X_T =4.5Ω

Trunk Line

Loading	25%

Rated Current =530A

Voltage V_S	33.0kV

Voltage V_i	32.0kV (3%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} =5.7Ω X_{B1} =9.8Ω

Branch Line 1

Loading	16%

Rated Current =530A

Voltage V_{r1}	31.2kV (6%Drop)

L_{B2} (Distributed or Concentrated Load) R_{B2} =8.6Ω X_{B2} =11.2Ω

Branch Line 2

Loading	10%

Rated Current =455A

Voltage V_{r2}	31.6kV (4%Drop)

<Branch Line 2>

Load L_{B2}	44A
Line Type	AAC120mm2 No.7
Line Length Len_{B1}	31.3km
Type of Distributed Load	Equality
Total Transformer Capacity of secondary substations CAP_{B2}	1650kVA

=====Equation=====

$V_i = V_{s} - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage
V_i : Interim Voltage
V_{r1} : Received Voltage
V_{r2} : Received Voltage

I_{max} : Maximum Current
L_T : Load (Trunk line)
L_{B1} : Load (Branch Line 1)
L_{B2} : Load (Branch Line 2)

R_T, R_{B1}, R_{B2} : Resistance
X_T, X_{B1}, X_{B2} : Reactance
cosθ : Power Factor
f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPANDO
Feeder Name	HOHOE-JASIKAN

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	1.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	50kVA	

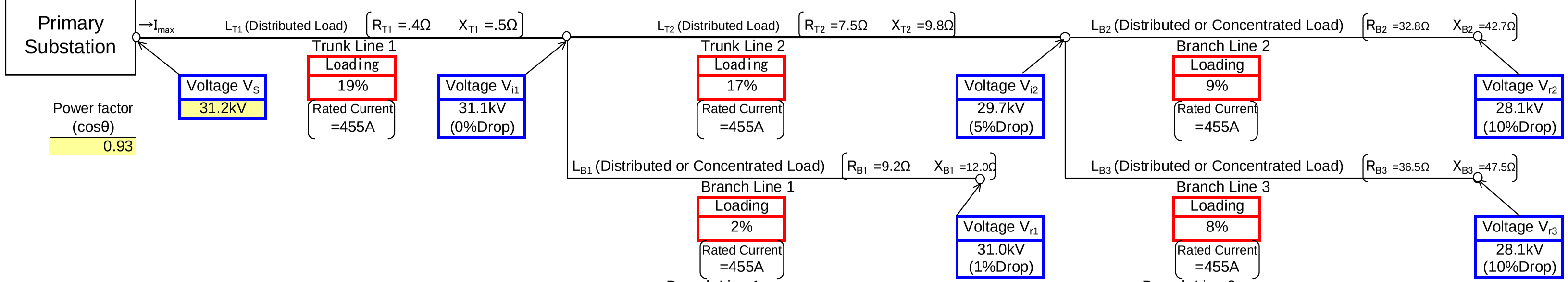
<Trank Line 2>

Load L_{T2}	3A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	27.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	450kVA	

<Branch Line 2>

Load L_{B2}	39A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	119.7km	
Type of Distributed Load	Middle Smaller	
Total Transformer Capacity of secondary substations CAP_{B2}	5700kVA	

Maximum Current I_{max}
87.0A



Power factor (cosθ)
0.93

<Branch Line 1>

Load L_{B1}	8A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	33.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1175kVA	

<Branch Line 3>

Load L_{B3}	37A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	133.2km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	5350kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis

- Volta current -

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	AFLAO
Feeder Name	AFLAO

: Input data in colored cells

Type-2

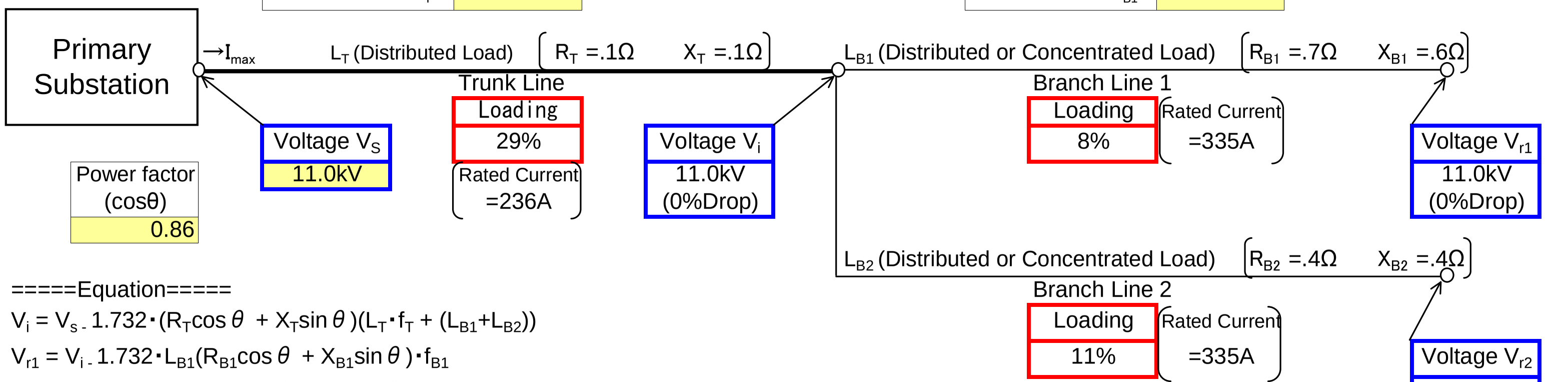
Maximum Current I_{max}
69.0A

<Trank Line>

Load L_T	4A	
Line Type	Cu35mm2	No.15
Line Legth Len_T	.2km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	315kVA	

<Branch Line 1>

Load L_{B1}	28A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	4.4km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	2130kVA	



Power factor (cosθ)
0.86

<Branch Line 2>

Load L_{B2}	37A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	2.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	2760kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage; I_{max} : Maximum Current; R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage; L_T : Load (Trunk line); X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage; L_{B1} : Load (Branch Line 1); cosθ : Power Factor

V_{r2} : Received Voltage; L_{B2} : Load (Branch Line 2); f_T, f_{B1}, f_{B2} : Dispersal Load Factor CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	AFLAO
Feeder Name	DENU

: Input data in colored cells

Type-2

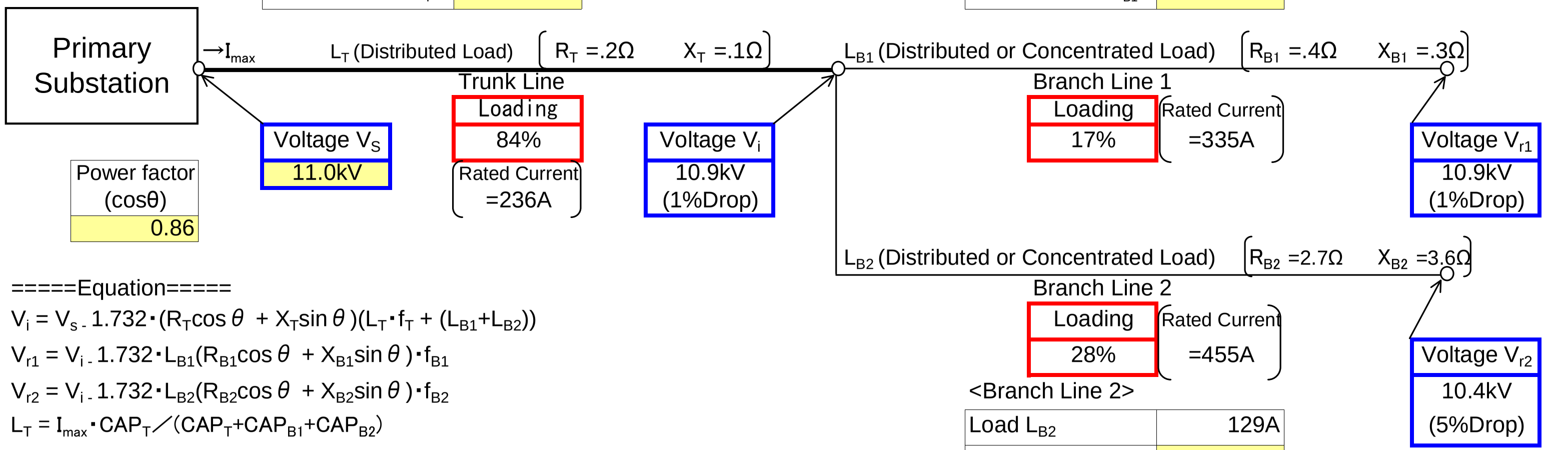
<Trank Line>

Load L_T	14A
Line Type	Cu35mm2 No.15
Line Legth Len_T	.3km
Type of Distributed Load	Received Larger
Total Transformer Capacity of secondary substations CAP_T	315kVA

<Branch Line 1>

Load L_{B1}	55A
Line Type	185ALXPLE(11kV) No.24
Line Length Len_{B1}	2.7km
Type of Distributed Load	Equality
Total Transformer Capacity of secondary substations CAP_{B1}	1260kVA

Maximum Current I_{max}	198.0A
Power factor (cosθ)	0.86



<Branch Line 2>

Load L_{B2}	129A
Line Type	AAC120mm2 No.7
Line Length Len_{B1}	10.0km
Type of Distributed Load	Equality
Total Transformer Capacity of secondary substations CAP_{B2}	2930kVA

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage I_{max} : Maximum Current R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage L_T : Load (Trunk line) X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage L_{B1} : Load (Branch Line 1) cosθ : Power Factor
V_{r2} : Received Voltage L_{B2} : Load (Branch Line 2) f_T, f_{B1}, f_{B2} : Dispersal Load Factor $CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	AFLAO
Feeder Name	ABOR

: Input data in colored cells

Type-3

Maximum Current I_{max}	
	83.0A

Power factor (cosθ)	
	0.86

Primary Substation

→I_{max}

Voltage V_S 33.0kV

<Trank Line 1>

Load L_{T1}	19A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	22.4km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	2050kVA	

L_{T1} (Distributed Load) (R_{T1} =6.1Ω X_{T1} =8.0Ω)

Trunk Line 1: Loading 18%, Rated Current =455A

Voltage V_{i1} 31.8kV (4%Drop)

<Trank Line 2>

Load L_{T2}	9A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	25.8km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	1000kVA	

L_{T2} (Distributed Load) (R_{T2} =7.1Ω X_{T2} =9.2Ω)

Trunk Line 2: Loading 12%, Rated Current =455A

Voltage V_{i2} 30.9kV (6%Drop)

<Branch Line 2>

Load L_{B2}	24A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	70.3km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	2600kVA	

L_{B2} (Distributed or Concentrated Load) (R_{B2} =19.3Ω X_{B2} =25.1Ω)

Branch Line 2: Loading 5%, Rated Current =455A

Voltage V_{r2} 30.5kV (8%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =3.7Ω X_{B1} =4.9Ω)

Branch Line 1: Loading 2%, Rated Current =455A

Voltage V_{r1} 31.8kV (4%Drop)

<Branch Line 1>

Load L_{B1}	10A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	13.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1100kVA	

L_{B3} (Distributed or Concentrated Load) (R_{B3} =7.2Ω X_{B3} =9.3Ω)

Branch Line 3: Loading 4%, Rated Current =455A

Voltage V_{r3} 30.8kV (7%Drop)

<Branch Line 3>

Load L_{B3}	20A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	26.2km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{B3}	2125kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

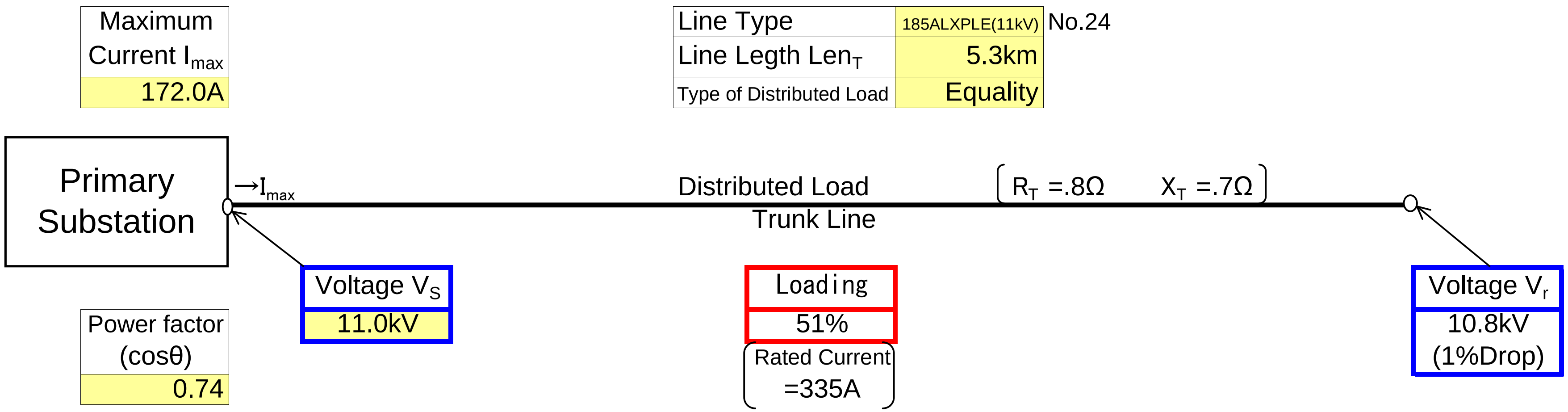
Substation Name	HO
Feeder Name	CENTRAL FEEDER

: Input data in colored cells

Type-1

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	5.3km	
Type of Distributed Load	Equality	



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	HO
Feeder Name	SOKODE

: Input data in colored cells

Type-2

Maximum Current I_{max}	138.0A

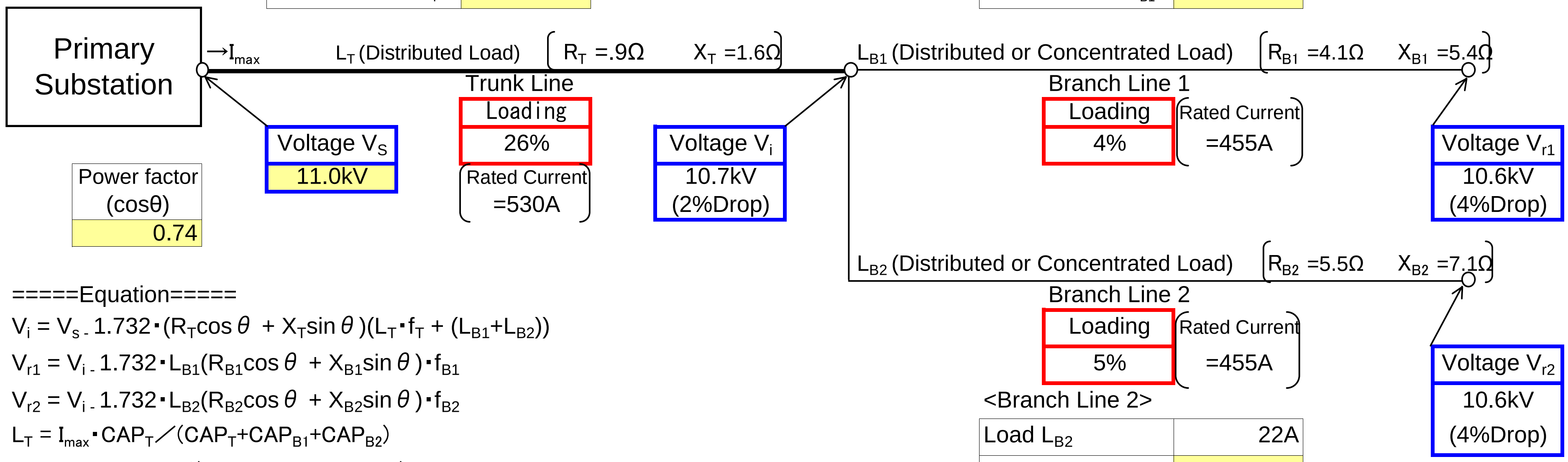
Power factor (cosθ)	0.74

<Trank Line>

Load L_T	96A	
Line Type	AAC150mm2	No.6
Line Legth Len_T	4.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	5390kVA	

<Branch Line 1>

Load L_{B1}	20A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	15.0km	
Type of Distributed Load	Middle Smaller	
Total Transformer Capacity of secondary substations CAP_{B1}	1150kVA	



<Branch Line 2>

Load L_{B2}	22A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	20.0km	
Type of Distributed Load	Middle Smaller	
Total Transformer Capacity of secondary substations CAP_{B2}	1240kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

$CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	HO
Feeder Name	TANYIGBE

: Input data in colored cells

Type-3

Maximum Current I_{max}: 185.0A

Power factor ($\cos\theta$): 0.74

<Trank Line 1>

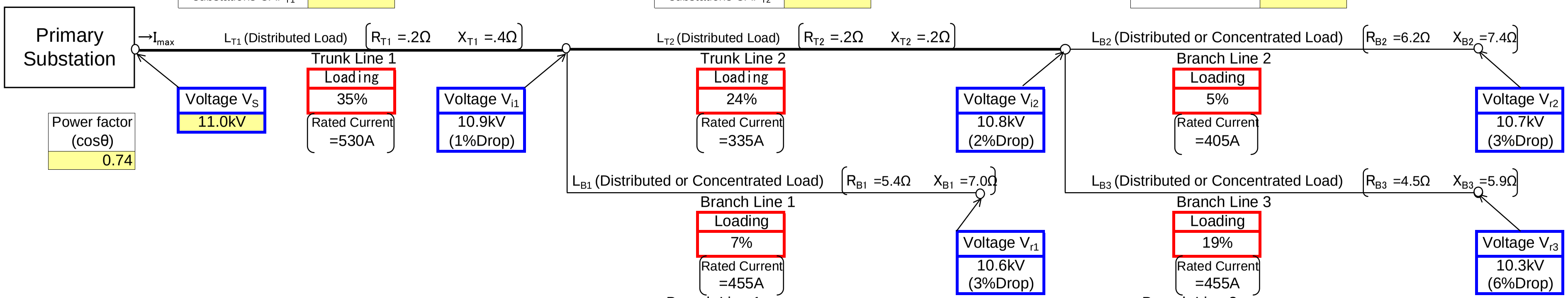
Load L_{T1}	26A	
Line Type	AAC150mm2	No.6
Line Legth Len_{T1}	1.1km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	1395kVA	

<Trank Line 2>

Load L_{T2}	21A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T2}	1.2km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	1130kVA	

<Branch Line 2>

Load L_{B2}	19A	
Line Type	AAC100mm2	No.8
Line Length Len_{B1}	20.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1000kVA	



<Branch Line 1>

Load L_{B1}	33A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	19.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1750kVA	

<Branch Line 3>

Load L_{B3}	85A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	16.5km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{B3}	4500kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	$\cos\theta$	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	HOHOE
Feeder Name	ST FRANCIS

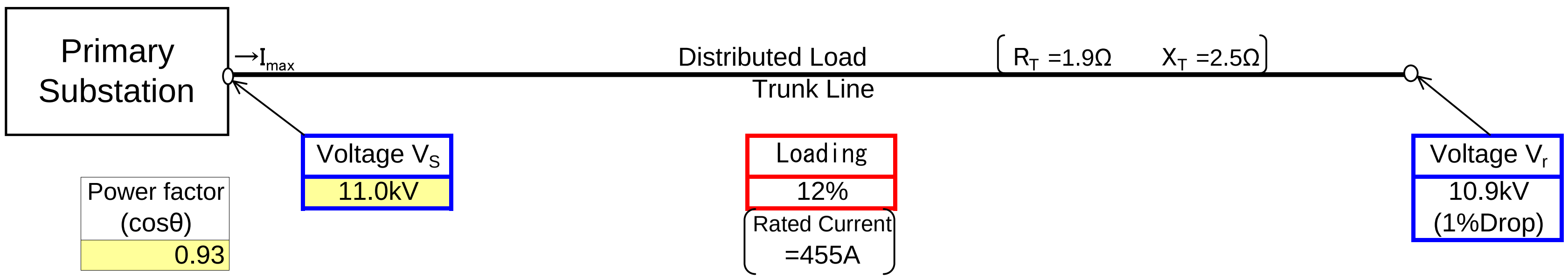
: Input data in colored cells

Type-1

<Trank Line>		
Line Type	AAC120mm2	No.7
Line Legth Len_T	7.1km	
Type of Distributed Load	Equality	

Maximum Current I_{max}
54.0A

Power factor (cosθ)
0.93



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	HOHOE
Feeder Name	HOPITAL

: Input data in colored cells

Type-2

Maximum Current I_{max}: 134.0A

Power factor ($\cos\theta$): 0.93

<Trank Line>

Load L_T	11A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	.1km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_T	200kVA	

<Branch Line 1>

Load L_{B1}	22A	
Line Type	95ALXPLE(11kV)	No.21
Line Length Len_{B1}	.5km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	415kVA	

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =.0Ω X_T =.0Ω)

Trunk Line — Loading 29% (Rated Current =455A)

Voltage V_S: 11.0kV

Voltage V_i: 11.0kV (0%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =.1Ω X_{B1} =.1Ω)

Branch Line 1 — Loading 10% (Rated Current =225A)

Voltage V_{r1}: 11.0kV (0%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =.8Ω X_{B2} =1.0Ω)

Branch Line 2 — Loading 22% (Rated Current =455A)

Voltage V_{r2}: 10.9kV (1%Drop)

<Branch Line 2>

Load L_{B2}	101A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	2.9km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	1915kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

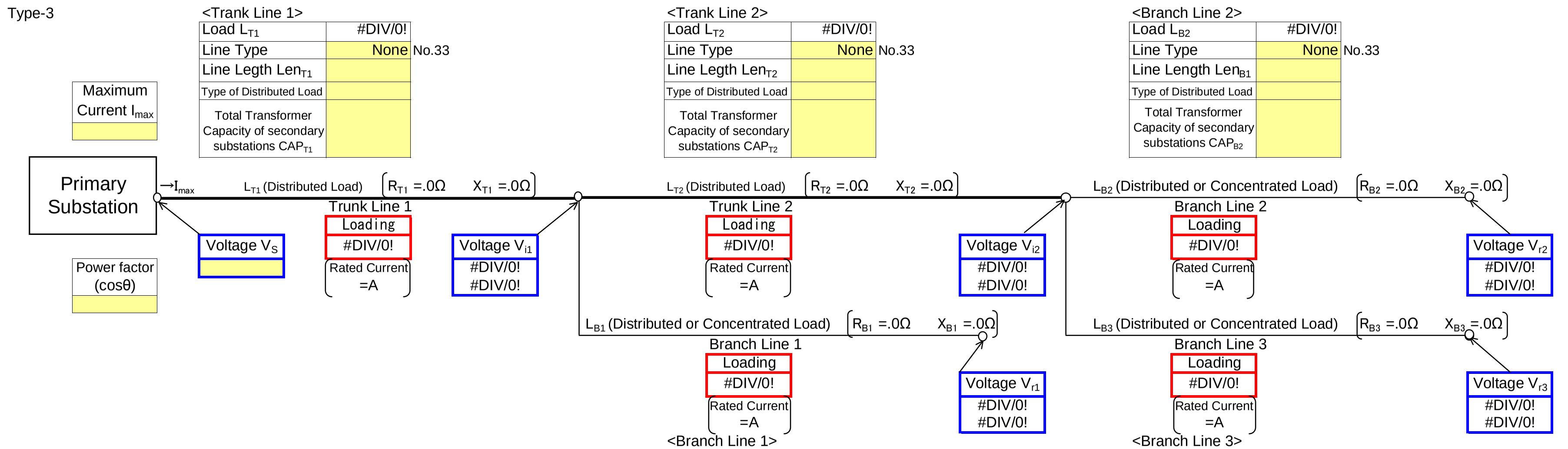
$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$\cos\theta$: Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	
Feeder Name	

: Input data in colored cells



<Branch Line 1>

Load L_{B1}	#DIV/0!	
Line Type	None	No.33
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		

<Branch Line 3>

Load L_{B3}	#DIV/0!	
Line Type	None	No.33
Line Length Len_{B3}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B3}		

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

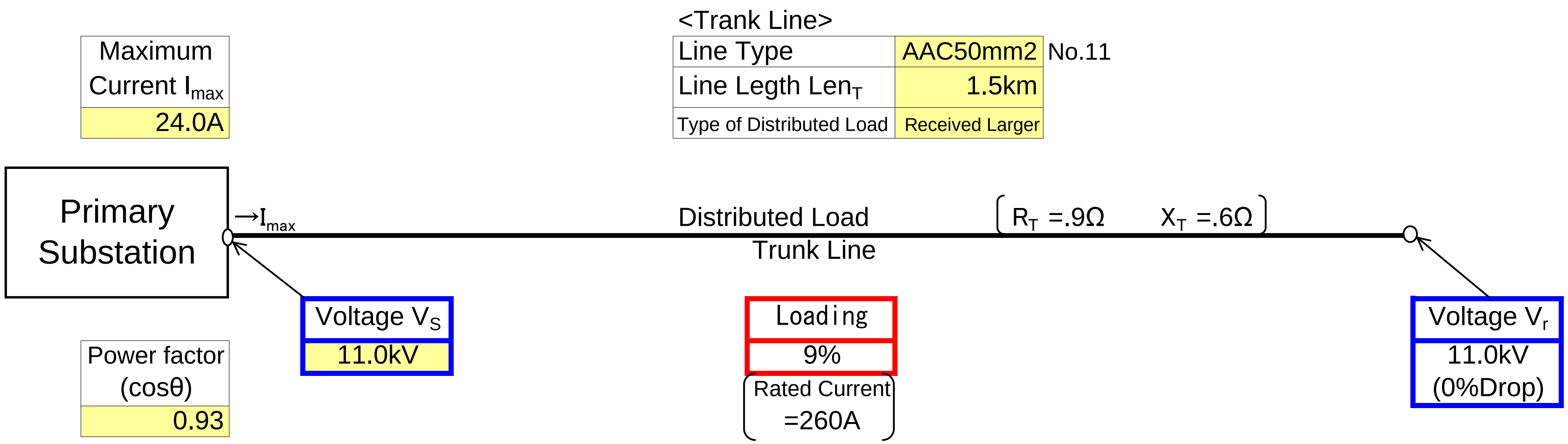
V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ANLOGA
Feeder Name	ANTECH

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s : Supply Voltage	R_T : Resistance	f_T : Dispersal Load Factor
V_r : Received Voltage	X_T : Reactance	
I_{max} : Maximum Current	cosθ : Power Factor	

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ANLOGA
Feeder Name	KETA

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	14A	
Line Type	Cu35mm2	No.15
Line Legth Len_T	33.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	3815kVA	

<Branch Line 1>

Load L_{B1}	6A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	.3km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	1600kVA	

Maximum Current I_{max}	24.0A

Power factor (cosθ)	0.93

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) R_T =23.8Ω X_T =15.8Ω

Trunk Line

Loading	10%
Rated Current	=236A

Voltage V_S	11.0kV

Voltage V_i	10.2kV (8%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} =.0Ω X_{B1} =.0Ω

Branch Line 1

Loading	2%
Rated Current	=335A

Voltage V_{r1}	10.2kV (8%Drop)

L_{B2} (Distributed or Concentrated Load) R_{B2} =2.2Ω X_{B2} =.9Ω

Branch Line 2

Loading	3%
Rated Current	=137A

Voltage V_{r2}	10.2kV (8%Drop)

<Branch Line 2>

Load L_{B2}	4A	
Line Type	Cu16mm2	No.16
Line Length Len_{B1}	1.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1215kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor

V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — $CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	KPANDO
Feeder Name	KPANDO TOWN

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	9A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	1.4km	
Type of Distributed Load	Middle Smaller	
Total Transformer Capacity of secondary substations CAP_T	400kVA	

<Branch Line 1>

Load L_{B1}	34A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	6.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1580kVA	

Maximum Current I_{max}
76.0A

Power factor (cosθ)
0.93

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =.4Ω X_T =.5Ω)

Trunk Line

Loading
17%

(Rated Current =455A)

Voltage V_S
11.0kV

Voltage V_i
10.9kV (1%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =1.6Ω X_{B1} =2.1Ω)

Branch Line 1

Loading
8%

(Rated Current =455A)

Voltage V_{r1}
10.9kV (1%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =.7Ω X_{B2} =.9Ω)

Branch Line 2

Loading
7%

(Rated Current =455A)

Voltage V_{r2}
10.9kV (1%Drop)

<Branch Line 2>

Load L_{B2}	33A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	2.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1515kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage　I_{max} : Maximum Current　R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage　L_T : Load (Trunk line)　X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage　L_{B1} : Load (Branch Line 1)　cosθ : Power Factor

V_{r2} : Received Voltage　L_{B2} : Load (Branch Line 2)　f_T, f_{B1}, f_{B2} : Dispersal Load Factor　$CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPANDO
Feeder Name	SOVIE-VAKPO

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	13A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	20.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	850kVA	

<Trank Line 2>

Load L_{T2}	2A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	3.6km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	100kVA	

<Branch Line 2>

Load L_{B2}	24A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	21.3km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1525kVA	

Maximum Current I_{max}	61.0A
Power factor (cosθ)	0.93

Primary Substation

$\rightarrow I_{max}$

Voltage V_S: 11.0kV

L_{T1} (Distributed Load) (R_{T1} =5.7Ω X_{T1} =7.4Ω)
Trunk Line 1 — Loading 13% (Rated Current =455A)

Voltage V_{i1}: 10.2kV (7%Drop)

L_{T2} (Distributed Load) (R_{T2} =1.0Ω X_{T2} =1.3Ω)
Trunk Line 2 — Loading 8% (Rated Current =455A)

Voltage V_{i2}: 10.2kV (8%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =5.8Ω X_{B2} =7.6Ω)
Branch Line 2 — Loading 5% (Rated Current =455A)

Voltage V_{r2}: 10.0kV (9%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =3.9Ω X_{B1} =5.0Ω)
Branch Line 1 — Loading 3% (Rated Current =455A)

Voltage V_{r1}: 10.2kV (7%Drop)

L_{B3} (Distributed or Concentrated Load) (R_{B3} =2.7Ω X_{B3} =3.5Ω)
Branch Line 3 — Loading 2% (Rated Current =455A)

Voltage V_{r3}: 10.1kV (8%Drop)

<Branch Line 1>

Load L_{B1}	13A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	14.1km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	850kVA	

<Branch Line 3>

Load L_{B3}	9A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	9.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	550kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

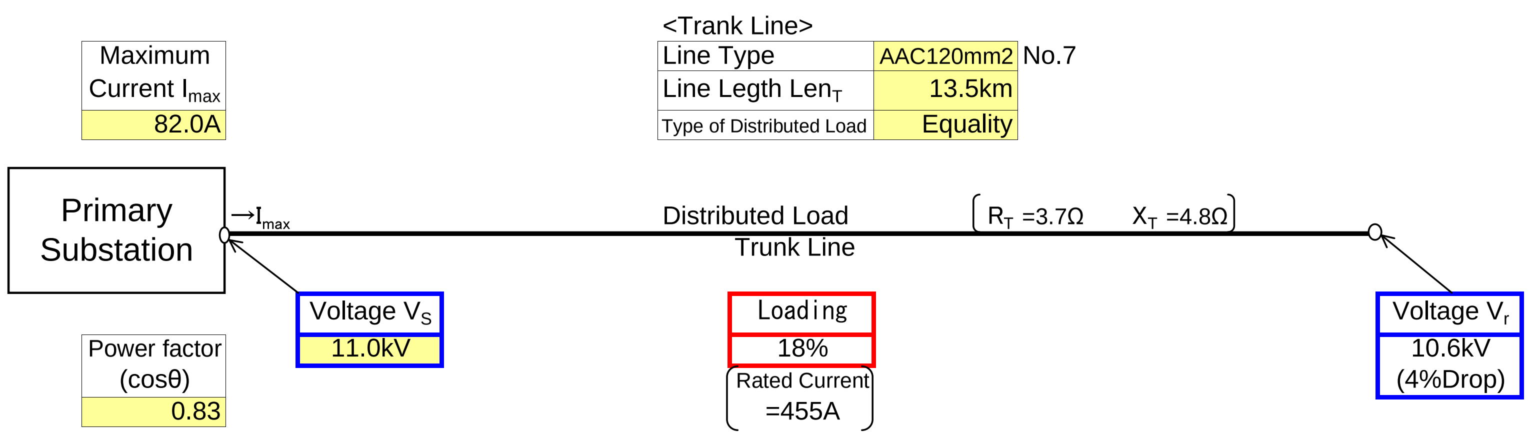
V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPEVE
Feeder Name	GWCL

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPEVE
Feeder Name	HAVE

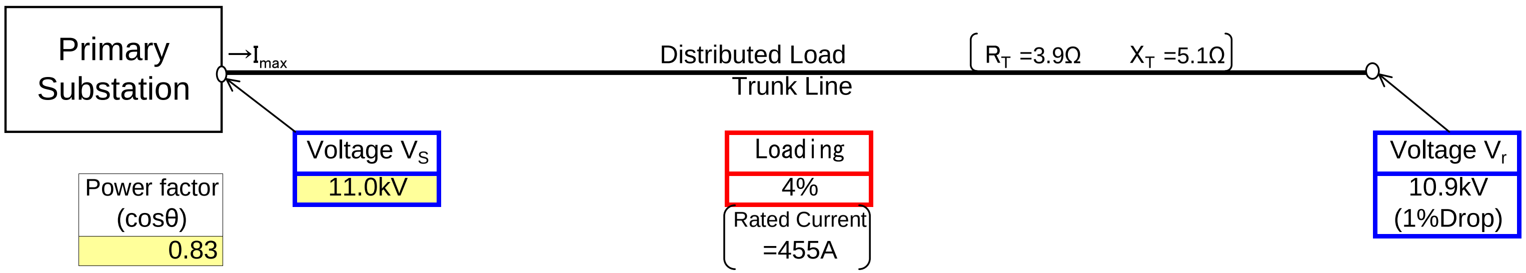
: Input data in colored cells

Type-1

Maximum Current I_{max}
17.0A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	14.4km	
Type of Distributed Load	Equality	



Power factor (cosθ)
0.83

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPEVE
Feeder Name	KPEVE TOWNSHIP

: Input data in colored cells

Type-2

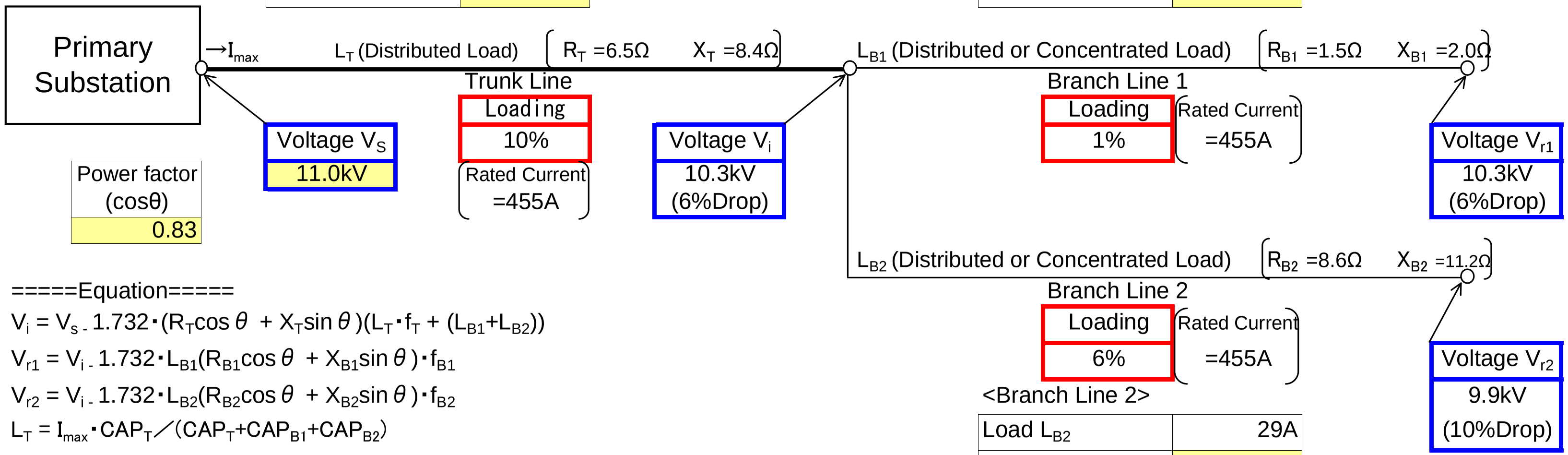
<Trank Line>

Load L_T	11A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	23.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	1050kVA	

Maximum Current I_{max}	44.0A
Power factor (cosθ)	0.83

<Branch Line 1>

Load L_{B1}	5A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	5.5km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	450kVA	



<Branch Line 2>

Load L_{B2}	29A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	31.3km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	2765kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_S : Supply Voltage; I_{max} : Maximum Current; R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage; L_T : Load (Trunk line); X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage; L_{B1} : Load (Branch Line 1); cosθ : Power Factor

V_{r2} : Received Voltage; L_{B2} : Load (Branch Line 2); f_T, f_{B1}, f_{B2} : Dispersal Load Factor; CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPEVE
Feeder Name	NEW HAVE FDR

: Input data in colored cells

Type-2

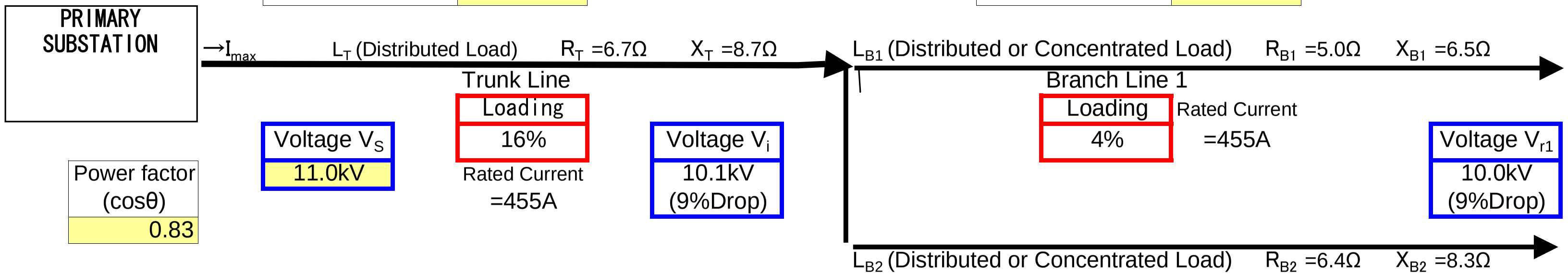
<Trank Line>

Load L_T	37A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	24.4km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	1650kVA	

<Branch Line 1>

Load L_{B1}	20A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	18.2km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	900kVA	

Maximum Current I_{max}
71.0A



Power factor (cosθ)
0.83

Branch Line 2

Loading
3%

Rated Current =455A

Voltage V_{r2}
9.9kV
(10%Drop)

<Branch Line 2>

Load L_{B2}	14A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	23.3km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	650kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage; I_{max} : Maximum Current; R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage; L_T : Load (Trunk line); X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage; L_{B1} : Load (Branch Line 1); cosθ : Power Factor

V_{r2} : Received Voltage; L_{B2} : Load (Branch Line 2); f_T, f_{B1}, f_{B2} : Dispersal Load Factor; $CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPEVE
Feeder Name	TSITO-AMEDZOPE

: Input data in colored cells

Type-3

Maximum Current I_{max}
50.0A

Power factor (cosθ)
0.83

Primary Substation

<Trank Line 1>

Load L_{T1}	1A	
Line Type	AAC150mm2	No.6
Line Legth Len_{T1}	9.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	200kVA	

<Trank Line 2>

Load L_{T2}	5A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	20.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	700kVA	

<Branch Line 2>

Load L_{B2}	12A	
Line Type	AAC100mm2	No.8
Line Length Len_{B1}	31.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1600kVA	

→I_{max}

L_{T1} (Distributed Load) (R_{T1} =2.0Ω X_{T1} =3.3Ω)

Trunk Line 1: Loading 9%, (Rated Current =530A)

Voltage V_S: 33.0kV

Voltage V_{i1}: 32.7kV (1%Drop)

L_{T2} (Distributed Load) (R_{T2} =5.5Ω X_{T2} =7.1Ω)

Trunk Line 2: Loading 5%, (Rated Current =455A)

Voltage V_{i2}: 32.3kV (2%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =9.5Ω X_{B2} =11.4Ω)

Branch Line 2: Loading 3%, (Rated Current =405A)

Voltage V_{r2}: 32.2kV (2%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =4.4Ω X_{B1} =5.7Ω)

Branch Line 1: Loading 5%, (Rated Current =455A)

Voltage V_{r1}: 32.6kV (1%Drop)

L_{B3} (Distributed or Concentrated Load) (R_{B3} =6.2Ω X_{B3} =7.5Ω)

Branch Line 3: Loading 2%, (Rated Current =405A)

Voltage V_{r3}: 32.3kV (2%Drop)

<Branch Line 1>

Load L_{B1}	21A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	15.9km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	2900kVA	

<Branch Line 3>

Load L_{B3}	10A	
Line Type	AAC100mm2	No.8
Line Length Len_{B3}	20.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	1350kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

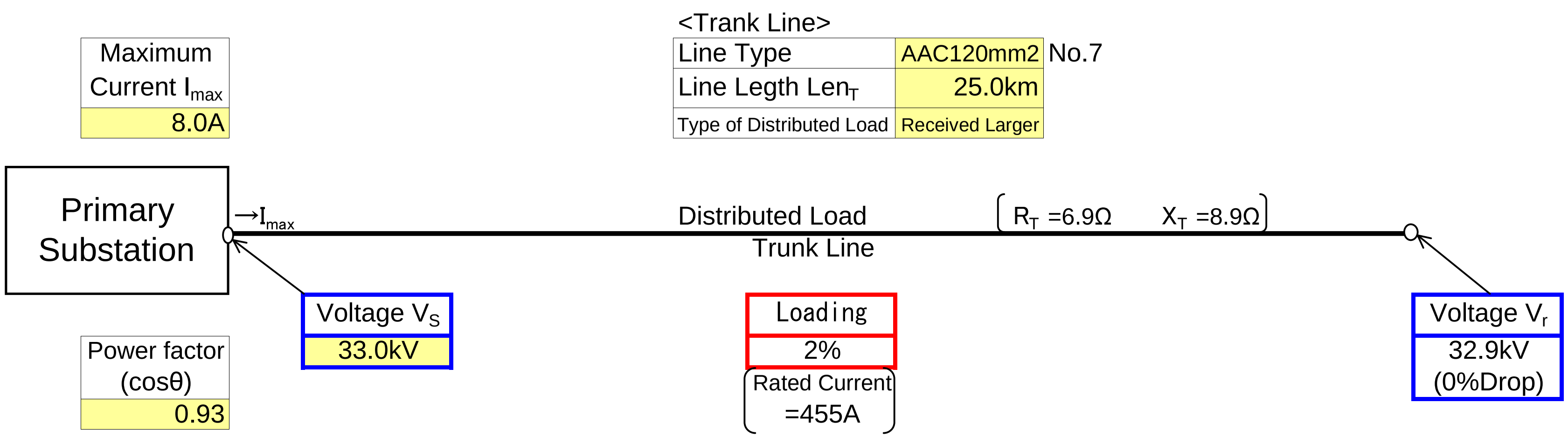
V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$, CAP_{B2}, CAP_{B3} : Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ : Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	SOGAKOPE
Feeder Name	ADIDOME

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	SOGAKOPE
Feeder Name	SOGA-AKATSI

: Input data in colored cells

Type-2

Maximum Current I_{max}: 172.0A

Power factor (cosθ): 0.93

<Trank Line>

Load L_T	28A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	22.5km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_T	1315kVA	

<Branch Line 1>

Load L_{B1}	36A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	36.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1700kVA	

Primary Substation

→I_{max}

L_T (Distributed Load) (R_T =6.2Ω X_T =8.0Ω)

Trunk Line

Loading
38%

(Rated Current =455A)

Voltage V_S: 34.0kV

Voltage V_i: 31.7kV (7%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =9.9Ω X_{B1} =12.8Ω)

Branch Line 1

Loading
8%

(Rated Current =455A)

Voltage V_{r1}: 31.3kV (8%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =6.9Ω X_{B2} =8.9Ω)

Branch Line 2

Loading
24%

(Rated Current =455A)

Voltage V_{r2}: 30.8kV (9%Drop)

<Branch Line 2>

Load L_{B2}	107A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	25.0km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	5000kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	SOGAKOPE
Feeder Name	SOGA-AKATSI

: Input data in colored cells

Type-3

Maximum Current I_{max}
200.0A

Power factor (cosθ)
0.93

<Trank Line 1>

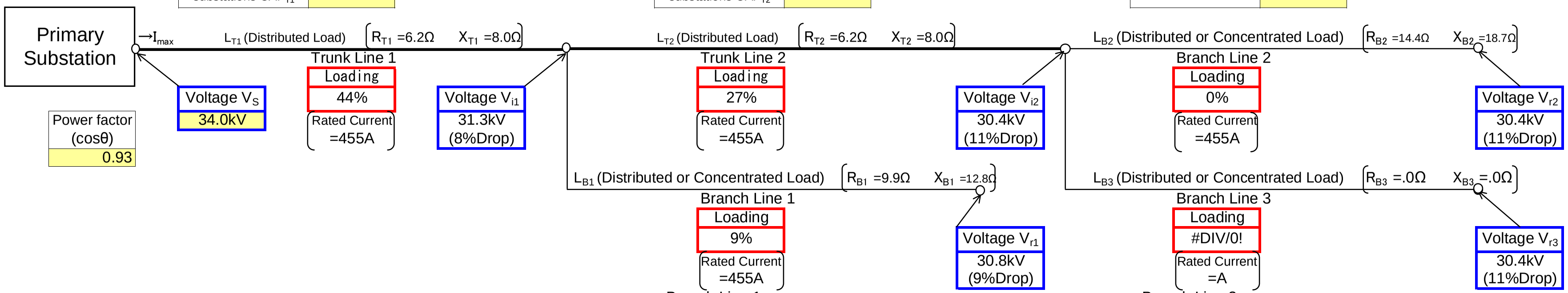
Load L_{T1}	33A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	22.5km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	1315kVA	

<Trank Line 2>

Load L_{T2}	125A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	22.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	5000kVA	

<Branch Line 2>

Load L_{B2}	A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	52.5km	
Type of Distributed Load	Middle Smaller	
Total Transformer Capacity of secondary substations CAP_{B2}		



<Branch Line 1>

Load L_{B1}	42A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	36.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1700kVA	

<Branch Line 3>

Load L_{B3}	A	
Line Type	None	No.33
Line Length Len_{B3}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B3}		

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

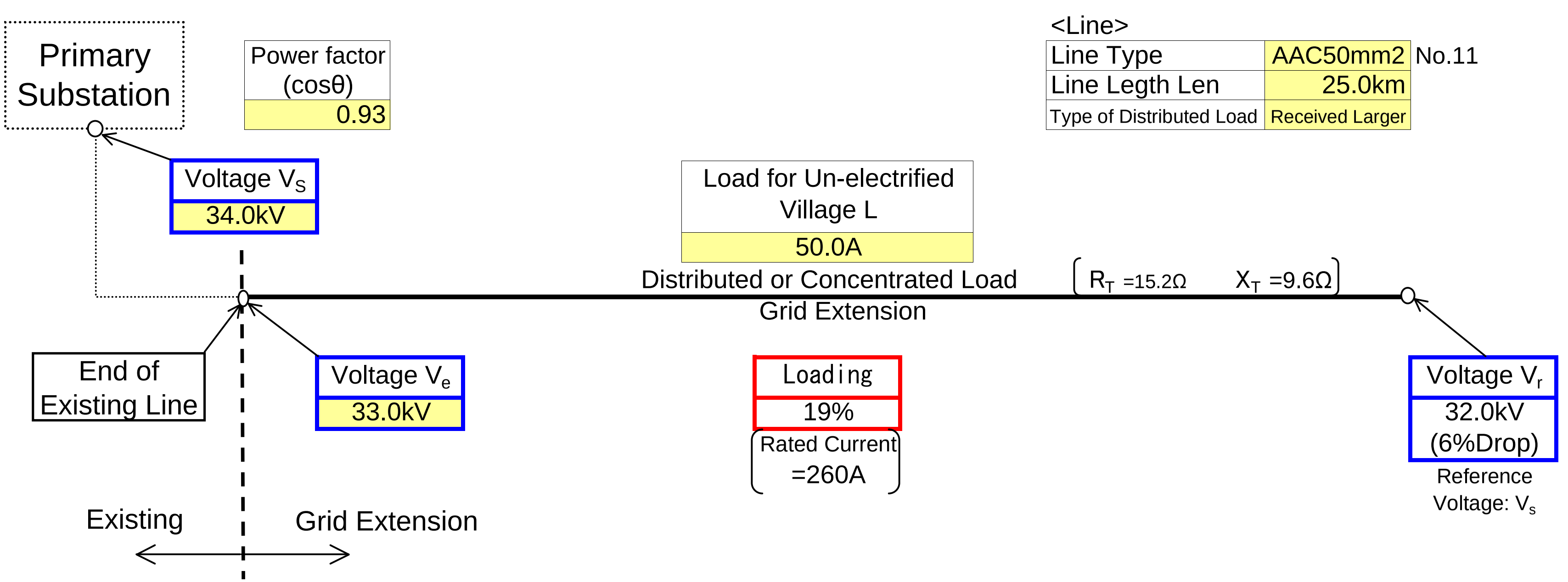
$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step B *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	SOGAKOPE
Feeder Name	ADIDOME

: Input data in colored cells



=====Equation=====

V_r = Ve - 1.732･L(Rcosθ + Xsinθ)･f

V_s	: Supply Voltage	L	: Load for Un-electrified Village	f	: Dispersal Load Factor
V_e	: Voltage at the end of Existing Line	R	: Resistance		
		X	: Reactance		
V_r	: Received Voltage	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	TSITO
Feeder Name	ADULT COLLEGE

: Input data in colored cells

Type-1

Maximum Current I_{max}	3.0A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	1.0km	
Type of Distributed Load	Received Larger	

Primary Substation

$\rightarrow I_{max}$

Distributed Load

Trunk Line

R_T =.3Ω　X_T =.4Ω

Voltage V_S	11.0kV

Loading
1%

Rated Current =455A

Voltage V_r
11.0kV (0%Drop)

Power factor (cosθ)	0.83

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s : Supply Voltage　　R_T : Resistance　　f_T : Dispersal Load Factor

V_r : Received Voltage　　X_T : Reactance

I_{max} : Maximum Current　　cosθ : Power Factor

TSITO TOWN

Substation Name	ANLOGA
Feeder Name	WIND FARM

: Input data in colored cells

Type-2

Maximum Current I_{max}: 15.0A

Power factor ($\cos\theta$): 0.83

Primary Substation TSITO

<Trank Line>

Load L_T	7A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	1.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	250kVA	

$\rightarrow I_{max}$ L_T (Distributed Load) R_T =.3Ω X_T =.4Ω

Trunk Line: Loading 3% (Rated Current =455A)

Voltage V_S: 11.0kV

Voltage V_i: 11.0kV (0%Drop)

<Branch Line 1>

Load L_{B1}	3A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	1.7km	
Type of Distributed Load	Middle Smaller	
Total Transformer Capacity of secondary substations CAP_{B1}	100kVA	

L_{B1} (Distributed or Concentrated Load) R_{B1} =.5Ω X_{B1} =.6Ω

Branch Line 1: Loading 1% (Rated Current =455A)

Voltage V_{r1}: 11.0kV (0%Drop)

L_{B2} (Distributed or Concentrated Load) R_{B2} =.1Ω X_{B2} =.2Ω

Branch Line 2: Loading 1% (Rated Current =455A)

Voltage V_{r2}: 11.0kV (0%Drop)

<Branch Line 2>

Load L_{B2}	5A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	.5km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	200kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — $\cos\theta$: Power Factor

V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Substation Name	TSITO
Feeder Name	PEKI

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	1.3km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	kVA	

<Trank Line 2>

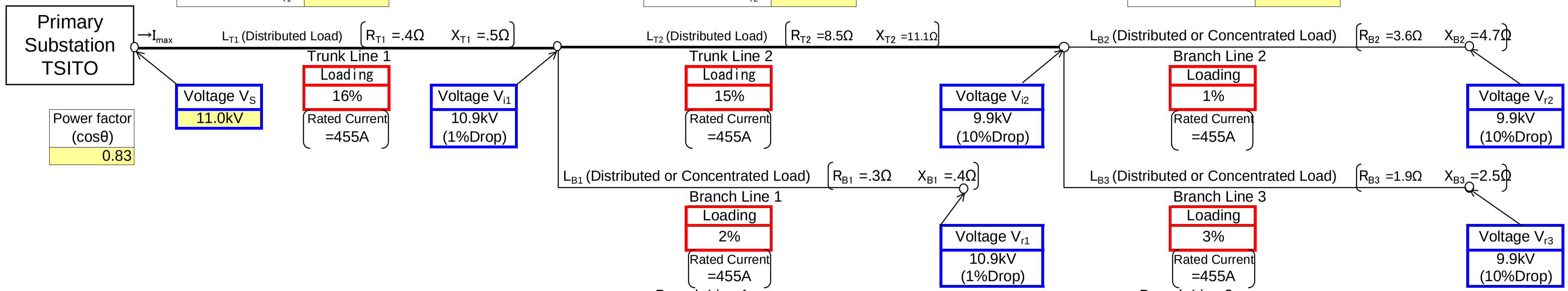
Load L_{T2}	46A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	31.1km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	2065kVA	

<Branch Line 2>

Load L_{B2}	5A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	13.2km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	225kVA	

Maximum Current I_{max}
74.0A

Power factor (cosθ)
0.83



<Branch Line 1>

Load L_{B1}	8A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	1.1km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	350kVA	

<Branch Line 3>

Load L_{B3}	15A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	7.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	675kVA	

=====Equation=====

$V_{i1} = V_S - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1} + CAP_{T2} + CAP_{B1} + CAP_{B2} + CAP_{B3})$

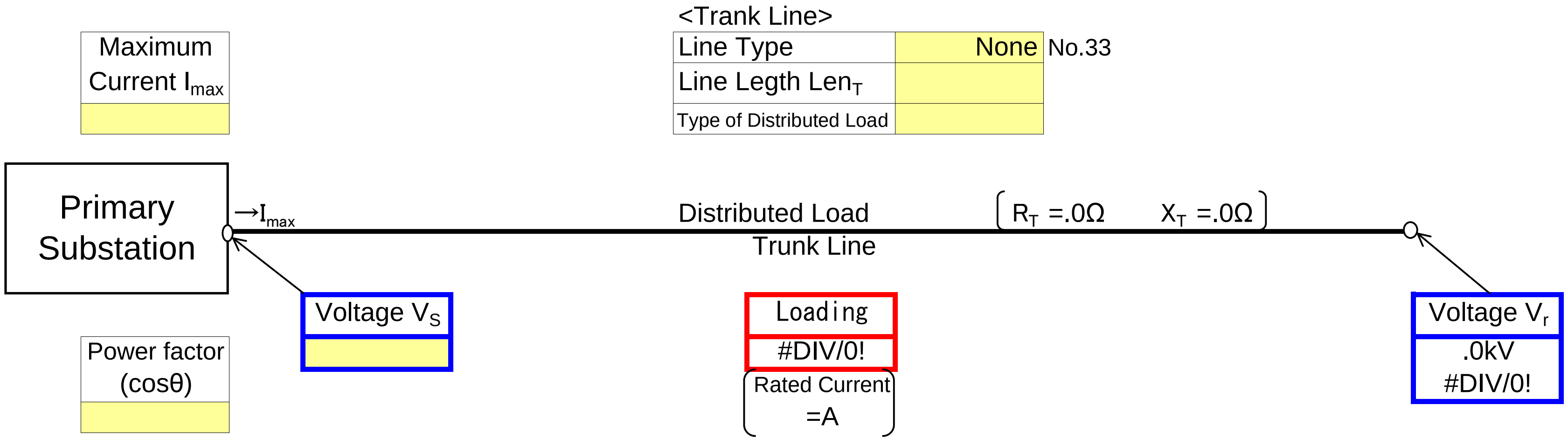
$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1} + CAP_{T2} + CAP_{B1} + CAP_{B2} + CAP_{B3})$

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	
Feeder Name	

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Step A (Type-2)

Substation Name	ANLOGA
Feeder Name	WIND FARM

: Input data in colored cells

Type-2

<Trank Line>

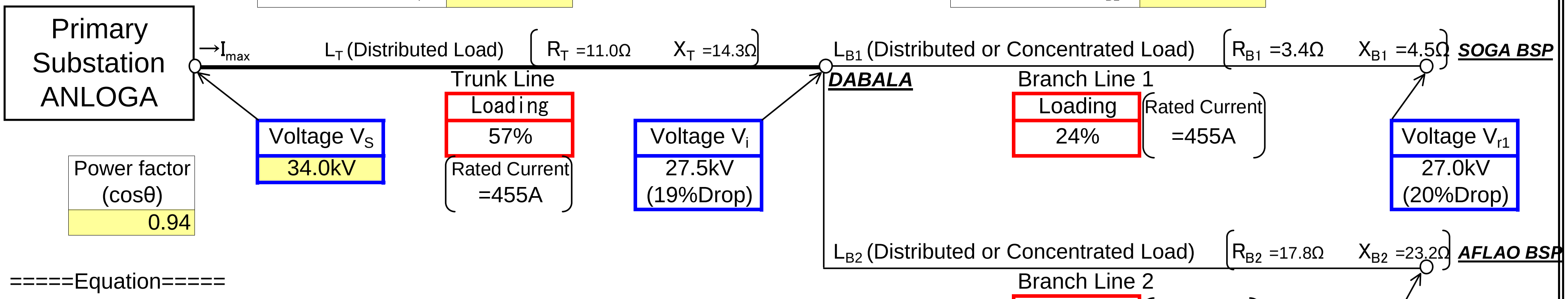
Load L_T	30A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	40.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	4000kVA	

<Branch Line 1>

Load L_{B1}	111A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	12.5km	
Type of Distributed Load	Middle Smaller	
Total Transformer Capacity of secondary substations CAP_{B1}	15000kVA	

Maximum Current I_{max}
260.0A

Power factor (cosθ)
0.94



<Branch Line 2>

Load L_{B2}	119A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	65.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	16000kVA	

=====Equation=====

$V_i = V_{S} - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage　I_{max} : Maximum Current　R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage　L_T : Load (Trunk line)　X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage　L_{B1} : Load (Branch Line 1)　cosθ : Power Factor
V_{r2} : Received Voltage　L_{B2} : Load (Branch Line 2)　f_T, f_{B1}, f_{B2} : Dispersal Load Factor　CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Substation Name	ANLOGA
Feeder Name	WIND FARM

: Input data in colored cells

Type-3

Maximum Current I_{max}
602.0A

Power factor (cosθ)
0.85

<Trank Line 1>

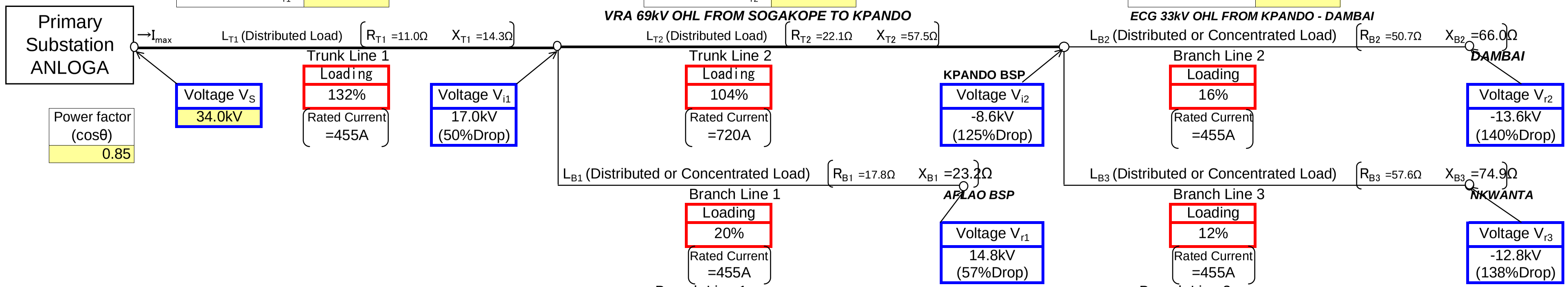
Load L_{T1}	37A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	40.0km	
Type of Distributed Load	Middle Smaller	
Total Transformer Capacity of secondary substations CAP_{T1}	4000kVA	

<Trank Line 2>

Load L_{T2}	343A	
Line Type	AAC240mm2	No.4
Line Legth Len_{T2}	173.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	37000kVA	

<Branch Line 2>

Load L_{B2}	74A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	185.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	8000kVA	



<Branch Line 1>

Load L_{B1}	93A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	65.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	10000kVA	

<Branch Line 3>

Load L_{B3}	56A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	210.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	6000kVA	

=====Equation=====

$V_{i1} = V_{s} - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPANDO
Feeder Name	NKONYA

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	3A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	56.9km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	1500kVA	

<Trank Line 2>

Load L_{T2}	3A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	33.4km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	1800kVA	

<Branch Line 2>

Load L_{B2}	11A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	101.4km	
Type of Distributed Load	Middle Smaller	
Total Transformer Capacity of secondary substations CAP_{B2}	5700kVA	

Maximum Current I_{max}
31.0A

Primary Substation

$\rightarrow I_{max}$

Power factor (cosθ)
0.93

Voltage V_S
31.1kV

L_{T1} (Distributed Load) R_{T1} =15.6Ω X_{T1} =20.3Ω

Trunk Line 1

Loading
7%

Rated Current =455A

Voltage V_{i1}
30.0kV (4%Drop)

L_{T2} (Distributed Load) R_{T2} =9.2Ω X_{T2} =11.9Ω

Trunk Line 2

Loading
6%

Rated Current =455A

Voltage V_{i2}
29.4kV (5%Drop)

L_{B2} (Distributed or Concentrated Load) R_{B2} =27.8Ω X_{B2} =36.2Ω

Branch Line 2

Loading
2%

Rated Current =455A

Voltage V_{r2}
29.1kV (7%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} =3.8Ω X_{B1} =4.9Ω

Branch Line 1

Loading
0%

Rated Current =455A

Voltage V_{r1}
30.0kV (4%Drop)

L_{B3} (Distributed or Concentrated Load) R_{B3} =36.5Ω X_{B3} =47.5Ω

Branch Line 3

Loading
3%

Rated Current =455A

Voltage V_{r3}
28.9kV (7%Drop)

<Branch Line 1>

Load L_{B1}	2A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	13.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	825kVA	

<Branch Line 3>

Load L_{B3}	12A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	133.2km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	6550kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage — I_{max} : Maximum Current — $R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$: Resistance

V_{i1} : Interim Voltage — L_{T1} : Load (Trunk line 1) — $X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$: Reactance

V_{i2} : Interim Voltage — L_{T2} : Load (Trunk line 2) — $f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$: Dispersal Load Factor

V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — $CAP_{T1}, CAP_{T2}, CAP_{B1}$

V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — CAP_{B2}, CAP_{B3} : Total Transformer Capacity of secondary substations

V_{r3} : Received Voltage — L_{B3} : Load (Branch Line 3) — cosθ : Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPANDO
Feeder Name	NKONYA

: Input data in colored cells

Type-2

Maximum Current I_{max}
19.0A

<Trank Line>

Load L_T	9A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	56.9km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	1550kVA	

<Branch Line 1>

Load L_{B1}	5A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	26.3km	
Type of Distributed Load	Middle Smaller	
Total Transformer Capacity of secondary substations CAP_{B1}	960kVA	

$\rightarrow I_{max}$ L_T (Distributed Load) R_T =15.6Ω X_T =20.3Ω

L_{B1} (Distributed or Concentrated Load) R_{B1} =7.2Ω X_{B1} =9.4Ω

Power factor (cosθ)
0.93

Voltage V_S
33.0kV

Trunk Line

Loading
4%

Rated Current =455A

Voltage V_i
32.4kV (2%Drop)

Branch Line 1

Loading
1%

Rated Current =455A

Voltage V_{r1}
32.4kV (2%Drop)

L_{B2} (Distributed or Concentrated Load) R_{B2} =3.8Ω X_{B2} =4.9Ω

Branch Line 2

Loading
1%

Rated Current =455A

Voltage V_{r2}
32.4kV (2%Drop)

<Branch Line 2>

Load L_{B2}	5A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	13.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	825kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance	
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance	
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor	
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor	CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KPANDO
Feeder Name	HOHOE

: Input data in colored cells

Type-2

Maximum Current I_{max}: 134.0A

Power factor (cosθ): 0.93

<Trank Line>

Load L_T	3A	
Line Type	AAC150mm2	No.6
Line Legth Len_T	13.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	100kVA	

<Branch Line 1>

Load L_{B1}	87A	
Line Type	AAC150mm2	No.6
Line Length Len_{B1}	28.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	3250kVA	

Primary Substation

$\rightarrow I_{max}$ L_T (Distributed Load) (R_T =2.7Ω X_T =4.5Ω)

Voltage V_S: 33.0kV

Trunk Line Loading: 25% (Rated Current =530A)

Voltage V_i: 32.0kV (3%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =5.7Ω X_{B1} =9.8Ω)

Branch Line 1 Loading: 16% (Rated Current =530A)

Voltage V_{r1}: 31.2kV (6%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =8.6Ω X_{B2} =11.2Ω)

Branch Line 2 Loading: 10% (Rated Current =455A)

Voltage V_{r2}: 31.6kV (4%Drop)

<Branch Line 2>

Load L_{B2}	44A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	31.3km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1650kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	KPANDO
Feeder Name	HOHOE-JASIKAN

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	1.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	50kVA	

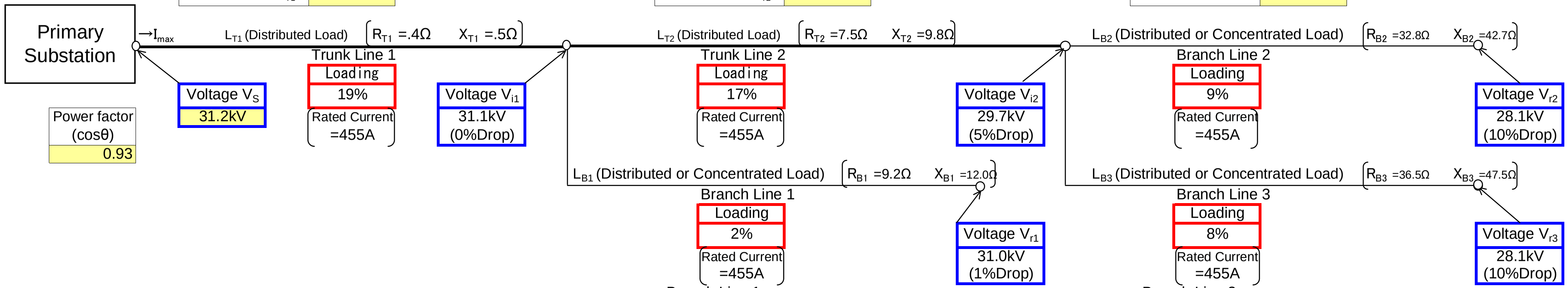
<Trank Line 2>

Load L_{T2}	3A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	27.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	450kVA	

<Branch Line 2>

Load L_{B2}	39A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	119.7km	
Type of Distributed Load	Middle Smaller	
Total Transformer Capacity of secondary substations CAP_{B2}	5700kVA	

Maximum Current I_{max}
87.0A



Power factor (cosθ)
0.93

<Branch Line 1>

Load L_{B1}	8A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	33.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1175kVA	

<Branch Line 3>

Load L_{B3}	37A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	133.2km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	5350kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage
V_{i1} : Interim Voltage
V_{i2} : Interim Voltage
V_{r1} : Received Voltage
V_{r2} : Received Voltage
V_{r3} : Received Voltage

I_{max} : Maximum Current
L_{T1} : Load (Trunk line 1)
L_{T2} : Load (Trunk line 2)
L_{B1} : Load (Branch Line 1)
L_{B2} : Load (Branch Line 2)
L_{B3} : Load (Branch Line 3)

$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$: Resistance
$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$: Reactance
$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$: Dispersal Load Factor
$CAP_{T1}, CAP_{T2}, CAP_{B1}$, CAP_{B2}, CAP_{B3} : Total Transformer Capacity of secondary substations
cosθ : Power Factor

Power System Analysis

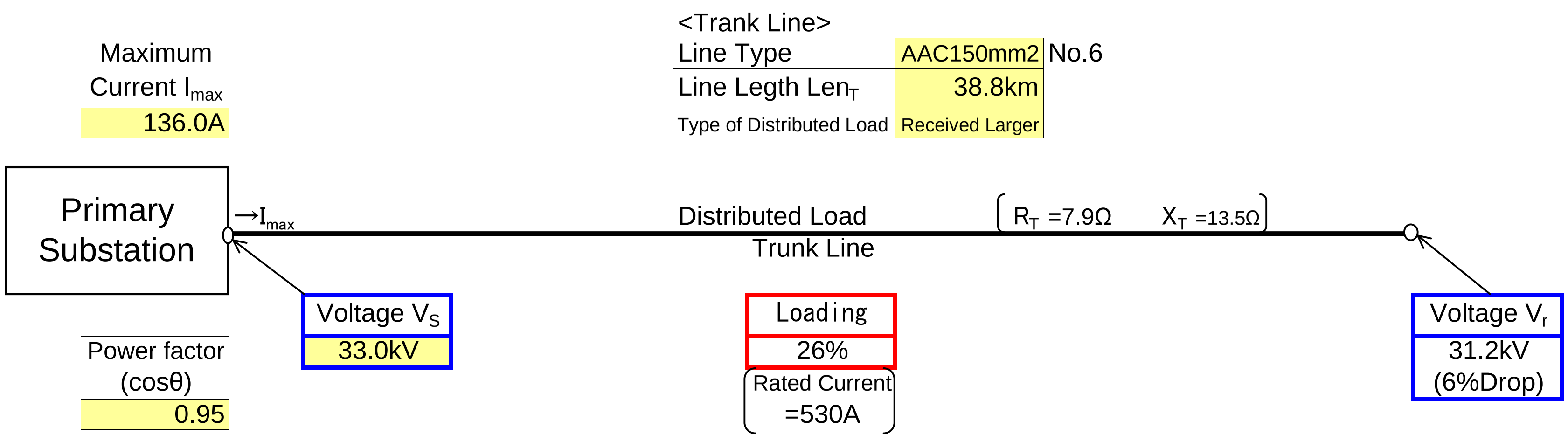
- Western 2006 -

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ATUABO
Feeder Name	Aboso 1

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

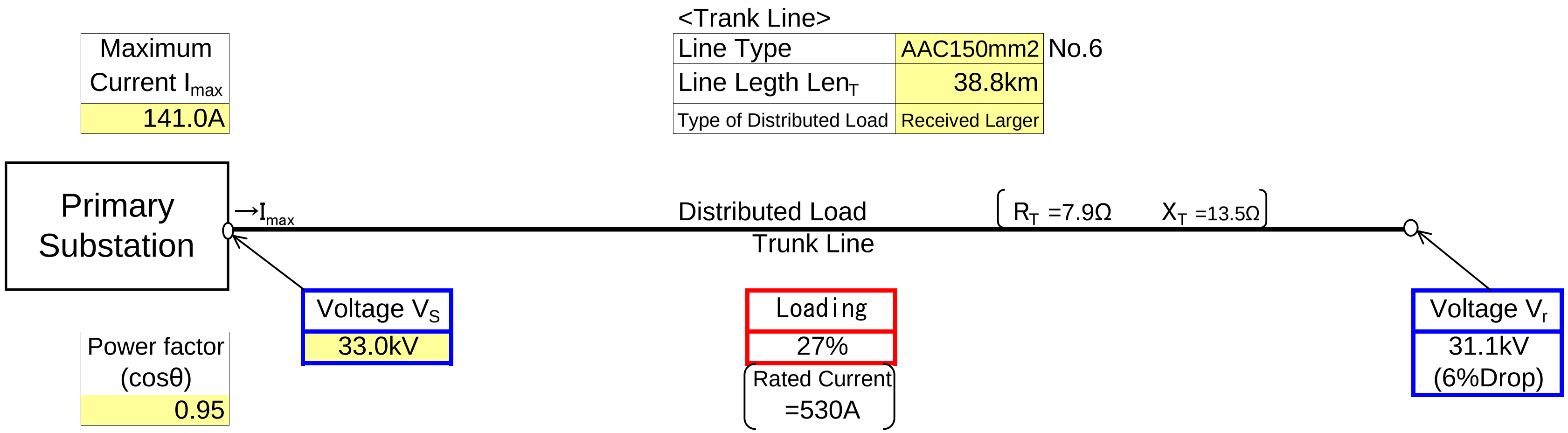
V_S	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ATUABO
Feeder Name	Aboso 2

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station C
Feeder Name	AGONA

: Input data in colored cells

Type-2

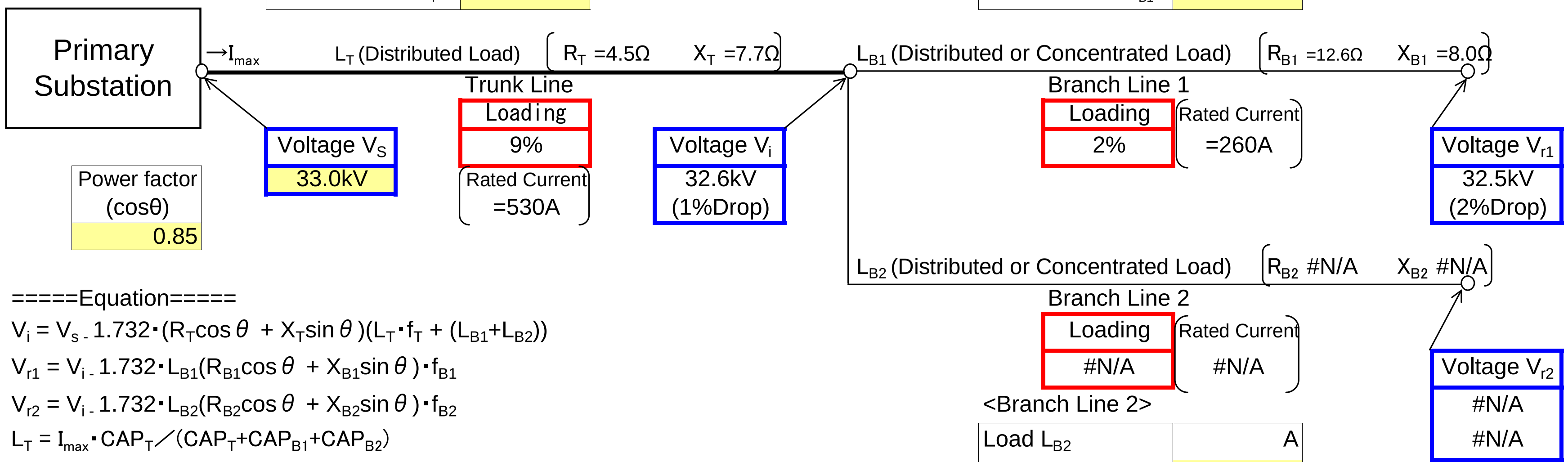
<Trank Line>

Load L_T	41A	
Line Type	AAC150mm2	No.6
Line Legth Len_T	22.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	4160kVA	

<Branch Line 1>

Load L_{B1}	5A	
Line Type	AAC50mm2	No.11
Line Length Len_{B1}	20.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	500kVA	

Maximum Current I_{max}
46.0A



<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage I_{max} : Maximum Current R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage L_T : Load (Trunk line) X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage L_{B1} : Load (Branch Line 1) cosθ : Power Factor

V_{r2} : Received Voltage L_{B2} : Load (Branch Line 2) f_T, f_{B1}, f_{B2} : Dispersal Load Factor $CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	BOGOSO
Feeder Name	BOGOSO/ASANKO

: Input data in colored cells

Type-3

Maximum Current I_{max}
94.0A

Power factor (cosθ)
0.94

Primary Substation →I_{max}

Voltage V_S 33.0kV

<Trank Line 1>

Load L_{T1}	43A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	89.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	3250kVA	

L_{T1} (Distributed Load) (R_{T1} =24.4Ω X_{T1} =31.8Ω)

Trunk Line 1: Loading 21%, Rated Current =455A

Voltage V_{i1} 28.7kV (13%Drop)

<Trank Line 2>

Load L_{T2}	9A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	42.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	650kVA	

L_{T2} (Distributed Load) (R_{T2} =11.5Ω X_{T2} =15.0Ω)

Trunk Line 2: Loading 8%, Rated Current =455A

Voltage V_{i2} 27.9kV (16%Drop)

<Branch Line 2>

Load L_{B2}	17A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	12.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	1300kVA	

L_{B2} (Distributed or Concentrated Load) (R_{B2} =3.3Ω X_{B2} =4.3Ω)

Branch Line 2: Loading 4%, Rated Current =455A

Voltage V_{r2} 27.8kV (16%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =6.9Ω X_{B1} =8.9Ω)

Branch Line 1: Loading 3%, Rated Current =455A

Voltage V_{r1} 28.6kV (13%Drop)

<Branch Line 1>

Load L_{B1}	15A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	25.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	1150kVA	

L_{B3} (Distributed or Concentrated Load) (R_{B3} =13.7Ω X_{B3} =17.8Ω)

Branch Line 3: Loading 2%, Rated Current =455A

Voltage V_{r3} 27.7kV (16%Drop)

<Branch Line 3>

Load L_{B3}	11A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	50.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	800kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ATUABO
Feeder Name	BONSA

: Input data in colored cells

Type-3

Maximum Current I_{max}
42.0A

Power factor (cosθ)
0.85

<Trank Line 1>

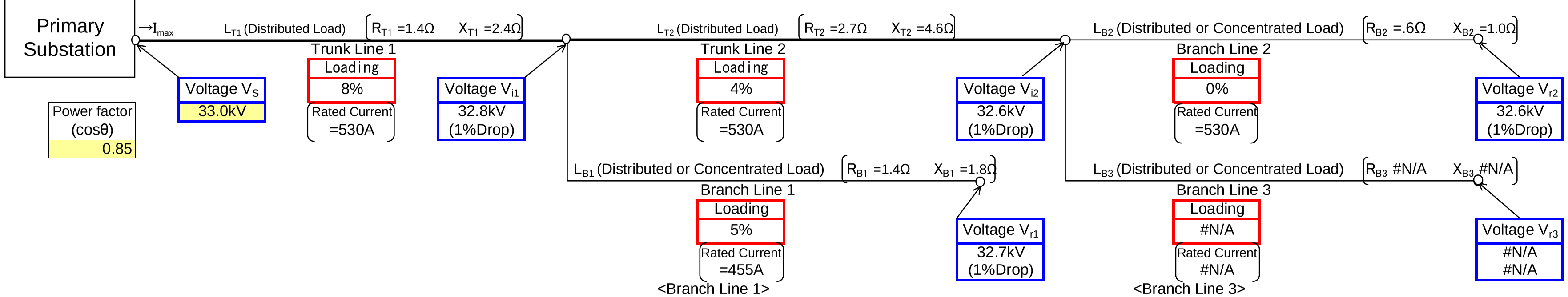
Load L_{T1}	A	
Line Type	AAC150mm2	No.6
Line Legth Len_{T1}	7.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	kVA	

<Trank Line 2>

Load L_{T2}	21A	
Line Type	AAC150mm2	No.6
Line Legth Len_{T2}	13.1km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_{T2}	5000kVA	

<Branch Line 2>

Load L_{B2}	A	
Line Type	AAC150mm2	No.6
Line Length Len_{B1}	3.0km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_{B2}	3kVA	



<Branch Line 1>

Load L_{B1}	21A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	5.0km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_{B1}	5000kVA	

<Branch Line 3>

Load L_{B3}	A	
Line Type		#N/A
Line Length Len_{B3}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B3}		

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	STN A
Feeder Name	CCT 1

: Input data in colored cells

Type-2

<Trank Line>

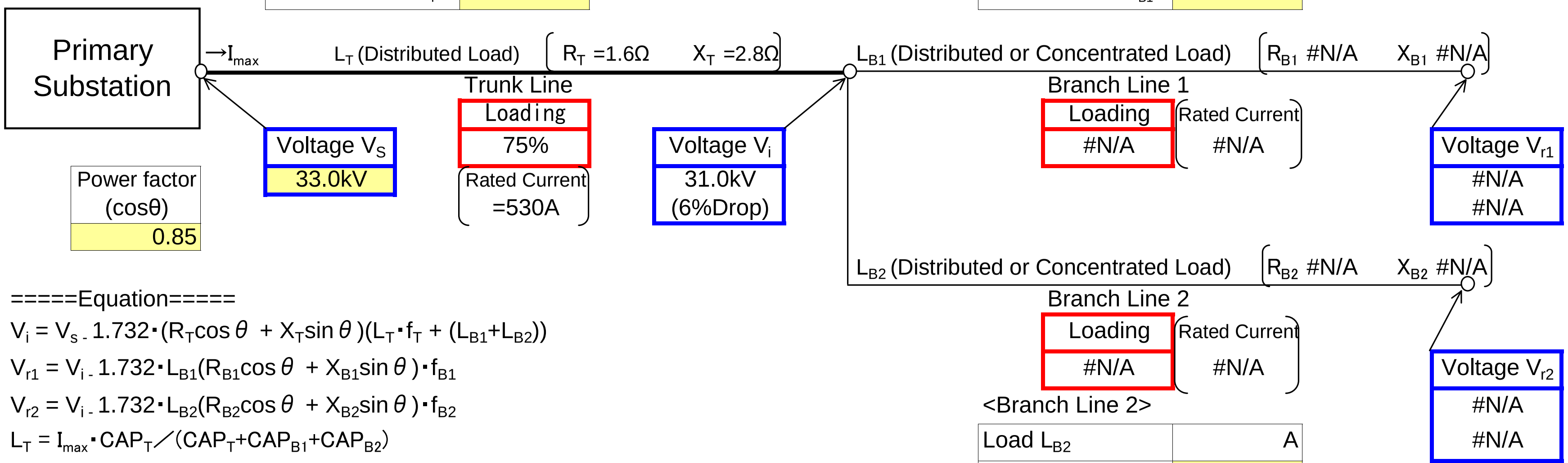
Load L_T	400A	
Line Type	AAC150mm2	No.6
Line Legth Len_T	8.0km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_T	20000kVA	

<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		

Maximum Current I_{max}
400.0A

Power factor (cosθ)
0.85



<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	CCT 2

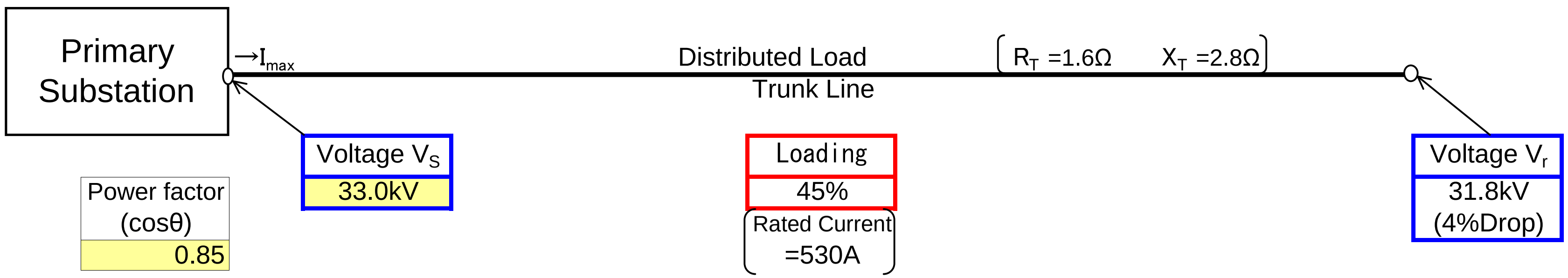
: Input data in colored cells

Type-1

Maximum Current I_{max}	
239.0A	

<Trank Line>

Line Type	AAC150mm2	No.6
Line Legth Len_T	8.0km	
Type of Distributed Load	Concentrated	



Power factor (cosθ)	
0.85	

=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$$

V_s : Supply Voltage R_T : Resistance f_T : Dispersal Load Factor

V_r : Received Voltage X_T : Reactance

I_{max} : Maximum Current cosθ : Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	CCT 2

: Input data in colored cells

Type-2

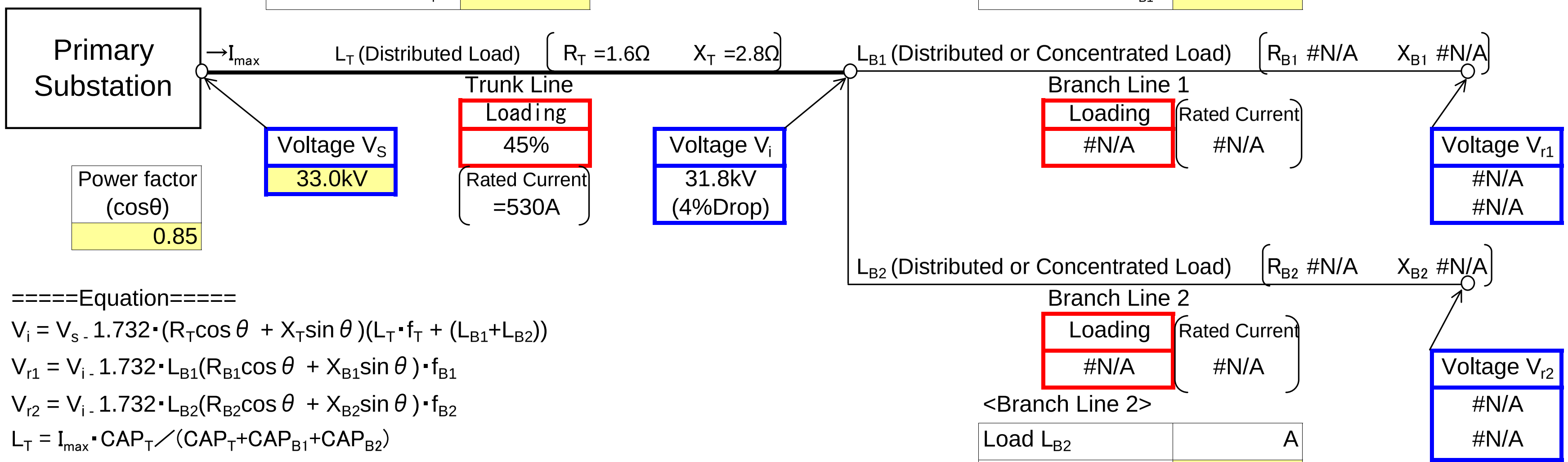
<Trank Line>

Load L_T	239A	
Line Type	AAC150mm2	No.6
Line Legth Len_T	8.0km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_T	10000kVA	

<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		

Maximum Current I_{max}	239.0A
Power factor (cosθ)	0.85



<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta)\cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta)\cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

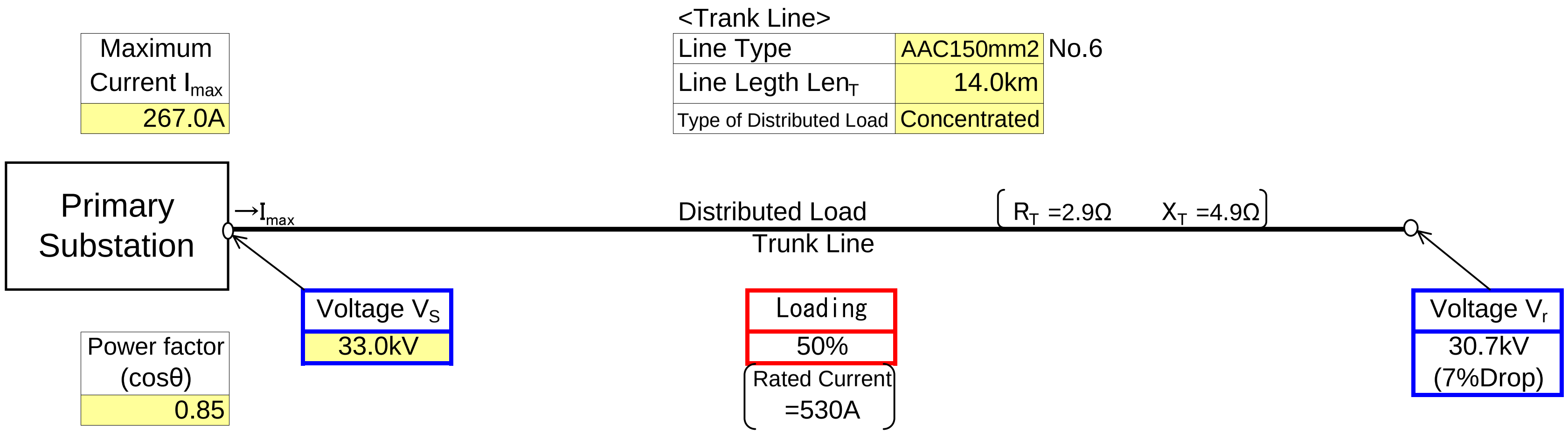
V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance	
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance	
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor	
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor	CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	CCT 5

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	$\cos\theta$	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A09

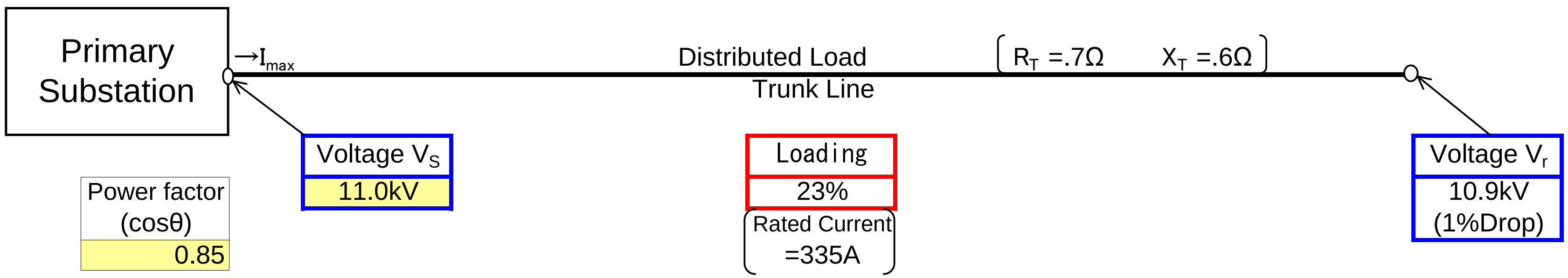
: Input data in colored cells

Type-1

Maximum Current I_{max}	76.0A

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	4.8km	
Type of Distributed Load	Received Larger	



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

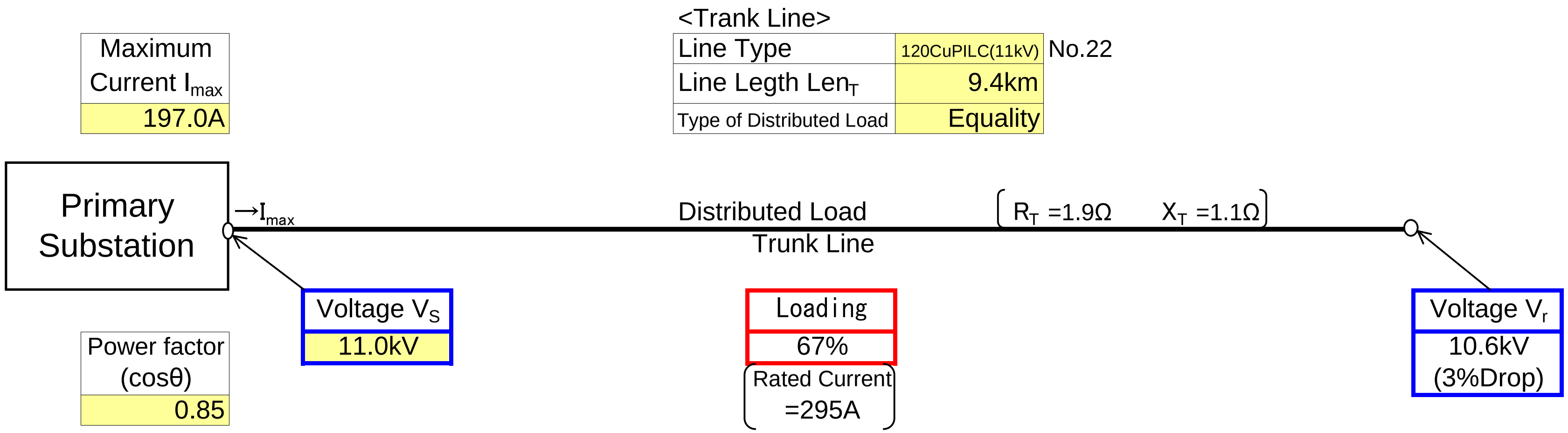
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A10

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A13

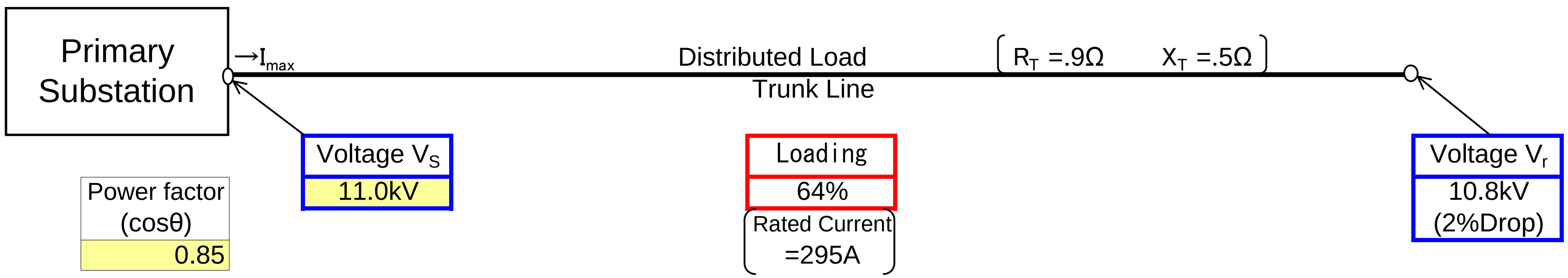
: Input data in colored cells

Type-1

Maximum Current I_{max}
190.0A

<Trank Line>

Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	4.5km	
Type of Distributed Load	Equality	



Power factor (cosθ)
0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A13

: Input data in colored cells

Type-2

Maximum Current I_{max}
190.0A

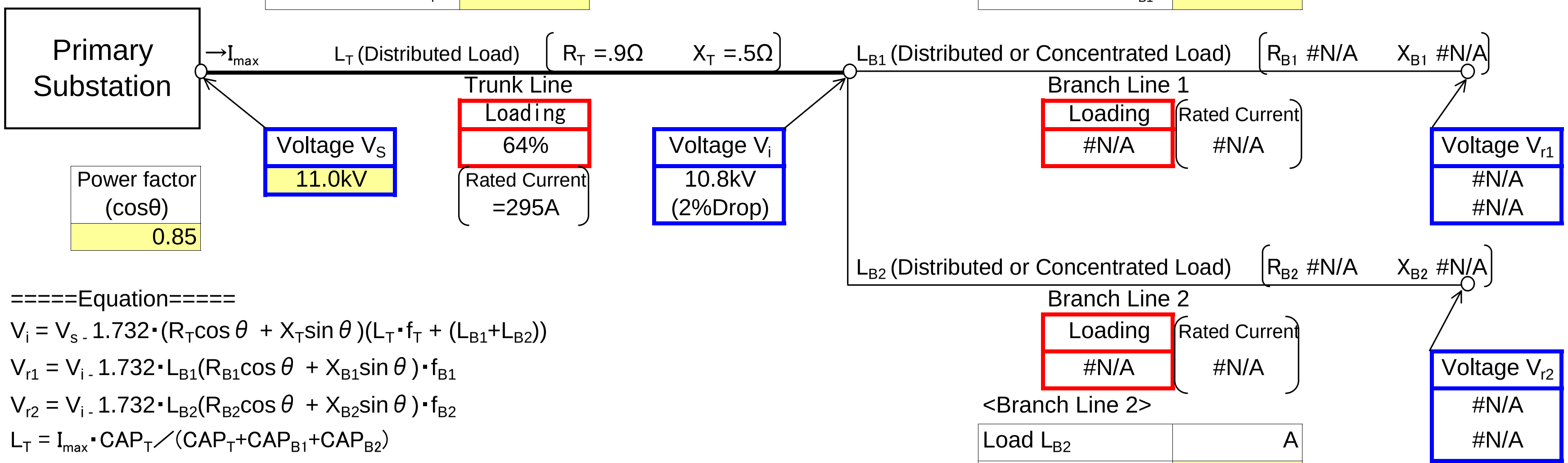
Power factor ($\cos\theta$)
0.85

<Trank Line>

Load L_T	190A	
Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	4.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	3245kVA	

<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		



<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

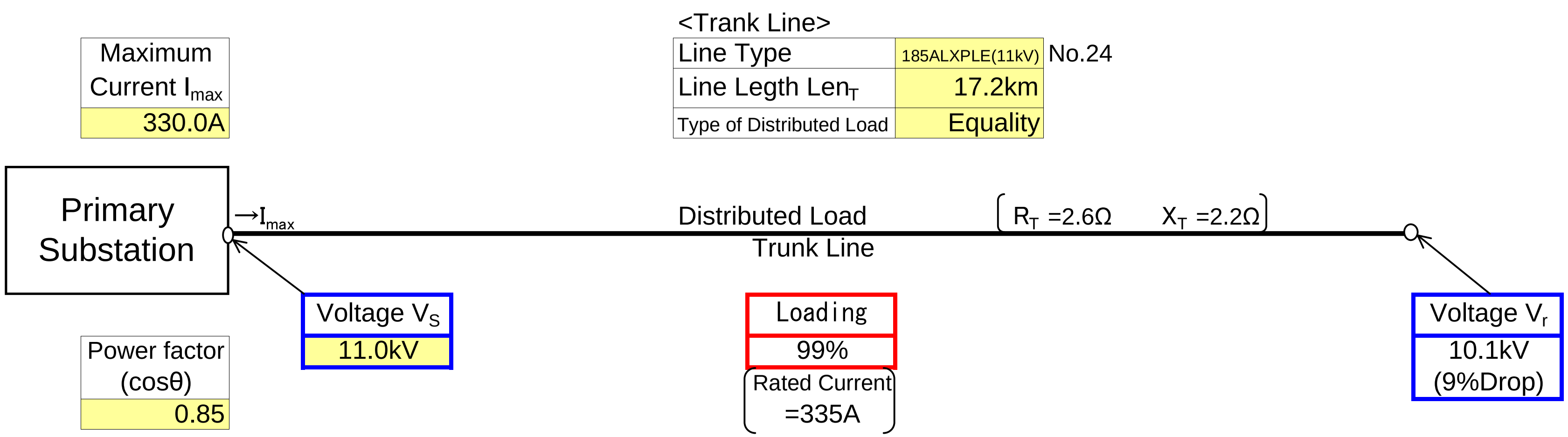
V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance	
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance	
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$\cos\theta$: Power Factor	
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor	CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A 31

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station A
Feeder Name	A31

: Input data in colored cells

Type-2

Maximum Current I_{max}
330.0A

Power factor (cosθ)
0.85

<Trank Line>

Load L_T	163A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	7.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	6945kVA	

<Branch Line 1>

Load L_{B1}	167A	
Line Type	Cu70mm2	No.14
Line Length Len_{B1}	12.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	7120kVA	

Primary Substation

→I_{max}

L_T (Distributed Load) R_T =1.2Ω X_T =1.0Ω

Trunk Line

Loading
99%

Rated Current =335A

Voltage V_S
11.0kV

Voltage V_i
10.4kV (6%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} =3.5Ω X_{B1} =5.3Ω

Branch Line 1

Loading
45%

Rated Current =369A

Voltage V_{r1}
9.5kV (13%Drop)

L_{B2} (Distributed or Concentrated Load) R_{B2} #N/A X_{B2} #N/A

Branch Line 2

Loading
#N/A

Rated Current #N/A

Voltage V_{r2}
#N/A
#N/A

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance	
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance	
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor	
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor	CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station A
Feeder Name	A31 (1 of 2)

: Input data in colored cells

Type-2

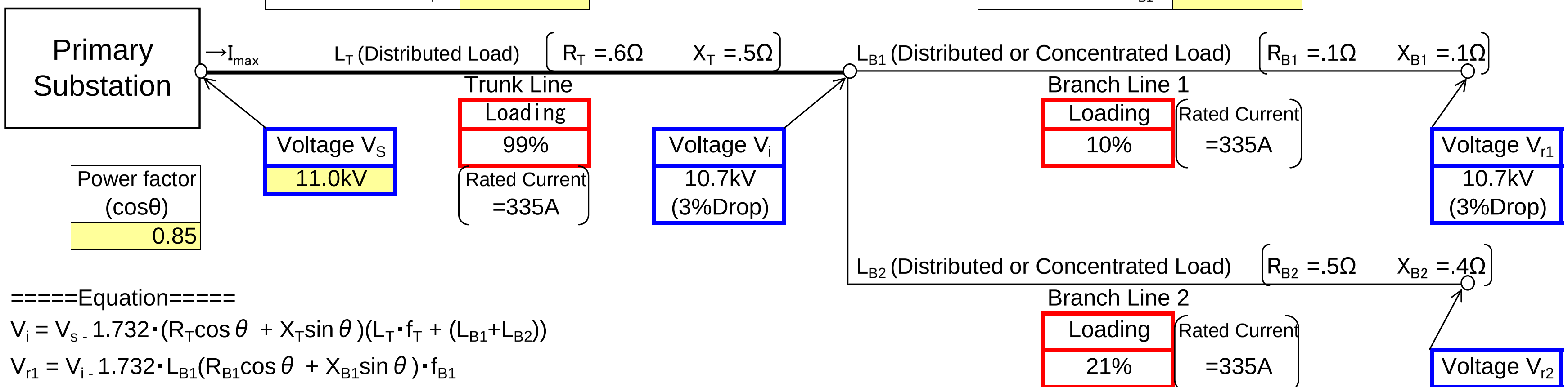
<Trank Line>

Load L_T	224A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	4.3km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	4715kVA	

<Branch Line 1>

Load L_{B1}	34A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	.9km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	715kVA	

Maximum Current I_{max}	330.0A
Power factor (cosθ)	0.85



<Branch Line 2>

Load L_{B2}	72A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	3.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1515kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_T, R_{B1}, R_{B2}	: Resistance
V_i	: Interim Voltage	L_T	: Load (Trunk line)	X_T, X_{B1}, X_{B2}	: Reactance
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	cosθ	: Power Factor
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	f_T, f_{B1}, f_{B2}	: Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station A
Feeder Name	A31 (2 of 2)

: Input data in colored cells

Type-2

Maximum Current I_{max}
205.0A

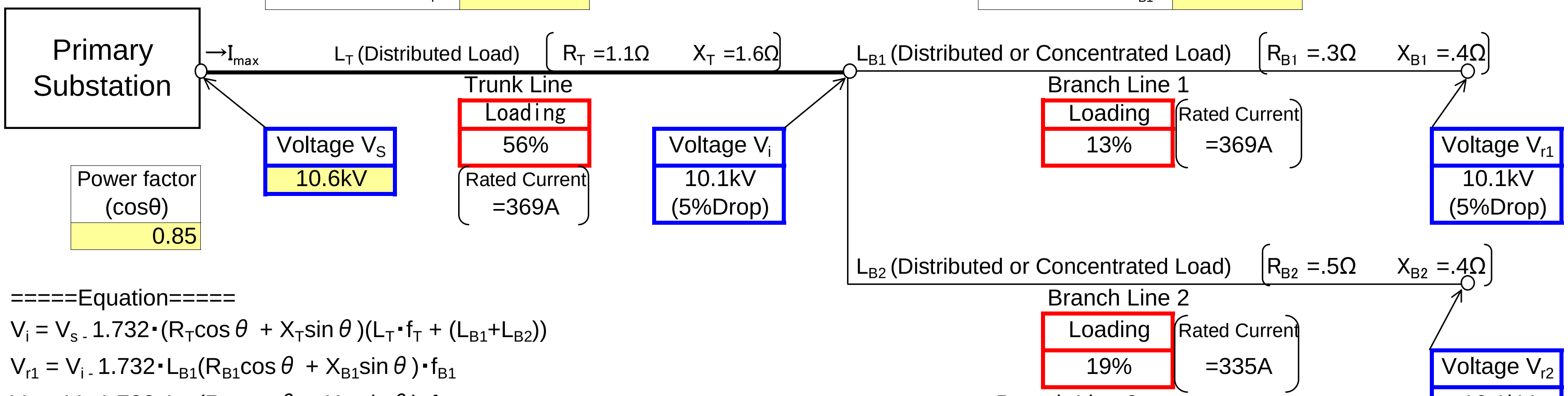
Power factor (cosθ)
0.85

<Trank Line>

Load L_T	94A	
Line Type	Cu70mm2	No.14
Line Legth Len_T	3.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	2245kVA	

<Branch Line 1>

Load L_{B1}	47A	
Line Type	Cu70mm2	No.14
Line Length Len_{B1}	1.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	1115kVA	



<Branch Line 2>

Load L_{B2}	64A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	3.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1515kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance	
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance	
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor	
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor	CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	EEDER A31 (2 of 2

: Input data in colored cells

Type-3

Maximum Current I_{max}
167.0A

Power factor (cosθ)
0.85

<Trank Line 1>

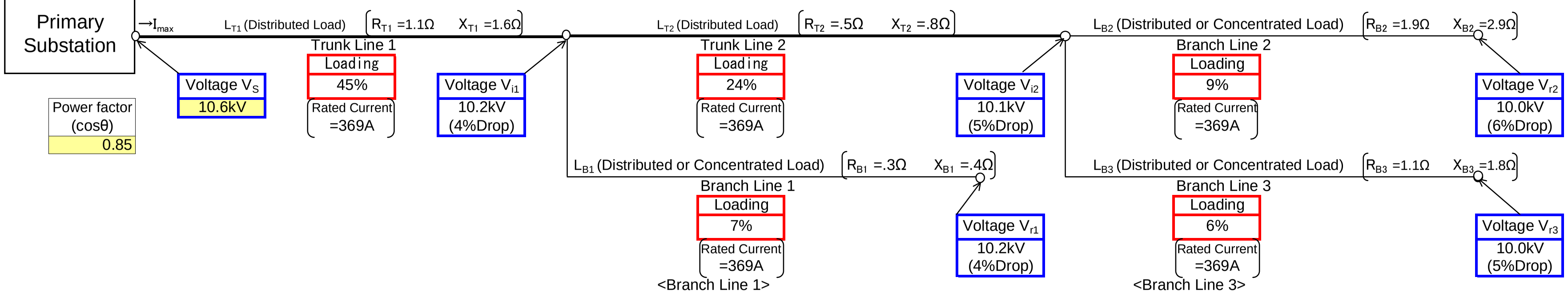
Load L_{T1}	53A	
Line Type	Cu70mm2	No.14
Line Legth Len_{T1}	3.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	2245kVA	

<Trank Line 2>

Load L_{T2}	33A	
Line Type	Cu70mm2	No.14
Line Legth Len_{T2}	1.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	1400kVA	

<Branch Line 2>

Load L_{B2}	34A	
Line Type	Cu70mm2	No.14
Line Length Len_{B1}	6.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1445kVA	



<Branch Line 1>

Load L_{B1}	26A	
Line Type	Cu70mm2	No.14
Line Length Len_{B1}	1.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	1115kVA	

<Branch Line 3>

Load L_{B3}	21A	
Line Type	Cu70mm2	No.14
Line Length Len_{B3}	4.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	915kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A41

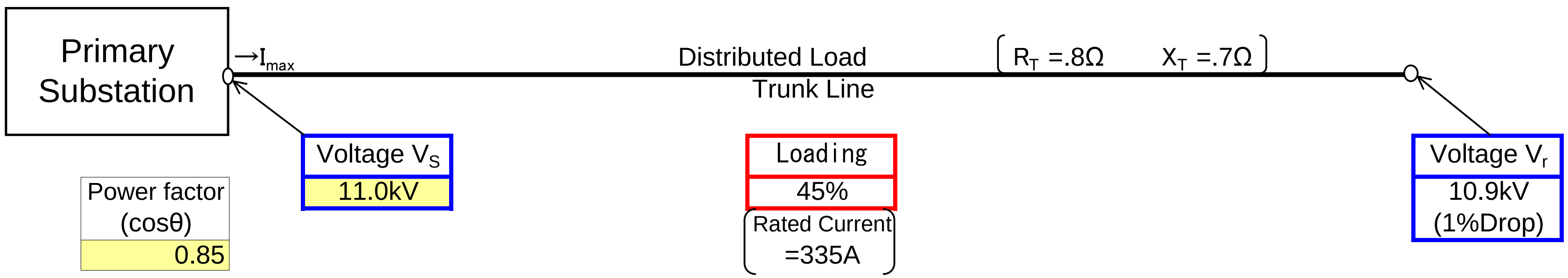
: Input data in colored cells

Type-1

Maximum Current I_{max}	
150.0A	

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	5.4km	
Type of Distributed Load	Equality	



=====Equation=====

V_r = Vs - 1.732･I_{max}($R_T$cos θ + $X_T$sin θ)･f_T

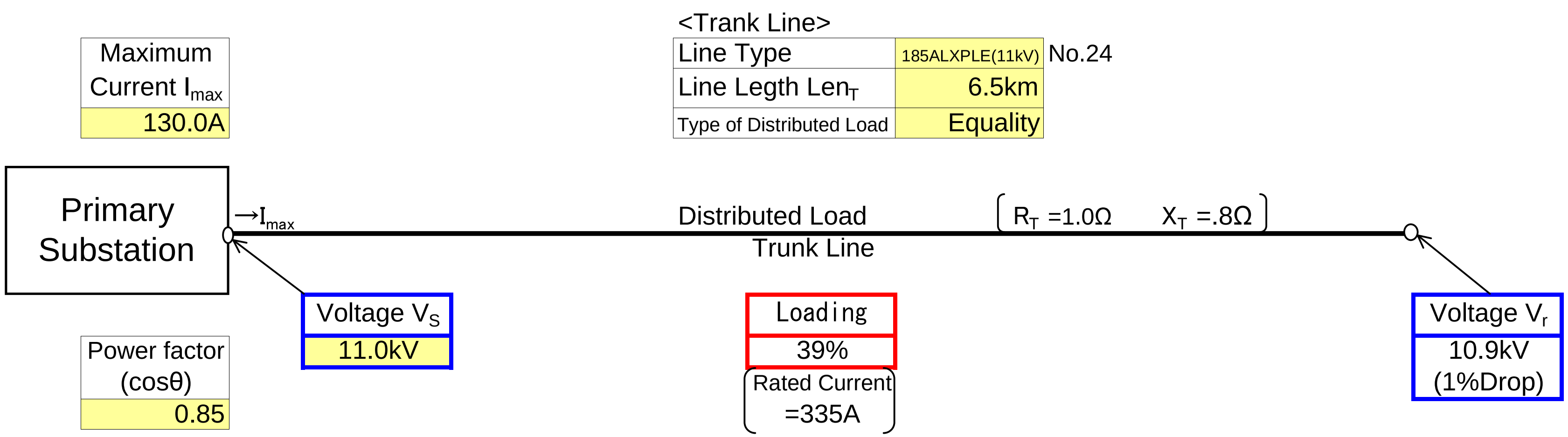
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A44

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A55

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	A	
Line Type	240CuPILC(11kV)	No.25
Line Legth Len_T	.4km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_T	kVA	

<Branch Line 1>

Load L_{B1}	243A	
Line Type	AAC150mm2	No.6
Line Length Len_{B1}	7.6km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_{B1}	10715kVA	

Maximum Current I_{max}	250.0A
Power factor (cosθ)	0.85

Primary Substation

→I_{max}

L_T (Distributed Load) R_T =.0Ω X_T =.0Ω

Trunk Line

Loading
60%

Rated Current =415A

Voltage V_S
11.0kV

Voltage V_i
11.0kV (0%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} =1.6Ω X_{B1} =2.6Ω

Branch Line 1

Loading
46%

Rated Current =530A

Voltage V_{r1}
9.8kV (11%Drop)

L_{B2} (Distributed or Concentrated Load) R_{B2} =.1Ω X_{B2} =.1Ω

Branch Line 2

Loading
2%

Rated Current =455A

Voltage V_{r2}
11.0kV (0%Drop)

<Branch Line 2>

Load L_{B2}	7A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	.3km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_{B2}	315kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

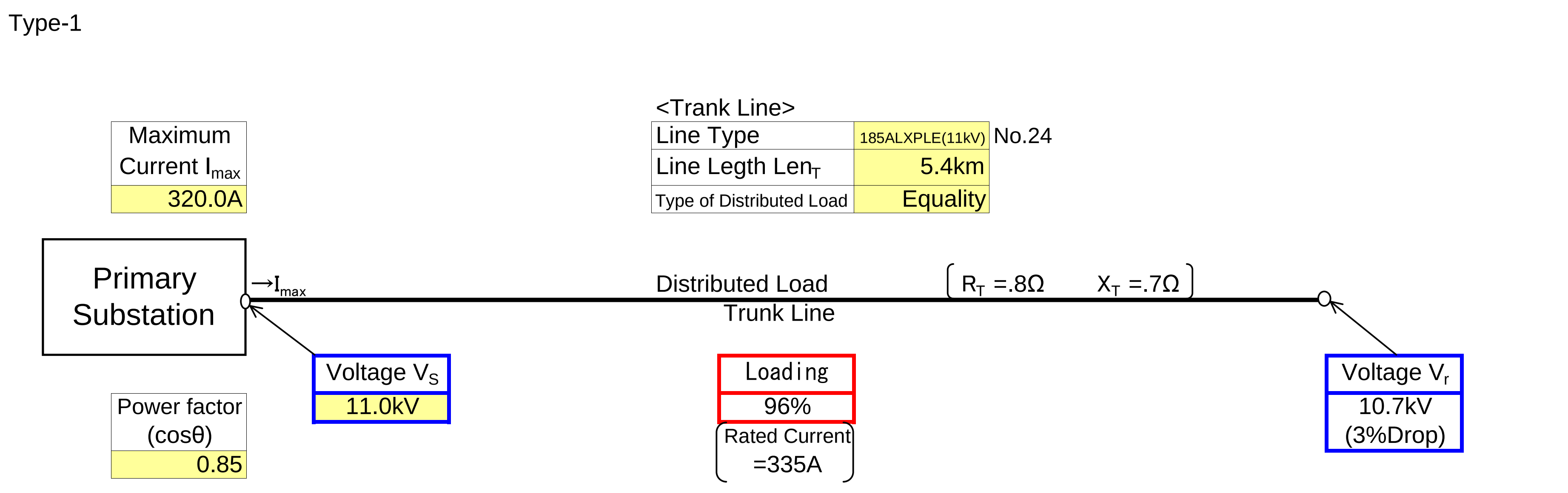
V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A41

: Input data in colored cells



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A57

: Input data in colored cells

Type-2

Maximum Current I_{max}	98.0A

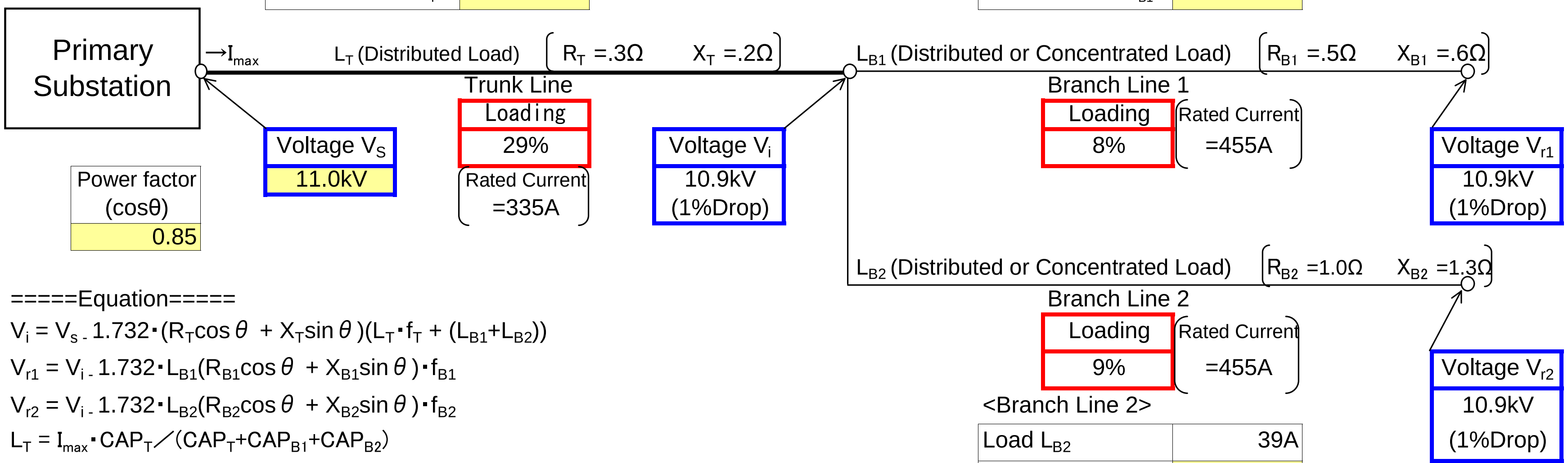
Power factor (cosθ)	0.85

<Trank Line>

Load L_T	22A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	1.9km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	615kVA	

<Branch Line 1>

Load L_{B1}	37A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	1.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1015kVA	



<Branch Line 2>

Load L_{B2}	39A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	3.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1080kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_T, R_{B1}, R_{B2}	: Resistance
V_i	: Interim Voltage	L_T	: Load (Trunk line)	X_T, X_{B1}, X_{B2}	: Reactance
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	cosθ	: Power Factor
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	f_T, f_{B1}, f_{B2}	: Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	BOGOSO
Feeder Name	BOGOSO/ASANKO

: Input data in colored cells

Type-3

Maximum Current I_{max}
94.0A

Power factor ($\cos\theta$)
0.94

Primary Substation $\rightarrow I_{max}$

Voltage V_s
34.5kV

<Trank Line 1>

Load L_{T1}	43A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	89.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	3250kVA	

L_{T1} (Distributed Load) (R_{T1} =24.4Ω X_{T1} =31.8Ω)

Trunk Line 1

Loading
21%

(Rated Current =455A)

Voltage V_{i1}
30.2kV (12%Drop)

<Trank Line 2>

Load L_{T2}	9A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	42.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	650kVA	

L_{T2} (Distributed Load) (R_{T2} =11.5Ω X_{T2} =15.0Ω)

Trunk Line 2

Loading
8%

(Rated Current =455A)

Voltage V_{i2}
29.4kV (15%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =6.9Ω X_{B1} =8.9Ω)

Branch Line 1

Loading
3%

(Rated Current =455A)

Voltage V_{r1}
30.1kV (13%Drop)

<Branch Line 1>

Load L_{B1}	15A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	25.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	1150kVA	

<Branch Line 2>

Load L_{B2}	17A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	12.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	1300kVA	

L_{B2} (Distributed or Concentrated Load) (R_{B2} =3.3Ω X_{B2} =4.3Ω)

Branch Line 2

Loading
4%

(Rated Current =455A)

Voltage V_{r2}
29.3kV (15%Drop)

L_{B3} (Distributed or Concentrated Load) (R_{B3} =13.7Ω X_{B3} =17.8Ω)

Branch Line 3

Loading
2%

(Rated Current =455A)

Voltage V_{r3}
29.2kV (15%Drop)

<Branch Line 3>

Load L_{B3}	11A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	50.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	800kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage
V_{i1} : Interim Voltage
V_{i2} : Interim Voltage
V_{r1} : Received Voltage
V_{r2} : Received Voltage
V_{r3} : Received Voltage

I_{max} : Maximum Current
L_{T1} : Load (Trunk line 1)
L_{T2} : Load (Trunk line 2)
L_{B1} : Load (Branch Line 1)
L_{B2} : Load (Branch Line 2)
L_{B3} : Load (Branch Line 3)

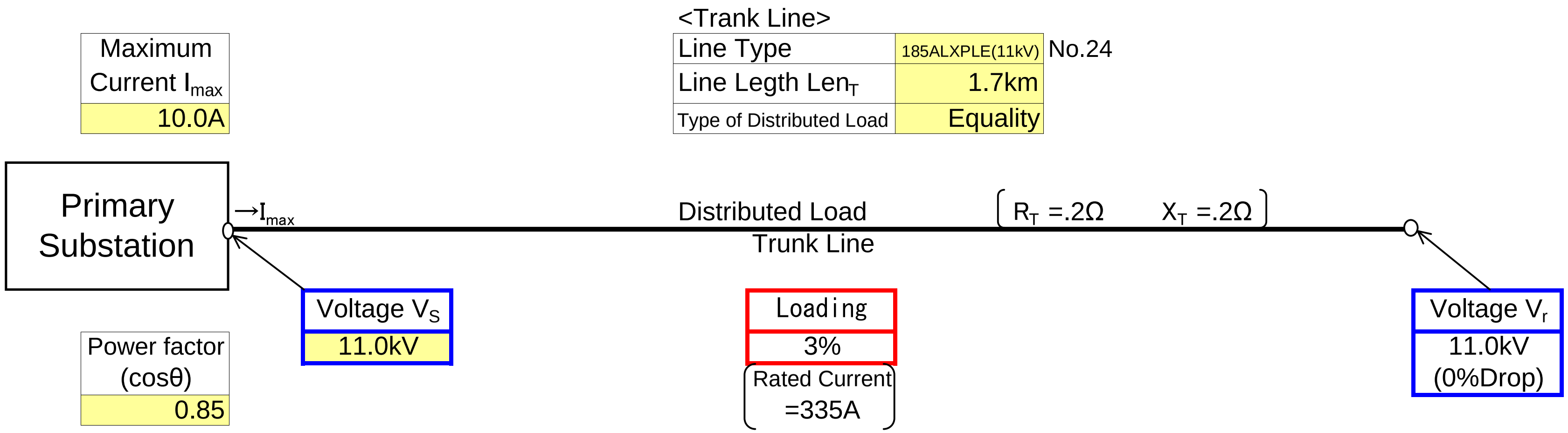
$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$: Resistance
$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$: Reactance
$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$: Dispersal Load Factor
$CAP_{T1}, CAP_{T2}, CAP_{B1}, CAP_{B2}, CAP_{B3}$: Total Transformer Capacity of secondary substations
$\cos\theta$: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B01

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B09

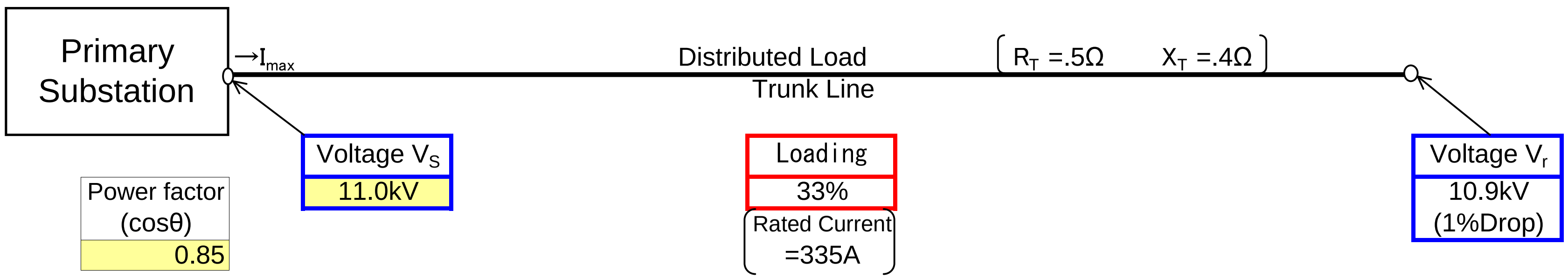
: Input data in colored cells

Type-1

Maximum Current I_{max}	110.0A

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	3.5km	
Type of Distributed Load	Equality	



Power factor (cosθ)	0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B11

: Input data in colored cells

Type-2

Maximum Current I_{max}
110.0A

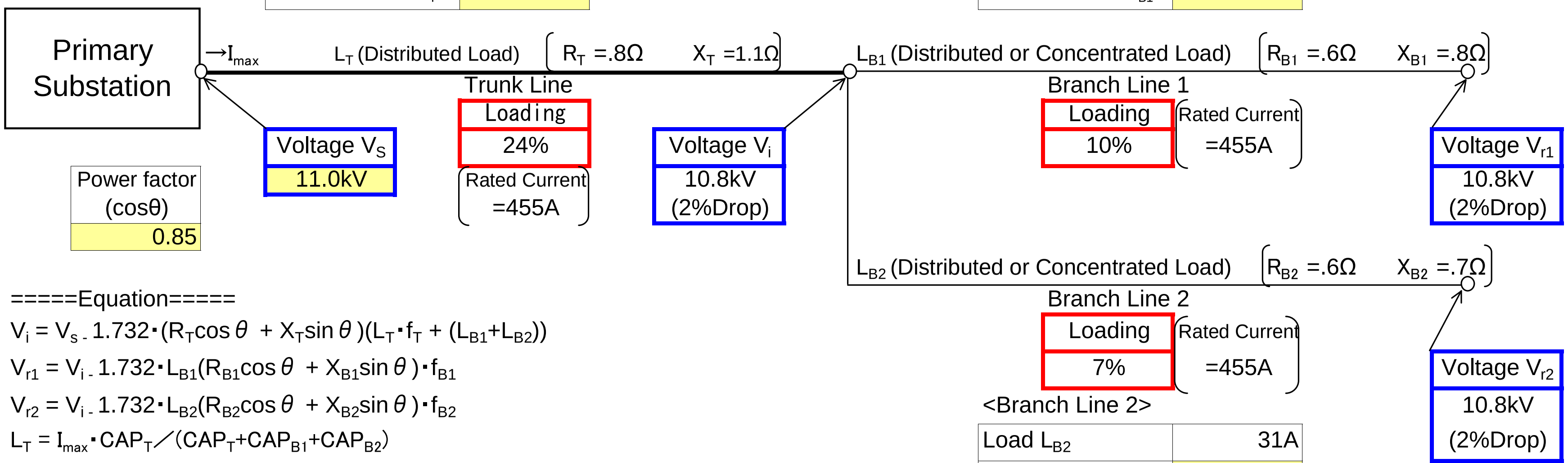
Power factor (cosθ)
0.85

<Trank Line>

Load L_T	35A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	3.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	1730kVA	

<Branch Line 1>

Load L_{B1}	44A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	2.2km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	2145kVA	



<Branch Line 2>

Load L_{B2}	31A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	2.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1545kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_T, R_{B1}, R_{B2}	: Resistance
V_i	: Interim Voltage	L_T	: Load (Trunk line)	X_T, X_{B1}, X_{B2}	: Reactance
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	cosθ	: Power Factor
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	f_T, f_{B1}, f_{B2}	: Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station B
Feeder Name	B21

: Input data in colored cells

Type-3

Maximum Current I_{max}
270.0A

Power factor (cosθ)
0.95

<Trank Line 1>

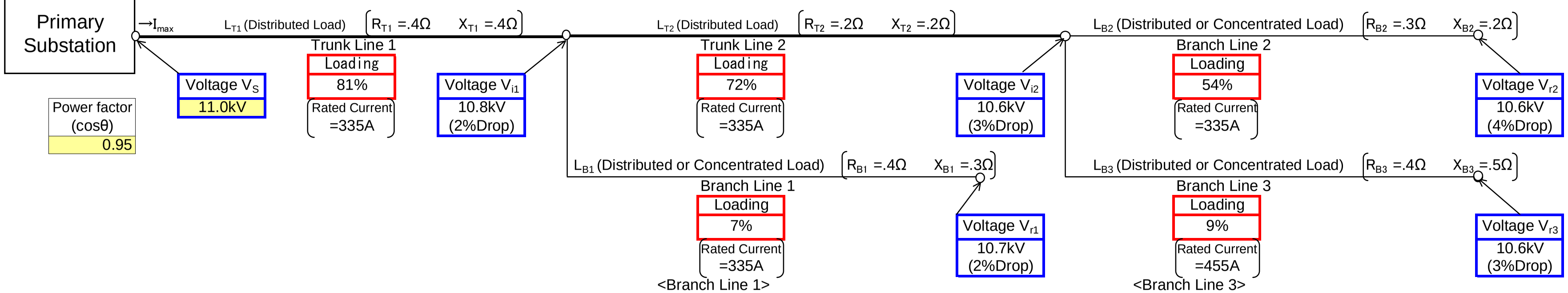
Load L_{T1}	7A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	2.9km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	400kVA	

<Trank Line 2>

Load L_{T2}	18A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T2}	1.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	1000kVA	

<Branch Line 2>

Load L_{B2}	182A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	1.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	10180kVA	



<Branch Line 1>

Load L_{B1}	23A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	2.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1300kVA	

<Branch Line 3>

Load L_{B3}	40A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	1.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	2230kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

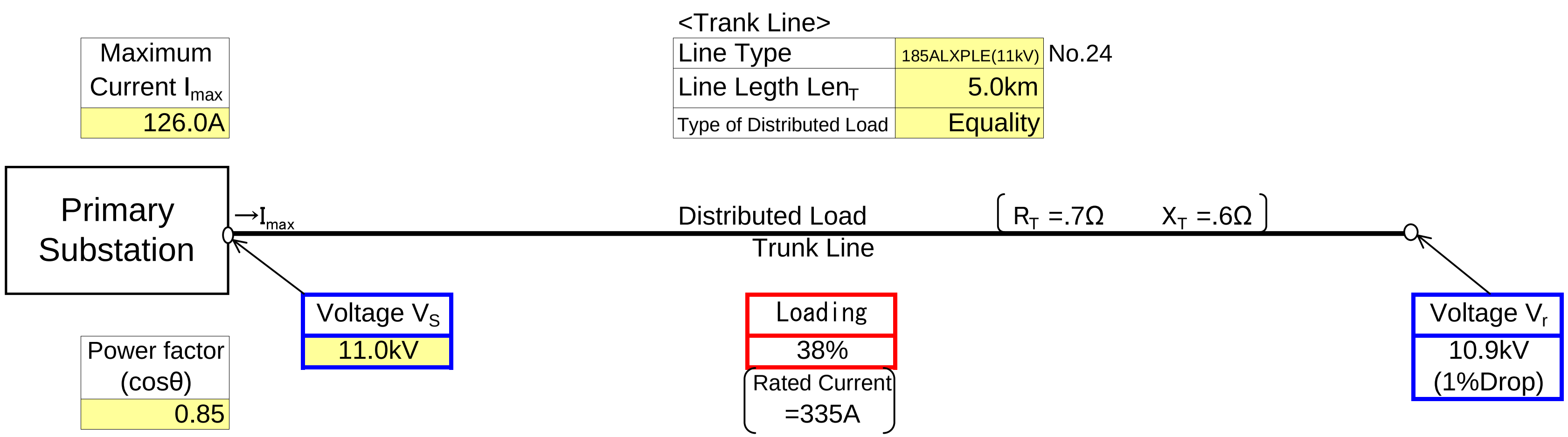
V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B32

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B41

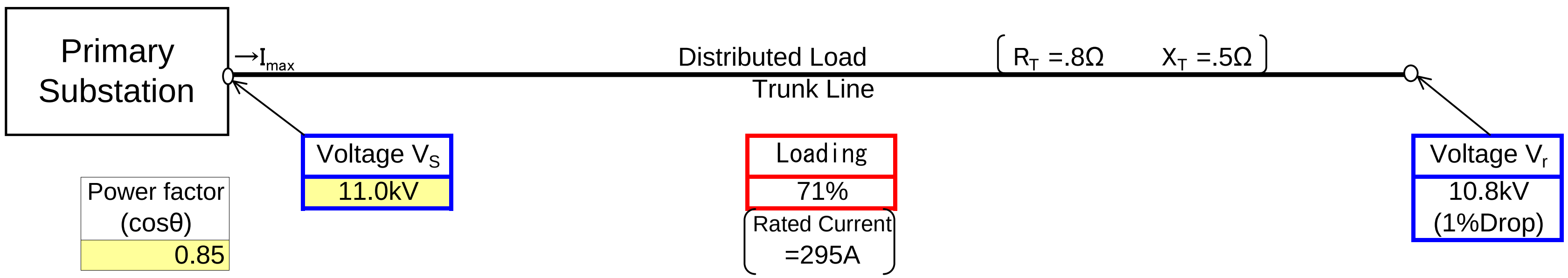
: Input data in colored cells

Type-1

Maximum Current I_{max}
210.0A

<Trank Line>

Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	3.9km	
Type of Distributed Load	Equality	



Power factor (cosθ)
0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

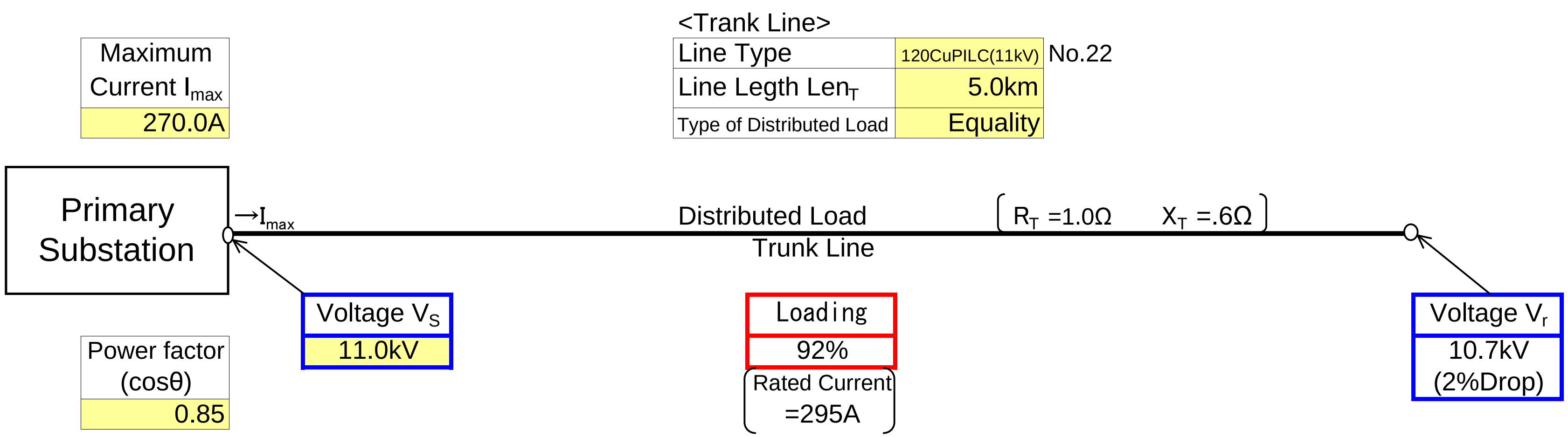
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station B
Feeder Name	B51

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

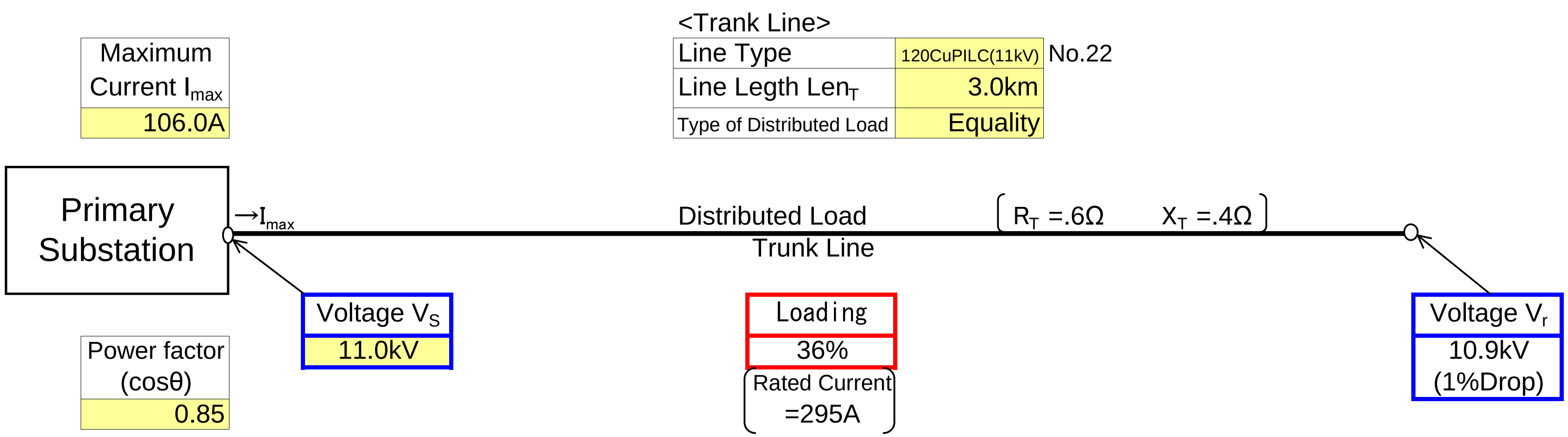
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B52

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B67

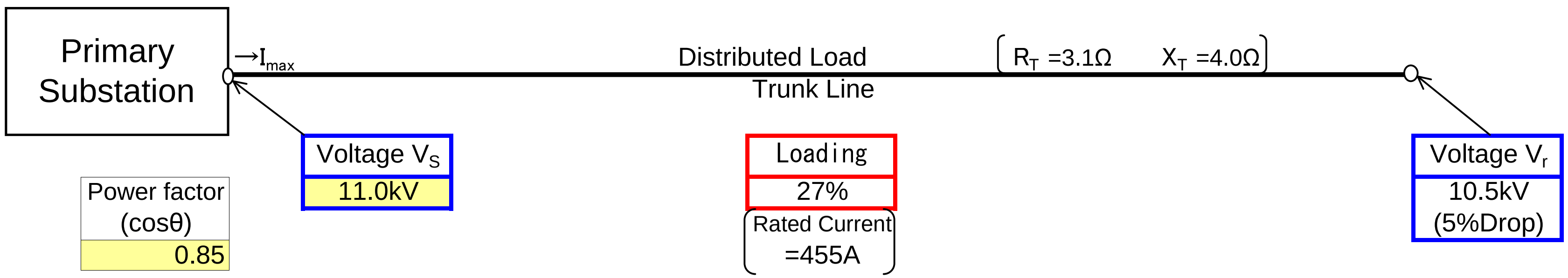
: Input data in colored cells

Type-1

Maximum Current I_{max}	125.0A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	11.3km	
Type of Distributed Load	Equality	



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_S	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B71(GHACEM)

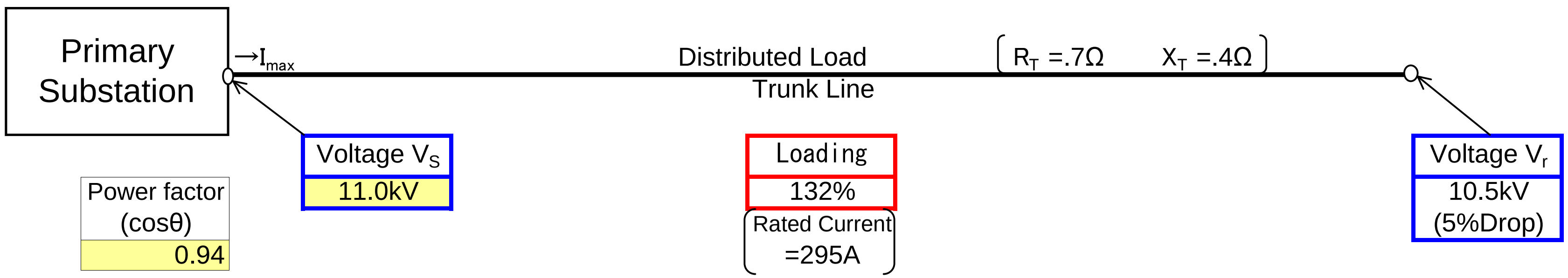
: Input data in colored cells

Type-1

Maximum Current I_{max}	390.0A

<Trank Line>

Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	3.5km	
Type of Distributed Load	Concentrated	



Power factor (cosθ)	0.94

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B81

: Input data in colored cells

Type-2

Maximum Current I_{max}
175.0A

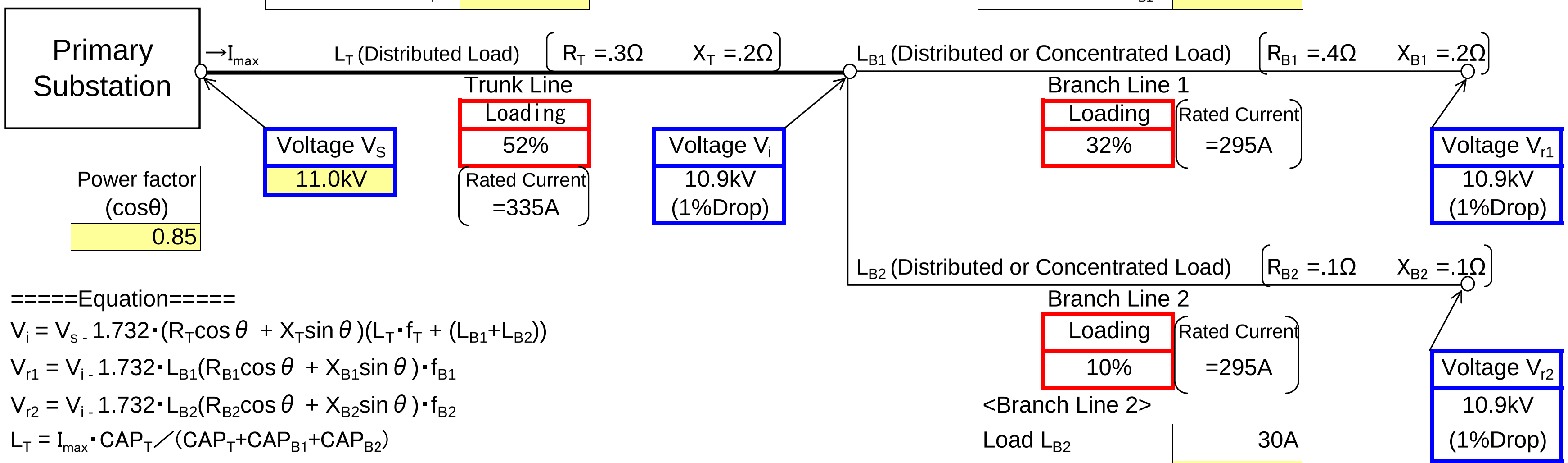
Power factor (cosθ)
0.85

<Trank Line>

Load L_T	49A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	1.9km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	1300kVA	

<Branch Line 1>

Load L_{B1}	95A	
Line Type	120CuPILC(11kV)	No.22
Line Length Len_{B1}	2.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	2500kVA	



<Branch Line 2>

Load L_{B2}	30A	
Line Type	120CuPILC(11kV)	No.22
Line Length Len_{B1}	.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	800kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor

V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station B
Feeder Name	B87

: Input data in colored cells

Type-2

Maximum Current I_{max}
120.0A

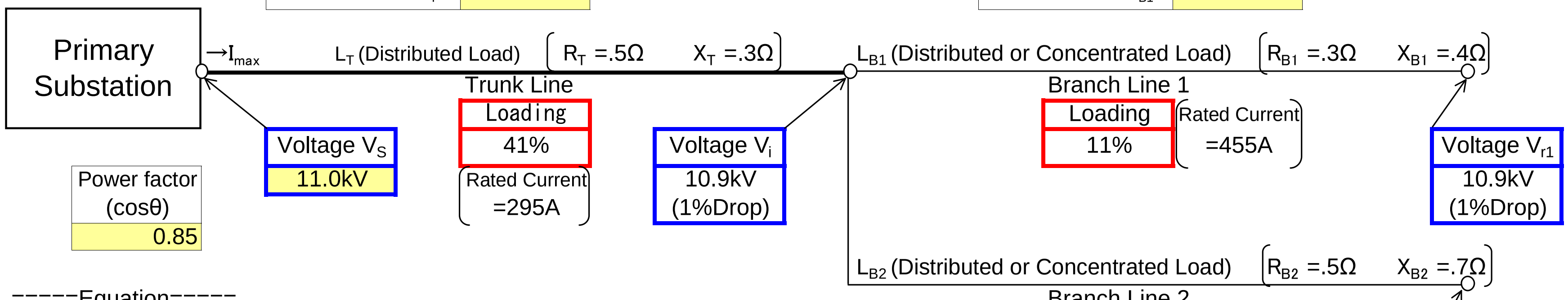
Power factor (cosθ)
0.85

<Trank Line>

Load L_T	49A	
Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	2.7km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_T	1600kVA	

<Branch Line 1>

Load L_{B1}	50A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	1.2km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1615kVA	



<Branch Line 2>

Load L_{B2}	21A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	2.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	680kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage
V_i : Interim Voltage
V_{r1} : Received Voltage
V_{r2} : Received Voltage

I_{max} : Maximum Current
L_T : Load (Trunk line)
L_{B1} : Load (Branch Line 1)
L_{B2} : Load (Branch Line 2)

R_T, R_{B1}, R_{B2} : Resistance
X_T, X_{B1}, X_{B2} : Reactance
cosθ : Power Factor
f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station C
Feeder Name	C01

: Input data in colored cells

Type-2

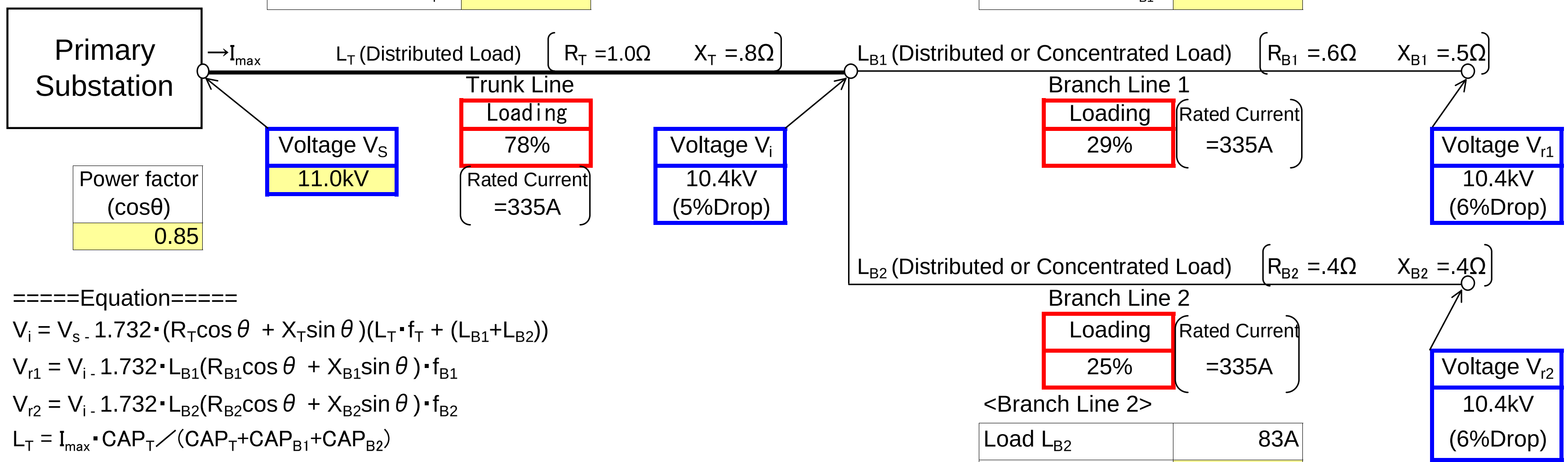
<Trank Line>

Load L_T	80A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	6.6km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_T	2215kVA	

<Branch Line 1>

Load L_{B1}	96A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	3.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	2650kVA	

Maximum Current I_{max}	260.0A
Power factor (cosθ)	0.85



<Branch Line 2>

Load L_{B2}	83A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	3.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	2300kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_T, R_{B1}, R_{B2}	: Resistance
V_i	: Interim Voltage	L_T	: Load (Trunk line)	X_T, X_{B1}, X_{B2}	: Reactance
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	cosθ	: Power Factor
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	f_T, f_{B1}, f_{B2}	: Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN C
Feeder Name	C02

: Input data in colored cells

Type-1

Maximum Current I_{max}
140.0A

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	2.5km	
Type of Distributed Load	Equality	

Primary Substation

$\rightarrow I_{max}$

Distributed Load

Trunk Line

R_T =.4Ω　X_T =.3Ω

Power factor (cosθ)
0.90

Voltage V_S
11.0kV

Loading
42%

Rated Current =335A

Voltage V_r
10.9kV (1%Drop)

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station C
Feeder Name	C02

: Input data in colored cells

Type-2

<Trank Line>

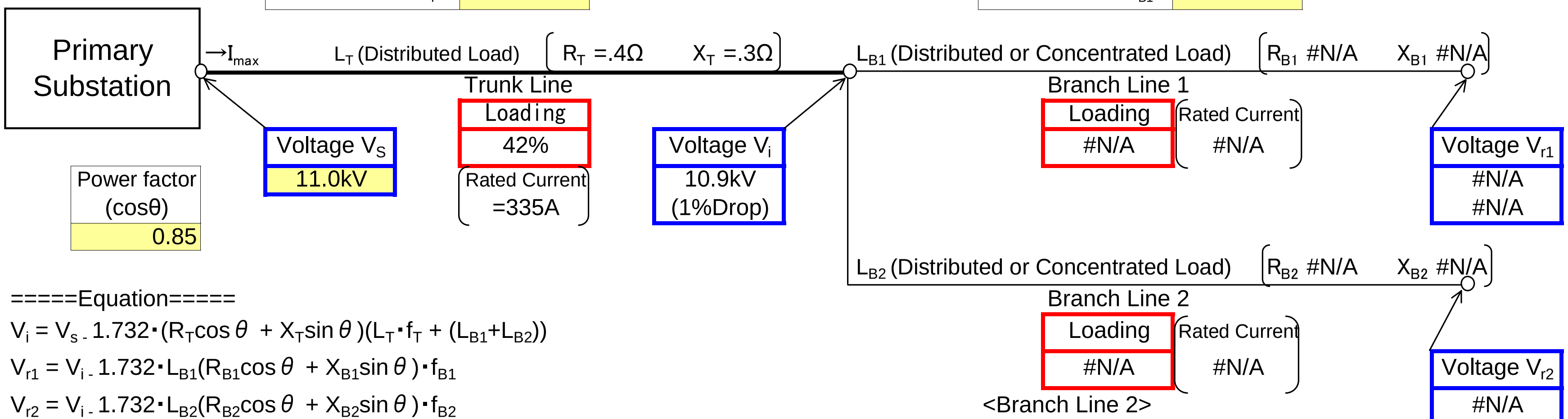
Load L_T	140A
Line Type	185ALXPLE(11kV) No.24
Line Legth Len_T	2.5km
Type of Distributed Load	Equality
Total Transformer Capacity of secondary substations CAP_T	3500kVA

<Branch Line 1>

Load L_{B1}	A
Line Type	#N/A
Line Length Len_{B1}	
Type of Distributed Load	
Total Transformer Capacity of secondary substations CAP_{B1}	

Maximum Current I_{max}
140.0A

Power factor (cosθ)
0.85



<Branch Line 2>

Load L_{B2}	A
Line Type	#N/A
Line Length Len_{B1}	
Type of Distributed Load	
Total Transformer Capacity of secondary substations CAP_{B2}	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage　I_{max} : Maximum Current　R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage　L_T : Load (Trunk line)　X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage　L_{B1} : Load (Branch Line 1)　cosθ : Power Factor

V_{r2} : Received Voltage　L_{B2} : Load (Branch Line 2)　f_T, f_{B1}, f_{B2} : Dispersal Load Factor　CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station C
Feeder Name	C08

: Input data in colored cells

Type-2

Maximum Current I_{max}
220.0A

Power factor ($\cos\theta$)
0.85

<Trank Line>

Load L_T	A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	1.3km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_T	kVA	

<Branch Line 1>

Load L_{B1}	49A	
Line Type	Cu35mm2	No.15
Line Length Len_{B1}	1.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1915kVA	

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =.2Ω X_T =.2Ω)

Trunk Line

Loading
66%

(Rated Current =335A)

Voltage V_S
11.0kV

Voltage V_i
10.9kV (1%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =1.3Ω X_{B1} =.8Ω)

Branch Line 1

Loading
21%

(Rated Current =236A)

Voltage V_{r1}
10.8kV (1%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =10.3Ω X_{B2} =13.5Ω)

Branch Line 2

Loading
38%

(Rated Current =455A)

Voltage V_{r2}
8.6kV (22%Drop)

<Branch Line 2>

Load L_{B2}	171A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	37.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	6645kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

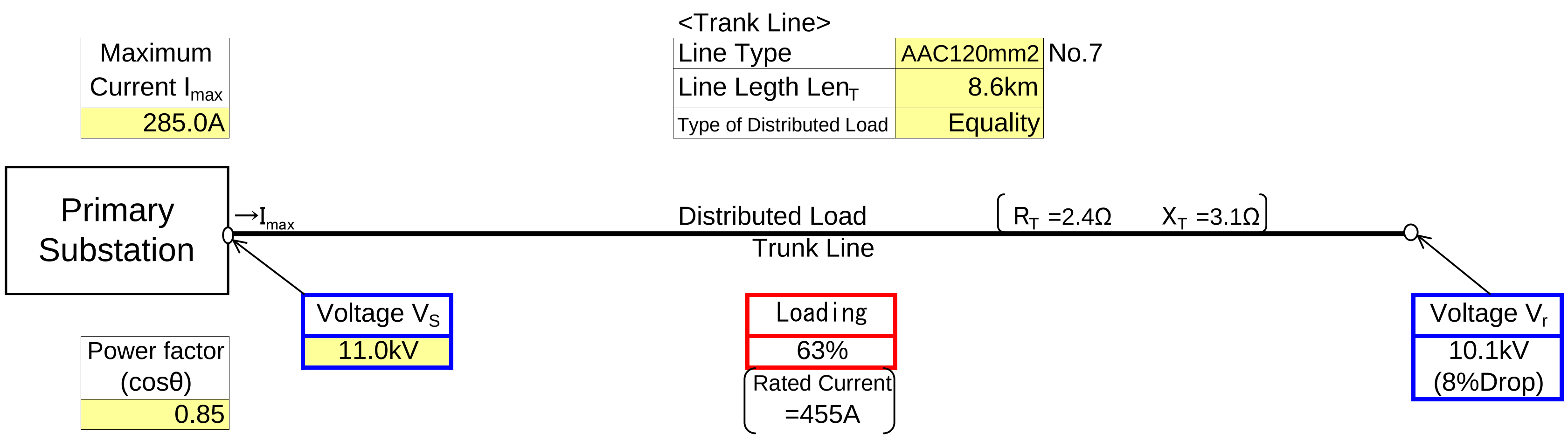
V_s : Supply Voltage
V_i : Interim Voltage
V_{r1} : Received Voltage
V_{r2} : Received Voltage
I_{max} : Maximum Current
L_T : Load (Trunk line)
L_{B1} : Load (Branch Line 1)
L_{B2} : Load (Branch Line 2)
R_T, R_{B1}, R_{B2} : Resistance
X_T, X_{B1}, X_{B2} : Reactance
$\cos\theta$: Power Factor
f_T, f_{B1}, f_{B2} : Dispersal Load Factor
$CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN C
Feeder Name	C10

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station C
Feeder Name	C10

: Input data in colored cells

Type-2

Maximum Current I_{max}
285.0A

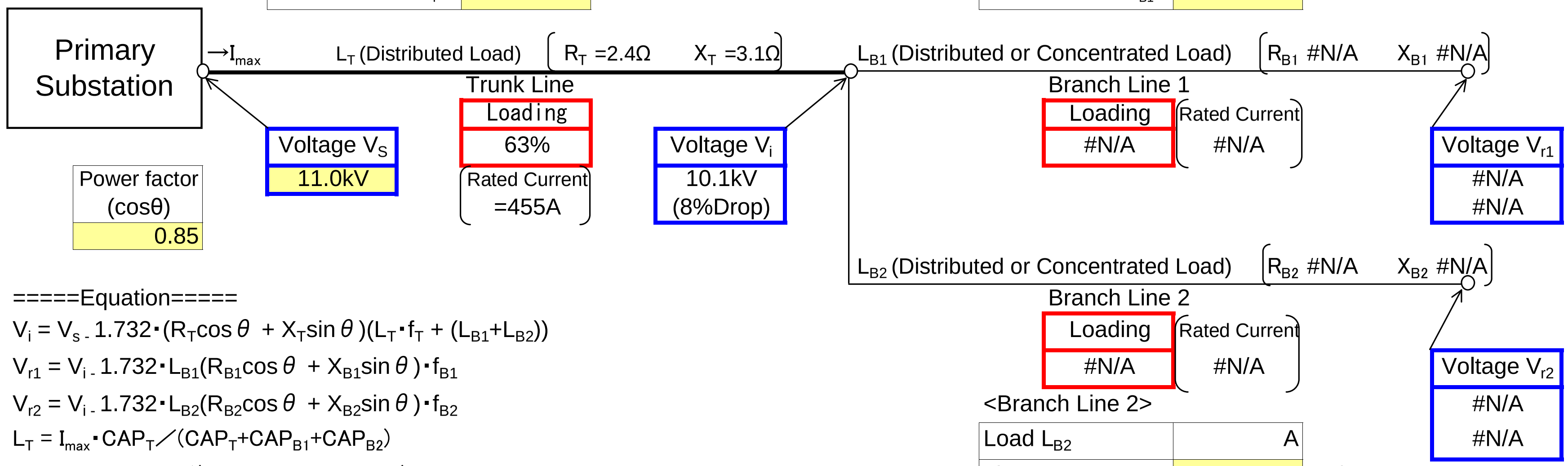
Power factor (cosθ)
0.85

<Trank Line>

Load L_T	285A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	8.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	8175kVA	

<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		



<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor
V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ATUABO
Feeder Name	TEBEREBE 1

: Input data in colored cells

Type-1

Maximum Current I_{max}
238.0A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	8.0km	
Type of Distributed Load	Concentrated	

Primary Substation

$\rightarrow I_{max}$

Distributed Load

Trunk Line

$R_T = 2.2\Omega$ $X_T = 2.9\Omega$

Power factor (cosθ)
0.95

Voltage V_S
33.0kV

Loading
52%

Rated Current =455A

Voltage V_r
31.8kV (4%Drop)

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

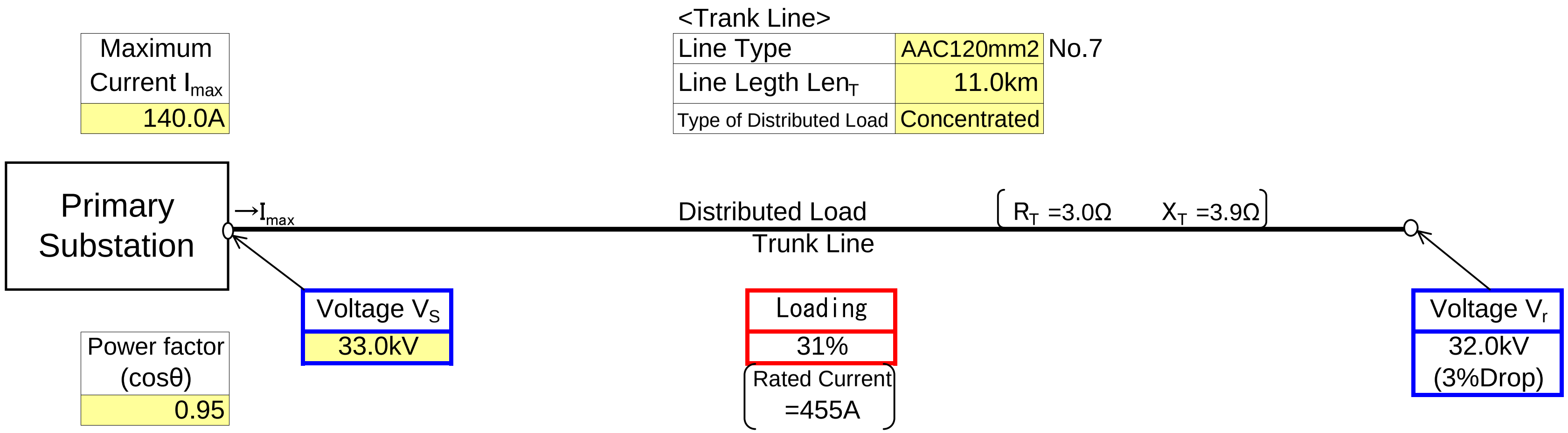
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ATUABO
Feeder Name	TEBEREBE 2

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

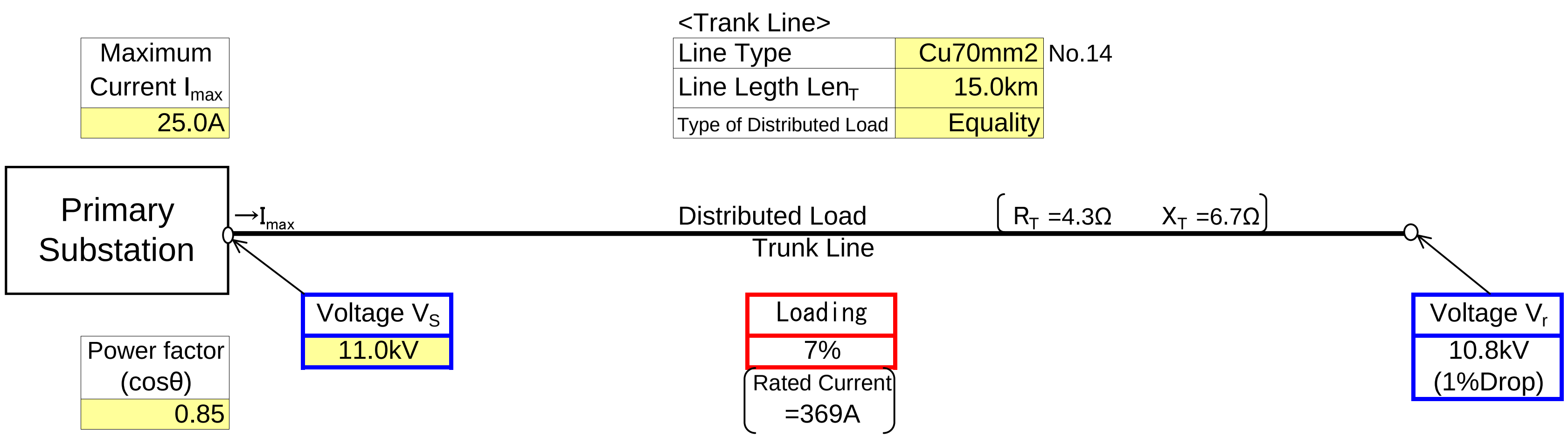
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ATUABO
Feeder Name	TOWN 1

: Input data in colored cells

Type-1



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	ATUABO
Feeder Name	TOWN 2

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	A
Line Type	AAC150mm2 No.6
Line Legth Len_{T1}	7.0km
Type of Distributed Load	Equality
Total Transformer Capacity of secondary substations CAP_{T1}	kVA

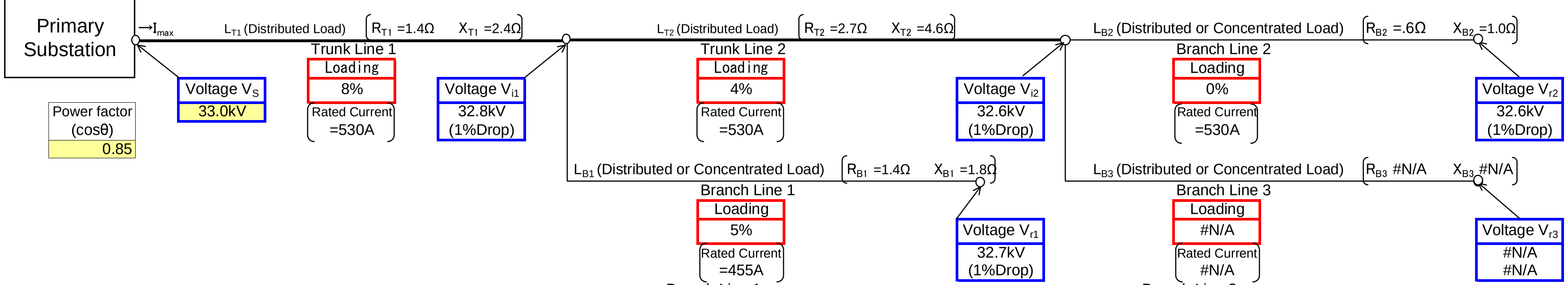
<Trank Line 2>

Load L_{T2}	21A
Line Type	AAC150mm2 No.6
Line Legth Len_{T2}	13.1km
Type of Distributed Load	Concentrated
Total Transformer Capacity of secondary substations CAP_{T2}	5000kVA

<Branch Line 2>

Load L_{B2}	A
Line Type	AAC150mm2 No.6
Line Length Len_{B1}	3.0km
Type of Distributed Load	Concentrated
Total Transformer Capacity of secondary substations CAP_{B2}	3kVA

Maximum Current I_{max}	42.0A
Power factor (cosθ)	0.85



<Branch Line 1>

Load L_{B1}	21A
Line Type	AAC120mm2 No.7
Line Length Len_{B1}	5.0km
Type of Distributed Load	Concentrated
Total Transformer Capacity of secondary substations CAP_{B1}	5000kVA

<Branch Line 3>

Load L_{B3}	A
Line Type	#N/A
Line Length Len_{B3}	
Type of Distributed Load	
Total Transformer Capacity of secondary substations CAP_{B3}	

=====Equation=====

$V_{i1} = V_s - 1.732\cdot(R_{T1}\cos\theta + X_{T1}\sin\theta)\cdot(L_{T1}\cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732\cdot(R_{T2}\cos\theta + X_{T2}\sin\theta)\cdot(L_{T2}\cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732\cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta)\cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732\cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta)\cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732\cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta)\cdot f_{B3}$

$L_{T1} = I_{max}\cdot CAP_{T1}/(CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max}\cdot CAP_{T2}/(CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max}\cdot CAP_{B1}/(CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max}\cdot CAP_{B2}/(CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max}\cdot CAP_{B3}/(CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis

- Western 2007-2017 -

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station C
Feeder Name	AGONA

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	73A	
Line Type	AAC150mm2	No.6
Line Legth Len_T	22.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	4160kVA	

<Branch Line 1>

Load L_{B1}	9A	
Line Type	AAC50mm2	No.11
Line Length Len_{B1}	20.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	500kVA	

Maximum Current I_{max}	82.0A
Power factor (cosθ)	0.85

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) R_T =4.5Ω X_T =7.7Ω

Trunk Line

Loading
15%

Rated Current =530A

Voltage V_S
33.0kV

Voltage V_i
32.2kV (2%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} =12.6Ω X_{B1} =8.0Ω

Branch Line 1

Loading
3%

Rated Current =260A

Voltage V_{r1}
32.1kV (3%Drop)

L_{B2} (Distributed or Concentrated Load) R_{B2} #N/A X_{B2} #N/A

Branch Line 2

Loading
#N/A

Rated Current #N/A

Voltage V_{r2}
#N/A
#N/A

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	BOGOSO
Feeder Name	BOGOSO/ASANKO

: Input data in colored cells

Type-3

Maximum Current I_{max}
94.0A

Power factor (cosθ)
0.94

<Trank Line 1>

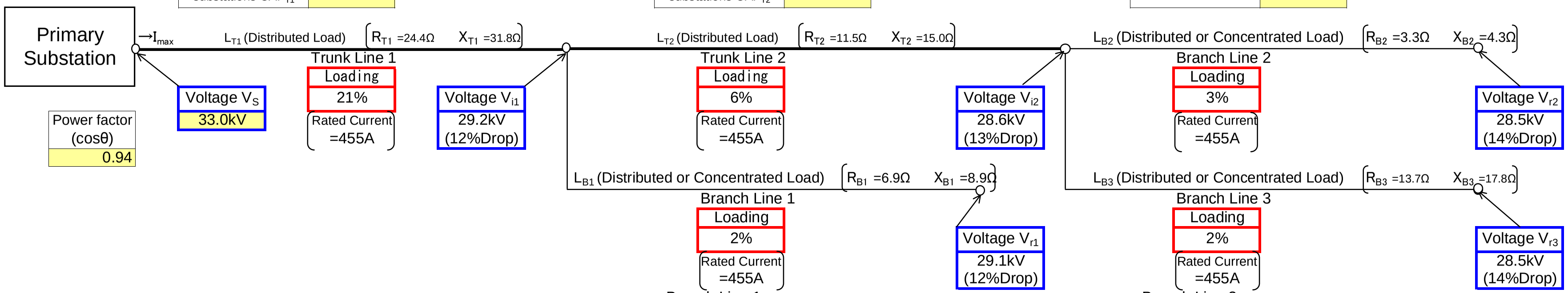
Load L_{T1}	58A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	89.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	6350kVA	

<Trank Line 2>

Load L_{T2}	6A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	42.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	650kVA	

<Branch Line 2>

Load L_{B2}	12A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	12.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	1300kVA	



<Branch Line 1>

Load L_{B1}	11A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	25.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	1150kVA	

<Branch Line 3>

Load L_{B3}	7A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	50.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	800kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

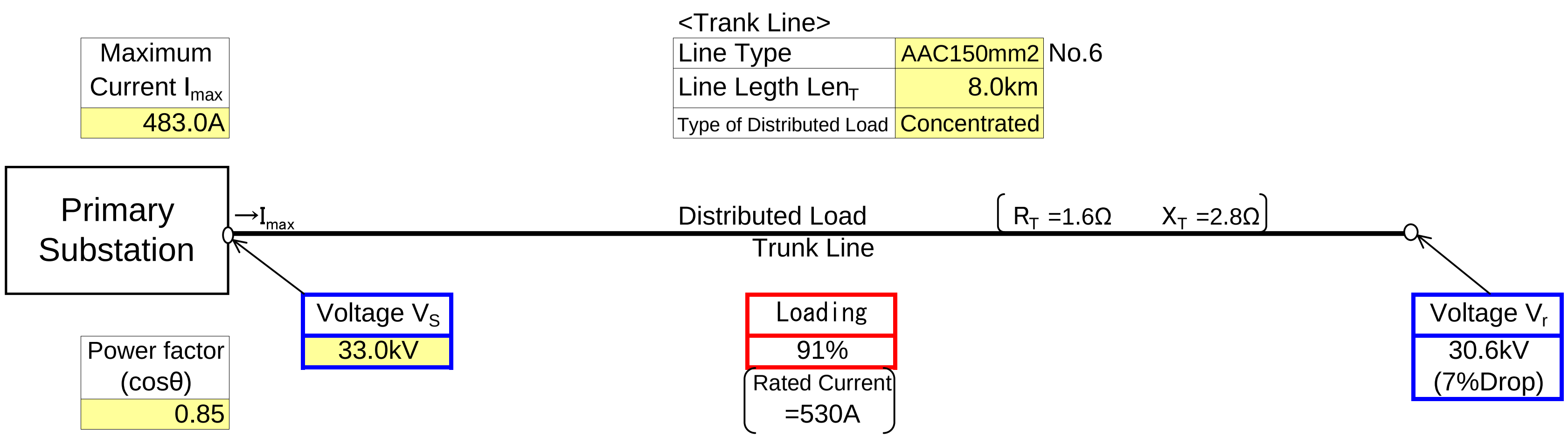
V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	CCT 1

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	CCT 1

: Input data in colored cells

Type-2

<Trank Line>

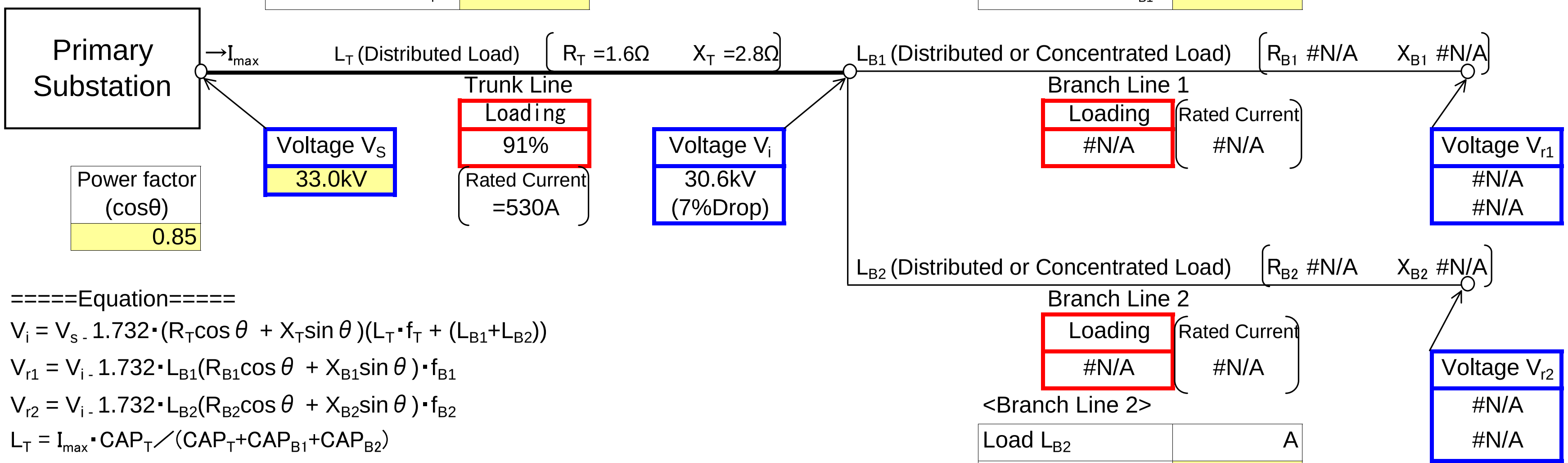
Load L_T	483A	
Line Type	AAC150mm2	No.6
Line Legth Len_T	8.0km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_T	20000kVA	

<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		

Maximum Current I_{max}
483.0A

Power factor (cosθ)
0.85



=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

V_s : Supply Voltage
V_i : Interim Voltage
V_{r1} : Received Voltage
V_{r2} : Received Voltage

I_{max} : Maximum Current
L_T : Load (Trunk line)
L_{B1} : Load (Branch Line 1)
L_{B2} : Load (Branch Line 2)

R_T, R_{B1}, R_{B2} : Resistance
X_T, X_{B1}, X_{B2} : Reactance
cosθ : Power Factor
f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	CCT 2

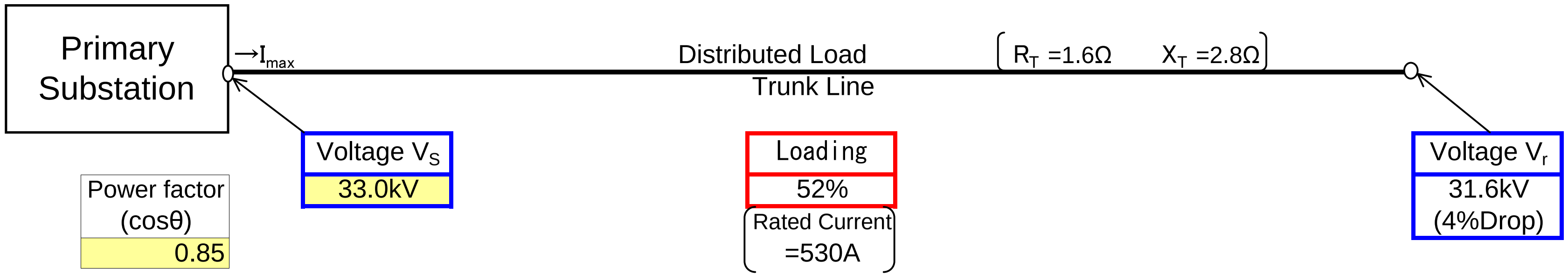
: Input data in colored cells

Type-1

Maximum Current I_{max}
276.0A

<Trank Line>

Line Type	AAC150mm2	No.6
Line Legth Len_T	8.0km	
Type of Distributed Load	Concentrated	



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	CCT 2

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	276A	
Line Type	AAC150mm2	No.6
Line Legth Len_T	8.0km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_T	10000kVA	

<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		

Maximum Current I_{max}	276.0A
Power factor (cosθ)	0.85

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) R_T =1.6Ω X_T =2.8Ω

Trunk Line

Loading
52%

Rated Current =530A

Voltage V_S
33.0kV

Voltage V_i
31.6kV (4%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} #N/A X_{B1} #N/A

Branch Line 1

Loading
#N/A

Rated Current #N/A

Voltage V_{r1}
#N/A
#N/A

L_{B2} (Distributed or Concentrated Load) R_{B2} #N/A X_{B2} #N/A

Branch Line 2

Loading
#N/A

Rated Current #N/A

Voltage V_{r2}
#N/A
#N/A

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1} + L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1} \cos\theta + X_{B1} \sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2} \cos\theta + X_{B2} \sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	CCT 5

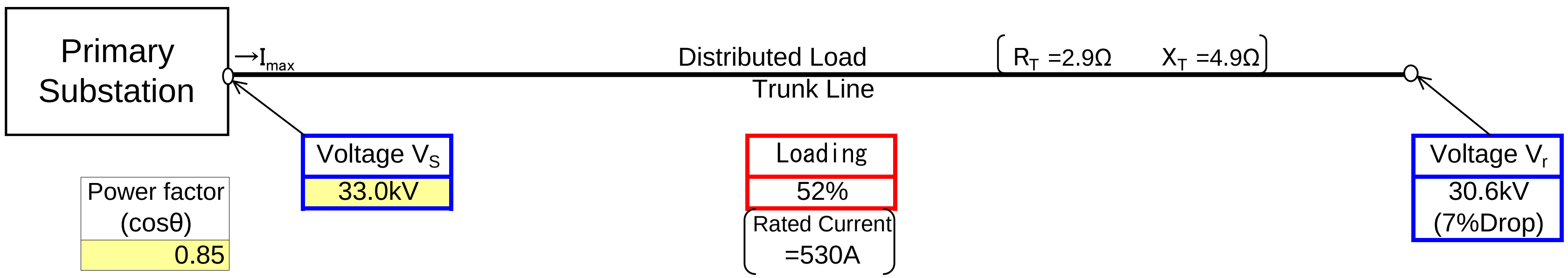
: Input data in colored cells

Type-1

Maximum Current I_{max}	277.0A

<Trank Line>

Line Type	AAC150mm2	No.6
Line Legth Len_T	14.0km	
Type of Distributed Load	Concentrated	



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A09

: Input data in colored cells

Type-1

Maximum Current I_{max}
115.0A

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	4.8km	
Type of Distributed Load	Received Larger	

Primary Substation

$\rightarrow I_{max}$

Distributed Load

Trunk Line

R_T =.7Ω X_T =.6Ω

Power factor (cosθ)
0.85

Voltage V_S
11.0kV

Loading
34%

Rated Current =335A

Voltage V_r
10.9kV (1%Drop)

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A09

: Input data in colored cells

Type-2

Maximum Current I_{max}
115.0A

Power factor (cosθ)
0.85

<Trank Line>

Load L_T	115A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	4.8km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_T	1500kVA	

<Branch Line 1>

Load L_{B1}	A	
Line Type	None	No.33
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =.7Ω X_T =.6Ω)

Trunk Line

Loading
34%

(Rated Current =335A)

Voltage V_S
11.0kV

Voltage V_i
10.9kV (1%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =.0Ω X_{B1} =.0Ω)

Branch Line 1

Loading
#DIV/0!

(Rated Current =A)

Voltage V_{r1}
10.9kV (1%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =.0Ω X_{B2} =.0Ω)

Branch Line 2

Loading
#DIV/0!

(Rated Current =A)

Voltage V_{r2}
10.9kV (1%Drop)

<Branch Line 2>

Load L_{B2}	A	
Line Type	None	No.33
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage I_{max} : Maximum Current R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage L_T : Load (Trunk line) X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage L_{B1} : Load (Branch Line 1) cosθ : Power Factor

V_{r2} : Received Voltage L_{B2} : Load (Branch Line 2) f_T, f_{B1}, f_{B2} : Dispersal Load Factor CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A10

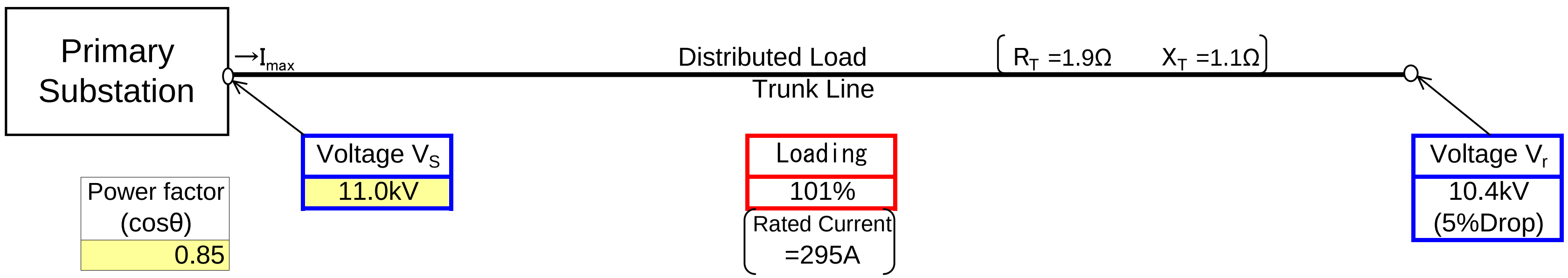
: Input data in colored cells

Type-1

Maximum Current I_{max}	298.0A

<Trank Line>

Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	9.4km	
Type of Distributed Load	Equality	



Power factor (cosθ)	0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	STN A
Feeder Name	A10

: Input data in colored cells

Type-2

<Trank Line>

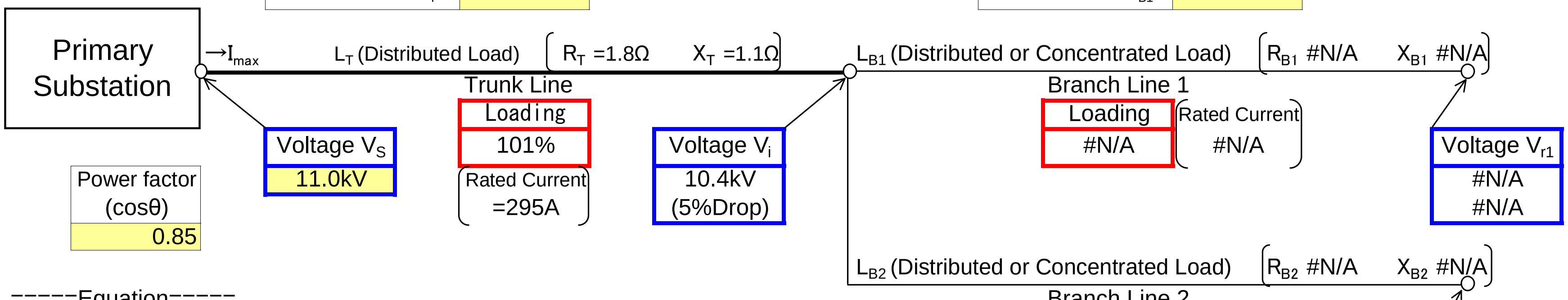
Load L_T	298A	
Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	9.4km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	3680kVA	

<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		

Maximum Current I_{max}
298.0A

Power factor (cosθ)
0.85



Branch Line 2

Loading	Rated Current
#N/A	#N/A

Voltage V_{r2}
#N/A
#N/A

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance	
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance	
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor	
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor	CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Step A (Type-1)

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A13

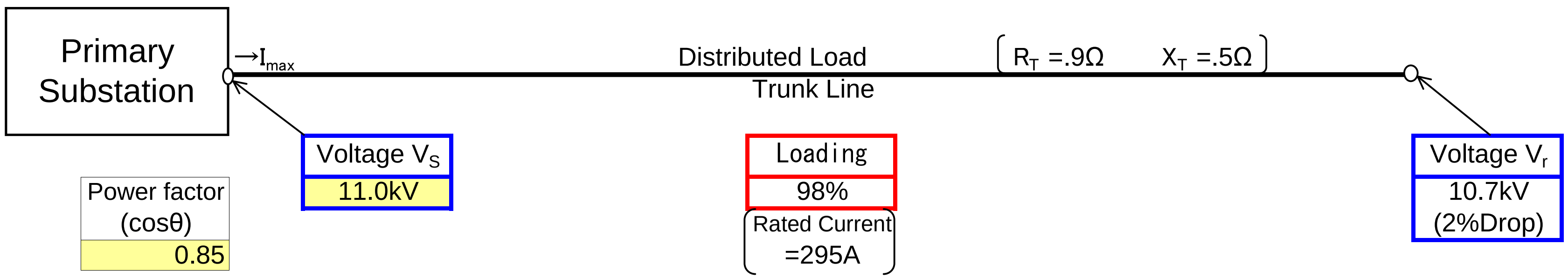
: Input data in colored cells

Type-1

Maximum Current I_{max}	
288.0A	

<Trank Line>

Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	4.5km	
Type of Distributed Load	Equality	



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A13

: Input data in colored cells

Type-2

Maximum Current I_{max}
288.0A

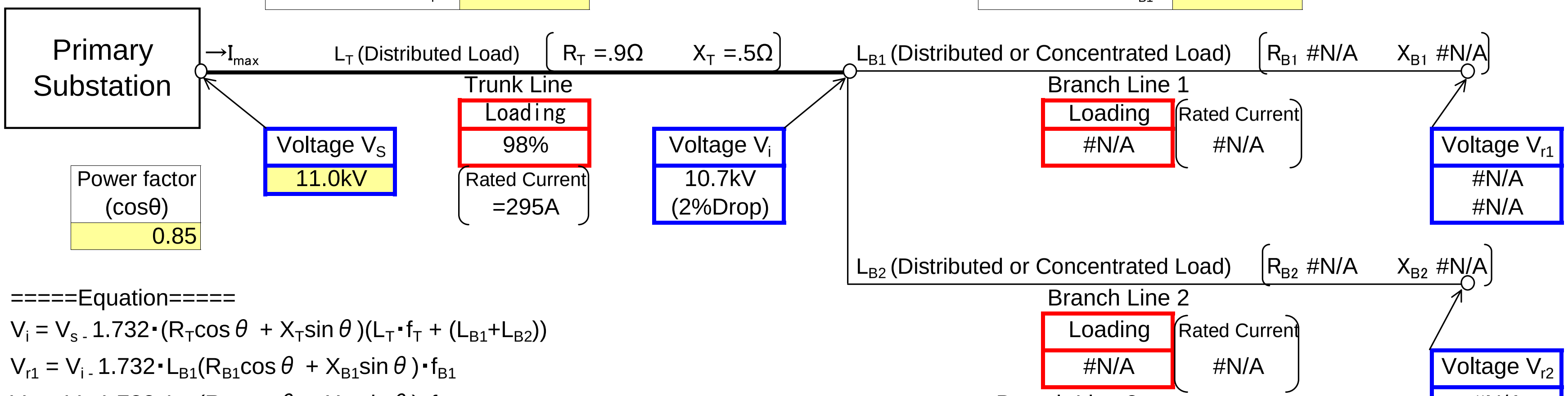
Power factor ($\cos\theta$)
0.85

<Trank Line>

Load L_T	288A	
Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	4.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	3245kVA	

<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		



<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage　I_{max} : Maximum Current　R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage　L_T : Load (Trunk line)　X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage　L_{B1} : Load (Branch Line 1)　$\cos\theta$: Power Factor

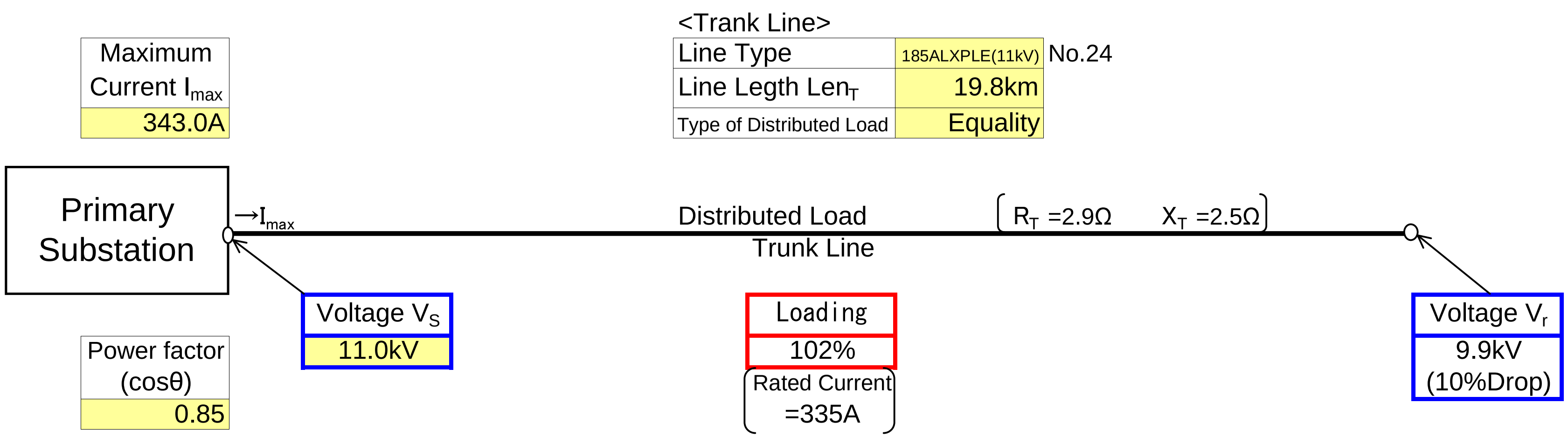
V_{r2} : Received Voltage　L_{B2} : Load (Branch Line 2)　f_T, f_{B1}, f_{B2} : Dispersal Load Factor　CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A 31

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station A
Feeder Name	A31

: Input data in colored cells

Type-2

Maximum Current I_{max}	343.0A

Power factor (cosθ)	0.85

<Trank Line>

Load L_T	154A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	7.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	6945kVA	

<Branch Line 1>

Load L_{B1}	189A	
Line Type	Cu70mm2	No.14
Line Length Len_{B1}	12.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	8520kVA	

Primary Substation

$\rightarrow I_{max}$ L_T (Distributed Load) (R_T =1.2Ω X_T =1.0Ω)

Trunk Line

Loading
102%

(Rated Current =335A)

Voltage V_S
11.0kV

Voltage V_i
10.3kV (6%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =3.5Ω X_{B1} =5.3Ω)

Branch Line 1

Loading
51%

(Rated Current =369A)

Voltage V_{r1}
9.4kV (15%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} #N/A X_{B2} #N/A)

Branch Line 2

Loading
#N/A

(Rated Current #N/A)

Voltage V_{r2}
#N/A
#N/A

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_T, R_{B1}, R_{B2}	: Resistance
V_i	: Interim Voltage	L_T	: Load (Trunk line)	X_T, X_{B1}, X_{B2}	: Reactance
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	cosθ	: Power Factor
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	f_T, f_{B1}, f_{B2}	: Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station A
Feeder Name	A31 (1 of 2)

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	233A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	4.3km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	4715kVA	

<Branch Line 1>

Load L_{B1}	35A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	.9km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	715kVA	

Maximum Current I_{max}	343.0A
Power factor (cosθ)	0.85

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) R_T =.6Ω X_T =.5Ω

Trunk Line

Loading
102%

Rated Current =335A

Voltage V_S
11.0kV

Voltage V_i
10.7kV (3%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} =.1Ω X_{B1} =.1Ω

Branch Line 1

Loading
11%

Rated Current =335A

Voltage V_{r1}
10.7kV (3%Drop)

L_{B2} (Distributed or Concentrated Load) R_{B2} =.5Ω X_{B2} =.4Ω

Branch Line 2

Loading
22%

Rated Current =335A

Voltage V_{r2}
10.6kV (3%Drop)

<Branch Line 2>

Load L_{B2}	75A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	3.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1515kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_T, R_{B1}, R_{B2}	: Resistance
V_i	: Interim Voltage	L_T	: Load (Trunk line)	X_T, X_{B1}, X_{B2}	: Reactance
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	cosθ	: Power Factor
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	f_T, f_{B1}, f_{B2}	: Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station A
Feeder Name	A31 (2 of 2)

: Input data in colored cells

Type-2

Maximum Current I_{max}	205.0A

Power factor (cosθ)	0.85

<Trank Line>

Load L_T	94A	
Line Type	Cu70mm2	No.14
Line Legth Len_T	3.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	2245kVA	

<Branch Line 1>

Load L_{B1}	47A	
Line Type	Cu70mm2	No.14
Line Length Len_{B1}	1.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	1115kVA	

Primary Substation

→I_{max} L_T (Distributed Load) (R_T =1.1Ω X_T =1.6Ω)

Trunk Line

Loading
56%

(Rated Current =369A)

Voltage V_S
10.6kV

Voltage V_i
10.1kV (5%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =.3Ω X_{B1} =.4Ω)

Branch Line 1

Loading
13%

(Rated Current =369A)

Voltage V_{r1}
10.1kV (5%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =.5Ω X_{B2} =.4Ω)

Branch Line 2

Loading
19%

(Rated Current =335A)

Voltage V_{r2}
10.1kV (5%Drop)

<Branch Line 2>

Load L_{B2}	64A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	3.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1515kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage
V_i : Interim Voltage
V_{r1} : Received Voltage
V_{r2} : Received Voltage
I_{max} : Maximum Current
L_T : Load (Trunk line)
L_{B1} : Load (Branch Line 1)
L_{B2} : Load (Branch Line 2)
R_T, R_{B1}, R_{B2} : Resistance
X_T, X_{B1}, X_{B2} : Reactance
cosθ : Power Factor
f_T, f_{B1}, f_{B2} : Dispersal Load Factor
CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	STN A
Feeder Name	EEDER A31 (2 of 2

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	79A
Line Type	Cu70mm2 No.14
Line Legth Len_{T1}	3.7km
Type of Distributed Load	Equality
Total Transformer Capacity of secondary substations CAP_{T1}	3445kVA

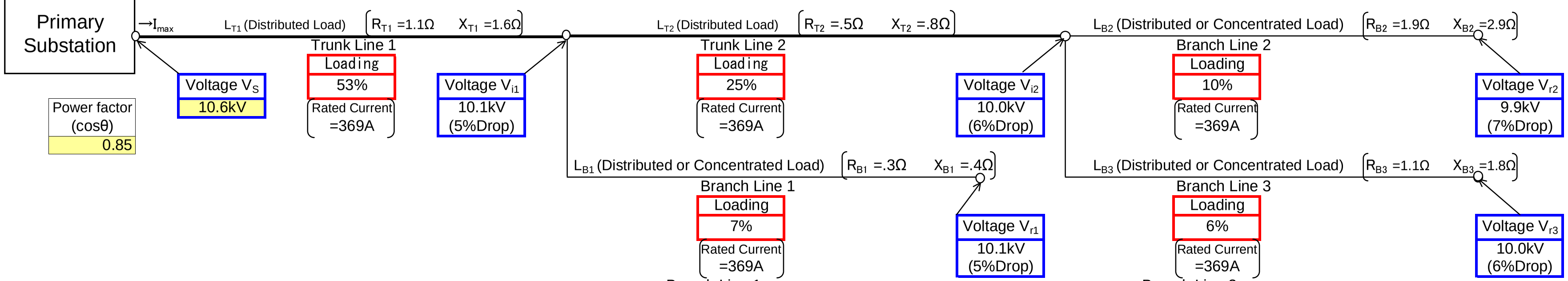
<Trank Line 2>

Load L_{T2}	32A
Line Type	Cu70mm2 No.14
Line Legth Len_{T2}	1.7km
Type of Distributed Load	Equality
Total Transformer Capacity of secondary substations CAP_{T2}	1400kVA

<Branch Line 2>

Load L_{B2}	38A
Line Type	Cu70mm2 No.14
Line Length Len_{B1}	6.6km
Type of Distributed Load	Equality
Total Transformer Capacity of secondary substations CAP_{B2}	1645kVA

Maximum Current I_{max}	196.0A
Power factor (cosθ)	0.85



<Branch Line 1>

Load L_{B1}	26A
Line Type	Cu70mm2 No.14
Line Length Len_{B1}	1.0km
Type of Distributed Load	Received Larger
Total Transformer Capacity of secondary substations CAP_{B1}	1115kVA

<Branch Line 3>

Load L_{B3}	21A
Line Type	Cu70mm2 No.14
Line Length Len_{B3}	4.0km
Type of Distributed Load	Equality
Total Transformer Capacity of secondary substations CAP_{B3}	915kVA

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A41

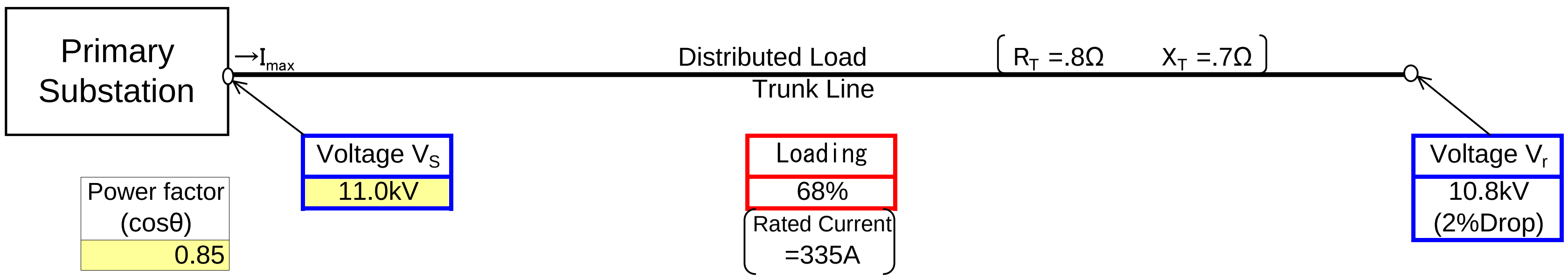
: Input data in colored cells

Type-1

Maximum Current I_{max}
227.0A

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	5.4km	
Type of Distributed Load	Middle Larger	



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	
Feeder Name	A41

: Input data in colored cells

Type-2

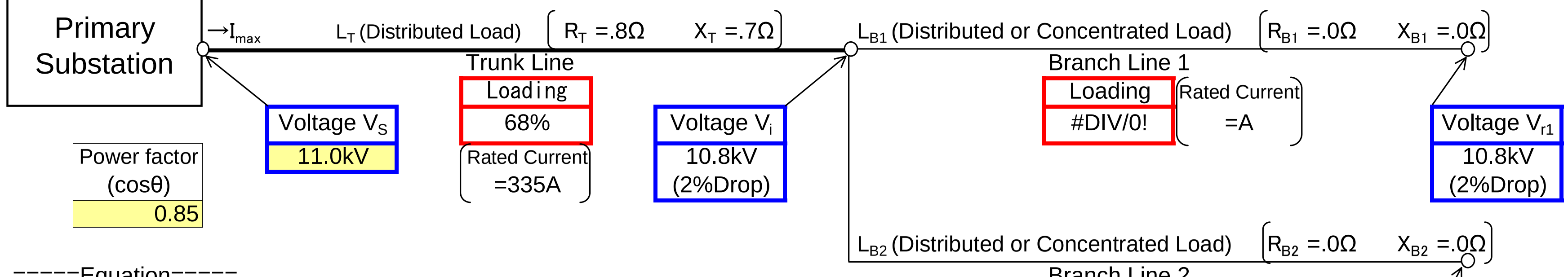
<Trank Line>

Load L_T	227A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	5.4km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_T	2300kVA	

<Branch Line 1>

Load L_{B1}	A	
Line Type	None	No.33
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		

Maximum Current I_{max}	227.0A
Power factor (cosθ)	0.85



<Branch Line 2>

Load L_{B2}	A	
Line Type	None	No.33
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

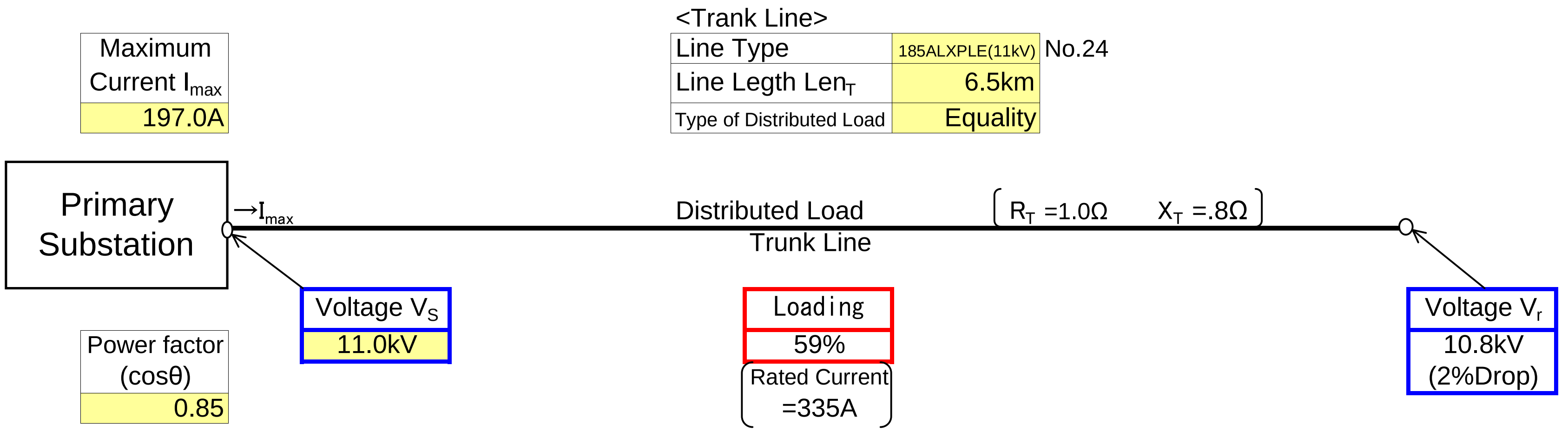
$CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A44

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A44

: Input data in colored cells

Type-2

Maximum Current I_{max}
197.0A

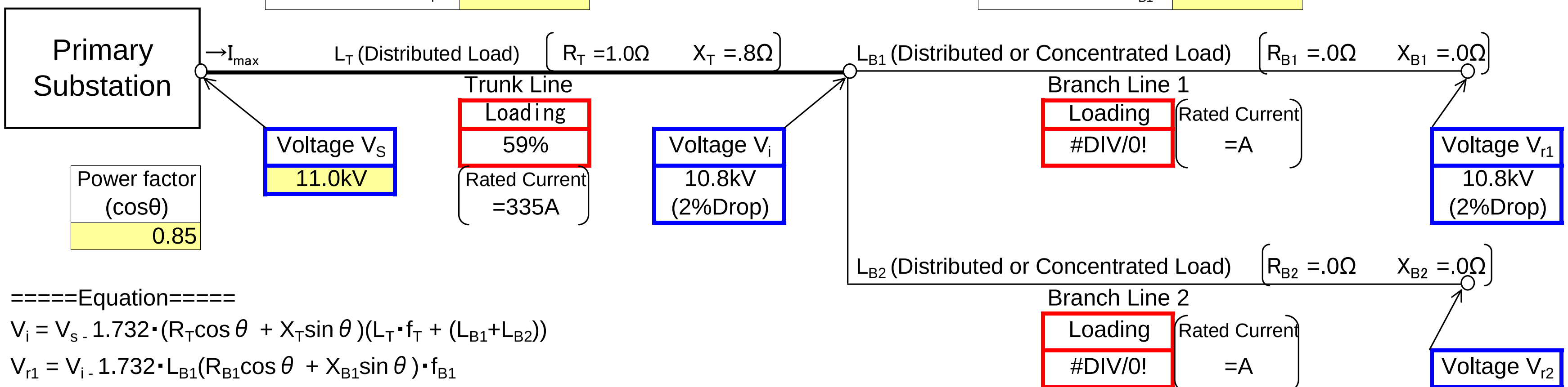
<Trank Line>

Load L_T	197A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	6.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	2300kVA	

<Branch Line 1>

Load L_{B1}	A	
Line Type	None	No.33
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		

Power factor (cosθ)
0.85



<Branch Line 2>

Load L_{B2}	A	
Line Type	None	No.33
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance	
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance	
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor	
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor	CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A55

: Input data in colored cells

Type-2

Maximum Current I_{max}
365.0A

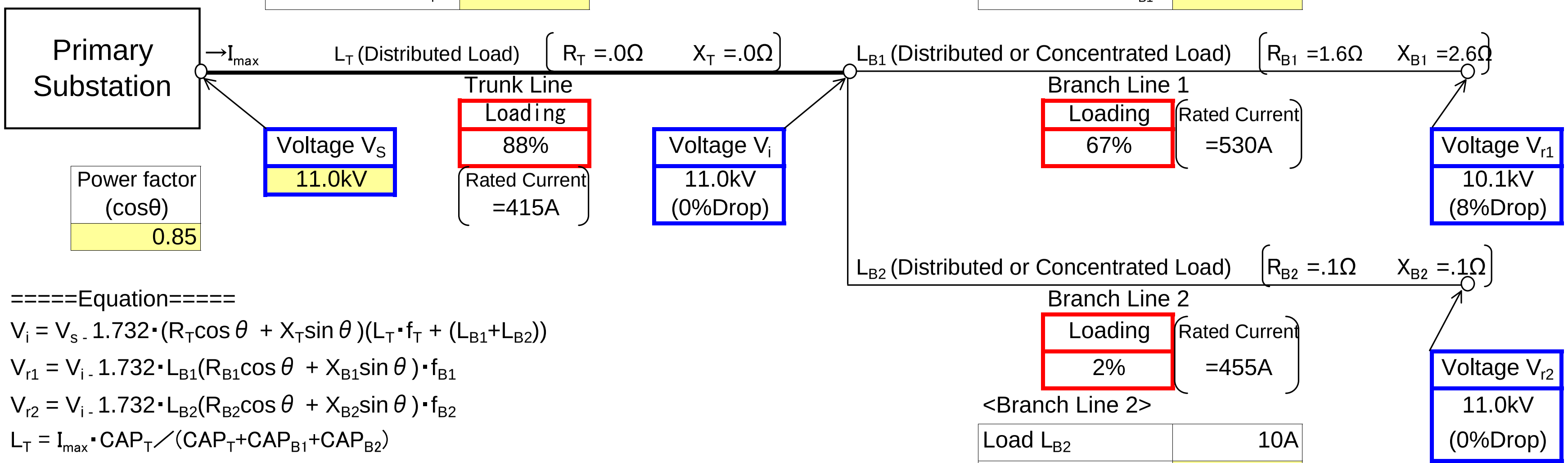
Power factor (cosθ)
0.85

<Trank Line>

Load L_T	A	
Line Type	240CuPILC(11kV)	No.25
Line Legth Len_T	.4km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	kVA	

<Branch Line 1>

Load L_{B1}	355A	
Line Type	AAC150mm2	No.6
Line Length Len_{B1}	7.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	10715kVA	



<Branch Line 2>

Load L_{B2}	10A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	.3km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_{B2}	315kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A57

: Input data in colored cells

Type-2

Maximum Current I_{max}
148.0A

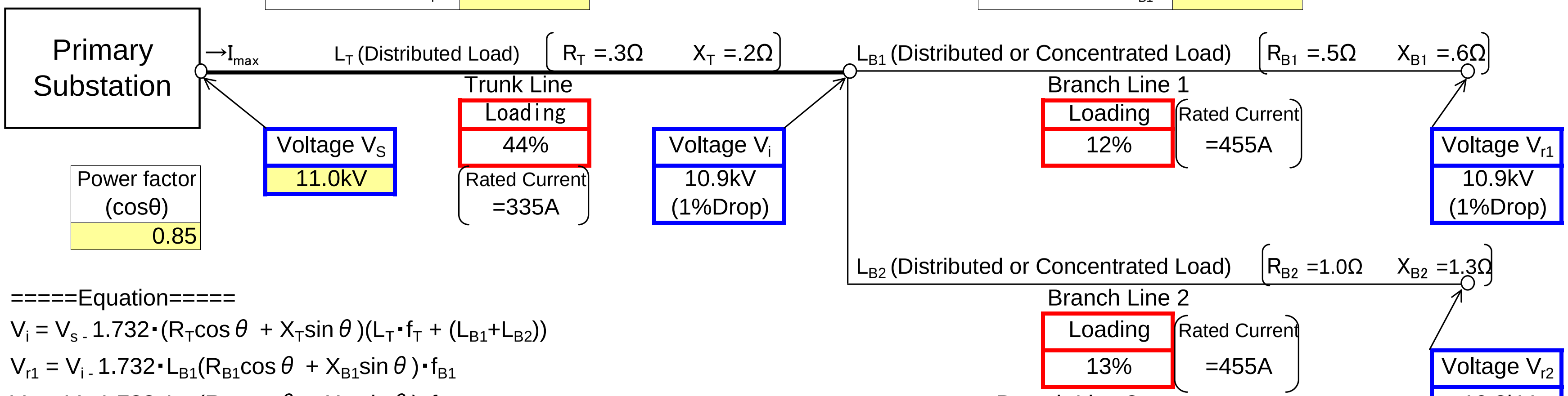
Power factor (cosθ)
0.85

<Trank Line>

Load L_T	34A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	1.9km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	615kVA	

<Branch Line 1>

Load L_{B1}	55A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	1.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1015kVA	



<Branch Line 2>

Load L_{B2}	59A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	3.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1080kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_T, R_{B1}, R_{B2}	: Resistance
V_i	: Interim Voltage	L_T	: Load (Trunk line)	X_T, X_{B1}, X_{B2}	: Reactance
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	cosθ	: Power Factor
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	f_T, f_{B1}, f_{B2}	: Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B01

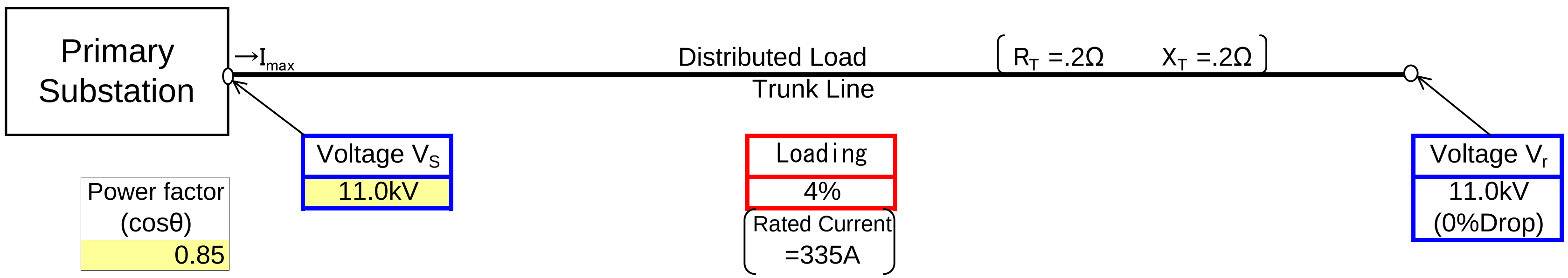
: Input data in colored cells

Type-1

Maximum Current I_{max}
15.0A

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	1.7km	
Type of Distributed Load	Equality	



Power factor (cosθ)
0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B09

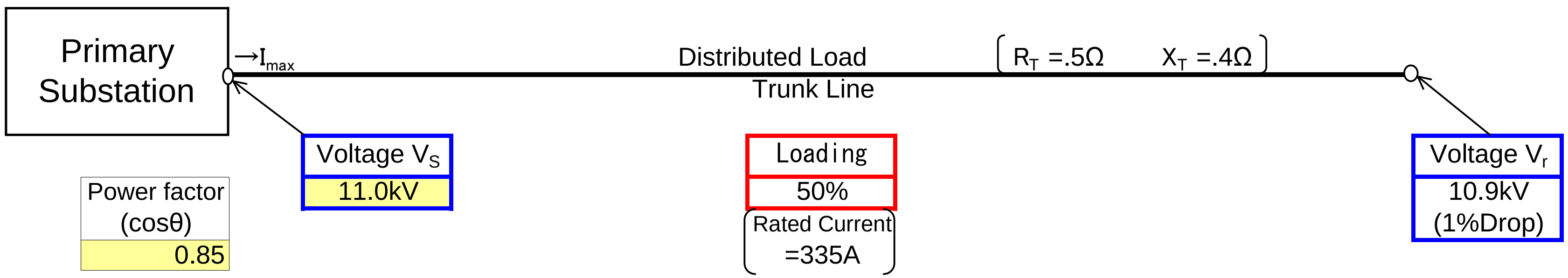
: Input data in colored cells

Type-1

Maximum Current I_{max}
167.0A

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	3.5km	
Type of Distributed Load	Equality	



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B11

: Input data in colored cells

Type-2

Maximum Current I_{max}
167.0A

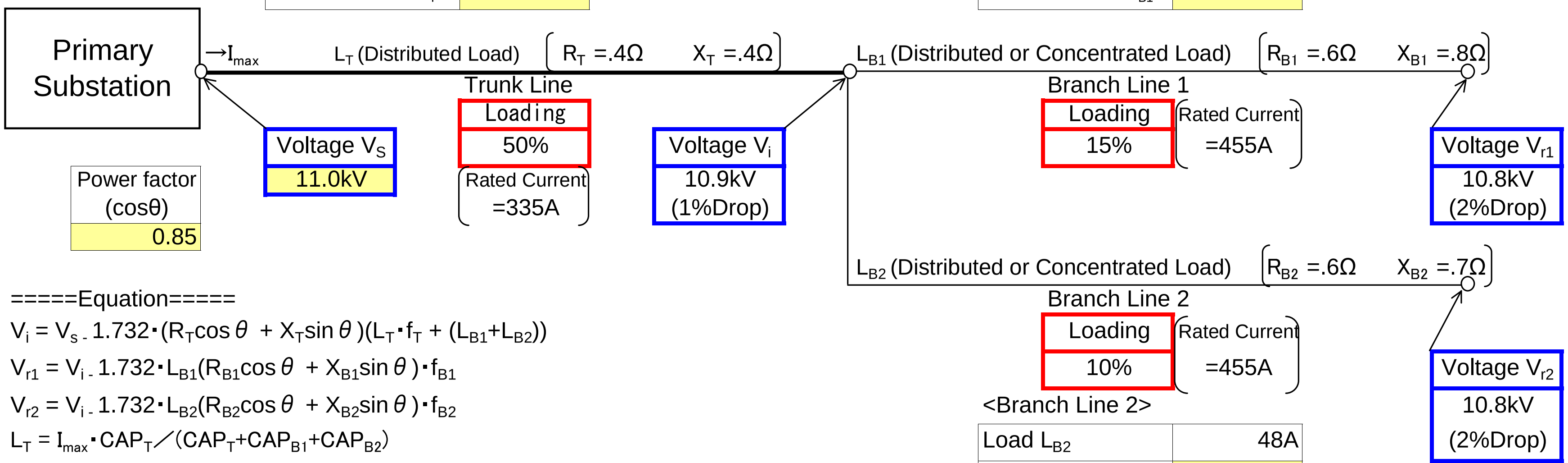
Power factor (cosθ)
0.85

<Trank Line>

Load L_T	53A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	3.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	1730kVA	

<Branch Line 1>

Load L_{B1}	66A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	2.2km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	2145kVA	



<Branch Line 2>

Load L_{B2}	48A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	2.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1545kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage, I_{max} : Maximum Current, R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage, L_T : Load (Trunk line), X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage, L_{B1} : Load (Branch Line 1), cosθ : Power Factor

V_{r2} : Received Voltage, L_{B2} : Load (Branch Line 2), f_T, f_{B1}, f_{B2} : Dispersal Load Factor, CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station B
Feeder Name	B21

: Input data in colored cells

Type-3

Maximum Current I_{max}	339.0A
Power factor (cosθ)	0.95

<Trank Line 1>

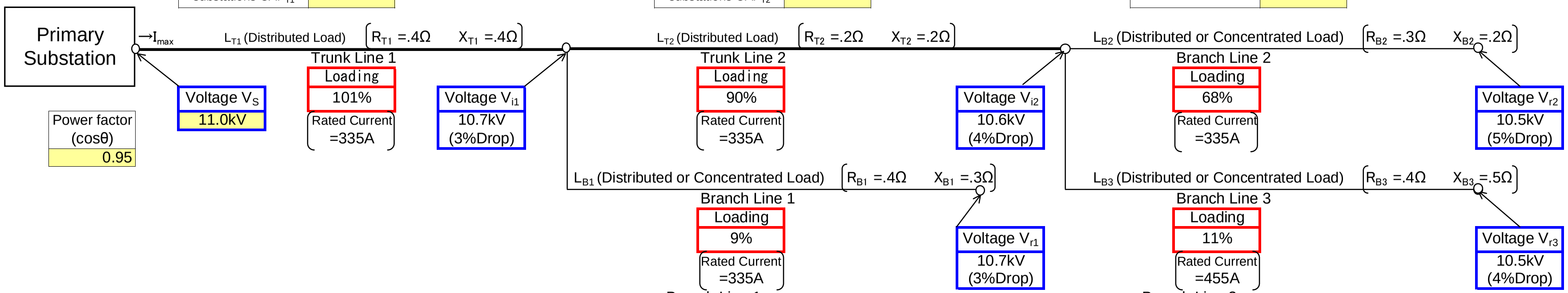
Load L_{T1}	9A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	2.9km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	400kVA	

<Trank Line 2>

Load L_{T2}	22A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T2}	1.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	1000kVA	

<Branch Line 2>

Load L_{B2}	228A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	1.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	10180kVA	



<Branch Line 1>

Load L_{B1}	29A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	2.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1300kVA	

<Branch Line 3>

Load L_{B3}	50A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	1.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	2230kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B32

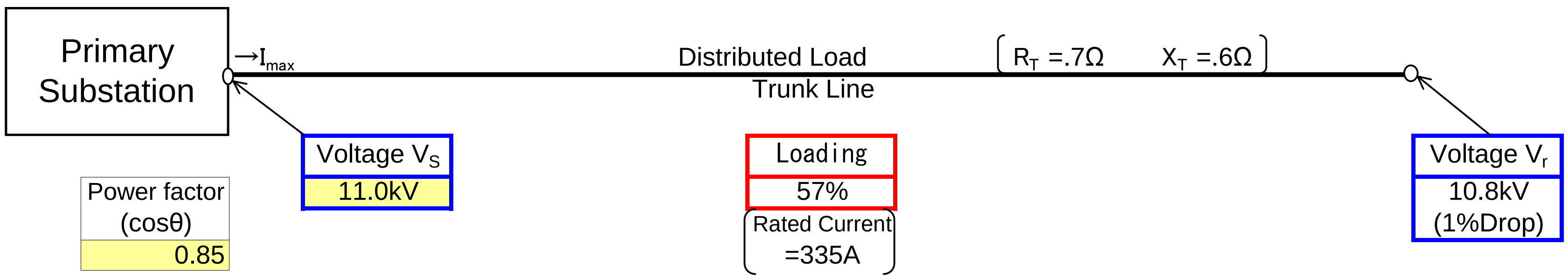
: Input data in colored cells

Type-1

Maximum Current I_{max}	191.0A

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	5.0km	
Type of Distributed Load	Equality	



Power factor (cosθ)	0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B41

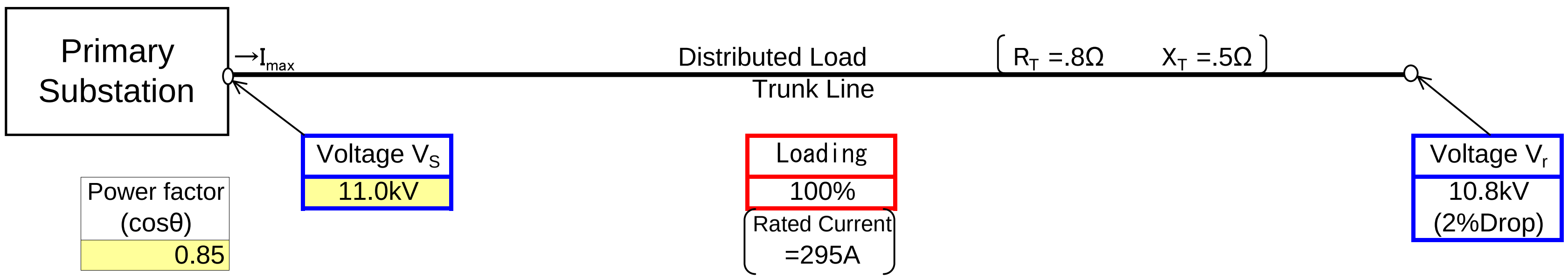
: Input data in colored cells

Type-1

Maximum Current I_{max}
295.0A

<Trank Line>

Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	3.9km	
Type of Distributed Load	Equality	



Power factor (cosθ)
0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station B
Feeder Name	B51

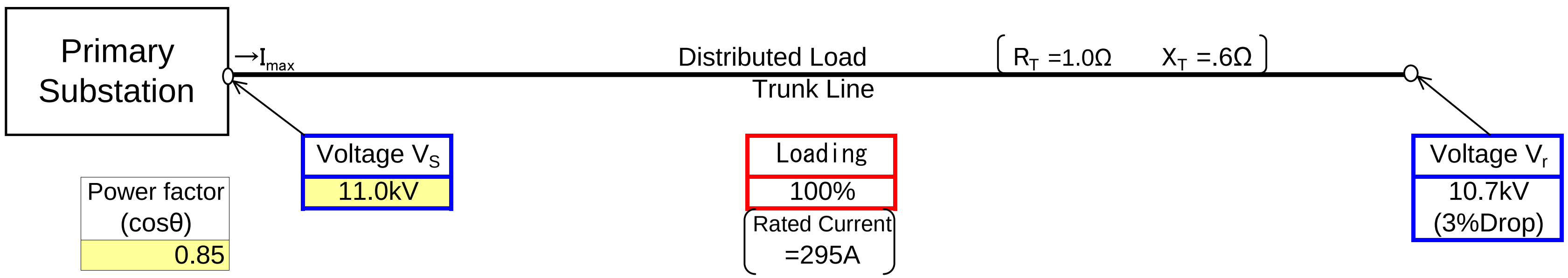
: Input data in colored cells

Type-1

Maximum Current I_{max}
294.0A

<Trank Line>

Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	5.0km	
Type of Distributed Load	Equality	



Power factor (cosθ)
0.85

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$

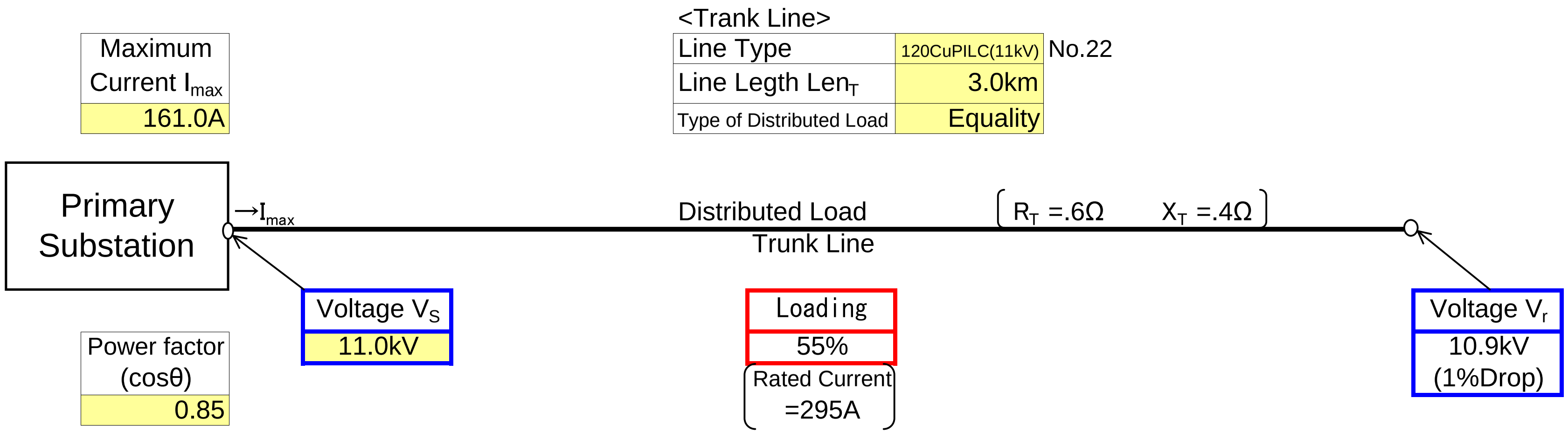
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B52

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	BOGOSO
Feeder Name	BOGOSO/ASANKO

: Input data in colored cells

Type-3

Maximum Current I_{max}
94.0A

Power factor (cosθ)
0.94

<Trank Line 1>

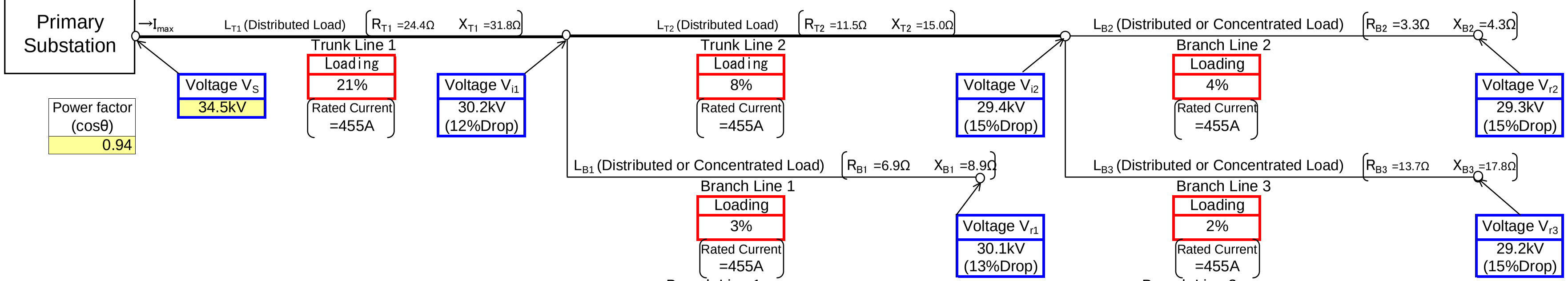
Load L_{T1}	43A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	89.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	3250kVA	

<Trank Line 2>

Load L_{T2}	9A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	42.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	650kVA	

<Branch Line 2>

Load L_{B2}	17A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	12.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	1300kVA	



<Branch Line 1>

Load L_{B1}	15A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	25.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	1150kVA	

<Branch Line 3>

Load L_{B3}	11A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	50.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	800kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B67

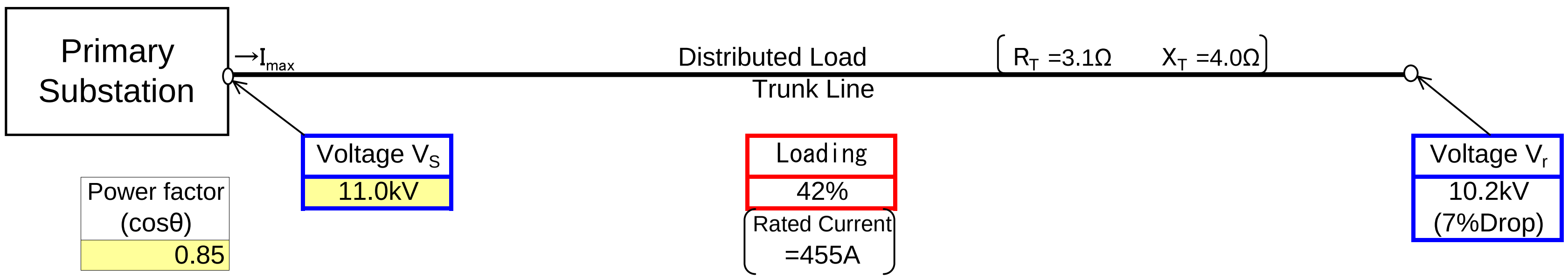
: Input data in colored cells

Type-1

Maximum Current I_{max}	189.0A

<Trank Line>

Line Type	AAC120mm2	No.7
Line Legth Len_T	11.3km	
Type of Distributed Load	Equality	



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN
Feeder Name	B67

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	189A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	11.3km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	5295kVA	

<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		

Maximum Current I_{max}
189.0A

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) R_T =3.1Ω X_T =4.0Ω

Trunk Line

Loading
42%

Rated Current =455A

Voltage V_S
11.0kV

Voltage V_i
10.2kV (7%Drop)

Power factor (cosθ)
0.85

L_{B1} (Distributed or Concentrated Load) R_{B1} #N/A X_{B1} #N/A

Branch Line 1

Loading
#N/A

Rated Current #N/A

Voltage V_{r1}
#N/A
#N/A

L_{B2} (Distributed or Concentrated Load) R_{B2} #N/A X_{B2} #N/A

Branch Line 2

Loading
#N/A

Rated Current #N/A

Voltage V_{r2}
#N/A
#N/A

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

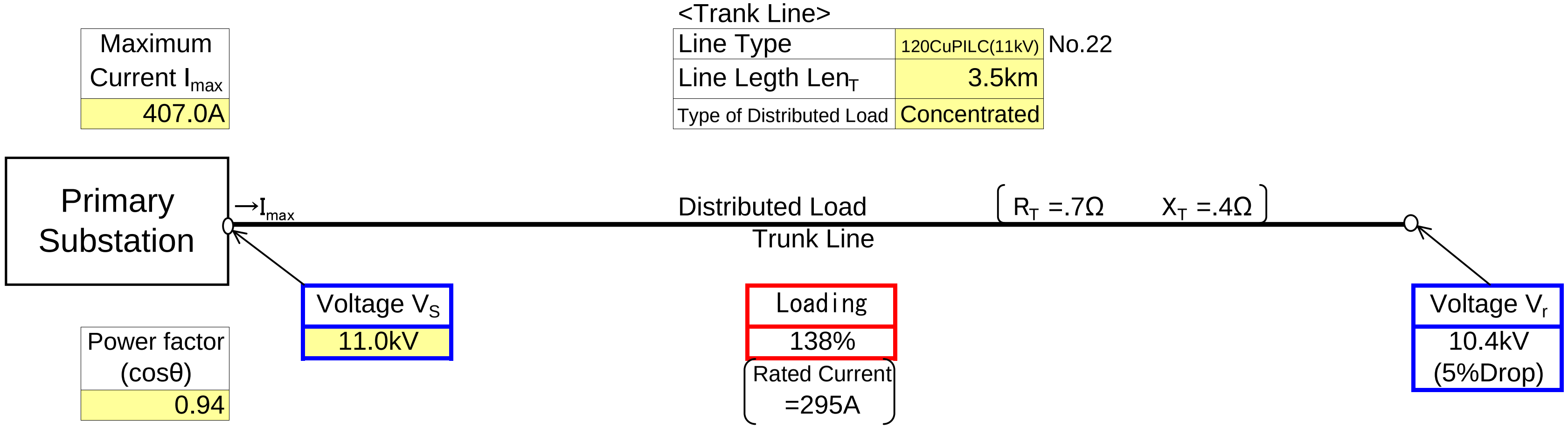
CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B71(GHACEM)

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B71 (GHACEM)

: Input data in colored cells

Type-2

<Trank Line>

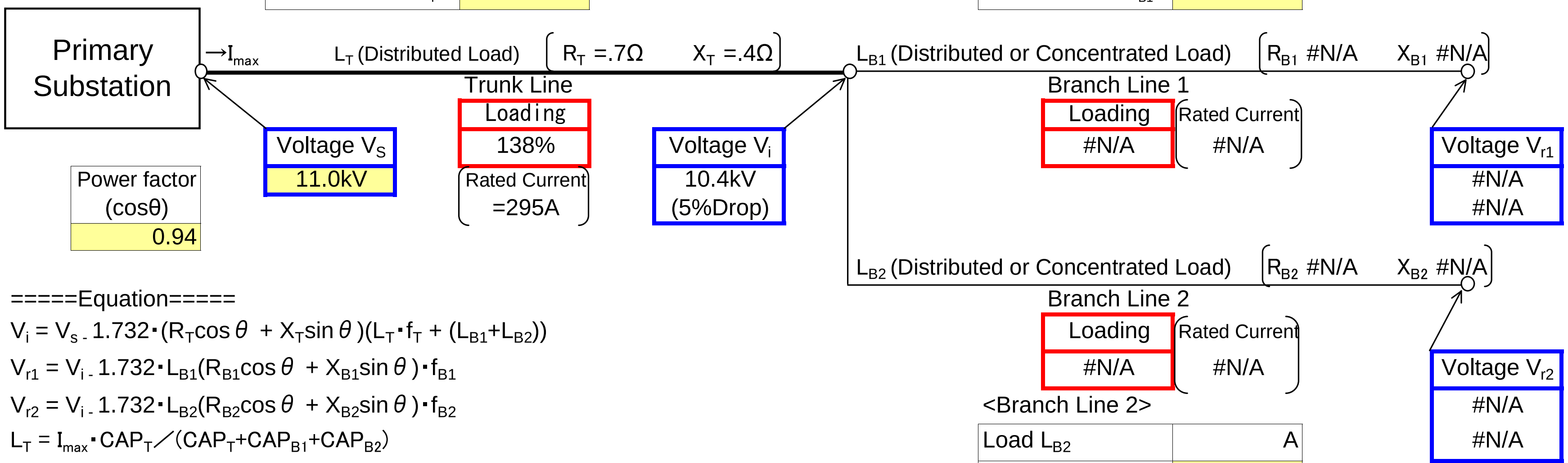
Load L_T	407A	
Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	3.5km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_T	10630kVA	

<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		

Maximum Current I_{max}	407.0A

Power factor (cosθ)	0.94



<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_T, R_{B1}, R_{B2}	: Resistance
V_i	: Interim Voltage	L_T	: Load (Trunk line)	X_T, X_{B1}, X_{B2}	: Reactance
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	cosθ	: Power Factor
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	f_T, f_{B1}, f_{B2}	: Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	STN B
Feeder Name	B71 (GHACEM)

: Input data in colored cells

Type-3

Maximum Current I_{max}
407.0A

Power factor (cosθ)
0.94

<Trank Line 1>

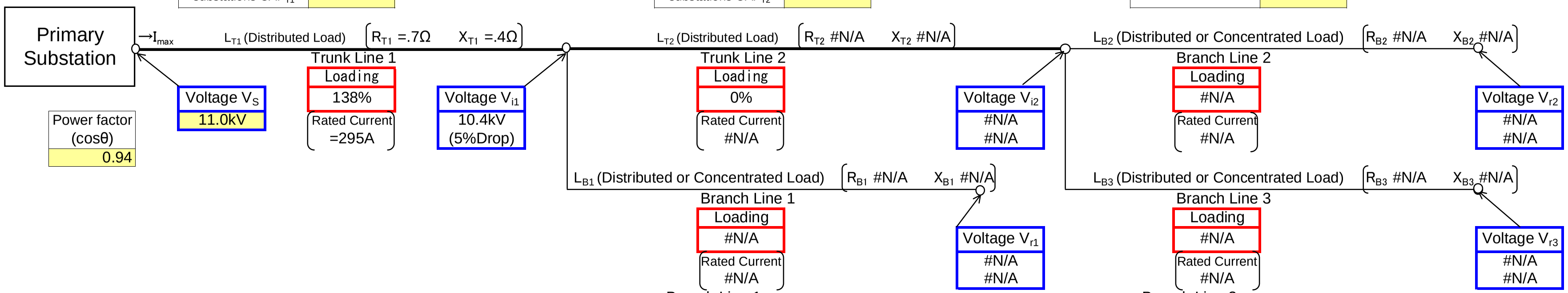
Load L_{T1}	407A	
Line Type	120CuPILC(11kV)	No.22
Line Legth Len_{T1}	3.5km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_{T1}	10630kVA	

<Trank Line 2>

Load L_{T2}	A	
Line Type		#N/A
Line Legth Len_{T2}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{T2}		

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		



<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		

<Branch Line 3>

Load L_{B3}	A	
Line Type		#N/A
Line Length Len_{B3}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B3}		

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B81

: Input data in colored cells

Type-2

Maximum Current I_{max}
265.0A

Power factor ($\cos\theta$)
0.85

Primary Substation

<Trank Line>

Load L_T	75A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	1.9km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	1300kVA	

<Branch Line 1>

Load L_{B1}	144A	
Line Type	120CuPILC(11kV)	No.22
Line Length Len_{B1}	2.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	2500kVA	

$\rightarrow I_{max}$ L_T (Distributed Load) (R_T =.3Ω X_T =.2Ω)

Trunk Line

Loading
79%

(Rated Current =335A)

Voltage V_S
11.0kV

Voltage V_i
10.9kV (1%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =.4Ω X_{B1} =.2Ω)

Branch Line 1

Loading
49%

(Rated Current =295A)

Voltage V_{r1}
10.8kV (2%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =.1Ω X_{B2} =.1Ω)

Branch Line 2

Loading
16%

(Rated Current =295A)

Voltage V_{r2}
10.9kV (1%Drop)

<Branch Line 2>

Load L_{B2}	46A	
Line Type	120CuPILC(11kV)	No.22
Line Length Len_{B1}	.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	800kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage; I_{max} : Maximum Current; R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage; L_T : Load (Trunk line); X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage; L_{B1} : Load (Branch Line 1); $\cos\theta$: Power Factor

V_{r2} : Received Voltage; L_{B2} : Load (Branch Line 2); f_T, f_{B1}, f_{B2} : Dispersal Load Factor; CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station B
Feeder Name	B87

: Input data in colored cells

Type-2

Maximum Current I_{max}: 182.0A

Power factor (cosθ): 0.85

<Trank Line>

Load L_T	75A	
Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	2.7km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_T	1600kVA	

<Branch Line 1>

Load L_{B1}	75A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	1.2km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1615kVA	

Primary Substation $\rightarrow I_{max}$

L_T (Distributed Load) (R_T =.5Ω X_T =.3Ω)

Trunk Line: Loading 62% (Rated Current =295A)

Voltage V_S: 11.0kV

Voltage V_i: 10.8kV (1%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =.3Ω X_{B1} =.4Ω)

Branch Line 1: Loading 17% (Rated Current =455A)

Voltage V_{r1}: 10.8kV (2%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =.5Ω X_{B2} =.7Ω)

Branch Line 2: Loading 7% (Rated Current =455A)

Voltage V_{r2}: 10.8kV (2%Drop)

<Branch Line 2>

Load L_{B2}	32A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	2.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	680kVA	

=====Equation=====

$V_i = V_s - 1.732\cdot(R_T\cos\theta + X_T\sin\theta)(L_T\cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732\cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta)\cdot f_{B1}$

$V_{r2} = V_i - 1.732\cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta)\cdot f_{B2}$

$L_T = I_{max}\cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max}\cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max}\cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_T, R_{B1}, R_{B2}	: Resistance
V_i	: Interim Voltage	L_T	: Load (Trunk line)	X_T, X_{B1}, X_{B2}	: Reactance
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	cosθ	: Power Factor
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	f_T, f_{B1}, f_{B2}	: Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station C
Feeder Name	C01

: Input data in colored cells

Type-2

Maximum Current I_{max}
314.0A

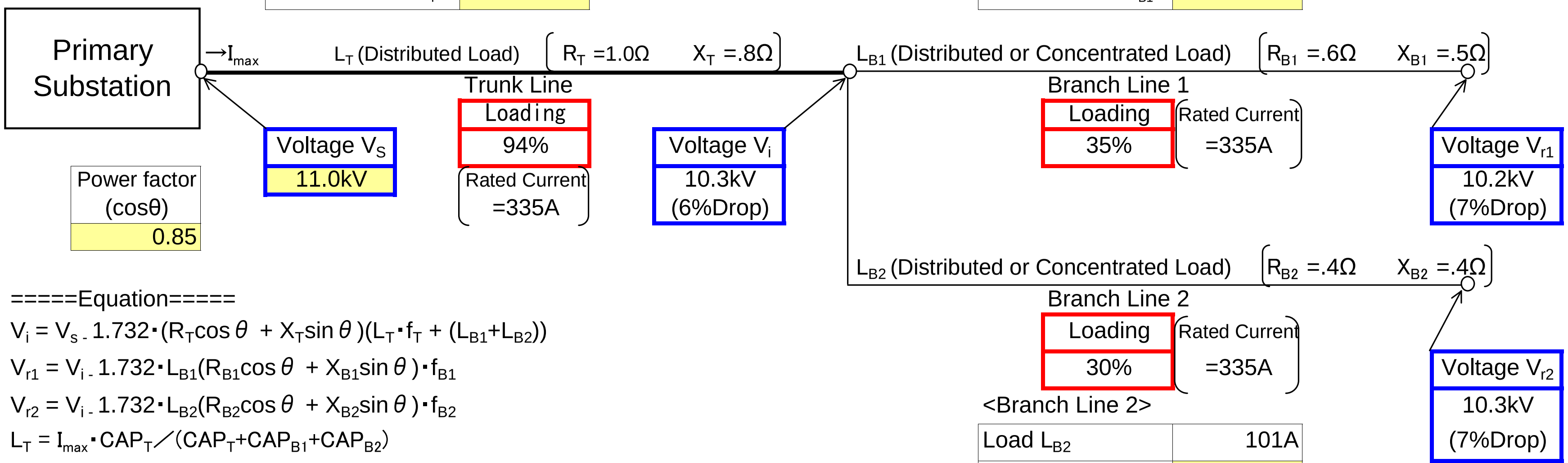
Power factor (cosθ)
0.85

<Trank Line>

Load L_T	97A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	6.6km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_T	2215kVA	

<Branch Line 1>

Load L_{B1}	116A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	3.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	2650kVA	



<Branch Line 2>

Load L_{B2}	101A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	3.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	2300kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor

V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN C
Feeder Name	C02

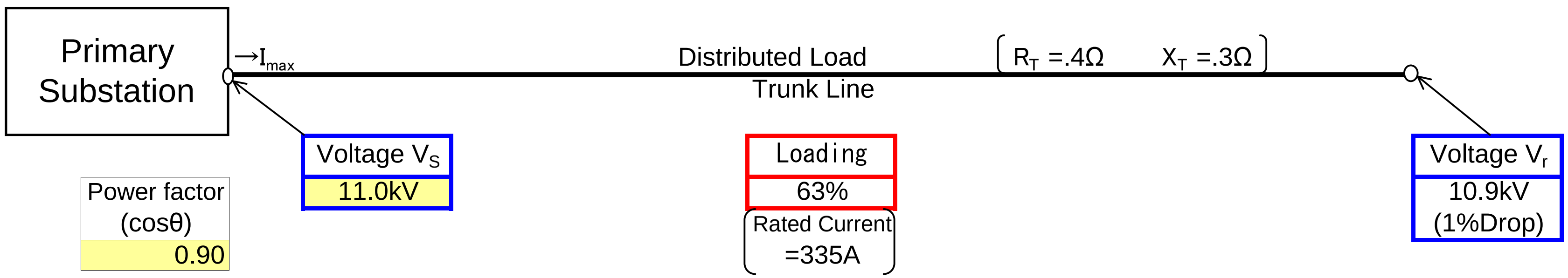
: Input data in colored cells

Type-1

Maximum Current I_{max}
212.0A

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	2.5km	
Type of Distributed Load	Equality	



Power factor (cosθ)
0.90

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station C
Feeder Name	C02

: Input data in colored cells

Type-2

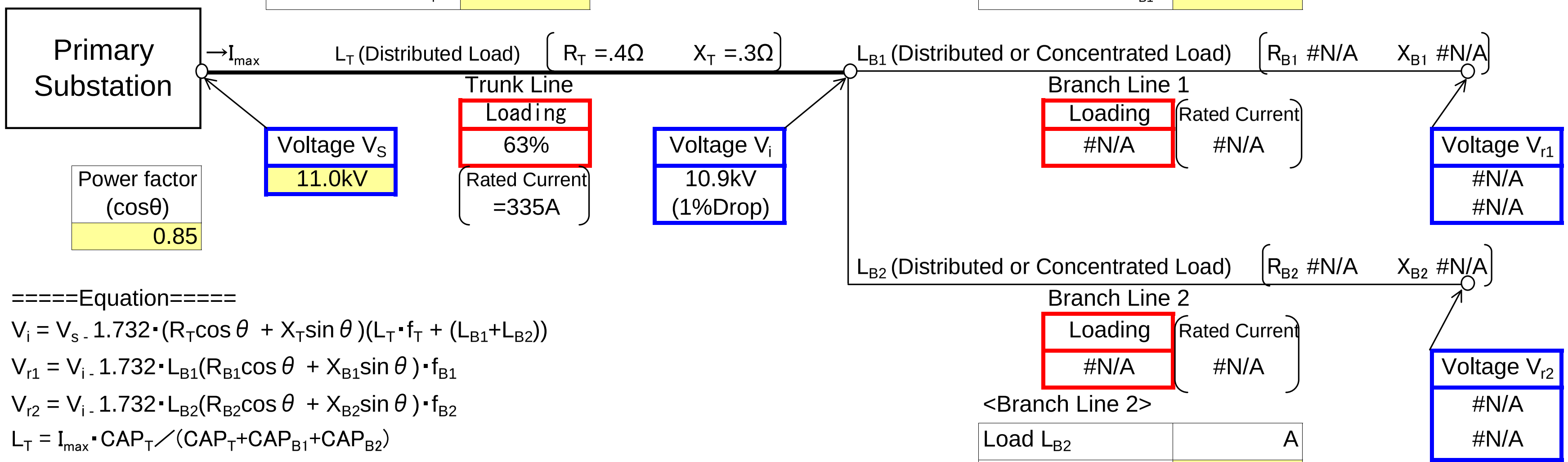
<Trank Line>

Load L_T	212A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	2.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	3500kVA	

<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		

Maximum Current I_{max}	212.0A
Power factor (cosθ)	0.85



<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732\cdot(R_T\cos\theta + X_T\sin\theta)(L_T\cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732\cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta)\cdot f_{B1}$

$V_{r2} = V_i - 1.732\cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta)\cdot f_{B2}$

$L_T = I_{max}\cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max}\cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max}\cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage　I_{max} : Maximum Current　R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage　L_T : Load (Trunk line)　X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage　L_{B1} : Load (Branch Line 1)　cosθ : Power Factor
V_{r2} : Received Voltage　L_{B2} : Load (Branch Line 2)　f_T, f_{B1}, f_{B2} : Dispersal Load Factor　CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station C
Feeder Name	C08

: Input data in colored cells

Type-2

Maximum Current I_{max}
228.0A

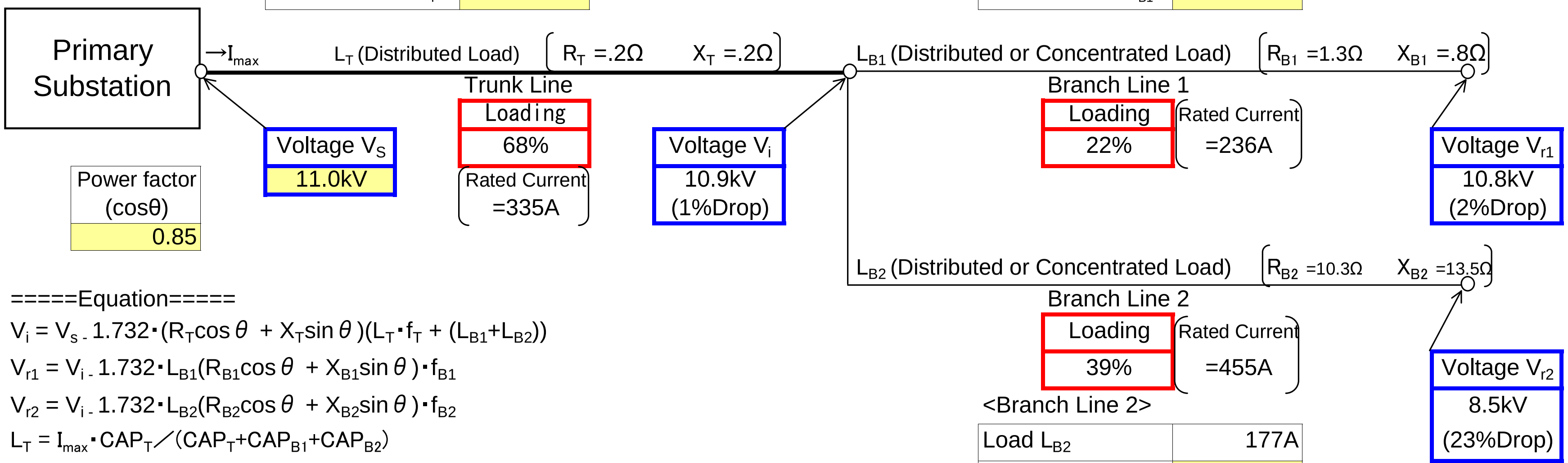
Power factor (cosθ)
0.85

<Trank Line>

Load L_T	A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	1.3km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_T	kVA	

<Branch Line 1>

Load L_{B1}	51A	
Line Type	Cu35mm2	No.15
Line Length Len_{B1}	1.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1915kVA	



<Branch Line 2>

Load L_{B2}	177A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	37.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	6645kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

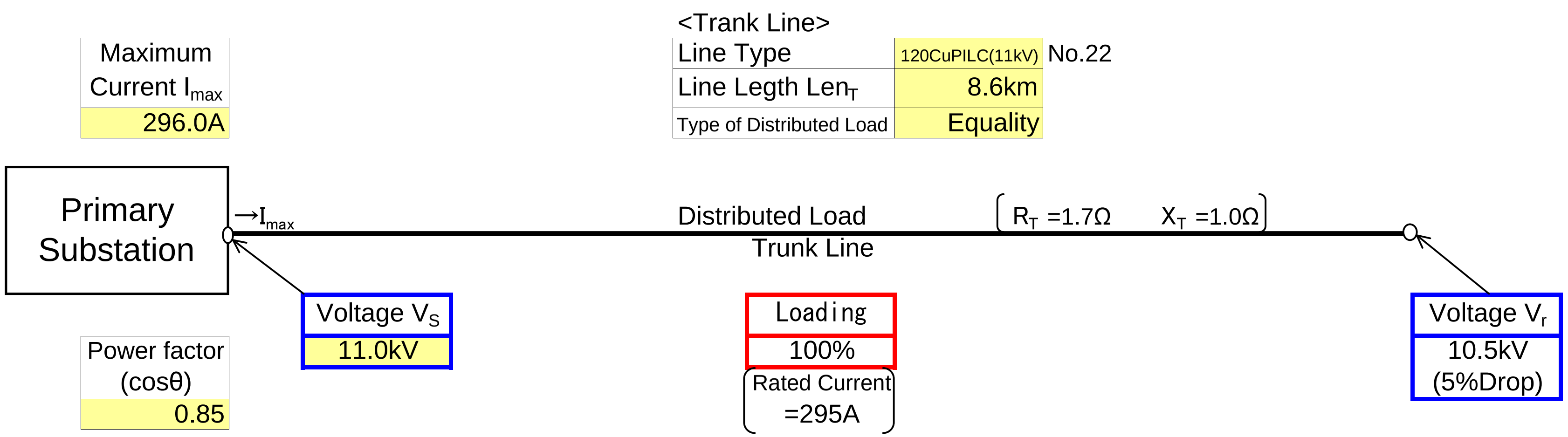
V_s : Supply Voltage I_{max} : Maximum Current R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage L_T : Load (Trunk line) X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage L_{B1} : Load (Branch Line 1) cosθ : Power Factor
V_{r2} : Received Voltage L_{B2} : Load (Branch Line 2) f_T, f_{B1}, f_{B2} : Dispersal Load Factor CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN C
Feeder Name	C10

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station C
Feeder Name	C10

: Input data in colored cells

Type-2

Maximum Current I_{max}
296.0A

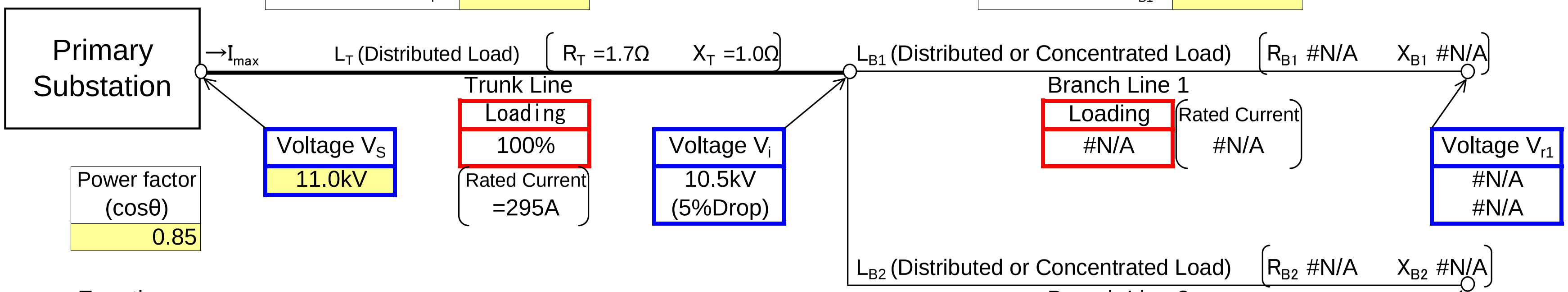
Power factor (cosθ)
0.85

<Trank Line>

Load L_T	296A	
Line Type	120CuPILC(11kV)	No.22
Line Legth Len_T	8.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	8175kVA	

<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		



<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage I_{max} : Maximum Current R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage L_T : Load (Trunk line) X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage L_{B1} : Load (Branch Line 1) cosθ : Power Factor
V_{r2} : Received Voltage L_{B2} : Load (Branch Line 2) f_T, f_{B1}, f_{B2} : Dispersal Load Factor $CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis

- Western after countermeasure -

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	PRESTEA
Feeder Name	KROFOFROM

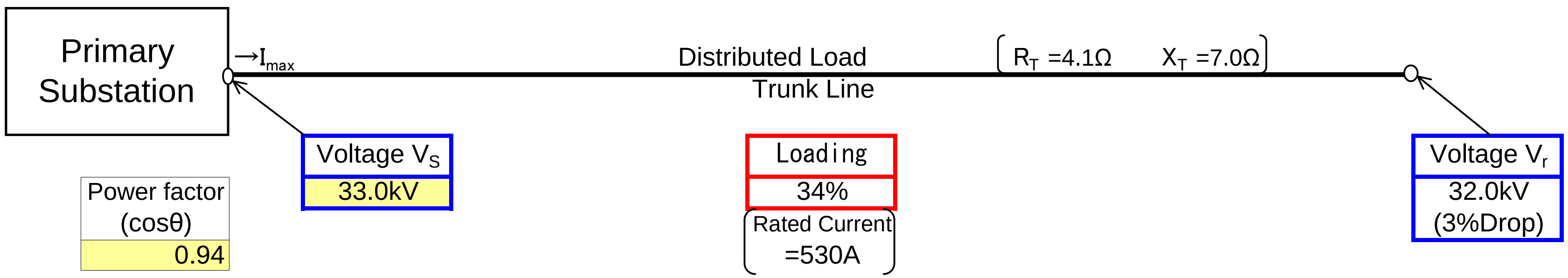
: Input data in colored cells

Type-1

Maximum Current I_{max}	180.0A

<Trank Line>

Line Type	AAC150mm2	No.6
Line Legth Len_T	20.0km	
Type of Distributed Load	Middle Larger	



Power factor (cosθ)	0.94

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	KROFOFROM
Feeder Name	ASANKO/ENCHI

: Input data in colored cells

Type-3

Maximum Current I_{max}	119.0A
Power factor (cosθ)	0.94

Primary Substation

→I_{max}

Voltage V_S 32.0kV

<Trank Line 1>

Load L_{T1}	51A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	60.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	2900kVA	

L_{T1} (Distributed Load) (R_{T1} =16.5Ω X_{T1} =21.4Ω)

Trunk Line 1: Loading 26% (Rated Current =455A)

Voltage V_{i1} 28.3kV (12%Drop)

<Trank Line 2>

Load L_{T2}	11A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	42.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	650kVA	

L_{T2} (Distributed Load) (R_{T2} =11.5Ω X_{T2} =15.0Ω)

Trunk Line 2: Loading 11% (Rated Current =455A)

Voltage V_{i2} 27.1kV (15%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =6.9Ω X_{B1} =8.9Ω)

Branch Line 1: Loading 4% (Rated Current =455A)

Voltage V_{r1} 28.1kV (12%Drop)

<Branch Line 1>

Load L_{B1}	20A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	25.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	1150kVA	

<Branch Line 2>

Load L_{B2}	23A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	12.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	1300kVA	

L_{B2} (Distributed or Concentrated Load) (R_{B2} =3.3Ω X_{B2} =4.3Ω)

Branch Line 2: Loading 5% (Rated Current =455A)

Voltage V_{r2} 27.0kV (16%Drop)

L_{B3} (Distributed or Concentrated Load) (R_{B3} =13.7Ω X_{B3} =17.8Ω)

Branch Line 3: Loading 3% (Rated Current =455A)

Voltage V_{r3} 26.9kV (16%Drop)

<Branch Line 3>

Load L_{B3}	14A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	50.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	800kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3} : Total Transformer Capacity of secondary substations
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ : Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	PRESTEA
Feeder Name	KROFOFROM

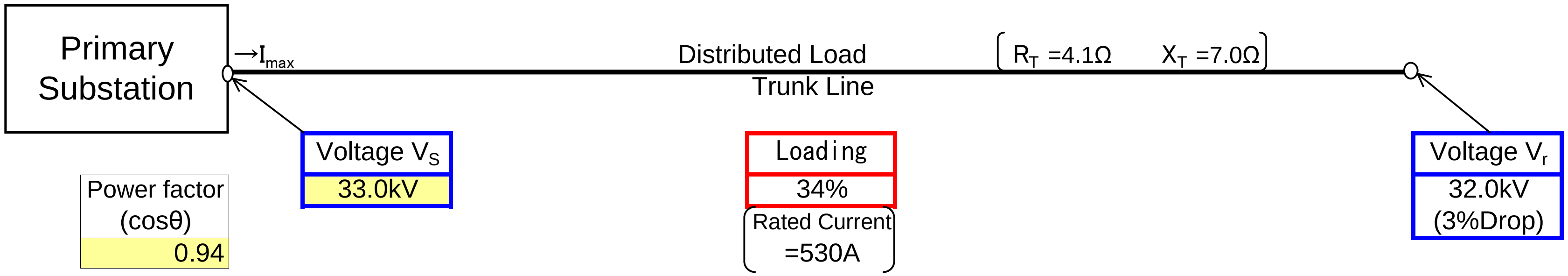
: Input data in colored cells

Type-1

Maximum Current I_{max}	180.0A

<Trank Line>

Line Type	AAC150mm2	No.6
Line Legth Len_T	20.0km	
Type of Distributed Load	Middle Larger	



Power factor (cosθ)	0.94

=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	KROFOROM
Feeder Name	DGOSO/AKROPON

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	2A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	10.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	100kVA	

<Branch Line 1>

Load L_{B1}	35A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	44.0km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	2000kVA	

Maximum Current I_{max}	58.0A

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) R_T =2.7Ω X_T =3.6Ω

Trunk Line

Loading	13%

Rated Current =455A

Voltage V_S	32.0kV

Voltage V_i	31.6kV (1%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} =12.1Ω X_{B1} =15.7Ω

Branch Line 1

Loading	8%

Rated Current =455A

Voltage V_{r1}	31.1kV (3%Drop)

Power factor (cosθ)	0.94

L_{B2} (Distributed or Concentrated Load) R_{B2} =13.7Ω X_{B2} =17.8Ω

Branch Line 2

Loading	5%

Rated Current =455A

Voltage V_{r2}	31.3kV (2%Drop)

<Branch Line 2>

Load L_{B2}	21A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	50.0km	
Type of Distributed Load	Middle Larger	
Total Transformer Capacity of secondary substations CAP_{B2}	1200kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage I_{max} : Maximum Current R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage L_T : Load (Trunk line) X_T, X_{B1}, X_{B2} : Reactance

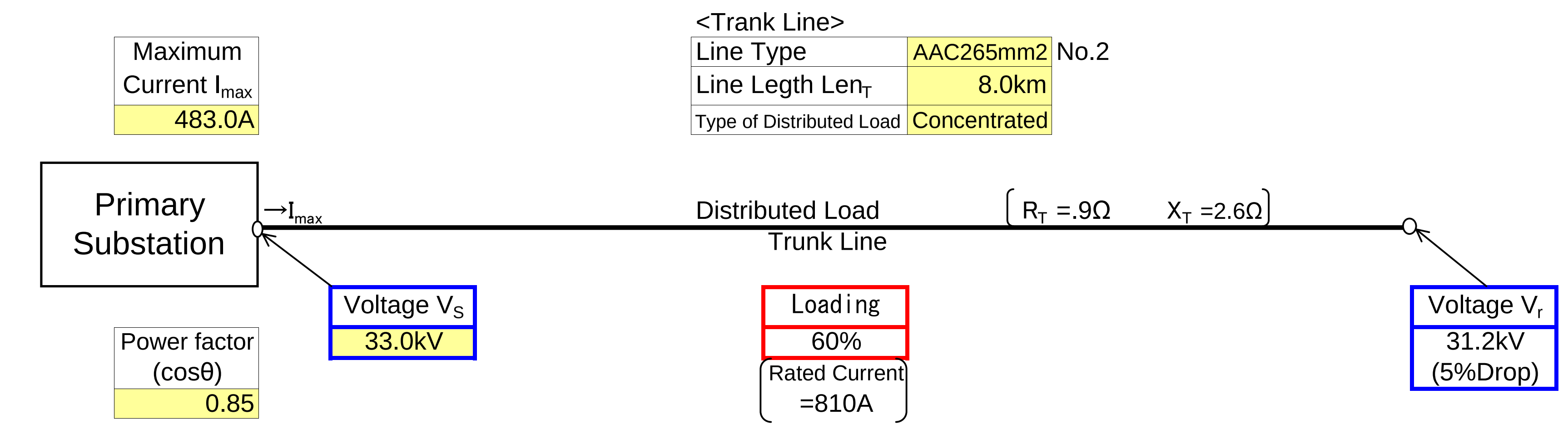
V_{r1} : Received Voltage L_{B1} : Load (Branch Line 1)   cosθ : Power Factor

V_{r2} : Received Voltage L_{B2} : Load (Branch Line 2) f_T, f_{B1}, f_{B2} : Dispersal Load Factor CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	CCT 1

: Input data in colored cells



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$

V_s : Supply Voltage
V_r : Received Voltage
I_{max} : Maximum Current

R_T : Resistance
X_T : Reactance
cosθ : Power Factor

f_T : Dispersal Load Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	CCT 1

: Input data in colored cells

Type-2

Maximum Current I_{max}
483.0A

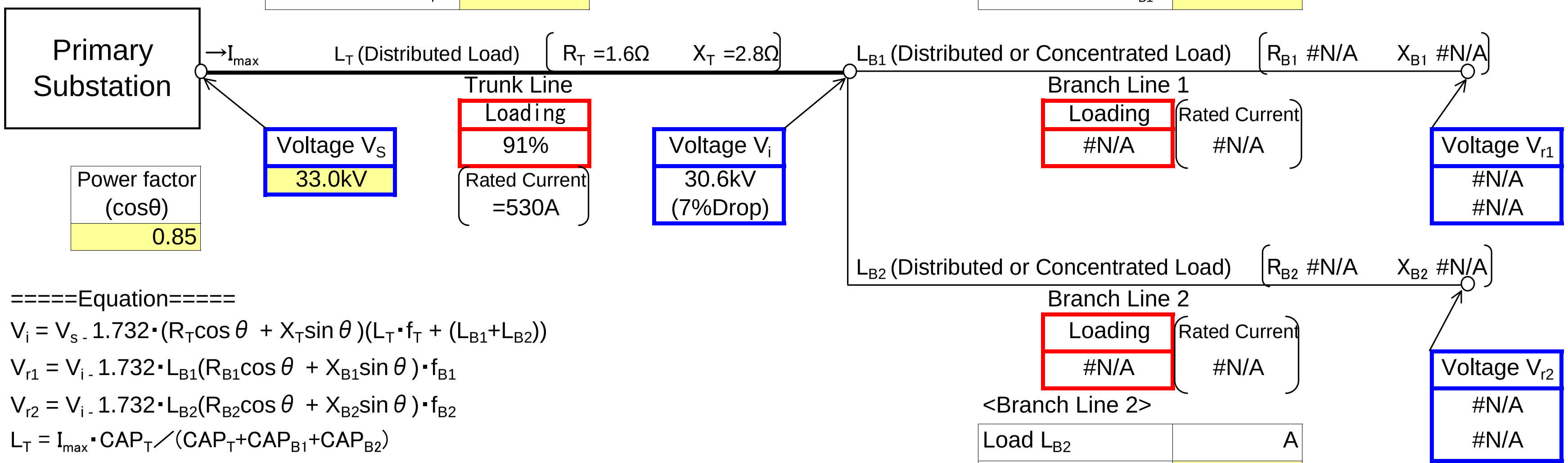
<Trank Line>

Load L_T	483A	
Line Type	AAC150mm2	No.6
Line Legth Len_T	8.0km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_T	20000kVA	

<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		

Power factor (cosθ)
0.85



<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage　I_{max} : Maximum Current　R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage　L_T : Load (Trunk line)　X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage　L_{B1} : Load (Branch Line 1)　cosθ : Power Factor
V_{r2} : Received Voltage　L_{B2} : Load (Branch Line 2)　f_T, f_{B1}, f_{B2} : Dispersal Load Factor　CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

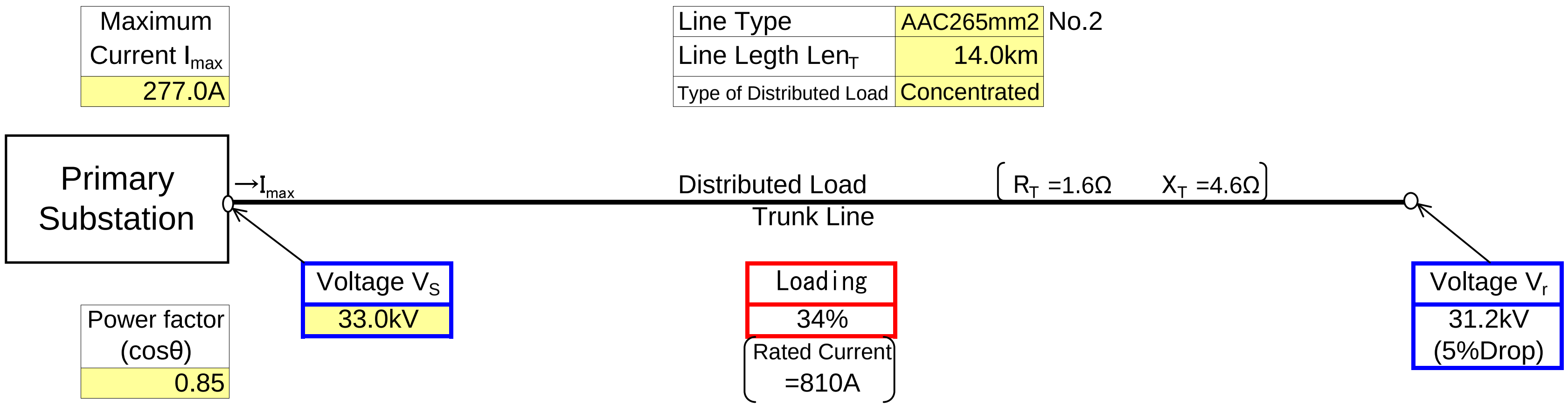
Substation Name	STN A
Feeder Name	CCT 5

: Input data in colored cells

Type-1

<Trank Line>

Line Type	AAC265mm2	No.2
Line Legth Len_T	14.0km	
Type of Distributed Load	Concentrated	



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

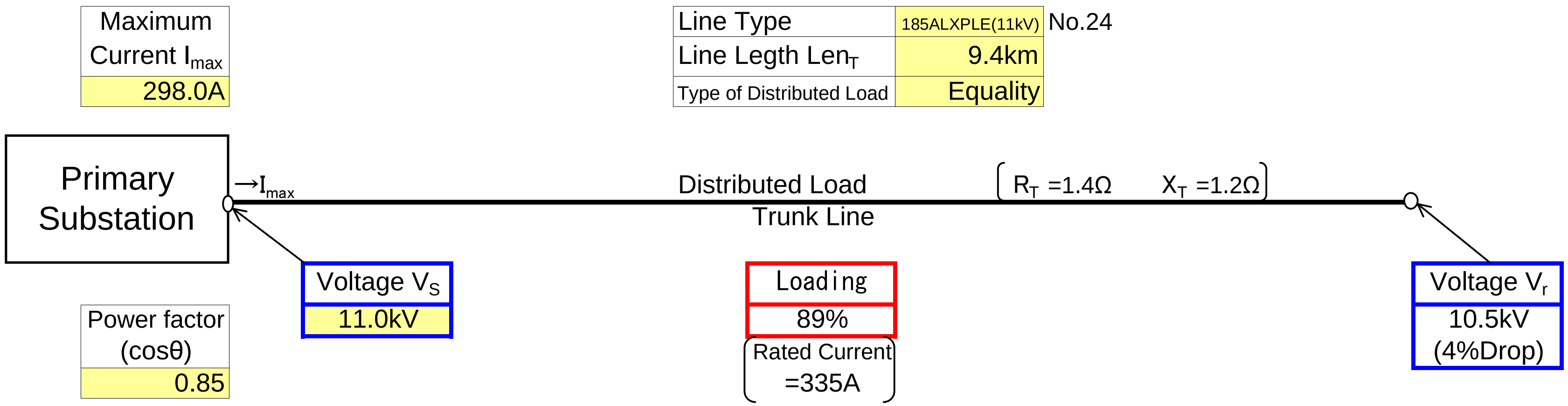
Substation Name	STN A
Feeder Name	A10

: Input data in colored cells

Type-1

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	9.4km	
Type of Distributed Load	Equality	



=====Equation=====

$$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$$

V_s : Supply Voltage	R_T : Resistance	f_T : Dispersal Load Factor	
V_r : Received Voltage	X_T : Reactance		
I_{max} : Maximum Current	cosθ : Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	A10

: Input data in colored cells

Type-2

Maximum Current I_{max}
298.0A

Power factor ($\cos\theta$)
0.85

<Trank Line>

Load L_T	298A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	9.4km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	3680kVA	

<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		

Primary Substation

$\rightarrow I_{max}$ L_T (Distributed Load) (R_T =1.4Ω X_T =1.2Ω)

Trunk Line

Loading
89%

(Rated Current =335A)

Voltage V_S
11.0kV

Voltage V_i
10.5kV (4%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} #N/A X_{B1} #N/A)

Branch Line 1

Loading
#N/A

(Rated Current #N/A)

Voltage V_{r1}
#N/A
#N/A

L_{B2} (Distributed or Concentrated Load) (R_{B2} #N/A X_{B2} #N/A)

Branch Line 2

Loading
#N/A

(Rated Current #N/A)

Voltage V_{r2}
#N/A
#N/A

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732\cdot(R_T\cos\theta + X_T\sin\theta)(L_T\cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732\cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta)\cdot f_{B1}$

$V_{r2} = V_i - 1.732\cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta)\cdot f_{B2}$

$L_T = I_{max}\cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max}\cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max}\cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$\cos\theta$: Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

$CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station A
Feeder Name	A31 (1 of 2)

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	233A	
Line Type	240CuXLPE(11kV)	No.26
Line Legth Len_T	4.3km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	4715kVA	

<Branch Line 1>

Load L_{B1}	35A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	.9km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	715kVA	

Maximum Current I_{max}
343.0A

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =.4Ω X_T =.6Ω)

Trunk Line

Loading
68%

(Rated Current =501A)

Voltage V_S
11.0kV

Voltage V_i
10.7kV (2%Drop)

Power factor (cosθ)
0.85

L_{B1} (Distributed or Concentrated Load) (R_{B1} =.1Ω X_{B1} =.1Ω)

Branch Line 1

Loading
11%

(Rated Current =335A)

Voltage V_{r1}
10.7kV (2%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =.5Ω X_{B2} =.4Ω)

Branch Line 2

Loading
22%

(Rated Current =335A)

Voltage V_{r2}
10.7kV (3%Drop)

<Branch Line 2>

Load L_{B2}	75A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	3.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1515kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN A
Feeder Name	EEDER A31 (2 of 2

: Input data in colored cells

Type-3

Maximum Current I_{max}
196.0A

Power factor (cosθ)
0.85

<Trank Line 1>

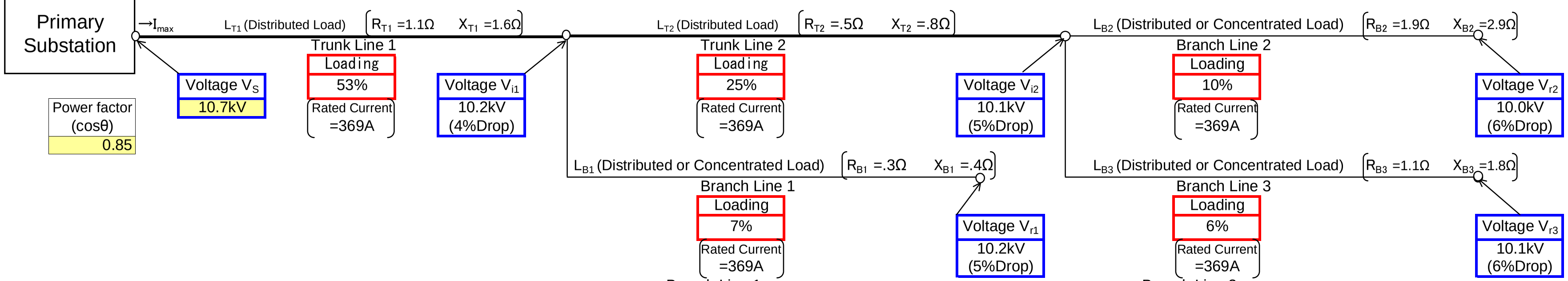
Load L_{T1}	79A	
Line Type	Cu70mm2	No.14
Line Legth Len_{T1}	3.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	3445kVA	

<Trank Line 2>

Load L_{T2}	32A	
Line Type	Cu70mm2	No.14
Line Legth Len_{T2}	1.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	1400kVA	

<Branch Line 2>

Load L_{B2}	38A	
Line Type	Cu70mm2	No.14
Line Length Len_{B1}	6.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	1645kVA	



<Branch Line 1>

Load L_{B1}	26A	
Line Type	Cu70mm2	No.14
Line Length Len_{B1}	1.0km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{B1}	1115kVA	

<Branch Line 3>

Load L_{B3}	21A	
Line Type	Cu70mm2	No.14
Line Length Len_{B3}	4.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	915kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	STN A
Feeder Name	A55

: Input data in colored cells

Type-2

Maximum Current I_{max}
365.0A

Power factor (cosθ)
0.85

<Trank Line>

Load L_T	A	
Line Type	240CuXLPE(11kV)	No.26
Line Legth Len_T	.4km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	kVA	

<Branch Line 1>

Load L_{B1}	355A	
Line Type	AAC265mm2	No.2
Line Length Len_{B1}	7.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	10715kVA	

Primary Substation

→I_{max}

L_T (Distributed Load) (R_T =.0Ω X_T =.1Ω)

Trunk Line

Loading
73%

(Rated Current =501A)

Voltage V_S
11.0kV

Voltage V_i
11.0kV (0%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =.9Ω X_{B1} =2.5Ω)

Branch Line 1

Loading
44%

(Rated Current =810A)

Voltage V_{r1}
10.3kV (6%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =.1Ω X_{B2} =.1Ω)

Branch Line 2

Loading
2%

(Rated Current =455A)

Voltage V_{r2}
11.0kV (0%Drop)

<Branch Line 2>

Load L_{B2}	10A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	.3km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_{B2}	315kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage I_{max} : Maximum Current R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage L_T : Load (Trunk line) X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage L_{B1} : Load (Branch Line 1) cosθ : Power Factor

V_{r2} : Received Voltage L_{B2} : Load (Branch Line 2) f_T, f_{B1}, f_{B2} : Dispersal Load Factor CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	Station B
Feeder Name	B21

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	9A	
Line Type	240CuXLPE(11kV)	No.26
Line Legth Len_{T1}	2.9km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	400kVA	

<Trank Line 2>

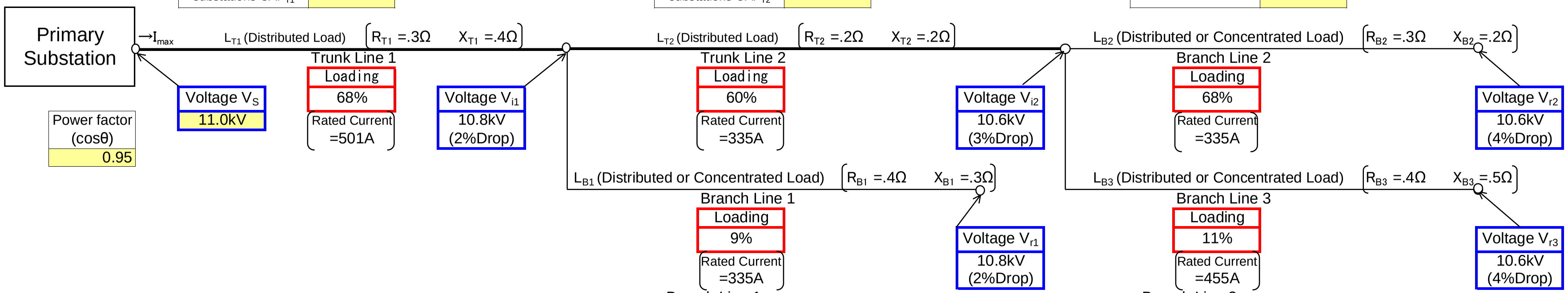
Load L_{T2}	22A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T2}	1.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	1000kVA	

<Branch Line 2>

Load L_{B2}	228A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	1.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	10180kVA	

Maximum Current I_{max}
339.0A

Power factor (cosθ)
0.95



<Branch Line 1>

Load L_{B1}	29A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	2.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1300kVA	

<Branch Line 3>

Load L_{B3}	50A	
Line Type	AAC120mm2	No.7
Line Length Len_{B3}	1.5km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B3}	2230kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

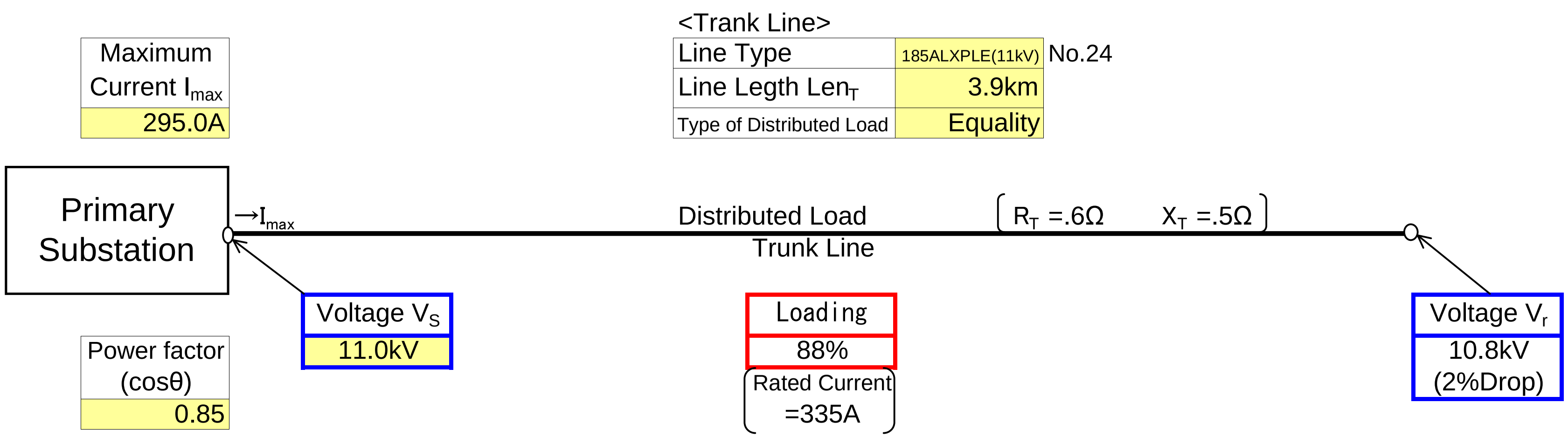
V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	STN B
Feeder Name	B41

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T \cos\theta + X_T \sin\theta) \cdot f_T$

V_S	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station B
Feeder Name	B51

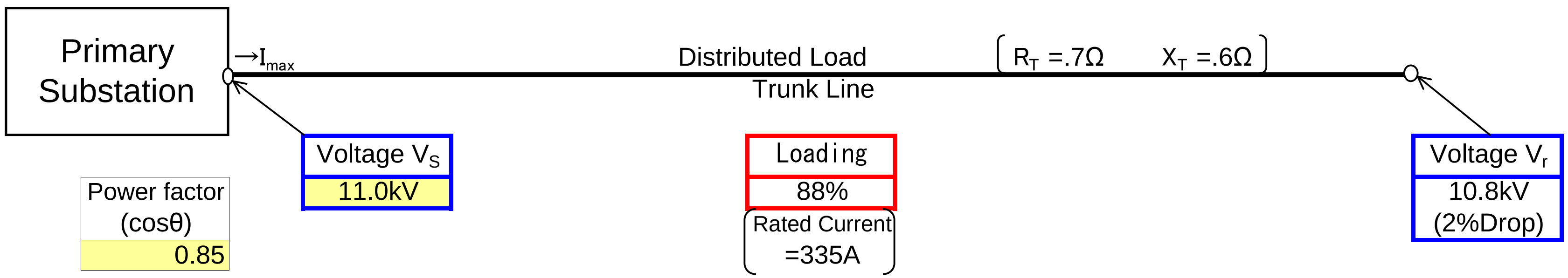
: Input data in colored cells

Type-1

Maximum Current I_{max}	294.0A
Power factor (cosθ)	0.85

<Trank Line>

Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	5.0km	
Type of Distributed Load	Equality	



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta)\cdot f_T$

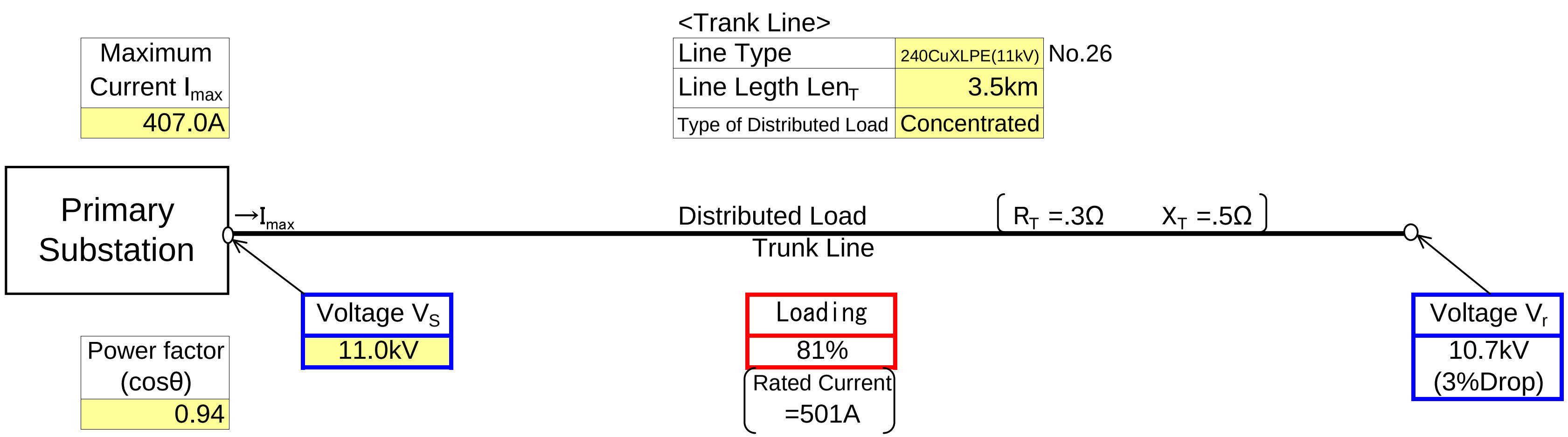
V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B71(GHACEM)

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	cosθ	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B71 (GHACEM)

: Input data in colored cells

Type-2

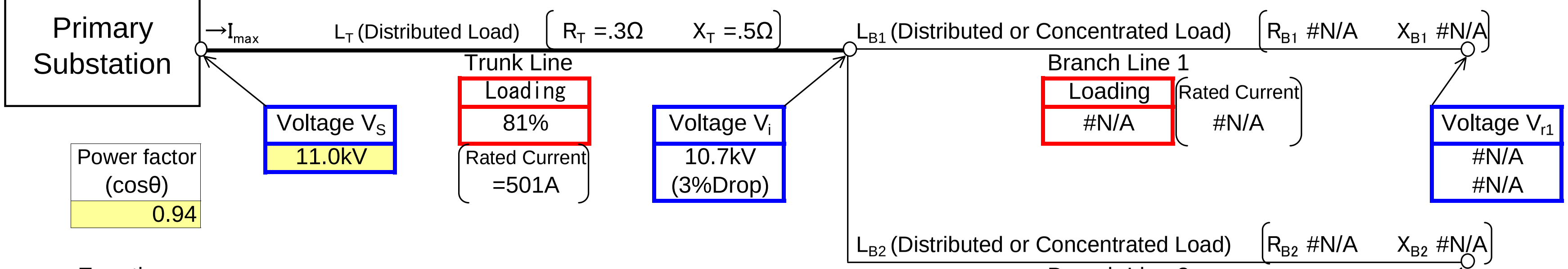
Maximum Current I_{max}	407.0A
Power factor (cosθ)	0.94

<Trank Line>

Load L_T	407A	
Line Type	240CuXLPE(11kV)	No.26
Line Legth Len_T	3.5km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_T	10630kVA	

<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		



<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN B
Feeder Name	B71 (GHACEM)

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	407A	
Line Type	240CuXLPE(11kV)	No.26
Line Legth Len_{T1}	3.5km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_{T1}	10630kVA	

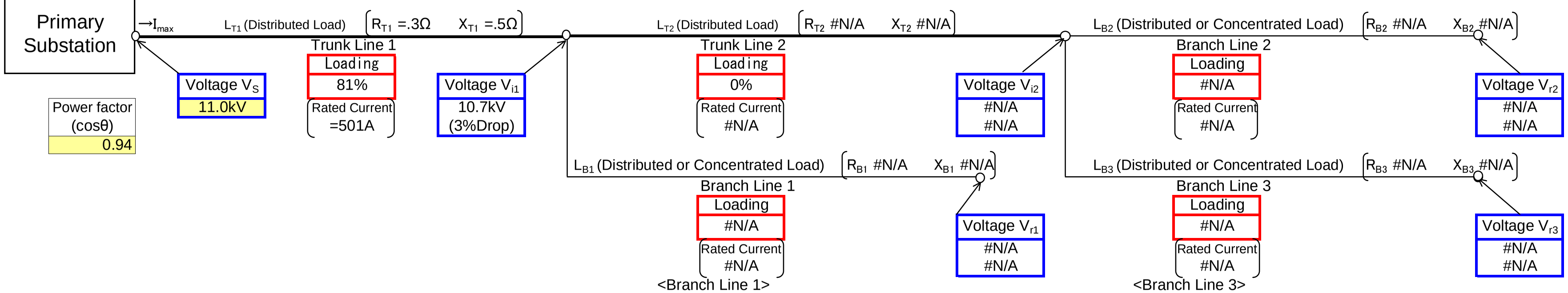
<Trank Line 2>

Load L_{T2}	A	
Line Type		#N/A
Line Legth Len_{T2}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{T2}		

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

Maximum Current I_{max}	407.0A
Power factor (cosθ)	0.94



<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		

<Branch Line 3>

Load L_{B3}	A	
Line Type		#N/A
Line Length Len_{B3}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B3}		

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station C
Feeder Name	C01

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	97A	
Line Type	240CuXLPE(11kV)	No.26
Line Legth Len_T	6.6km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_T	2215kVA	

<Branch Line 1>

Load L_{B1}	116A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	3.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	2650kVA	

Maximum Current I_{max}	314.0A
Power factor (cosθ)	0.85

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =.6Ω X_T =.9Ω)

Trunk Line

Loading	63%

(Rated Current =501A)

Voltage V_S	11.0kV

Voltage V_i	10.4kV (5%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =.6Ω X_{B1} =.5Ω)

Branch Line 1

Loading	35%

(Rated Current =335A)

Voltage V_{r1}	10.4kV (6%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =.4Ω X_{B2} =.4Ω)

Branch Line 2

Loading	30%

(Rated Current =335A)

Voltage V_{r2}	10.4kV (6%Drop)

<Branch Line 2>

Load L_{B2}	101A	
Line Type	185ALXPLE(11kV)	No.24
Line Length Len_{B1}	3.0km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	2300kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station C
Feeder Name	C08

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	A	
Line Type	240ALXLPE(33kV)	No.29
Line Legth Len_T	1.3km	
Type of Distributed Load	Concentrated	
Total Transformer Capacity of secondary substations CAP_T	kVA	

<Branch Line 1>

Load L_{B1}	18A	
Line Type	Cu35mm2	No.15
Line Length Len_{B1}	1.8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B1}	1915kVA	

Maximum Current I_{max}	80.0A
Power factor (cosθ)	0.85

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =.2Ω X_T =.3Ω)

Trunk Line

Loading
16%

(Rated Current =510A)

Voltage V_S
33.0kV

Voltage V_i
33.0kV (0%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =1.3Ω X_{B1} =.8Ω)

Branch Line 1

Loading
8%

(Rated Current =236A)

Voltage V_{r1}
32.9kV (0%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =10.3Ω X_{B2} =13.5Ω)

Branch Line 2

Loading
14%

(Rated Current =455A)

Voltage V_{r2}
32.1kV (3%Drop)

<Branch Line 2>

Load L_{B2}	62A	
Line Type	AAC120mm2	No.7
Line Length Len_{B1}	37.7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{B2}	6645kVA	

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

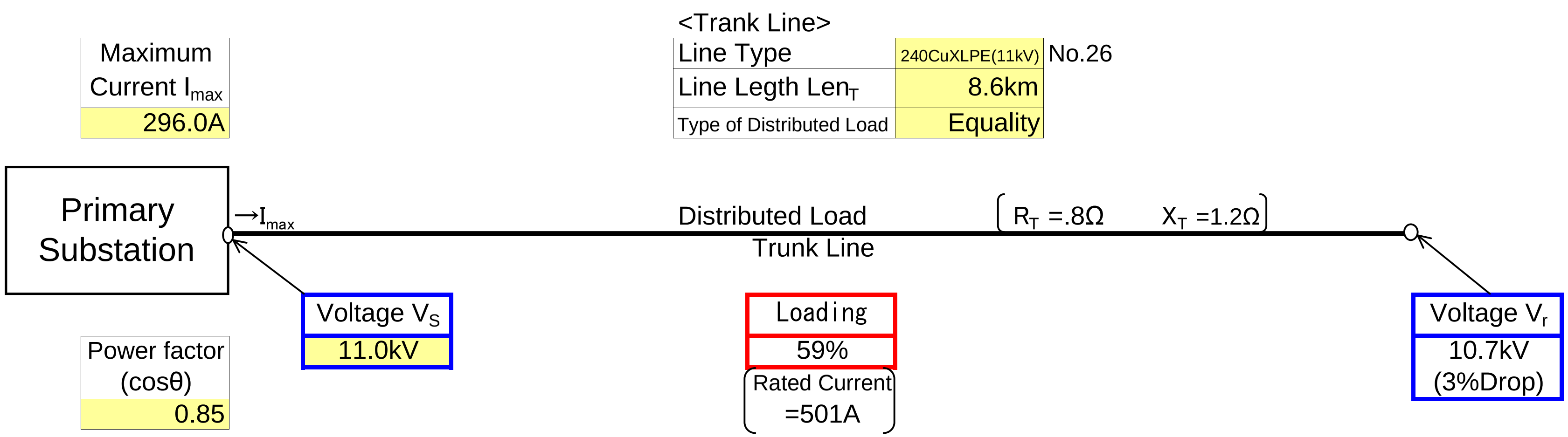
V_s : Supply Voltage
V_i : Interim Voltage
V_{r1} : Received Voltage
V_{r2} : Received Voltage
I_{max} : Maximum Current
L_T : Load (Trunk line)
L_{B1} : Load (Branch Line 1)
L_{B2} : Load (Branch Line 2)
R_T, R_{B1}, R_{B2} : Resistance
X_T, X_{B1}, X_{B2} : Reactance
cosθ : Power Factor
f_T, f_{B1}, f_{B2} : Dispersal Load Factor
$CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	STN C
Feeder Name	C10

: Input data in colored cells

Type-1



=====Equation=====

$V_r = Vs - 1.732 \cdot I_{max}(R_T\cos\theta + X_T\sin\theta) \cdot f_T$

V_s	: Supply Voltage	R_T	: Resistance	f_T	: Dispersal Load Factor
V_r	: Received Voltage	X_T	: Reactance		
I_{max}	: Maximum Current	$\cos\theta$	: Power Factor		

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Station C
Feeder Name	C10

: Input data in colored cells

Type-2

<Trank Line>

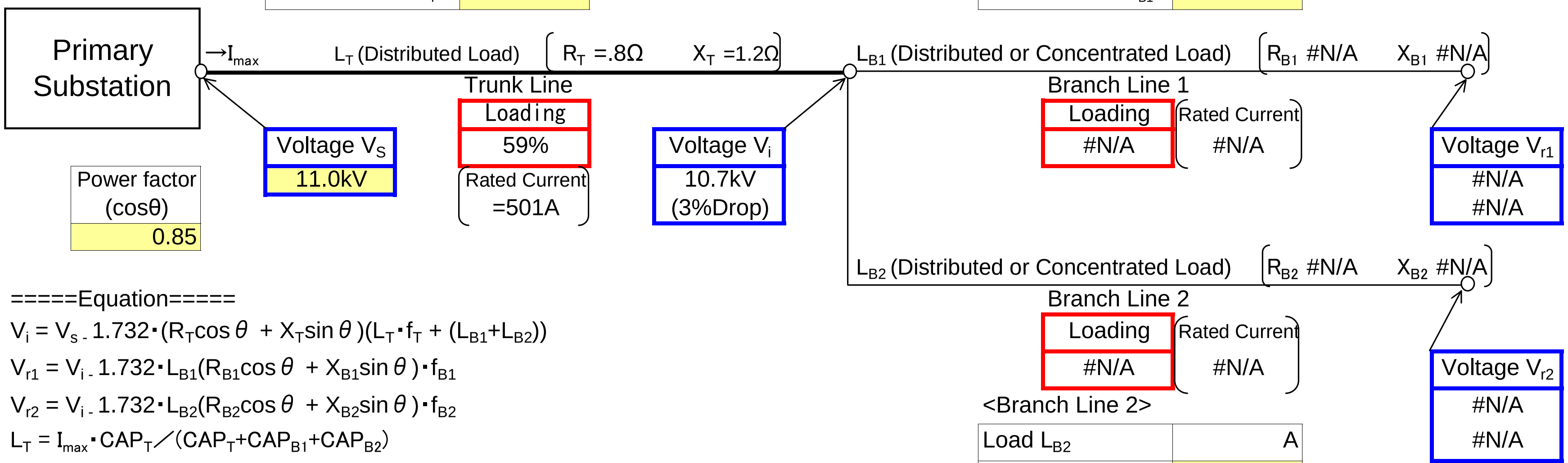
Load L_T	296A	
Line Type	240CuXLPE(11kV)	No.26
Line Legth Len_T	8.6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	8175kVA	

<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B1}		

Maximum Current I_{max}	
296.0A	

Power factor (cosθ)	
0.85	



<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Line Length Len_{B1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_S - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_T, R_{B1}, R_{B2}	: Resistance
V_i	: Interim Voltage	L_T	: Load (Trunk line)	X_T, X_{B1}, X_{B2}	: Reactance
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	cosθ	: Power Factor
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	f_T, f_{B1}, f_{B2}	: Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis

- Eastern -

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	Tafo BSP
Feeder Name	Kibi/Suhum

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T		

<Branch Line 1>

Load L_{B1}	212A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	12km	
Total Transformer Capacity of secondary substations CAP_{B1}	715kVA	

Maximum Current I_{max}
364A

Power factor (cosθ)
0.86

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =2Ω X_T =2Ω)

Trunk Line

Loading
80%

(Rated Current =455A)

Voltage V_S
11.0kV

Voltage V_i
9.4kV (15%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =3Ω X_{B1} =4Ω)

Branch Line 1

Loading
47%

(Rated Current =455A)

Voltage V_{r1}
8.5kV (23%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =1Ω X_{B2} =1Ω)

Branch Line 2

Loading
33%

(Rated Current =455A)

Voltage V_{r2}
9.0kV (18%Drop)

<Branch Line 2>

Load L_{B2}	152A	
Line Type	AAC120mm2	No.7
Type of Load	Concentrated	
Line Length Len_{B1}	4km	
Total Transformer Capacity of secondary substations CAP_{B2}	515kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage　I_{max} : Maximum Current　R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage　L_T : Load (Trunk line)　X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage　L_{B1} : Load (Branch Line 1)　cosθ : Power Factor

V_{r2} : Received Voltage　L_{B2} : Load (Branch Line 2)　f_T, f_{B1}, f_{B2} : Dispersal Load Factor　CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Kibi/Suhum

: Input data in colored cells

Type-2

Maximum Current I_{max}
364A

Power factor (cosθ)
0.86

<Trank Line>

Load L_T	279A	
Line Type	AAC150mm2	No.6
Line Legth Len_T	44km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	3430kVA	

<Branch Line 1>

Load L_{B1}	37A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	6km	
Total Transformer Capacity of secondary substations CAP_{B1}	450kVA	

Primary Substation

$\rightarrow I_{max}$ L_T (Distributed Load) (R_T =9Ω X_T =15Ω)

Trunk Line: Loading 69% (Rated Current =530A)

Voltage V_S: 8.5kV

Voltage V_i: 1.2kV (86%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =2Ω X_{B1} =2Ω)

Branch Line 1: Loading 8% (Rated Current =455A)

Voltage V_{r1}: 1.1kV (87%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =3Ω X_{B2} =4Ω)

Branch Line 2: Loading 11% (Rated Current =455A)

Voltage V_{r2}: .9kV (89%Drop)

<Branch Line 2>

Load L_{B2}	49A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	11km	
Total Transformer Capacity of secondary substations CAP_{B2}	600kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Kibi/Suhum

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	186A	
Line Type	AAC150mm2	No.6
Line Legth Len_T	20km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	2245kVA	

<Branch Line 1>

Load L_{B1}	76A	
Line Type	AAC150mm2	No.6
Type of Load	Equality	
Line Length Len_{B1}	12km	
Total Transformer Capacity of secondary substations CAP_{B1}	915kVA	

Maximum Current I_{max}	364A
Power factor (cosθ)	0.86

Primary Substation

$\rightarrow I_{max}$ L_T (Distributed Load) (R_T =4Ω X_T =7Ω)

Voltage V_S: 8.5kV

Trunk Line — Loading: 69% (Rated Current =530A)

Voltage V_i: 5.3kV (38%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =2Ω X_{B1} =4Ω)

Branch Line 1 — Loading: 14% (Rated Current =530A)

Voltage V_{r1}: 5.0kV (41%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =1Ω X_{B2} =1Ω)

Branch Line 2 — Loading: 22% (Rated Current =455A)

Voltage V_{r2}: 5.1kV (39%Drop)

<Branch Line 2>

Load L_{B2}	102A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B2}	1230kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage　I_{max} : Maximum Current　R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage　L_T : Load (Trunk line)　X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage　L_{B1} : Load (Branch Line 1)　cosθ : Power Factor
V_{r2} : Received Voltage　L_{B2} : Load (Branch Line 2)　f_T, f_{B1}, f_{B2} : Dispersal Load Factor　CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Tafo

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	31A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	1km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	200kVA	

<Trank Line 2>

Load L_{T2}	247A	
Line Type	Cu70mm2	No.14
Line Legth Len_{T2}	7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	1615kVA	

<Branch Line 2>

Load L_{B2}	48A	
Line Type	Cu70mm2	No.14
Type of Load	Concentrated	
Line Length Len_{B1}	4km	
Total Transformer Capacity of secondary substations CAP_{B2}	315kVA	

Maximum Current I_{max}	450A
Power factor (cosθ)	0.86

Primary Substation

$\rightarrow I_{max}$

L_{T1} (Distributed Load) $\{R_{T1} = \Omega \quad X_{T1} = \Omega\}$

Trunk Line 1: Loading 134%, Rated Current =335A

Voltage V_S: 11.0kV

Voltage V_{i1}: 10.8kV (1%Drop)

L_{T2} (Distributed Load) $\{R_{T2} = 2\Omega \quad X_{T2} = 3\Omega\}$

Trunk Line 2: Loading 111%, Rated Current =369A

Voltage V_{i2}: 9.4kV (14%Drop)

L_{B2} (Distributed or Concentrated Load) $\{R_{B2} = 1\Omega \quad X_{B2} = 2\Omega\}$

Branch Line 2: Loading 13%, Rated Current =369A

Voltage V_{r2}: 9.3kV (16%Drop)

L_{B1} (Distributed or Concentrated Load) $\{R_{B1} = \Omega \quad X_{B1} = \Omega\}$

Branch Line 1: Loading 11%, Rated Current =455A

Voltage V_{r1}: 10.8kV (2%Drop)

L_{B3} (Distributed or Concentrated Load) $\{R_{B3} = 2\Omega \quad X_{B3} = 3\Omega\}$

Branch Line 3: Loading 21%, Rated Current =369A

Voltage V_{r3}: 9.2kV (16%Drop)

<Branch Line 1>

Load L_{B1}	48A	
Line Type	AAC120mm2	No.7
Type of Load	Concentrated	
Line Length Len_{B1}	1km	
Total Transformer Capacity of secondary substations CAP_{B1}	315kVA	

<Branch Line 3>

Load L_{B3}	76A	
Line Type	Cu70mm2	No.14
Type of Load	Equality	
Line Length Len_{B3}	7km	
Total Transformer Capacity of secondary substations CAP_{B3}	500kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1} + CAP_{T2} + CAP_{B1} + CAP_{B2} + CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1} + CAP_{T2} + CAP_{B1} + CAP_{B2} + CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1} + CAP_{T2} + CAP_{B1} + CAP_{B2} + CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1} + CAP_{T2} + CAP_{B1} + CAP_{B2} + CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1} + CAP_{T2} + CAP_{B1} + CAP_{B2} + CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Tafo

: Input data in colored cells

Type-3

Maximum Current I_{max}
450A

Power factor (cosθ)
0.86

Primary Substation

→I_{max}

Voltage V_S
9.3kV

<Trank Line 1>

Load L_{T1}	70A	
Line Type	Cu70mm2	No.14
Line Legth Len_{T1}	8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	575kVA	

L_{T1} (Distributed Load) R_{T1} =2Ω X_{T1} =4Ω

Trunk Line 1

Loading
122%

Rated Current =369A

Voltage V_{i1}
6.5kV
(30%Drop)

<Trank Line 2>

Load L_{T2}	164A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	6km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	1350kVA	

L_{T2} (Distributed Load) R_{T2} =2Ω X_{T2} =2Ω

Trunk Line 2

Loading
71%

Rated Current =455A

Voltage V_{i2}
5.6kV
(57%Drop)

<Branch Line 2>

Load L_{B2}	A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	km	
Total Transformer Capacity of secondary substations CAP_{B2}		

L_{B2} (Distributed or Concentrated Load) R_{B2} =Ω X_{B2} =Ω

Branch Line 2

Loading
0%

Rated Current =455A

Voltage V_{r2}
5.6kV
(40%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} =3Ω X_{B1} =2Ω

Branch Line 1

Loading
46%

Rated Current =260A

Voltage V_{r1}
6.0kV
(36%Drop)

<Branch Line 1>

Load L_{B1}	119A	
Line Type	AAC50mm2	No.11
Type of Load	Received Larger	
Line Length Len_{B1}	6km	
Total Transformer Capacity of secondary substations CAP_{B1}	980kVA	

L_{B3} (Distributed or Concentrated Load) R_{B3} =7Ω X_{B3} =4Ω

Branch Line 3

Loading
37%

Rated Current =260A

Voltage V_{r3}
5.1kV
(45%Drop)

<Branch Line 3>

Load L_{B3}	97A	
Line Type	AAC50mm2	No.11
Type of Load	Sending Larger	
Line Length Len_{B3}	11km	
Total Transformer Capacity of secondary substations CAP_{B3}	800kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Tafo

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}		

<Trank Line 2>

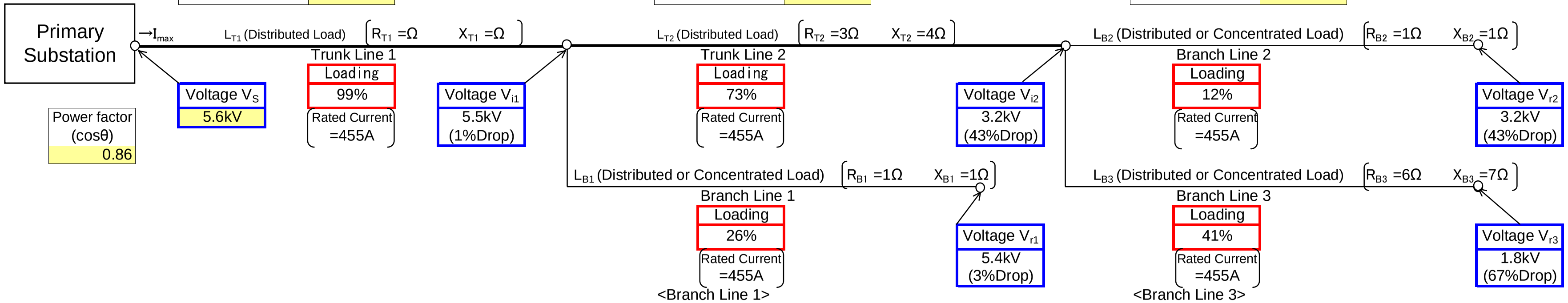
Load L_{T2}	90A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	11km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	575kVA	

<Branch Line 2>

Load L_{B2}	55A	
Line Type	AAC120mm2	No.7
Type of Load	Sending Larger	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B2}	350kVA	

Maximum Current I_{max}
450A

Power factor ($\cos\theta$)
0.86



<Branch Line 1>

Load L_{B1}	117A	
Line Type	AAC120mm2	No.7
Type of Load	Sending Larger	
Line Length Len_{B1}	4km	
Total Transformer Capacity of secondary substations CAP_{B1}	750kVA	

<Branch Line 3>

Load L_{B3}	188A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B3}	20km	
Total Transformer Capacity of secondary substations CAP_{B3}	1200kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	$\cos\theta$	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Tafo

: Input data in colored cells

Type-3

Maximum Current I_{max}: 450A

Power factor (cosθ): 0.86

Primary Substation

<Trank Line 1>

Load L_{T1}	199A	
Line Type	Cu70mm2	No.14
Line Legth Len_{T1}	23km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	1565kVA	

<Trank Line 2>

Load L_{T2}	78A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	7km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	615kVA	

<Branch Line 2>

Load L_{B2}	76A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	26km	
Total Transformer Capacity of secondary substations CAP_{B2}	600kVA	

→I_{max} L_{T1} (Distributed Load) (R_{T1} =7Ω X_{T1} =10Ω)

Voltage V_S: 9.3kV

Trunk Line 1: Loading 122% (Rated Current =369A)

Voltage V_{i1}: 2.0kV (79%Drop)

L_{T2} (Distributed Load) (R_{T2} =2Ω X_{T2} =2Ω)

Trunk Line 2: Loading 57% (Rated Current =455A)

Voltage V_{i2}: 1.2kV #########

L_{B2} (Distributed or Concentrated Load) (R_{B2} =7Ω X_{B2} =9Ω)

Branch Line 2: Loading 17% (Rated Current =455A)

Voltage V_{r2}: .2kV (98%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =Ω X_{B1} =Ω)

Branch Line 1: Loading 11% (Rated Current =369A)

Voltage V_{r1}: 2.0kV (79%Drop)

L_{B3} (Distributed or Concentrated Load) (R_{B3} =4Ω X_{B3} =5Ω)

Branch Line 3: Loading 13% (Rated Current =455A)

Voltage V_{r3}: .9kV (90%Drop)

<Branch Line 1>

Load L_{B1}	40A	
Line Type	Cu70mm2	No.14
Type of Load	Received Larger	
Line Length Len_{B1}	km	
Total Transformer Capacity of secondary substations CAP_{B1}	315kVA	

<Branch Line 3>

Load L_{B3}	57A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B3}	14km	
Total Transformer Capacity of secondary substations CAP_{B3}	450kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1} + CAP_{T2} + CAP_{B1} + CAP_{B2} + CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1} + CAP_{T2} + CAP_{B1} + CAP_{B2} + CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1} + CAP_{T2} + CAP_{B1} + CAP_{B2} + CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1} + CAP_{T2} + CAP_{B1} + CAP_{B2} + CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1} + CAP_{T2} + CAP_{B1} + CAP_{B2} + CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	OPASS

: Input data in colored cells

Type-2

Maximum Current I_{max}
52A

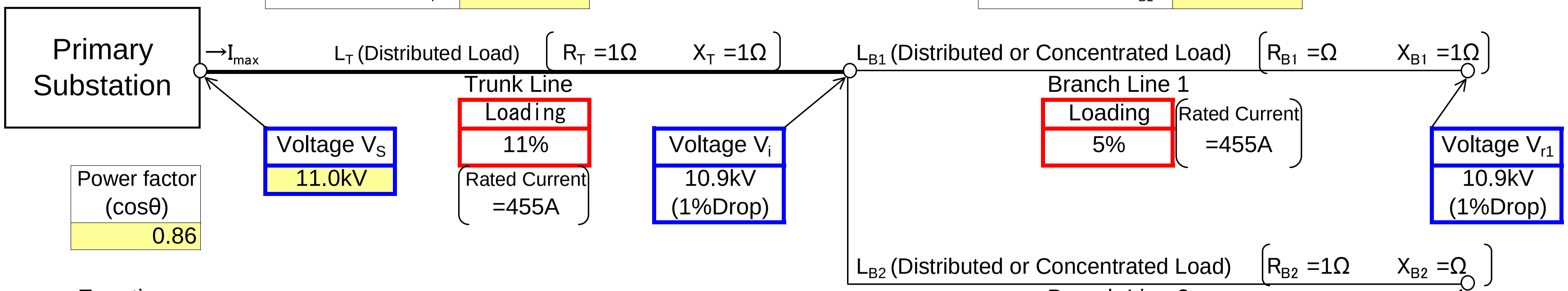
Power factor (cosθ)
0.86

<Trank Line>

Load L_T	27A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	4km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	1205kVA	

<Branch Line 1>

Load L_{B1}	23A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B1}	1015kVA	



<Branch Line 2>

Load L_{B2}	2A	
Line Type	AAC50mm2	No.11
Type of Load	Concentrated	
Line Length Len_{B1}	1km	
Total Transformer Capacity of secondary substations CAP_{B2}	100kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

$CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	K'dua-Mangoase

: Input data in colored cells

Type-2

Maximum Current I_{max}
325A

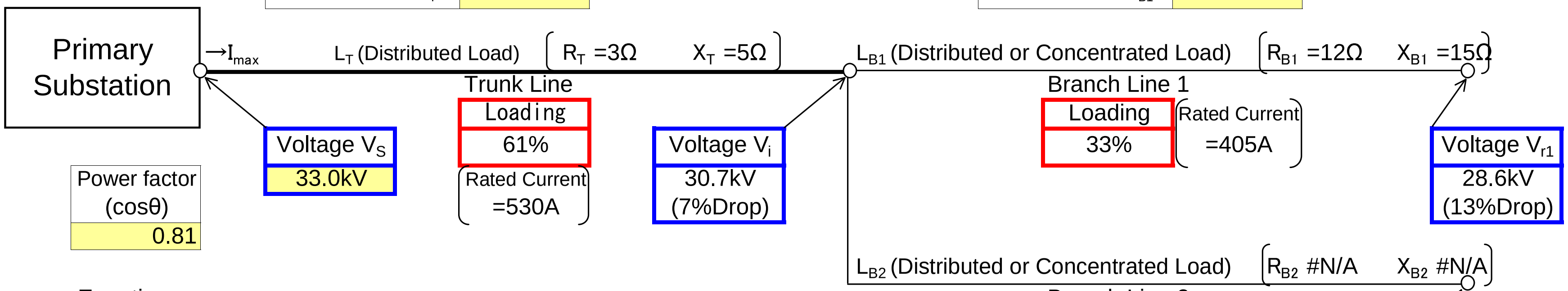
Power factor (cosθ)
0.81

<Trank Line>

Load L_T	193A	
Line Type	AAC150mm2	No.6
Line Legth Len_T	16km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	800kVA	

<Branch Line 1>

Load L_{B1}	132A	
Line Type	AAC100mm2	No.8
Type of Load	Equality	
Line Length Len_{B1}	40km	
Total Transformer Capacity of secondary substations CAP_{B1}	550kVA	



<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Koforidua
Feeder Name	Power House

: Input data in colored cells

Type-2

Maximum Current I_{max}
196A

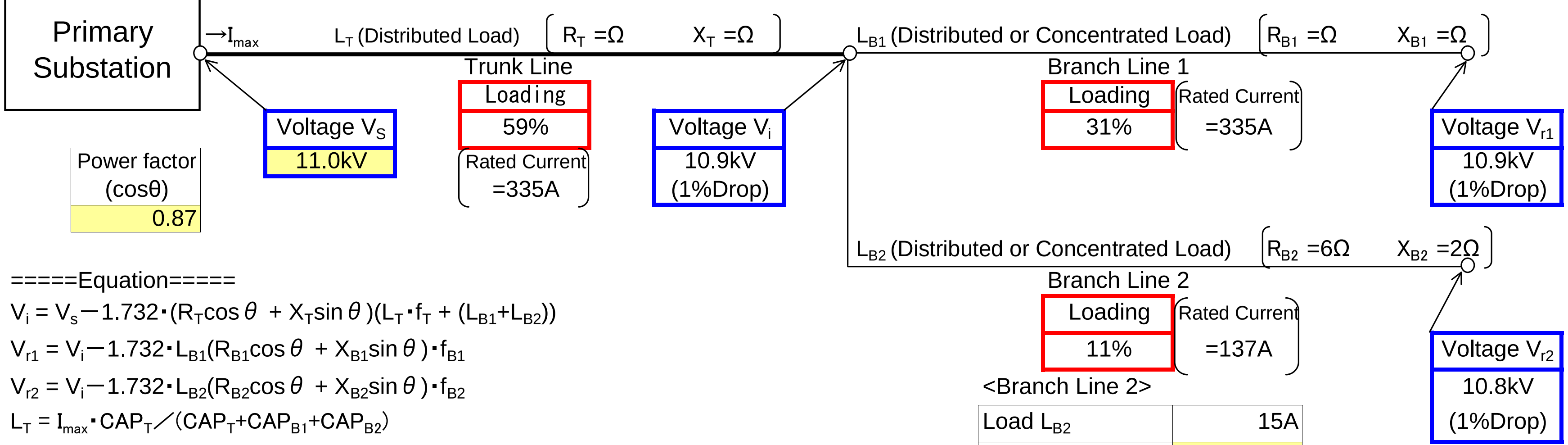
Power factor (cosθ)
0.87

<Trank Line>

Load L_T	78A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	2km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_T	2380kVA	

<Branch Line 1>

Load L_{B1}	103A	
Line Type	185ALXPLE(11kV)	No.24
Type of Load	Sending Larger	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B1}	3125kVA	



<Branch Line 2>

Load L_{B2}	15A	
Line Type	Cu16mm2	No.16
Type of Load	Sending Larger	
Line Length Len_{B1}	5km	
Total Transformer Capacity of secondary substations CAP_{B2}	450kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor

V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	Koforidua
Feeder Name	Estate Junction

: Input data in colored cells

Type-3

Maximum Current I_{max}
261A

Power factor (cosθ)
0.87

Primary Substation

$\rightarrow I_{max}$

Voltage V_s
11.0kV

<Trank Line 1>

Load L_{T1}	122A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	2km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	2030kVA	

L_{T1} (Distributed Load) (R_{T1} =Ω X_{T1} =Ω)

Trunk Line 1

Loading
78%

Rated Current =335A

Voltage V_{i1}
10.9kV (1%Drop)

<Trank Line 2>

Load L_{T2}	128A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	2130kVA	

L_{T2} (Distributed Load) (R_{T2} =2Ω X_{T2} =2Ω)

Trunk Line 2

Loading
38%

Rated Current =455A

Voltage V_{i2}
10.5kV (4%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =Ω X_{B1} =Ω)

Branch Line 1

Loading
3%

Rated Current =455A

Voltage V_{r1}
10.9kV (1%Drop)

<Branch Line 1>

Load L_{B1}	12A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	1km	
Total Transformer Capacity of secondary substations CAP_{B1}	200kVA	

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B2}		

L_{B2} (Distributed or Concentrated Load) (R_{B2} #N/A X_{B2} #N/A)

Branch Line 2

Loading
#N/A

Rated Current #N/A

Voltage V_{r2}
#N/A #N/A

L_{B3} (Distributed or Concentrated Load) (R_{B3} #N/A X_{B3} #N/A)

Branch Line 3

Loading
#N/A

Rated Current #N/A

Voltage V_{r3}
#N/A #N/A

<Branch Line 3>

Load L_{B3}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B3}		
Total Transformer Capacity of secondary substations CAP_{B3}		

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Koforidua
Feeder Name	Accra Rd

: Input data in colored cells

Type-3

Maximum Current I_{max}
250A

Power factor (cosθ)
0.87

<Trank Line 1>

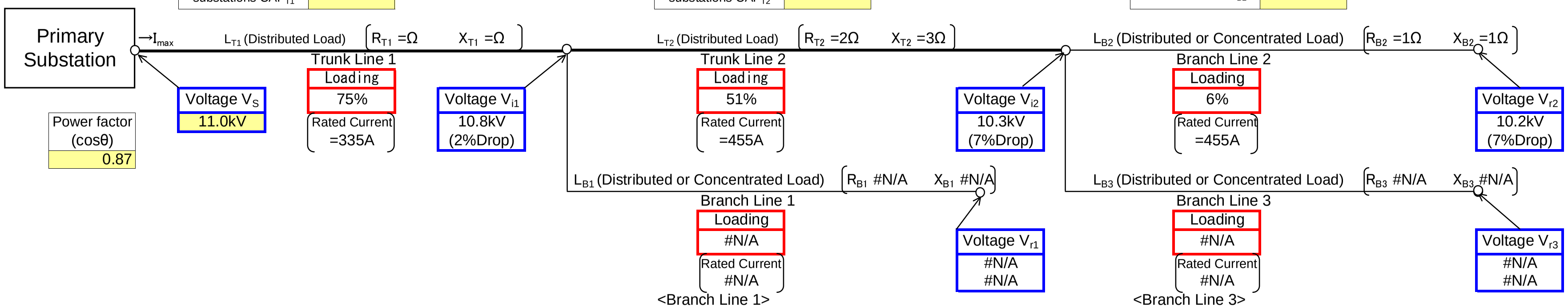
Load L_{T1}	78A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	3km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	1815kVA	

<Trank Line 2>

Load L_{T2}	145A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	3390kVA	

<Branch Line 2>

Load L_{B2}	27A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B2}	630kVA	



<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B1}		

<Branch Line 3>

Load L_{B3}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B3}		
Total Transformer Capacity of secondary substations CAP_{B3}		

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	Koforidua
Feeder Name	Old Estate

: Input data in colored cells

Type-3

Maximum Current I_{max}
162A

Power factor (cosθ)
0.87

<Trank Line 1>

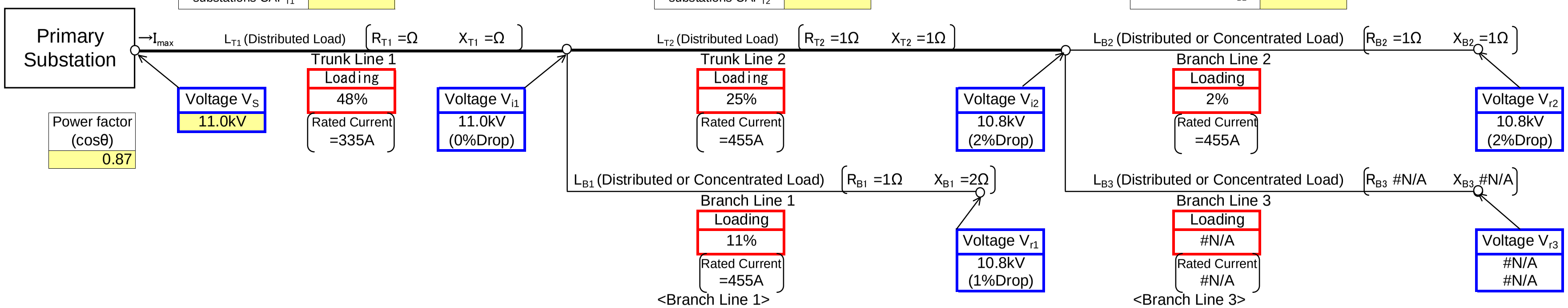
Load L_{T1}	29A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	1km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	615kVA	

<Trank Line 2>

Load L_{T2}	74A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	4km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	1545kVA	

<Branch Line 2>

Load L_{B2}	10A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B2}	200kVA	



<Branch Line 1>

Load L_{B1}	49A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	4km	
Total Transformer Capacity of secondary substations CAP_{B1}	1030kVA	

<Branch Line 3>

Load L_{B3}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B3}		
Total Transformer Capacity of secondary substations CAP_{B3}		

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Koforidua
Feeder Name	St. Joseph

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	74A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	16km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	4515kVA	

<Branch Line 1>

Load L_{B1}	3A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	1km	
Total Transformer Capacity of secondary substations CAP_{B1}	200kVA	

Maximum Current I_{max}	77A

Power factor (cosθ)	0.87

Primary Substation

$\rightarrow I_{max}$ L_T (Distributed Load) (R_T =4Ω X_T =6Ω)

Trunk Line

Loading
17%

(Rated Current =455A)

Voltage V_S
11.0kV

Voltage V_i
10.4kV (5%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =Ω X_{B1} =Ω)

Branch Line 1

Loading
1%

(Rated Current =455A)

Voltage V_{r1}
10.4kV (6%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} #N/A X_{B2} #N/A)

Branch Line 2

Loading
#N/A

(Rated Current #N/A)

Voltage V_{r2}
#N/A
#N/A

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor

V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Asesewa

: Input data in colored cells

Type-3

Maximum Current I_{max}
23A

Power factor (cosθ)
0.81

<Trank Line 1>

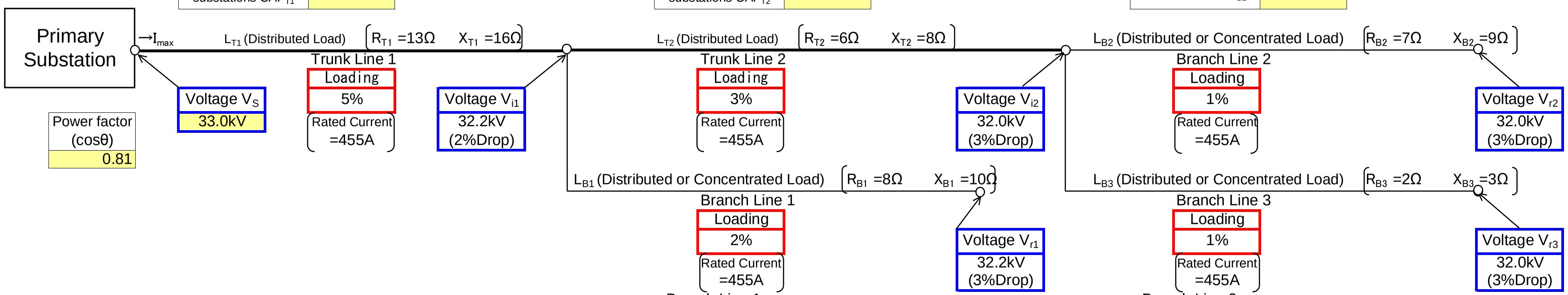
Load L_{T1}	2A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	46km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	250kVA	

<Trank Line 2>

Load L_{T2}	4A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	23km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	550kVA	

<Branch Line 2>

Load L_{B2}	5A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	25km	
Total Transformer Capacity of secondary substations CAP_{B2}	650kVA	



<Branch Line 1>

Load L_{B1}	7A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	28km	
Total Transformer Capacity of secondary substations CAP_{B1}	900kVA	

<Branch Line 3>

Load L_{B3}	5A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B3}	9km	
Total Transformer Capacity of secondary substations CAP_{B3}	600kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Akwatia BSP
Feeder Name	Akwatia

: Input data in colored cells

Type-3

Maximum Current I_{max}
191A

Power factor (cosθ)
0.87

Primary Substation

<Trank Line 1>

Load L_{T1}	A	
Line Type	95CuPILC(11kV)	No.20
Line Legth Len_{T1}	1km	
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{T1}		

<Trank Line 2>

Load L_{T2}	91A	
Line Type	Cu70mm2	No.14
Line Legth Len_{T2}	14km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	2980kVA	

<Branch Line 2>

Load L_{B2}	36A	
Line Type	Cu35mm2	No.15
Type of Load	Equality	
Line Length Len_{B1}	8km	
Total Transformer Capacity of secondary substations CAP_{B2}	1165kVA	

$\rightarrow I_{max}$

L_{T1} (Distributed Load) (R_{T1} =Ω X_{T1} =Ω)

Voltage V_S 11.0kV

Trunk Line 1: Loading 72%, Rated Current =265A

Voltage V_{i1} 10.9kV (1%Drop)

L_{T2} (Distributed Load) (R_{T2} =4Ω X_{T2} =6Ω)

Trunk Line 2: Loading 67%, Rated Current =369A

Voltage V_{i2} 9.4kV (15%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =6Ω X_{B2} =4Ω)

Branch Line 2: Loading 15%, Rated Current =236A

Voltage V_{r2} 9.2kV (17%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =2Ω X_{B1} =2Ω)

Branch Line 1: Loading 3%, Rated Current =455A

Voltage V_{r1} 10.9kV (1%Drop)

L_{B3} (Distributed or Concentrated Load) (R_{B3} =9Ω X_{B3} =6Ω)

Branch Line 3: Loading 22%, Rated Current =236A

Voltage V_{r3} 9.1kV (18%Drop)

<Branch Line 1>

Load L_{B1}	14A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	7km	
Total Transformer Capacity of secondary substations CAP_{B1}	450kVA	

<Branch Line 3>

Load L_{B3}	51A	
Line Type	Cu35mm2	No.15
Type of Load	Sending Larger	
Line Length Len_{B3}	13km	
Total Transformer Capacity of secondary substations CAP_{B3}	1665kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Akwatia BSP
Feeder Name	Asaman

: Input data in colored cells

Type-2

Maximum Current I_{max}
247A

<Trank Line>

Load L_T	159A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	35km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	3415kVA	

<Branch Line 1>

Load L_{B1}	88A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	8km	
Total Transformer Capacity of secondary substations CAP_{B1}	1895kVA	

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =10Ω X_T =12Ω)

Trunk Line

Loading
54%

(Rated Current =455A)

Voltage V_S
11.0kV

Voltage V_i
6.8kV (38%Drop)

Power factor (cosθ)
0.86

L_{B1} (Distributed or Concentrated Load) (R_{B1} =2Ω X_{B1} =3Ω)

Branch Line 1

Loading
19%

(Rated Current =455A)

Voltage V_{r1}
6.5kV (41%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} #N/A X_{B2} #N/A)

Branch Line 2

Loading
#N/A

(Rated Current #N/A)

Voltage V_{r2}
#N/A
#N/A

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nsawam Stn N
Feeder Name	Adoagyiri

: Input data in colored cells

Type-2

Maximum Current I_{max}	389A
Power factor (cosθ)	0.86

<Trank Line>

Load L_T	A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	26km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T		

<Branch Line 1>

Load L_{B1}	389A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	11km	
Total Transformer Capacity of secondary substations CAP_{B1}	400kVA	

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =7Ω X_T =9Ω)

Trunk Line

Loading	85%
Rated Current	=455A

Voltage V_S	11.0kV
Voltage V_i	3.8kV (66%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =3Ω X_{B1} =4Ω)

Branch Line 1

Loading	85%
Rated Current	=455A
Voltage V_{r1}	2.2kV (80%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} #N/A X_{B2} #N/A)

Branch Line 2

Loading	#N/A
Rated Current	#N/A
Voltage V_{r2}	#N/A #N/A

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor

V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Akwatia
Feeder Name	Oda

: Input data in colored cells

Type-3

Maximum Current I_{max}
185A

Power factor (cosθ)
0.91

Primary Substation

<Trank Line 1>

Load L_{T1}	8A	
Line Type	AAC150mm2	No.6
Line Legth Len_{T1}	27km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	200kVA	

<Trank Line 2>

Load L_{T2}	91A	
Line Type	AAC150mm2	No.6
Line Legth Len_{T2}	13km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	2200kVA	

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B2}		

→I_{max} L_{T1} (Distributed Load) (R_{T1} =6Ω X_{T1} =9Ω)

Voltage V_S
33.0kV

Trunk Line 1

Loading
35%

(Rated Current =530A)

Voltage V_{i1}
30.2kV (9%Drop)

L_{T2} (Distributed Load) (R_{T2} =3Ω X_{T2} =5Ω)

Trunk Line 2

Loading
22%

(Rated Current =530A)

Voltage V_{i2}
29.6kV (11%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} #N/A X_{B2} #N/A)

Branch Line 2

Loading
#N/A

(Rated Current #N/A)

Voltage V_{r2}
#N/A #N/A

L_{B1} (Distributed or Concentrated Load) (R_{B1} =5Ω X_{B1} =7Ω)

Branch Line 1

Loading
13%

(Rated Current =455A)

Voltage V_{r1}
29.6kV (10%Drop)

L_{B3} (Distributed or Concentrated Load) (R_{B3} =8Ω X_{B3} =11Ω)

Branch Line 3

Loading
6%

(Rated Current =455A)

Voltage V_{r3}
29.5kV (11%Drop)

<Branch Line 1>

Load L_{B1}	60A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	20km	
Total Transformer Capacity of secondary substations CAP_{B1}	1450kVA	

<Branch Line 3>

Load L_{B3}	25A	
Line Type	AAC120mm2	No.7
Type of Load	Sending Larger	
Line Length Len_{B3}	30km	
Total Transformer Capacity of secondary substations CAP_{B3}	615kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Akwatia BSP
Feeder Name	Oda

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	A
Line Type	AAC120mm2 No.7
Line Legth Len_{T1}	3km
Type of Distributed Load	Sending Larger
Total Transformer Capacity of secondary substations CAP_{T1}	

<Trank Line 2>

Load L_{T2}	76A
Line Type	AAC120mm2 No.7
Line Legth Len_{T2}	56km
Type of Distributed Load	Received Larger
Total Transformer Capacity of secondary substations CAP_{T2}	1700kVA

<Branch Line 2>

Load L_{B2}	71A
Line Type	AAC120mm2 No.7
Type of Load	Received Larger
Line Length Len_{B1}	40km
Total Transformer Capacity of secondary substations CAP_{B2}	1600kVA

Maximum Current I_{max}
185A

Power factor (cosθ)
0.91

Primary Substation

$\rightarrow I_{max}$

L_{T1} (Distributed Load) R_{T1} =1Ω X_{T1} =1Ω

Voltage V_s: 29.6kV

Trunk Line 1 — Loading 41%, Rated Current =455A

Voltage V_{i1}: 29.2kV (1%Drop)

L_{T2} (Distributed Load) R_{T2} =15Ω X_{T2} =20Ω

Trunk Line 2 — Loading 37%, Rated Current =455A

Voltage V_{i2}: 23.7kV (20%Drop)

L_{B2} (Distributed or Concentrated Load) R_{B2} =11Ω X_{B2} =14Ω

Branch Line 2 — Loading 16%, Rated Current =455A

Voltage V_{r2}: 22.4kV (24%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} =4Ω X_{B1} =6Ω

Branch Line 1 — Loading 3%, Rated Current =455A

Voltage V_{r1}: 29.2kV (1%Drop)

L_{B3} (Distributed or Concentrated Load) R_{B3} =2Ω X_{B3} =2Ω

Branch Line 3 — Loading 5%, Rated Current =455A

Voltage V_{r3}: 23.6kV (20%Drop)

<Branch Line 1>

Load L_{B1}	16A
Line Type	AAC120mm2 No.7
Type of Load	Sending Larger
Line Length Len_{B1}	16km
Total Transformer Capacity of secondary substations CAP_{B1}	350kVA

<Branch Line 3>

Load L_{B3}	22A
Line Type	AAC120mm2 No.7
Type of Load	Received Larger
Line Length Len_{B3}	7km
Total Transformer Capacity of secondary substations CAP_{B3}	500kVA

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Oda
Feeder Name	Town

: Input data in colored cells

Type-3

Maximum Current I_{max}
137A

Power factor (cosθ)
0.87

<Trank Line 1>

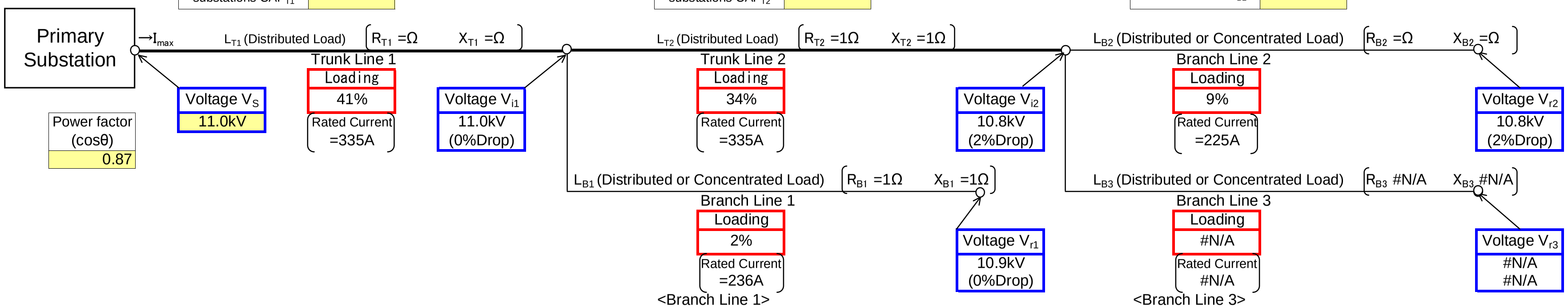
Load L_{T1}	20A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	1km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	500kVA	

<Trank Line 2>

Load L_{T2}	93A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T2}	6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	2330kVA	

<Branch Line 2>

Load L_{B2}	20A	
Line Type	95ALXPLE(11kV)	No.21
Type of Load	Equality	
Line Length Len_{B1}	1km	
Total Transformer Capacity of secondary substations CAP_{B2}	500kVA	



<Branch Line 1>

Load L_{B1}	4A	
Line Type	Cu35mm2	No.15
Type of Load	Received Larger	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B1}	100kVA	

<Branch Line 3>

Load L_{B3}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B3}		
Total Transformer Capacity of secondary substations CAP_{B3}		

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Oda
Feeder Name	Achiase

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	A
Line Type	185ALXPLE(11kV) No.24
Line Legth Len_{T1}	3km
Type of Distributed Load	Equality
Total Transformer Capacity of secondary substations CAP_{T1}	

<Trank Line 2>

Load L_{T2}	52A
Line Type	AAC120mm2 No.7
Line Legth Len_{T2}	5km
Type of Distributed Load	Received Larger
Total Transformer Capacity of secondary substations CAP_{T2}	900kVA

<Branch Line 2>

Load L_{B2}	107A
Line Type	Cu35mm2 No.15
Type of Load	Sending Larger
Line Length Len_{B1}	4km
Total Transformer Capacity of secondary substations CAP_{B2}	1850kVA

Maximum Current I_{max}	159A
Power factor (cosθ)	0.87

Primary Substation

$\rightarrow I_{max}$

Voltage V_s: 11.0kV

L_{T1} (Distributed Load) (R_{T1} =Ω X_{T1} =Ω)

Trunk Line 1 — Loading 47% — Rated Current =335A

Voltage V_{i1}: 10.9kV (1%Drop)

L_{T2} (Distributed Load) (R_{T2} =1Ω X_{T2} =2Ω)

Trunk Line 2 — Loading 47% — Rated Current =455A

Voltage V_{i2}: 10.4kV (6%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =3Ω X_{B2} =2Ω)

Branch Line 2 — Loading 45% — Rated Current =236A

Voltage V_{r2}: 10.1kV (8%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} #N/A X_{B1} #N/A)

Branch Line 1 — Loading #N/A — Rated Current #N/A

Voltage V_{r1}: #N/A #N/A

L_{B3} (Distributed or Concentrated Load) (R_{B3} #N/A X_{B3} #N/A)

Branch Line 3 — Loading #N/A — Rated Current #N/A

Voltage V_{r3}: #N/A #N/A

<Branch Line 1>

Load L_{B1}	A
Line Type	#N/A
Type of Load	
Line Length Len_{B1}	
Total Transformer Capacity of secondary substations CAP_{B1}	

<Branch Line 3>

Load L_{B3}	A
Line Type	#N/A
Type of Load	
Line Length Len_{B3}	
Total Transformer Capacity of secondary substations CAP_{B3}	

=====Equation=====

$V_{i1} = V_s - 1.732\cdot(R_{T1}\cos\theta + X_{T1}\sin\theta)\cdot(L_{T1}\cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732\cdot(R_{T2}\cos\theta + X_{T2}\sin\theta)\cdot(L_{T2}\cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732\cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta)\cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732\cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta)\cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732\cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta)\cdot f_{B3}$

$L_{T1} = I_{max}\cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max}\cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max}\cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max}\cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max}\cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	Oda
Feeder Name	Achiase

: Input data in colored cells

Type-3

Maximum Current I_{max}
159A

Power factor (cosθ)
0.87

<Trank Line 1>

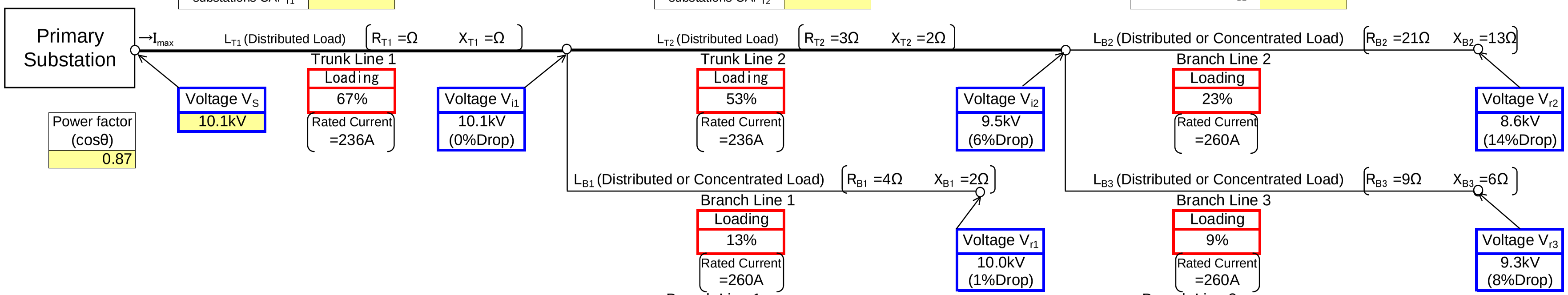
Load L_{T1}	A	
Line Type	Cu35mm2	No.15
Line Legth Len_{T1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{T1}		

<Trank Line 2>

Load L_{T2}	40A	
Line Type	Cu35mm2	No.15
Line Legth Len_{T2}	4km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	815kVA	

<Branch Line 2>

Load L_{B2}	60A	
Line Type	AAC50mm2	No.11
Type of Load	Sending Larger	
Line Length Len_{B1}	34km	
Total Transformer Capacity of secondary substations CAP_{B2}	1215kVA	



<Branch Line 1>

Load L_{B1}	34A	
Line Type	AAC50mm2	No.11
Type of Load	Equality	
Line Length Len_{B1}	6km	
Total Transformer Capacity of secondary substations CAP_{B1}	700kVA	

<Branch Line 3>

Load L_{B3}	25A	
Line Type	AAC50mm2	No.11
Type of Load	Equality	
Line Length Len_{B3}	15km	
Total Transformer Capacity of secondary substations CAP_{B3}	500kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Oda
Feeder Name	Sawmill

: Input data in colored cells

Type-2

Maximum Current I_{max}
168A

Power factor (cosθ)
0.87

<Trank Line>

Load L_T	69A	
Line Type	Cu35mm2	No.15
Line Legth Len_T	2km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	2115kVA	

<Branch Line 1>

Load L_{B1}	41A	
Line Type	Cu35mm2	No.15
Type of Load	Sending Larger	
Line Length Len_{B1}	1km	
Total Transformer Capacity of secondary substations CAP_{B1}	1250kVA	

Primary Substation

$\rightarrow I_{max}$ L_T (Distributed Load) (R_T =1Ω X_T =1Ω)

Trunk Line

Loading
71%

Rated Current =236A

Voltage V_S
11.0kV

Voltage V_i
10.6kV (4%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =Ω X_{B1} =Ω)

Branch Line 1

Loading
17%

Rated Current =236A

Voltage V_{r1}
10.6kV (4%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =1Ω X_{B2} =1Ω)

Branch Line 2

Loading
22%

Rated Current =260A

Voltage V_{r2}
10.5kV (5%Drop)

<Branch Line 2>

Load L_{B2}	57A	
Line Type	AAC50mm2	No.11
Type of Load	Received Larger	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B2}	1750kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor

V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nkawkaw BSP
Feeder Name	Donkorkrom

: Input data in colored cells

Type-3

Maximum Current I_{max}: 33A

Power factor (cosθ): 0.86

<Trank Line 1>

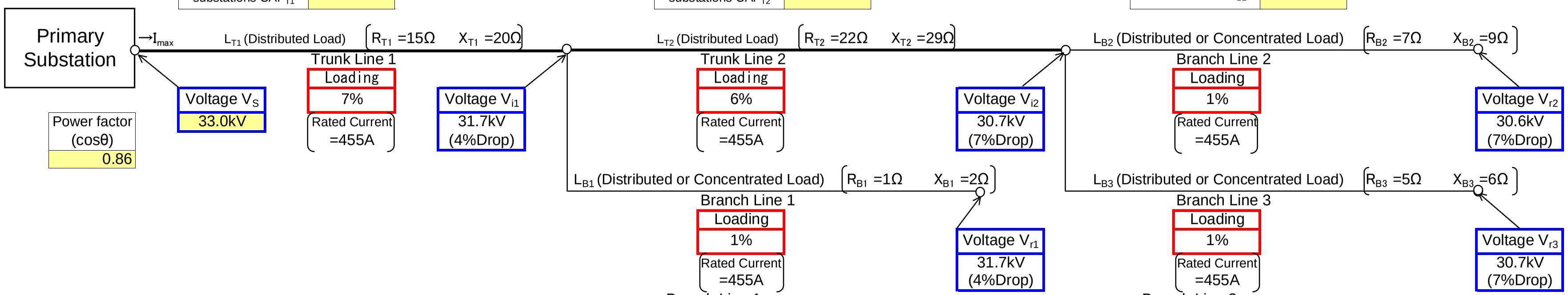
Load L_{T1}	3A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	56km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	450kVA	

<Trank Line 2>

Load L_{T2}	20A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	80km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	3265kVA	

<Branch Line 2>

Load L_{B2}	4A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	26km	
Total Transformer Capacity of secondary substations CAP_{B2}	700kVA	



<Branch Line 1>

Load L_{B1}	2A	
Line Type	AAC120mm2	No.7
Type of Load	Concentrated	
Line Length Len_{B1}	5km	
Total Transformer Capacity of secondary substations CAP_{B1}	400kVA	

<Branch Line 3>

Load L_{B3}	4A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B3}	17km	
Total Transformer Capacity of secondary substations CAP_{B3}	600kVA	

=====Equation=====

$V_{i1} = V_s - 1.732\cdot(R_{T1}\cos\theta + X_{T1}\sin\theta)\cdot(L_{T1}\cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732\cdot(R_{T2}\cos\theta + X_{T2}\sin\theta)\cdot(L_{T2}\cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732\cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta)\cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732\cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta)\cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732\cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta)\cdot f_{B3}$

$L_{T1} = I_{max}\cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max}\cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max}\cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max}\cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max}\cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nkawkaw BSP
Feeder Name	New Abirem

: Input data in colored cells

Type-3

Maximum Current I_{max}	
73A	

Power factor (cosθ)
0.86

<Trank Line 1>

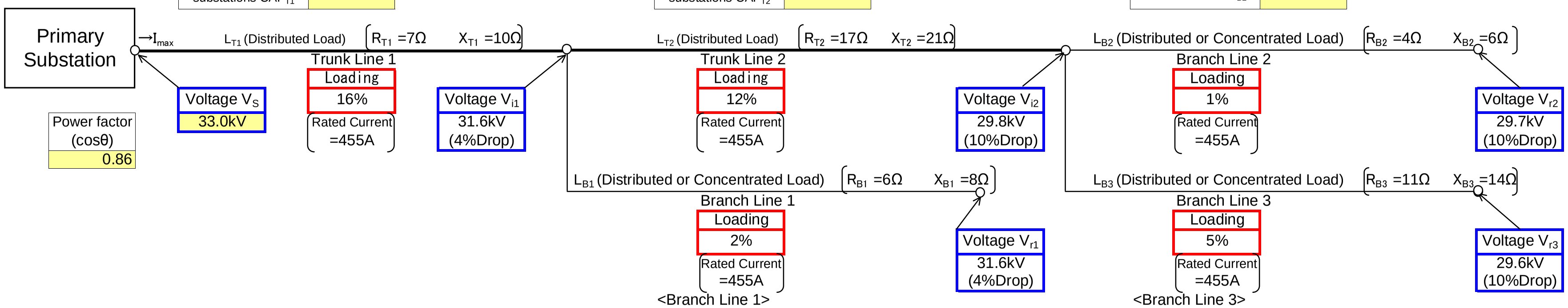
Load L_{T1}	10A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	27km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	1150kVA	

<Trank Line 2>

Load L_{T2}	27A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	60km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	3055kVA	

<Branch Line 2>

Load L_{B2}	6A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	16km	
Total Transformer Capacity of secondary substations CAP_{B2}	700kVA	



<Branch Line 1>

Load L_{B1}	7A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	23km	
Total Transformer Capacity of secondary substations CAP_{B1}	800kVA	

<Branch Line 3>

Load L_{B3}	23A	
Line Type	AAC120mm2	No.7
Type of Load	Sending Larger	
Line Length Len_{B3}	39km	
Total Transformer Capacity of secondary substations CAP_{B3}	2600kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	Nkawkaw BSP
Feeder Name	New Abirem

: Input data in colored cells

Type-3

Maximum Current I_{max}
73A

Power factor (cosθ)
0.91

<Trank Line 1>

Load L_{T1}	A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	1km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}		

<Trank Line 2>

Load L_{T2}	8A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	18km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	250kVA	

<Branch Line 2>

Load L_{B2}	10A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	16km	
Total Transformer Capacity of secondary substations CAP_{B2}	300kVA	

Primary Substation

$\rightarrow I_{max}$

Voltage V_S 29.7kV

L_{T1} (Distributed Load) R_{T1} =Ω X_{T1} =Ω

Trunk Line 1 — Loading 16% — Rated Current =455A

Voltage V_{i1} 29.6kV (0%Drop)

L_{T2} (Distributed Load) R_{T2} =5Ω X_{T2} =7Ω

Trunk Line 2 — Loading 7% — Rated Current =455A

Voltage V_{i2} 29.3kV (1%Drop)

L_{B2} (Distributed or Concentrated Load) R_{B2} =4Ω X_{B2} =6Ω

Branch Line 2 — Loading 2% — Rated Current =455A

Voltage V_{r2} 29.2kV (2%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} =5Ω X_{B1} =7Ω

Branch Line 1 — Loading 9% — Rated Current =455A

Voltage V_{r1} 29.3kV (1%Drop)

L_{B3} (Distributed or Concentrated Load) R_{B3} =3Ω X_{B3} =3Ω

Branch Line 3 — Loading 3% — Rated Current =455A

Voltage V_{r3} 29.2kV (2%Drop)

<Branch Line 1>

Load L_{B1}	43A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	19km	
Total Transformer Capacity of secondary substations CAP_{B1}	1350kVA	

<Branch Line 3>

Load L_{B3}	13A	
Line Type	AAC120mm2	No.7
Type of Load	Concentrated	
Line Length Len_{B3}	9km	
Total Transformer Capacity of secondary substations CAP_{B3}	400kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nkawkaw BSP
Feeder Name	Enyiresi

: Input data in colored cells

Type-3

Maximum Current I_{max}	
	13A

Power factor (cosθ)	
	0.86

<Trank Line 1>

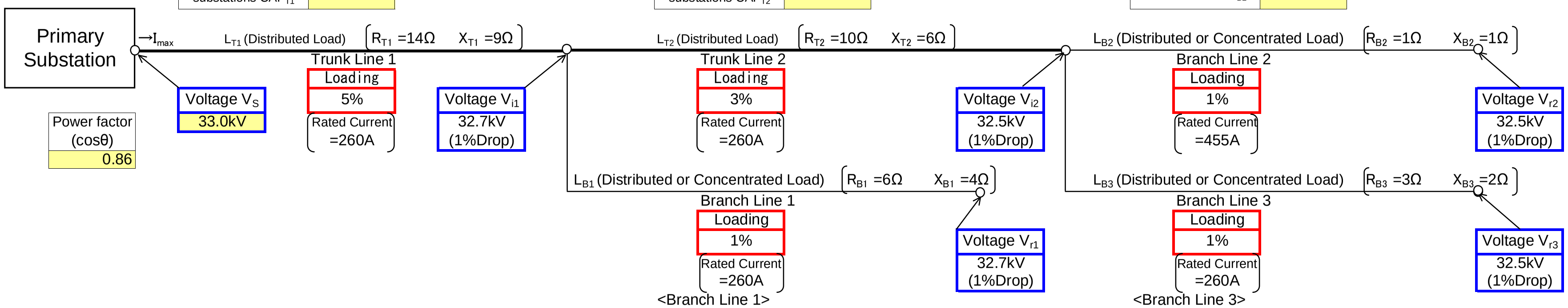
Load L_{T1}	3A	
Line Type	AAC50mm2	No.11
Line Legth Len_{T1}	23km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	250kVA	

<Trank Line 2>

Load L_{T2}	3A	
Line Type	AAC50mm2	No.11
Line Legth Len_{T2}	17km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	300kVA	

<Branch Line 2>

Load L_{B2}	3A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	4km	
Total Transformer Capacity of secondary substations CAP_{B2}	300kVA	



<Branch Line 1>

Load L_{B1}	2A	
Line Type	AAC50mm2	No.11
Type of Load	Concentrated	
Line Length Len_{B1}	10km	
Total Transformer Capacity of secondary substations CAP_{B1}	200kVA	

<Branch Line 3>

Load L_{B3}	3A	
Line Type	AAC50mm2	No.11
Type of Load	Sending Larger	
Line Length Len_{B3}	5km	
Total Transformer Capacity of secondary substations CAP_{B3}	250kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nkawkaw BSP
Feeder Name	Novotex

: Input data in colored cells

Type-3

Maximum Current I_{max}
99A

Power factor (cosθ)
0.92

<Trank Line 1>

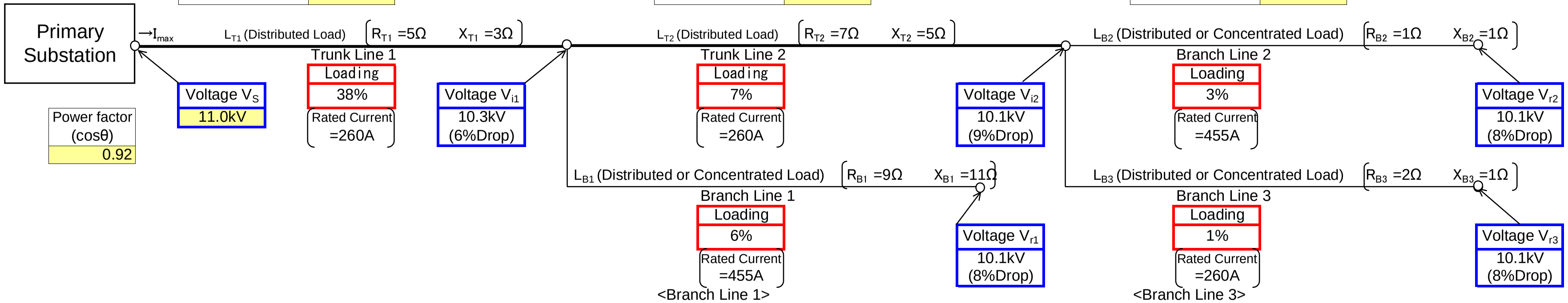
Load L_{T1}	51A	
Line Type	AAC50mm2	No.11
Line Legth Len_{T1}	9km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	1700kVA	

<Trank Line 2>

Load L_{T2}	4A	
Line Type	AAC50mm2	No.11
Line Legth Len_{T2}	12km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	150kVA	

<Branch Line 2>

Load L_{B2}	13A	
Line Type	AAC120mm2	No.7
Type of Load	Sending Larger	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B2}	450kVA	



<Branch Line 1>

Load L_{B1}	29A	
Line Type	AAC120mm2	No.7
Type of Load	Sending Larger	
Line Length Len_{B1}	31km	
Total Transformer Capacity of secondary substations CAP_{B1}	965kVA	

<Branch Line 3>

Load L_{B3}	1A	
Line Type	AAC50mm2	No.11
Type of Load	Concentrated	
Line Length Len_{B3}	3km	
Total Transformer Capacity of secondary substations CAP_{B3}	50kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nkawkaw BSP
Feeder Name	Mountains

: Input data in colored cells

Type-3

Maximum Current I_{max}	508A

Primary Substation

Power factor (cosθ)	0.92

Voltage V_S
11.0kV

<Trank Line 1>

Load L_{T1}	31A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	11km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	500kVA	

$\rightarrow I_{max}$ L_{T1} (Distributed Load) R_{T1} =3Ω X_{T1} =4Ω

Trunk Line 1: Loading 112%, Rated Current =455A

Voltage V_{i1}
7.4kV
(33%Drop)

<Trank Line 2>

Load L_{T2}	90A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	23km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	1465kVA	

L_{T2} (Distributed Load) R_{T2} =6Ω X_{T2} =8Ω

Trunk Line 2: Loading 93%, Rated Current =455A

Voltage V_{i2}
1.7kV
#########

<Branch Line 2>

Load L_{B2}	175A	
Line Type	Cu16mm2	No.16
Type of Load	Equality	
Line Length Len_{B1}	44km	
Total Transformer Capacity of secondary substations CAP_{B2}	2865kVA	

L_{B2} (Distributed or Concentrated Load) R_{B2} =56Ω X_{B2} =22Ω

Branch Line 2: Loading 128%, Rated Current =137A

Voltage V_{r2}
-7.5kV
#########

L_{B1} (Distributed or Concentrated Load) R_{B1} =16Ω X_{B1} =6Ω

Branch Line 1: Loading 40%, Rated Current =137A

Voltage V_{r1}
6.9kV
(38%Drop)

<Branch Line 1>

Load L_{B1}	55A	
Line Type	Cu16mm2	No.16
Type of Load	Sending Larger	
Line Length Len_{B1}	13km	
Total Transformer Capacity of secondary substations CAP_{B1}	900kVA	

L_{B3} (Distributed or Concentrated Load) R_{B3} =1Ω X_{B3} =1Ω

Branch Line 3: Loading 35%, Rated Current =455A

Voltage V_{r3}
1.4kV
(87%Drop)

<Branch Line 3>

Load L_{B3}	158A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B3}	3km	
Total Transformer Capacity of secondary substations CAP_{B3}	2575kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nkawkaw BSP
Feeder Name	Nkawkaw Town

: Input data in colored cells

Type-3

Maximum Current I_{max}
373A

Power factor (cosθ)
0.92

<Trank Line 1>

Load L_{T1}	37A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	2km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	200kVA	

<Trank Line 2>

Load L_{T2}	A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T2}	1km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T2}		

<Branch Line 2>

Load L_{B2}	37A	
Line Type	AAC120mm2	No.7
Type of Load	Concentrated	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B2}	200kVA	

Primary Substation

$\rightarrow I_{max}$

L_{T1} (Distributed Load) R_{T1} =1Ω X_{T1} =1Ω

Trunk Line 1: Loading 82%, Rated Current =455A

Voltage V_S: 11.0kV

Voltage V_{i1}: 10.5kV (5%Drop)

L_{T2} (Distributed Load) R_{T2} =Ω X_{T2} =Ω

Trunk Line 2: Loading 54%, Rated Current =335A

Voltage V_{i2}: 10.4kV (6%Drop)

L_{B2} (Distributed or Concentrated Load) R_{B2} =1Ω X_{B2} =1Ω

Branch Line 2: Loading 8%, Rated Current =455A

Voltage V_{r2}: 10.3kV (7%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} =Ω X_{B1} =Ω

Branch Line 1: Loading 41%, Rated Current =225A

Voltage V_{r1}: 10.4kV (6%Drop)

L_{B3} (Distributed or Concentrated Load) R_{B3} =1Ω X_{B3} =Ω

Branch Line 3: Loading 62%, Rated Current =335A

Voltage V_{r3}: 10.2kV (7%Drop)

<Branch Line 1>

Load L_{B1}	92A	
Line Type	95ALXPLE(11kV)	No.21
Type of Load	Concentrated	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B1}	500kVA	

<Branch Line 3>

Load L_{B3}	208A	
Line Type	185ALXPLE(11kV)	No.24
Type of Load	Equality	
Line Length Len_{B3}	4km	
Total Transformer Capacity of secondary substations CAP_{B3}	1130kVA	

=====Equation=====

$V_{i1} = V_s - 1.732\cdot(R_{T1}\cos\theta + X_{T1}\sin\theta)\cdot(L_{T1}\cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732\cdot(R_{T2}\cos\theta + X_{T2}\sin\theta)\cdot(L_{T2}\cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732\cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta)\cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732\cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta)\cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732\cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta)\cdot f_{B3}$

$L_{T1} = I_{max}\cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max}\cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max}\cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max}\cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max}\cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	Nkawkaw BSP
Feeder Name	Nkawkaw Town

: Input data in colored cells

Type-3

Maximum Current I_{max}
373A

Power factor (cosθ)
0.92

<Trank Line 1>

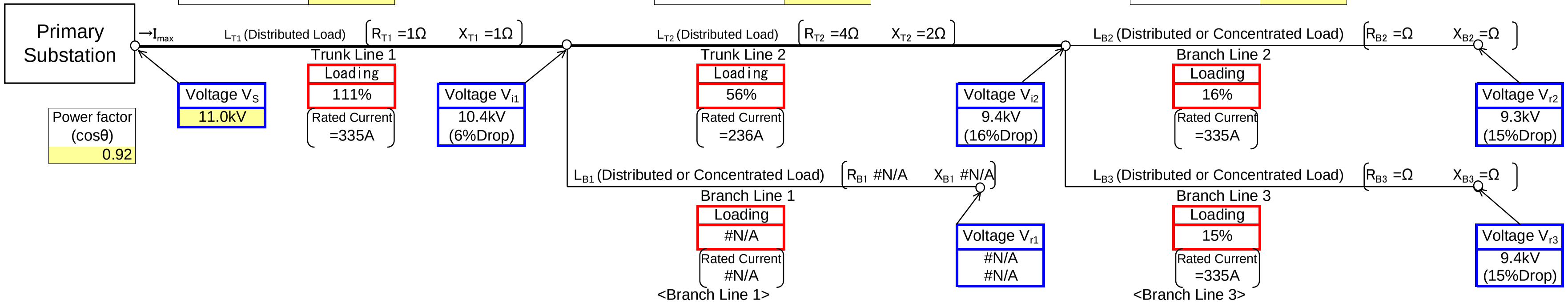
Load L_{T1}	185A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	6km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	1100kVA	

<Trank Line 2>

Load L_{T2}	84A	
Line Type	Cu35mm2	No.15
Line Legth Len_{T2}	5km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	500kVA	

<Branch Line 2>

Load L_{B2}	53A	
Line Type	185ALXPLE(11kV)	No.24
Type of Load	Concentrated	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B2}	315kVA	



<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B1}		

<Branch Line 3>

Load L_{B3}	51A	
Line Type	185ALXPLE(11kV)	No.24
Type of Load	Concentrated	
Line Length Len_{B3}	1km	
Total Transformer Capacity of secondary substations CAP_{B3}	300kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Kibi/Suhum

: Input data in colored cells

Type-2

Maximum Current I_{max}
364A

Power factor (cosθ)
0.86

<Trank Line>

Load L_T	A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T		

<Branch Line 1>

Load L_{B1}	212A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	12km	
Total Transformer Capacity of secondary substations CAP_{B1}	715kVA	

Primary Substation

$\rightarrow I_{max}$ L_T (Distributed Load) (R_T =2Ω X_T =2Ω)

Trunk Line

Loading
80%

(Rated Current =455A)

Voltage V_S
11.0kV

Voltage V_i
9.4kV (15%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =3Ω X_{B1} =4Ω)

Branch Line 1

Loading
47%

(Rated Current =455A)

Voltage V_{r1}
8.5kV (23%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =1Ω X_{B2} =1Ω)

Branch Line 2

Loading
33%

(Rated Current =455A)

Voltage V_{r2}
9.0kV (18%Drop)

<Branch Line 2>

Load L_{B2}	152A	
Line Type	AAC120mm2	No.7
Type of Load	Concentrated	
Line Length Len_{B1}	4km	
Total Transformer Capacity of secondary substations CAP_{B2}	515kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage, I_{max} : Maximum Current, R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage, L_T : Load (Trunk line), X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage, L_{B1} : Load (Branch Line 1), cosθ : Power Factor

V_{r2} : Received Voltage, L_{B2} : Load (Branch Line 2), f_T, f_{B1}, f_{B2} : Dispersal Load Factor, CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Kibi/Suhum

: Input data in colored cells

Type-2

Maximum Current I_{max}
364A

Power factor (cosθ)
0.86

<Trank Line>

Load L_T	279A	
Line Type	AAC150mm2	No.6
Line Legth Len_T	44km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	3430kVA	

<Branch Line 1>

Load L_{B1}	37A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	6km	
Total Transformer Capacity of secondary substations CAP_{B1}	450kVA	

Primary Substation

$\rightarrow I_{max}$ L_T (Distributed Load) (R_T =9Ω X_T =15Ω)

Trunk Line

Loading
69%

(Rated Current =530A)

Voltage V_S
8.5kV

Voltage V_i
1.2kV (86%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =2Ω X_{B1} =2Ω)

Branch Line 1

Loading
8%

(Rated Current =455A)

Voltage V_{r1}
1.1kV (87%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =3Ω X_{B2} =4Ω)

Branch Line 2

Loading
11%

(Rated Current =455A)

Voltage V_{r2}
.9kV (89%Drop)

<Branch Line 2>

Load L_{B2}	49A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	11km	
Total Transformer Capacity of secondary substations CAP_{B2}	600kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor

V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Kibi/Suhum

: Input data in colored cells

Type-2

Maximum Current I_{max}
364A

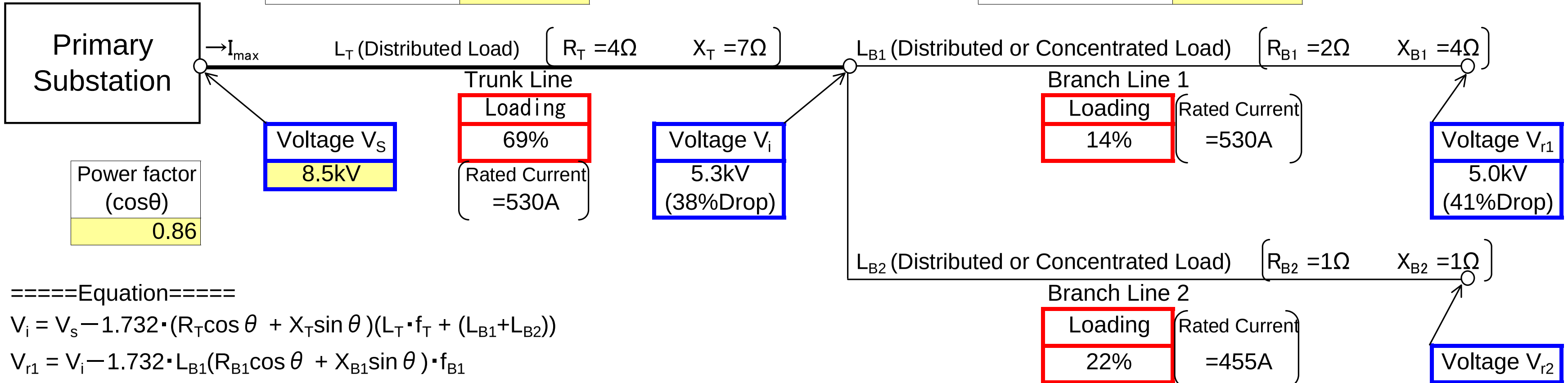
Power factor (cosθ)
0.86

<Trank Line>

Load L_T	186A	
Line Type	AAC150mm2	No.6
Line Legth Len_T	20km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	2245kVA	

<Branch Line 1>

Load L_{B1}	76A	
Line Type	AAC150mm2	No.6
Type of Load	Equality	
Line Length Len_{B1}	12km	
Total Transformer Capacity of secondary substations CAP_{B1}	915kVA	



<Branch Line 2>

Load L_{B2}	102A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B2}	1230kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1} + L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Tafo

: Input data in colored cells

Type-3

Maximum Current I_{max}
450A

Power factor (cosθ)
0.86

<Trank Line 1>

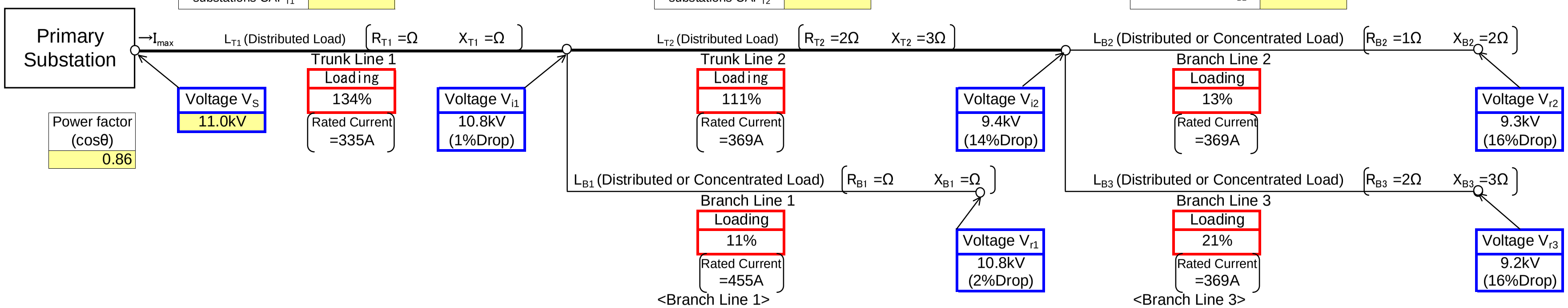
Load L_{T1}	31A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	1km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	200kVA	

<Trank Line 2>

Load L_{T2}	247A	
Line Type	Cu70mm2	No.14
Line Legth Len_{T2}	7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	1615kVA	

<Branch Line 2>

Load L_{B2}	48A	
Line Type	Cu70mm2	No.14
Type of Load	Concentrated	
Line Length Len_{B1}	4km	
Total Transformer Capacity of secondary substations CAP_{B2}	315kVA	



<Branch Line 1>

Load L_{B1}	48A	
Line Type	AAC120mm2	No.7
Type of Load	Concentrated	
Line Length Len_{B1}	1km	
Total Transformer Capacity of secondary substations CAP_{B1}	315kVA	

<Branch Line 3>

Load L_{B3}	76A	
Line Type	Cu70mm2	No.14
Type of Load	Equality	
Line Length Len_{B3}	7km	
Total Transformer Capacity of secondary substations CAP_{B3}	500kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Tafo

: Input data in colored cells

Type-3

Maximum Current I_{max}
450A

Power factor (cosθ)
0.86

<Trank Line 1>

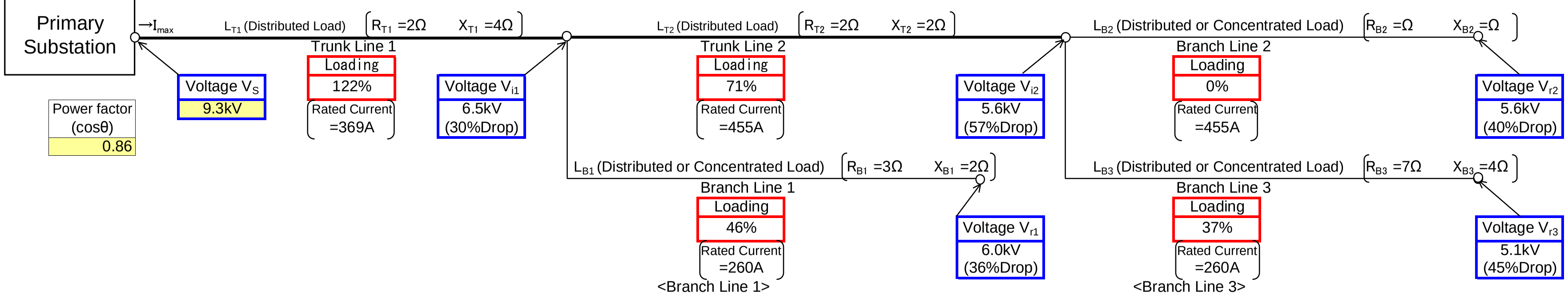
Load L_{T1}	70A	
Line Type	Cu70mm2	No.14
Line Legth Len_{T1}	8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	575kVA	

<Trank Line 2>

Load L_{T2}	164A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	6km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	1350kVA	

<Branch Line 2>

Load L_{B2}	A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	km	
Total Transformer Capacity of secondary substations CAP_{B2}		



<Branch Line 1>

Load L_{B1}	119A	
Line Type	AAC50mm2	No.11
Type of Load	Received Larger	
Line Length Len_{B1}	6km	
Total Transformer Capacity of secondary substations CAP_{B1}	980kVA	

<Branch Line 3>

Load L_{B3}	97A	
Line Type	AAC50mm2	No.11
Type of Load	Sending Larger	
Line Length Len_{B3}	11km	
Total Transformer Capacity of secondary substations CAP_{B3}	800kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Tafo

: Input data in colored cells

Type-3

Maximum Current I_{max}
450A

Power factor ($\cos\theta$)
0.86

<Trank Line 1>

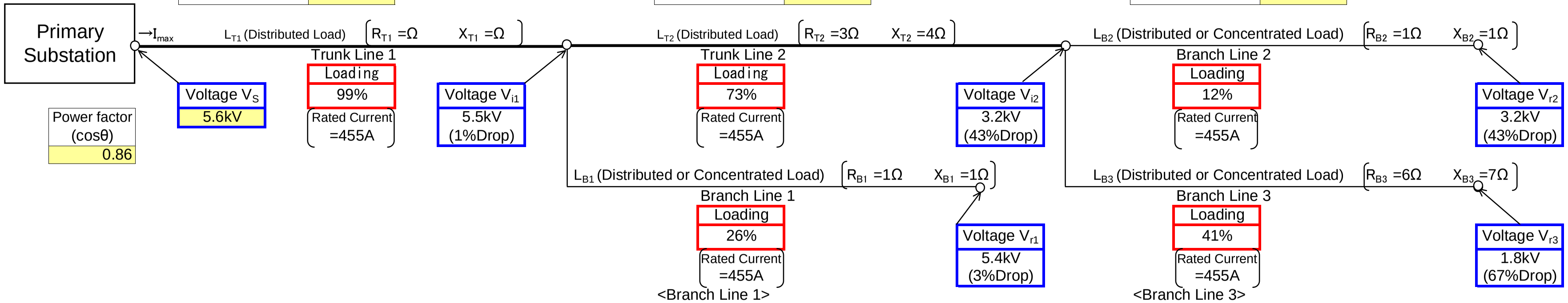
Load L_{T1}	A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}		

<Trank Line 2>

Load L_{T2}	90A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	11km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	575kVA	

<Branch Line 2>

Load L_{B2}	55A	
Line Type	AAC120mm2	No.7
Type of Load	Sending Larger	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B2}	350kVA	



<Branch Line 1>

Load L_{B1}	117A	
Line Type	AAC120mm2	No.7
Type of Load	Sending Larger	
Line Length Len_{B1}	4km	
Total Transformer Capacity of secondary substations CAP_{B1}	750kVA	

<Branch Line 3>

Load L_{B3}	188A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B3}	20km	
Total Transformer Capacity of secondary substations CAP_{B3}	1200kVA	

=====Equation=====

$V_{i1} = V_s - 1.732\cdot(R_{T1}\cos\theta + X_{T1}\sin\theta)\cdot(L_{T1}\cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732\cdot(R_{T2}\cos\theta + X_{T2}\sin\theta)\cdot(L_{T2}\cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732\cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta)\cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732\cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta)\cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732\cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta)\cdot f_{B3}$

$L_{T1} = I_{max}\cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max}\cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max}\cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max}\cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max}\cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	$\cos\theta$	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Tafo

: Input data in colored cells

Type-3

Maximum Current I_{max}: 450A

Power factor (cosθ): 0.86

Primary Substation

$\rightarrow I_{max}$

Voltage V_s: 9.3kV

<Trank Line 1>

Load L_{T1}	199A	
Line Type	Cu70mm2	No.14
Line Legth Len_{T1}	23km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	1565kVA	

L_{T1} (Distributed Load) (R_{T1} =7Ω X_{T1} =10Ω)

Trunk Line 1: Loading 122%, Rated Current =369A

Voltage V_{i1}: 2.0kV (79%Drop)

<Trank Line 2>

Load L_{T2}	78A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	7km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	615kVA	

L_{T2} (Distributed Load) (R_{T2} =2Ω X_{T2} =2Ω)

Trunk Line 2: Loading 57%, Rated Current =455A

Voltage V_{i2}: 1.2kV #########

<Branch Line 2>

Load L_{B2}	76A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	26km	
Total Transformer Capacity of secondary substations CAP_{B2}	600kVA	

L_{B2} (Distributed or Concentrated Load) (R_{B2} =7Ω X_{B2} =9Ω)

Branch Line 2: Loading 17%, Rated Current =455A

Voltage V_{r2}: .2kV (98%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =Ω X_{B1} =Ω)

Branch Line 1: Loading 11%, Rated Current =369A

Voltage V_{r1}: 2.0kV (79%Drop)

<Branch Line 1>

Load L_{B1}	40A	
Line Type	Cu70mm2	No.14
Type of Load	Received Larger	
Line Length Len_{B1}	km	
Total Transformer Capacity of secondary substations CAP_{B1}	315kVA	

L_{B3} (Distributed or Concentrated Load) (R_{B3} =4Ω X_{B3} =5Ω)

Branch Line 3: Loading 13%, Rated Current =455A

Voltage V_{r3}: .9kV (90%Drop)

<Branch Line 3>

Load L_{B3}	57A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B3}	14km	
Total Transformer Capacity of secondary substations CAP_{B3}	450kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	OPASS

: Input data in colored cells

Type-2

Maximum Current I_{max}
52A

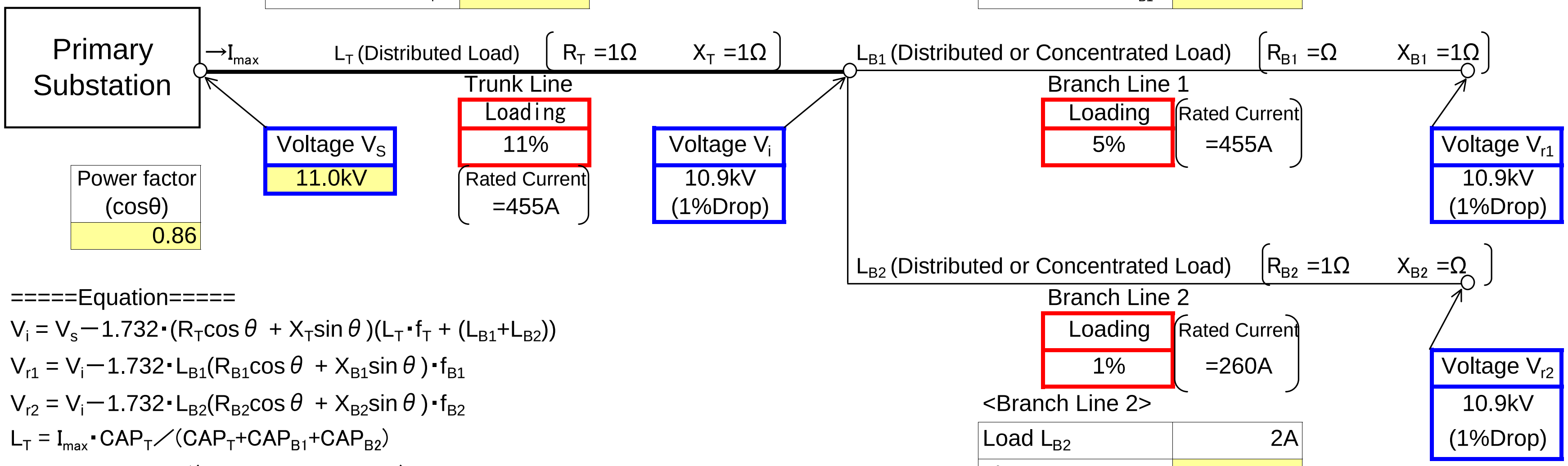
Power factor (cosθ)
0.86

<Trank Line>

Load L_T	27A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	4km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	1205kVA	

<Branch Line 1>

Load L_{B1}	23A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B1}	1015kVA	



<Branch Line 2>

Load L_{B2}	2A	
Line Type	AAC50mm2	No.11
Type of Load	Concentrated	
Line Length Len_{B1}	1km	
Total Transformer Capacity of secondary substations CAP_{B2}	100kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_T, R_{B1}, R_{B2}	: Resistance
V_i	: Interim Voltage	L_T	: Load (Trunk line)	X_T, X_{B1}, X_{B2}	: Reactance
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	cosθ	: Power Factor
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	f_T, f_{B1}, f_{B2}	: Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	K'dua-Mangoase

: Input data in colored cells

Type-2

Maximum Current I_{max}
325A

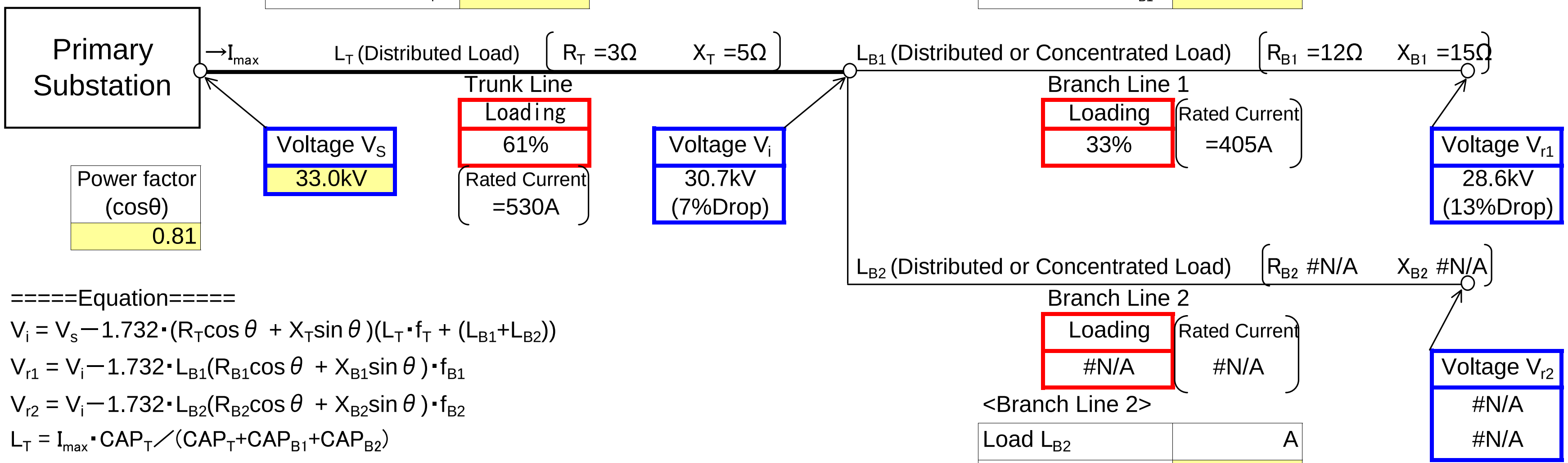
Power factor (cosθ)
0.81

<Trank Line>

Load L_T	193A	
Line Type	AAC150mm2	No.6
Line Legth Len_T	16km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	800kVA	

<Branch Line 1>

Load L_{B1}	132A	
Line Type	AAC100mm2	No.8
Type of Load	Equality	
Line Length Len_{B1}	40km	
Total Transformer Capacity of secondary substations CAP_{B1}	550kVA	



<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor

V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Koforidua
Feeder Name	Power House

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	78A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	2km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_T	2380kVA	

<Branch Line 1>

Load L_{B1}	103A	
Line Type	185ALXPLE(11kV)	No.24
Type of Load	Sending Larger	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B1}	3125kVA	

Maximum Current I_{max}
196A

Power factor (cosθ)
0.87

Primary Substation

$\rightarrow I_{max}$ L_T (Distributed Load) (R_T =Ω X_T =Ω)

Trunk Line

Loading
59%

(Rated Current =335A)

Voltage V_S
11.0kV

Voltage V_i
10.9kV (1%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =Ω X_{B1} =Ω)

Branch Line 1

Loading
31%

(Rated Current =335A)

Voltage V_{r1}
10.9kV (1%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =6Ω X_{B2} =2Ω)

Branch Line 2

Loading
11%

(Rated Current =137A)

Voltage V_{r2}
10.8kV (1%Drop)

<Branch Line 2>

Load L_{B2}	15A	
Line Type	Cu16mm2	No.16
Type of Load	Sending Larger	
Line Length Len_{B1}	5km	
Total Transformer Capacity of secondary substations CAP_{B2}	450kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage I_{max} : Maximum Current R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage L_T : Load (Trunk line) X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage L_{B1} : Load (Branch Line 1) cosθ : Power Factor

V_{r2} : Received Voltage L_{B2} : Load (Branch Line 2) f_T, f_{B1}, f_{B2} : Dispersal Load Factor CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Koforidua
Feeder Name	Estate Junction

: Input data in colored cells

Type-3

Maximum Current I_{max}
261A

Primary Substation

Power factor (cosθ)
0.87

<Trank Line 1>

Load L_{T1}	122A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	2km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	2030kVA	

<Trank Line 2>

Load L_{T2}	128A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	2130kVA	

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B2}		

$\rightarrow I_{max}$ L_{T1} (Distributed Load) (R_{T1} =Ω X_{T1} =Ω)

Voltage V_S: 11.0kV

Trunk Line 1: Loading 78%; Rated Current =335A

Voltage V_{i1}: 10.9kV (1%Drop)

L_{T2} (Distributed Load) (R_{T2} =2Ω X_{T2} =2Ω)

Trunk Line 2: Loading 38%; Rated Current =455A

Voltage V_{i2}: 10.5kV (4%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} #N/A X_{B2} #N/A)

Branch Line 2: Loading #N/A; Rated Current #N/A

Voltage V_{r2}: #N/A #N/A

L_{B1} (Distributed or Concentrated Load) (R_{B1} =Ω X_{B1} =Ω)

Branch Line 1: Loading 3%; Rated Current =455A

Voltage V_{r1}: 10.9kV (1%Drop)

L_{B3} (Distributed or Concentrated Load) (R_{B3} #N/A X_{B3} #N/A)

Branch Line 3: Loading #N/A; Rated Current #N/A

Voltage V_{r3}: #N/A #N/A

<Branch Line 1>

Load L_{B1}	12A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	1km	
Total Transformer Capacity of secondary substations CAP_{B1}	200kVA	

<Branch Line 3>

Load L_{B3}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B3}		
Total Transformer Capacity of secondary substations CAP_{B3}		

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	Koforidua
Feeder Name	Accra Rd

: Input data in colored cells

Type-3

Maximum Current I_{max}	250A
Power factor ($\cos\theta$)	0.87

<Trank Line 1>

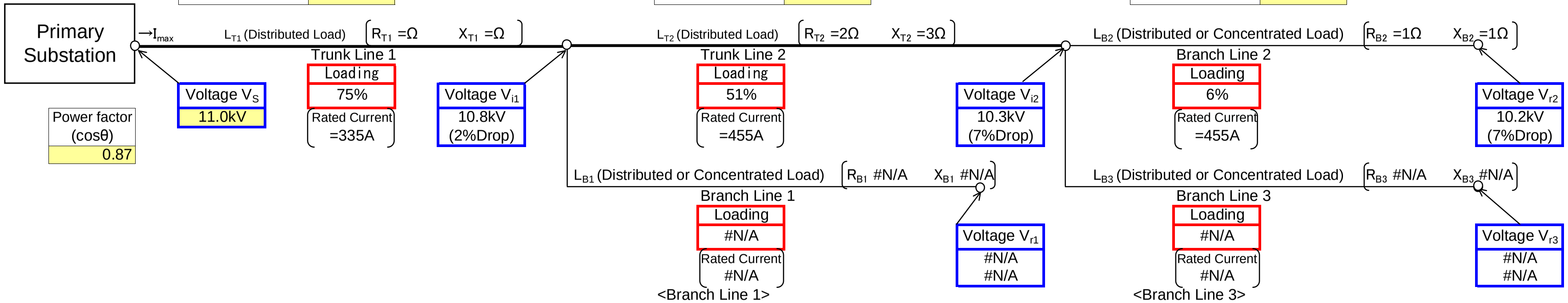
Load L_{T1}	78A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	3km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	1815kVA	

<Trank Line 2>

Load L_{T2}	145A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	3390kVA	

<Branch Line 2>

Load L_{B2}	27A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B2}	630kVA	



<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B1}		

<Branch Line 3>

Load L_{B3}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B3}		
Total Transformer Capacity of secondary substations CAP_{B3}		

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	$\cos\theta$	: Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Koforidua
Feeder Name	Old Estate

: Input data in colored cells

Type-3

Maximum Current I_{max}
162A

Power factor (cosθ)
0.87

<Trank Line 1>

Load L_{T1}	29A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	1km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	615kVA	

<Trank Line 2>

Load L_{T2}	74A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	4km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	1545kVA	

<Branch Line 2>

Load L_{B2}	10A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B2}	200kVA	

Primary Substation →I_{max}

Voltage V_s 11.0kV

L_{T1} (Distributed Load) (R_{T1} =Ω X_{T1} =Ω)

Trunk Line 1 Loading 48% (Rated Current =335A)

Voltage V_{i1} 11.0kV (0%Drop)

L_{T2} (Distributed Load) (R_{T2} =1Ω X_{T2} =1Ω)

Trunk Line 2 Loading 25% (Rated Current =455A)

Voltage V_{i2} 10.8kV (2%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =1Ω X_{B2} =1Ω)

Branch Line 2 Loading 2% (Rated Current =455A)

Voltage V_{r2} 10.8kV (2%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =1Ω X_{B1} =2Ω)

Branch Line 1 Loading 11% (Rated Current =455A)

Voltage V_{r1} 10.8kV (1%Drop)

L_{B3} (Distributed or Concentrated Load) (R_{B3} #N/A X_{B3} #N/A)

Branch Line 3 Loading #N/A (Rated Current #N/A)

Voltage V_{r3} #N/A #N/A

<Branch Line 1>

Load L_{B1}	49A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	4km	
Total Transformer Capacity of secondary substations CAP_{B1}	1030kVA	

<Branch Line 3>

Load L_{B3}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B3}		
Total Transformer Capacity of secondary substations CAP_{B3}		

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Koforidua
Feeder Name	St. Joseph

: Input data in colored cells

Type-2

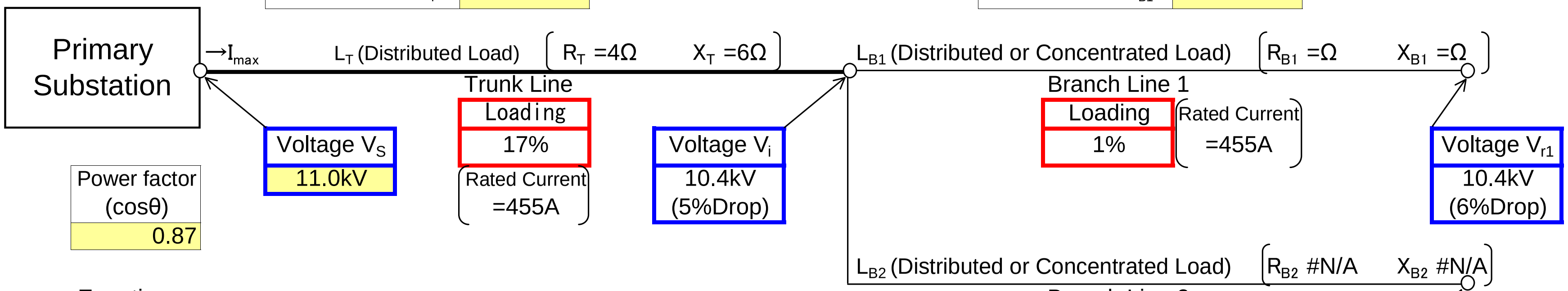
Maximum Current I_{max}
77A

<Trank Line>

Load L_T	74A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	16km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	4515kVA	

<Branch Line 1>

Load L_{B1}	3A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	1km	
Total Transformer Capacity of secondary substations CAP_{B1}	200kVA	



Power factor (cosθ)
0.87

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B2}		

V_s : Supply Voltage　I_{max} : Maximum Current　R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage　L_T : Load (Trunk line)　X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage　L_{B1} : Load (Branch Line 1)　cosθ : Power Factor

V_{r2} : Received Voltage　L_{B2} : Load (Branch Line 2)　f_T, f_{B1}, f_{B2} : Dispersal Load Factor　CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	Tafo BSP
Feeder Name	Asesewa

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	2A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	46km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	250kVA	

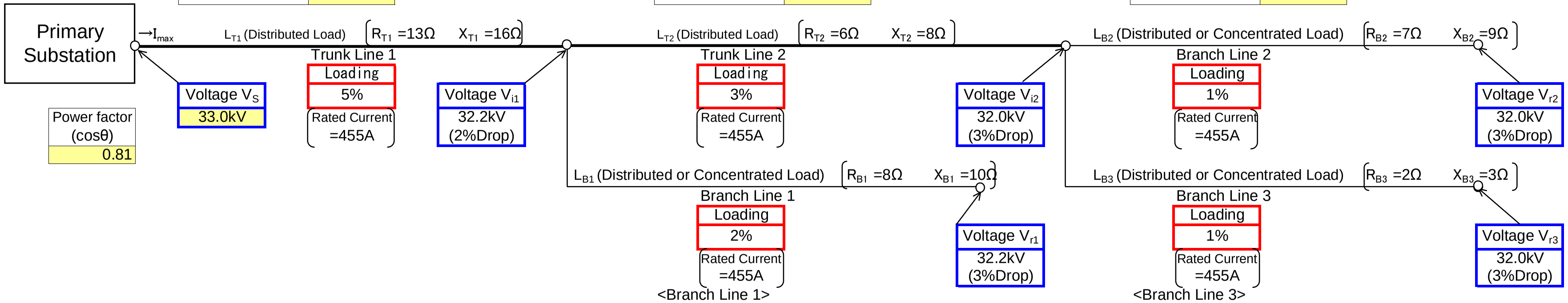
<Trank Line 2>

Load L_{T2}	4A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	23km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	550kVA	

<Branch Line 2>

Load L_{B2}	5A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	25km	
Total Transformer Capacity of secondary substations CAP_{B2}	650kVA	

Maximum Current I_{max}	23A
Power factor (cosθ)	0.81



<Branch Line 1>

Load L_{B1}	7A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	28km	
Total Transformer Capacity of secondary substations CAP_{B1}	900kVA	

<Branch Line 3>

Load L_{B3}	5A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B3}	9km	
Total Transformer Capacity of secondary substations CAP_{B3}	600kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	Akwatia BSP
Feeder Name	Akwatia

: Input data in colored cells

Type-3

Maximum Current I_{max}
191A

Power factor (cosθ)
0.87

Primary Substation

<Trank Line 1>

Load L_{T1}	A	
Line Type	95CuPILC(11kV)	No.20
Line Legth Len_{T1}	1km	
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{T1}		

<Trank Line 2>

Load L_{T2}	91A	
Line Type	Cu70mm2	No.14
Line Legth Len_{T2}	14km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	2980kVA	

<Branch Line 2>

Load L_{B2}	36A	
Line Type	Cu35mm2	No.15
Type of Load	Equality	
Line Length Len_{B1}	8km	
Total Transformer Capacity of secondary substations CAP_{B2}	1165kVA	

$\rightarrow I_{max}$

L_{T1} (Distributed Load) R_{T1} =Ω X_{T1} =Ω

Trunk Line 1 Loading 72% Rated Current =265A

Voltage V_s 11.0kV

Voltage V_{i1} 10.9kV (1%Drop)

L_{T2} (Distributed Load) R_{T2} =4Ω X_{T2} =6Ω

Trunk Line 2 Loading 67% Rated Current =369A

Voltage V_{i2} 9.4kV (15%Drop)

L_{B2} (Distributed or Concentrated Load) R_{B2} =6Ω X_{B2} =4Ω

Branch Line 2 Loading 15% Rated Current =236A

Voltage V_{r2} 9.2kV (17%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} =2Ω X_{B1} =2Ω

Branch Line 1 Loading 3% Rated Current =455A

Voltage V_{r1} 10.9kV (1%Drop)

L_{B3} (Distributed or Concentrated Load) R_{B3} =9Ω X_{B3} =6Ω

Branch Line 3 Loading 22% Rated Current =236A

Voltage V_{r3} 9.1kV (18%Drop)

<Branch Line 1>

Load L_{B1}	14A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	7km	
Total Transformer Capacity of secondary substations CAP_{B1}	450kVA	

<Branch Line 3>

Load L_{B3}	51A	
Line Type	Cu35mm2	No.15
Type of Load	Sending Larger	
Line Length Len_{B3}	13km	
Total Transformer Capacity of secondary substations CAP_{B3}	1665kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Akwatia BSP
Feeder Name	Asaman

: Input data in colored cells

Type-2

<Trank Line>

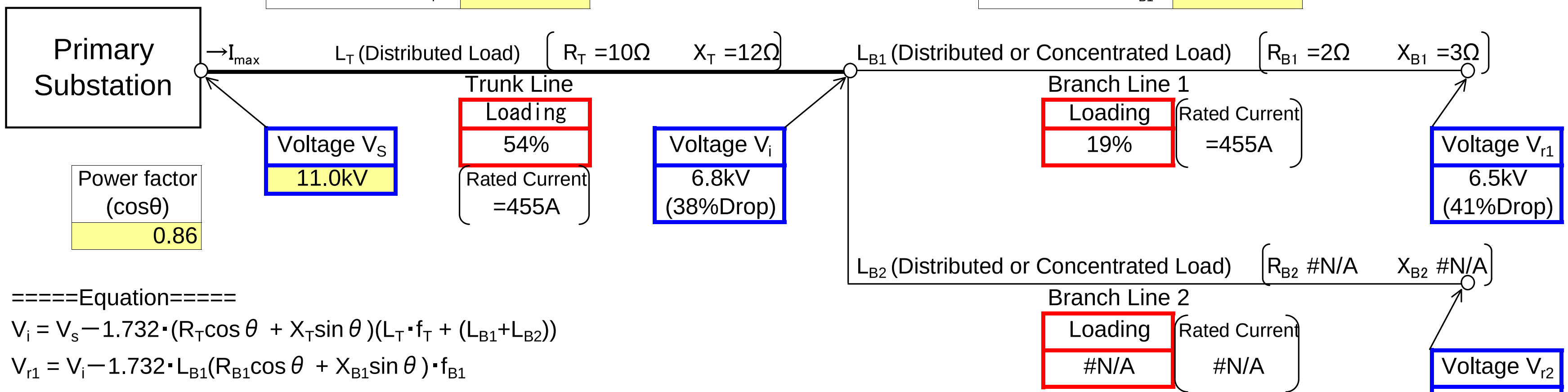
Load L_T	159A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	35km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	3415kVA	

<Branch Line 1>

Load L_{B1}	88A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	8km	
Total Transformer Capacity of secondary substations CAP_{B1}	1895kVA	

Maximum Current I_{max}	247A

Power factor (cosθ)	0.86



<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage I_{max} : Maximum Current R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage L_T : Load (Trunk line) X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage L_{B1} : Load (Branch Line 1) cosθ : Power Factor

V_{r2} : Received Voltage L_{B2} : Load (Branch Line 2) f_T, f_{B1}, f_{B2} : Dispersal Load Factor CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nsawam Stn N
Feeder Name	Adoagyiri

: Input data in colored cells

Type-2

Maximum Current I_{max}
389A

Power factor (cosθ)
0.86

<Trank Line>

Load L_T	A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	26km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T		

<Branch Line 1>

Load L_{B1}	389A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	11km	
Total Transformer Capacity of secondary substations CAP_{B1}	400kVA	

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =7Ω X_T =9Ω)

Trunk Line

Loading
85%

(Rated Current =455A)

Voltage V_S
11.0kV

Voltage V_i
3.8kV (66%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =3Ω X_{B1} =4Ω)

Branch Line 1

Loading
85%

(Rated Current =455A)

Voltage V_{r1}
2.2kV (80%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} #N/A X_{B2} #N/A)

Branch Line 2

Loading
#N/A

(Rated Current #N/A)

Voltage V_{r2}
#N/A
#N/A

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage; I_{max} : Maximum Current; R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage; L_T : Load (Trunk line); X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage; L_{B1} : Load (Branch Line 1); cosθ : Power Factor

V_{r2} : Received Voltage; L_{B2} : Load (Branch Line 2); f_T, f_{B1}, f_{B2} : Dispersal Load Factor; CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Akwatia
Feeder Name	Oda

: Input data in colored cells

Type-3

Maximum Current I_{max}: 185A

Power factor (cosθ): 0.91

Primary Substation

<Trank Line 1>

Load L_{T1}	8A	
Line Type	AAC150mm2	No.6
Line Legth Len_{T1}	27km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	200kVA	

$\rightarrow I_{max}$ L_{T1} (Distributed Load) (R_{T1} =6Ω X_{T1} =9Ω)

Voltage V_S: 33.0kV

Trunk Line 1 — Loading: 35% (Rated Current =530A)

Voltage V_{i1}: 30.2kV (9%Drop)

<Trank Line 2>

Load L_{T2}	91A	
Line Type	AAC150mm2	No.6
Line Legth Len_{T2}	13km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	2200kVA	

L_{T2} (Distributed Load) (R_{T2} =3Ω X_{T2} =5Ω)

Trunk Line 2 — Loading: 22% (Rated Current =530A)

Voltage V_{i2}: 29.6kV (11%Drop)

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B2}		

L_{B2} (Distributed or Concentrated Load) (R_{B2} #N/A X_{B2} #N/A)

Branch Line 2 — Loading: #N/A (Rated Current #N/A)

Voltage V_{r2}: #N/A #N/A

L_{B1} (Distributed or Concentrated Load) (R_{B1} =5Ω X_{B1} =7Ω)

Branch Line 1 — Loading: 13% (Rated Current =455A)

Voltage V_{r1}: 29.6kV (10%Drop)

<Branch Line 1>

Load L_{B1}	60A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	20km	
Total Transformer Capacity of secondary substations CAP_{B1}	1450kVA	

L_{B3} (Distributed or Concentrated Load) (R_{B3} =8Ω X_{B3} =11Ω)

Branch Line 3 — Loading: 6% (Rated Current =455A)

Voltage V_{r3}: 29.5kV (11%Drop)

<Branch Line 3>

Load L_{B3}	25A	
Line Type	AAC120mm2	No.7
Type of Load	Sending Larger	
Line Length Len_{B3}	30km	
Total Transformer Capacity of secondary substations CAP_{B3}	615kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Akwatia BSP
Feeder Name	Oda

: Input data in colored cells

Type-3

Maximum Current I_{max}
185A

Power factor (cosθ)
0.91

<Trank Line 1>

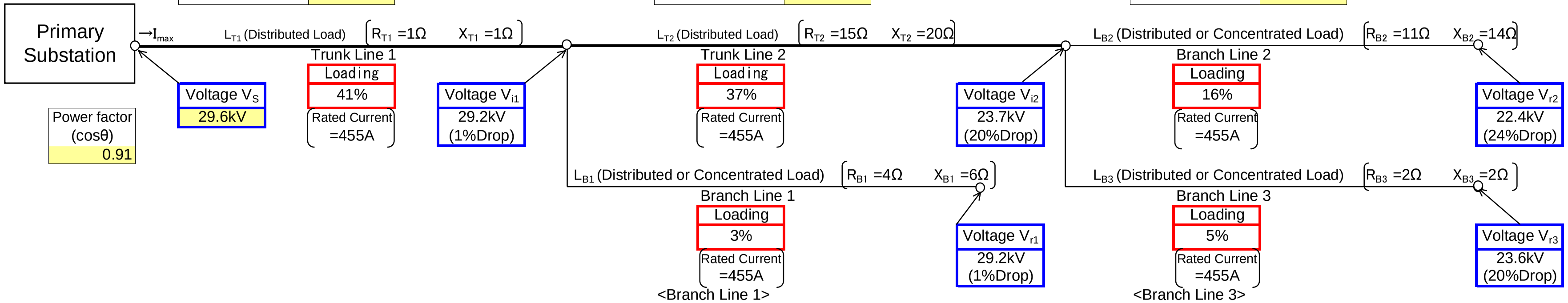
Load L_{T1}	A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	3km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T1}		

<Trank Line 2>

Load L_{T2}	76A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	56km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	1700kVA	

<Branch Line 2>

Load L_{B2}	71A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	40km	
Total Transformer Capacity of secondary substations CAP_{B2}	1600kVA	



<Branch Line 1>

Load L_{B1}	16A	
Line Type	AAC120mm2	No.7
Type of Load	Sending Larger	
Line Length Len_{B1}	16km	
Total Transformer Capacity of secondary substations CAP_{B1}	350kVA	

<Branch Line 3>

Load L_{B3}	22A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B3}	7km	
Total Transformer Capacity of secondary substations CAP_{B3}	500kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1} + CAP_{T2} + CAP_{B1} + CAP_{B2} + CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1} + CAP_{T2} + CAP_{B1} + CAP_{B2} + CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1} + CAP_{T2} + CAP_{B1} + CAP_{B2} + CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1} + CAP_{T2} + CAP_{B1} + CAP_{B2} + CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1} + CAP_{T2} + CAP_{B1} + CAP_{B2} + CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Oda
Feeder Name	Town

: Input data in colored cells

Type-3

Maximum Current I_{max}
137A

Primary Substation

Power factor (cosθ)
0.87

<Trank Line 1>

Load L_{T1}	20A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	1km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	500kVA	

<Trank Line 2>

Load L_{T2}	93A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T2}	6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	2330kVA	

<Branch Line 2>

Load L_{B2}	20A	
Line Type	95ALXPLE(11kV)	No.21
Type of Load	Equality	
Line Length Len_{B1}	1km	
Total Transformer Capacity of secondary substations CAP_{B2}	500kVA	

→I_{max}

L_{T1} (Distributed Load) (R_{T1} =Ω X_{T1} =Ω)

Voltage V_S: 11.0kV

Trunk Line 1 — Loading: 41% — Rated Current =335A

Voltage V_{i1}: 11.0kV (0%Drop)

L_{T2} (Distributed Load) (R_{T2} =1Ω X_{T2} =1Ω)

Trunk Line 2 — Loading: 34% — Rated Current =335A

Voltage V_{i2}: 10.8kV (2%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =Ω X_{B2} =Ω)

Branch Line 2 — Loading: 9% — Rated Current =225A

Voltage V_{r2}: 10.8kV (2%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =1Ω X_{B1} =1Ω)

Branch Line 1 — Loading: 2% — Rated Current =236A

Voltage V_{r1}: 10.9kV (0%Drop)

L_{B3} (Distributed or Concentrated Load) (R_{B3} #N/A X_{B3} #N/A)

Branch Line 3 — Loading: #N/A — Rated Current #N/A

Voltage V_{r3}: #N/A #N/A

<Branch Line 1>

Load L_{B1}	4A	
Line Type	Cu35mm2	No.15
Type of Load	Received Larger	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B1}	100kVA	

<Branch Line 3>

Load L_{B3}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B3}		
Total Transformer Capacity of secondary substations CAP_{B3}		

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Oda
Feeder Name	Achiase

: Input data in colored cells

Type-3

Maximum Current I_{max}	159A
Power factor (cosθ)	0.87

<Trank Line 1>

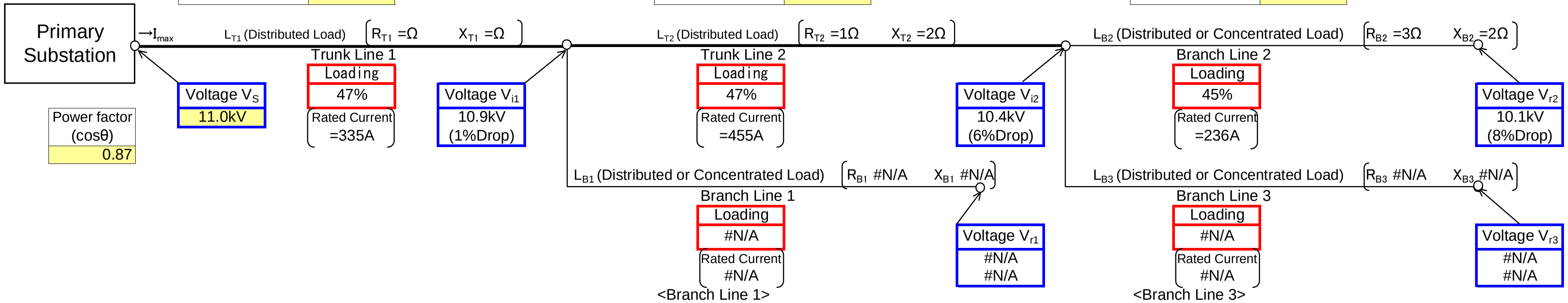
Load L_{T1}	A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	3km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}		

<Trank Line 2>

Load L_{T2}	52A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	5km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	900kVA	

<Branch Line 2>

Load L_{B2}	107A	
Line Type	Cu35mm2	No.15
Type of Load	Sending Larger	
Line Length Len_{B1}	4km	
Total Transformer Capacity of secondary substations CAP_{B2}	1850kVA	



<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B1}		

<Branch Line 3>

Load L_{B3}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B3}		
Total Transformer Capacity of secondary substations CAP_{B3}		

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Oda
Feeder Name	Achiase

: Input data in colored cells

Type-3

Maximum Current I_{max}
159A

Power factor (cosθ)
0.87

Primary Substation

<Trank Line 1>

Load L_{T1}	A	
Line Type	Cu35mm2	No.15
Line Legth Len_{T1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{T1}		

<Trank Line 2>

Load L_{T2}	40A	
Line Type	Cu35mm2	No.15
Line Legth Len_{T2}	4km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	815kVA	

<Branch Line 2>

Load L_{B2}	60A	
Line Type	AAC50mm2	No.11
Type of Load	Sending Larger	
Line Length Len_{B1}	34km	
Total Transformer Capacity of secondary substations CAP_{B2}	1215kVA	

→I_{max} L_{T1} (Distributed Load) R_{T1} =Ω X_{T1} =Ω

Trunk Line 1 Loading 67% Rated Current =236A

Voltage V_s 10.1kV

Voltage V_{i1} 10.1kV (0%Drop)

L_{T2} (Distributed Load) R_{T2} =3Ω X_{T2} =2Ω

Trunk Line 2 Loading 53% Rated Current =236A

Voltage V_{i2} 9.5kV (6%Drop)

L_{B2} (Distributed or Concentrated Load) R_{B2} =21Ω X_{B2} =13Ω

Branch Line 2 Loading 23% Rated Current =260A

Voltage V_{r2} 8.6kV (14%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} =4Ω X_{B1} =2Ω

Branch Line 1 Loading 13% Rated Current =260A

Voltage V_{r1} 10.0kV (1%Drop)

L_{B3} (Distributed or Concentrated Load) R_{B3} =9Ω X_{B3} =6Ω

Branch Line 3 Loading 9% Rated Current =260A

Voltage V_{r3} 9.3kV (8%Drop)

<Branch Line 1>

Load L_{B1}	34A	
Line Type	AAC50mm2	No.11
Type of Load	Equality	
Line Length Len_{B1}	6km	
Total Transformer Capacity of secondary substations CAP_{B1}	700kVA	

<Branch Line 3>

Load L_{B3}	25A	
Line Type	AAC50mm2	No.11
Type of Load	Equality	
Line Length Len_{B3}	15km	
Total Transformer Capacity of secondary substations CAP_{B3}	500kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Oda
Feeder Name	Sawmill

: Input data in colored cells

Type-2

<Trank Line>

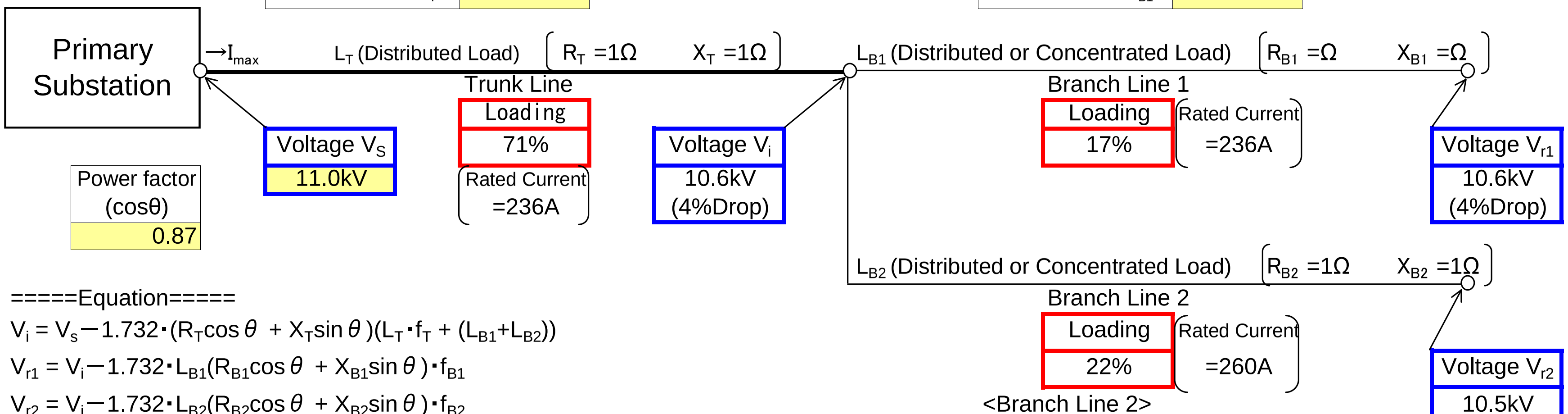
Load L_T	69A	
Line Type	Cu35mm2	No.15
Line Legth Len_T	2km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	2115kVA	

<Branch Line 1>

Load L_{B1}	41A	
Line Type	Cu35mm2	No.15
Type of Load	Sending Larger	
Line Length Len_{B1}	1km	
Total Transformer Capacity of secondary substations CAP_{B1}	1250kVA	

Maximum Current I_{max}
168A

Power factor (cosθ)
0.87



<Branch Line 2>

Load L_{B2}	57A	
Line Type	AAC50mm2	No.11
Type of Load	Received Larger	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B2}	1750kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nkawkaw BSP
Feeder Name	Donkorkrom

: Input data in colored cells

Type-3

Maximum Current I_{max}
33A

Power factor (cosθ)
0.86

<Trank Line 1>

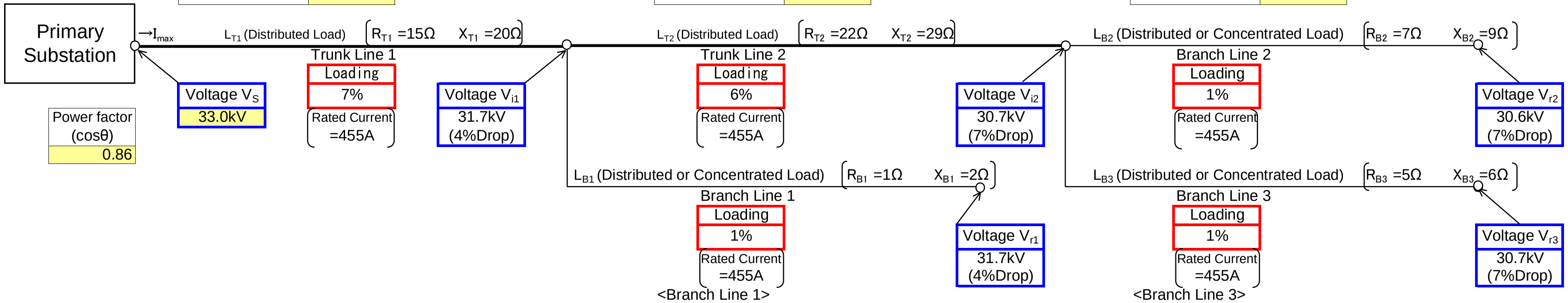
Load L_{T1}	3A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	56km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	450kVA	

<Trank Line 2>

Load L_{T2}	20A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	80km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	3265kVA	

<Branch Line 2>

Load L_{B2}	4A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	26km	
Total Transformer Capacity of secondary substations CAP_{B2}	700kVA	



<Branch Line 1>

Load L_{B1}	2A	
Line Type	AAC120mm2	No.7
Type of Load	Concentrated	
Line Length Len_{B1}	5km	
Total Transformer Capacity of secondary substations CAP_{B1}	400kVA	

<Branch Line 3>

Load L_{B3}	4A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B3}	17km	
Total Transformer Capacity of secondary substations CAP_{B3}	600kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nkawkaw BSP
Feeder Name	New Abirem

: Input data in colored cells

Type-3

Maximum Current I_{max}
73A

Power factor ($\cos\theta$)
0.86

<Trank Line 1>

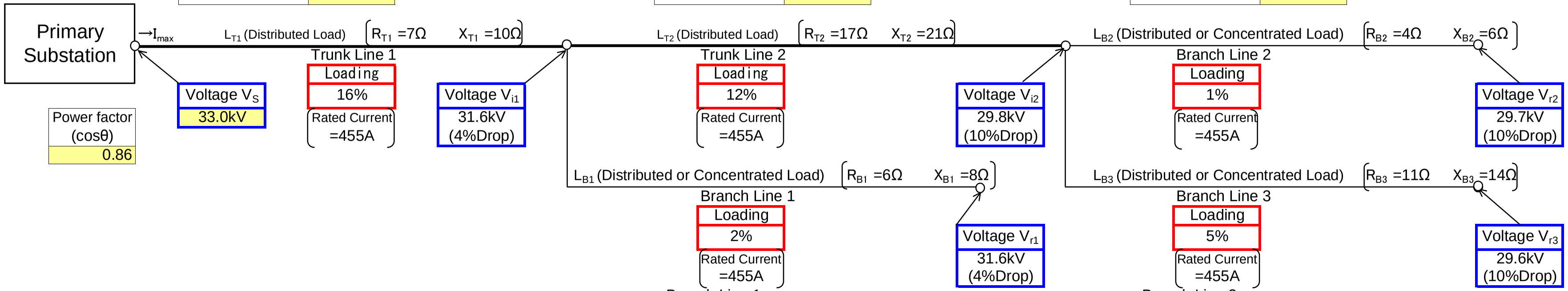
Load L_{T1}	10A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	27km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	1150kVA	

<Trank Line 2>

Load L_{T2}	27A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	60km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	3055kVA	

<Branch Line 2>

Load L_{B2}	6A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	16km	
Total Transformer Capacity of secondary substations CAP_{B2}	700kVA	



<Branch Line 1>

Load L_{B1}	7A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	23km	
Total Transformer Capacity of secondary substations CAP_{B1}	800kVA	

<Branch Line 3>

Load L_{B3}	23A	
Line Type	AAC120mm2	No.7
Type of Load	Sending Larger	
Line Length Len_{B3}	39km	
Total Transformer Capacity of secondary substations CAP_{B3}	2600kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	$\cos\theta$	: Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	Nkawkaw BSP
Feeder Name	New Abirem

: Input data in colored cells

Type-3

Maximum Current I_{max}
73A

Power factor (cosθ)
0.91

<Trank Line 1>

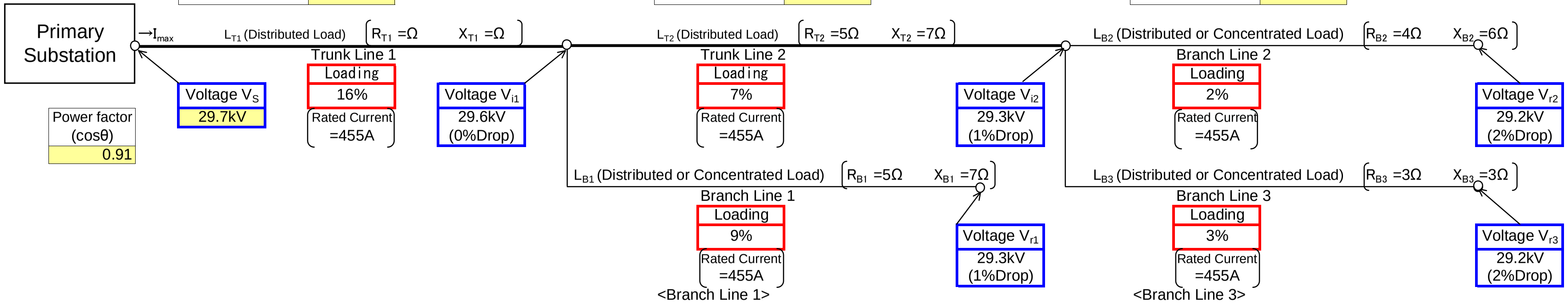
Load L_{T1}	A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	1km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}		

<Trank Line 2>

Load L_{T2}	8A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	18km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	250kVA	

<Branch Line 2>

Load L_{B2}	10A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	16km	
Total Transformer Capacity of secondary substations CAP_{B2}	300kVA	



<Branch Line 1>

Load L_{B1}	43A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	19km	
Total Transformer Capacity of secondary substations CAP_{B1}	1350kVA	

<Branch Line 3>

Load L_{B3}	13A	
Line Type	AAC120mm2	No.7
Type of Load	Concentrated	
Line Length Len_{B3}	9km	
Total Transformer Capacity of secondary substations CAP_{B3}	400kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage
V_{i1} : Interim Voltage
V_{i2} : Interim Voltage
V_{r1} : Received Voltage
V_{r2} : Received Voltage
V_{r3} : Received Voltage

I_{max} : Maximum Current
L_{T1} : Load (Trunk line 1)
L_{T2} : Load (Trunk line 2)
L_{B1} : Load (Branch Line 1)
L_{B2} : Load (Branch Line 2)
L_{B3} : Load (Branch Line 3)

$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$: Resistance
$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$: Reactance
$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$: Dispersal Load Factor
$CAP_{T1}, CAP_{T2}, CAP_{B1}$, CAP_{B2}, CAP_{B3} : Total Transformer Capacity of secondary substations
cosθ : Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	Nkawkaw BSP
Feeder Name	Enyiresi

: Input data in colored cells

Type-3

Maximum Current I_{max}
13A

Power factor (cosθ)
0.86

<Trank Line 1>

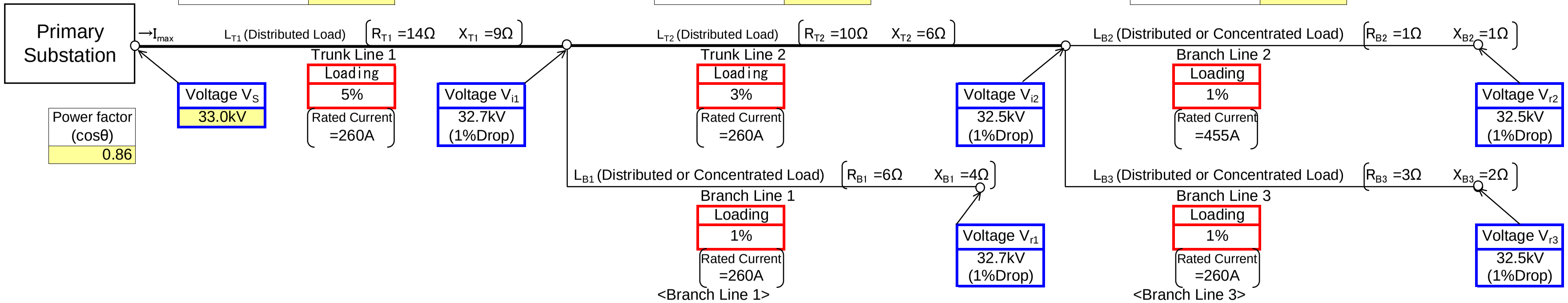
Load L_{T1}	3A	
Line Type	AAC50mm2	No.11
Line Legth Len_{T1}	23km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	250kVA	

<Trank Line 2>

Load L_{T2}	3A	
Line Type	AAC50mm2	No.11
Line Legth Len_{T2}	17km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	300kVA	

<Branch Line 2>

Load L_{B2}	3A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	4km	
Total Transformer Capacity of secondary substations CAP_{B2}	300kVA	



<Branch Line 1>

Load L_{B1}	2A	
Line Type	AAC50mm2	No.11
Type of Load	Concentrated	
Line Length Len_{B1}	10km	
Total Transformer Capacity of secondary substations CAP_{B1}	200kVA	

<Branch Line 3>

Load L_{B3}	3A	
Line Type	AAC50mm2	No.11
Type of Load	Sending Larger	
Line Length Len_{B3}	5km	
Total Transformer Capacity of secondary substations CAP_{B3}	250kVA	

=====Equation=====

$V_{i1} = V_s - 1.732\cdot(R_{T1}\cos\theta + X_{T1}\sin\theta)\cdot(L_{T1}\cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732\cdot(R_{T2}\cos\theta + X_{T2}\sin\theta)\cdot(L_{T2}\cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732\cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta)\cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732\cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta)\cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732\cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta)\cdot f_{B3}$

$L_{T1} = I_{max}\cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max}\cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max}\cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max}\cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max}\cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nkawkaw BSP
Feeder Name	Novotex

: Input data in colored cells

Type-3

Maximum Current I_{max}
99A

<Trank Line 1>

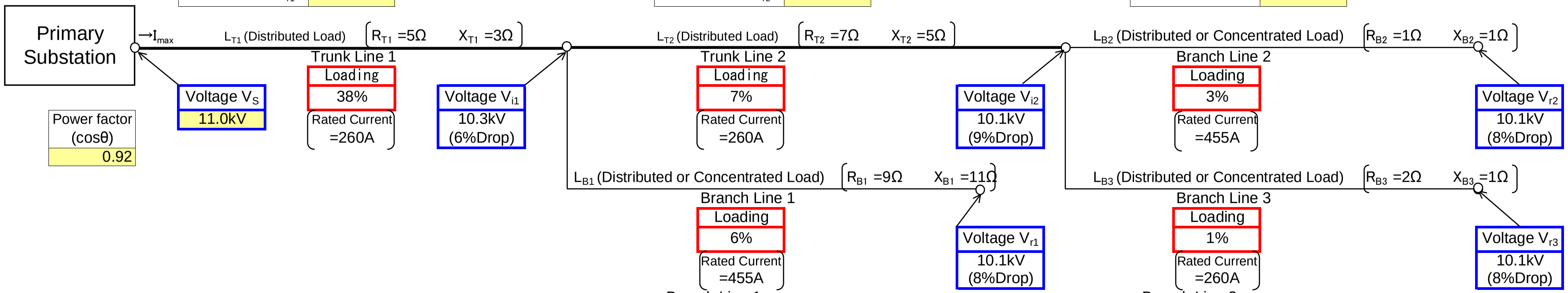
Load L_{T1}	51A	
Line Type	AAC50mm2	No.11
Line Legth Len_{T1}	9km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	1700kVA	

<Trank Line 2>

Load L_{T2}	4A	
Line Type	AAC50mm2	No.11
Line Legth Len_{T2}	12km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	150kVA	

<Branch Line 2>

Load L_{B2}	13A	
Line Type	AAC120mm2	No.7
Type of Load	Sending Larger	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B2}	450kVA	



Power factor (cosθ)
0.92

<Branch Line 1>

Load L_{B1}	29A	
Line Type	AAC120mm2	No.7
Type of Load	Sending Larger	
Line Length Len_{B1}	31km	
Total Transformer Capacity of secondary substations CAP_{B1}	965kVA	

<Branch Line 3>

Load L_{B3}	1A	
Line Type	AAC50mm2	No.11
Type of Load	Concentrated	
Line Length Len_{B3}	3km	
Total Transformer Capacity of secondary substations CAP_{B3}	50kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage
V_{i1} : Interim Voltage
V_{i2} : Interim Voltage
V_{r1} : Received Voltage
V_{r2} : Received Voltage
V_{r3} : Received Voltage

I_{max} : Maximum Current
L_{T1} : Load (Trunk line 1)
L_{T2} : Load (Trunk line 2)
L_{B1} : Load (Branch Line 1)
L_{B2} : Load (Branch Line 2)
L_{B3} : Load (Branch Line 3)

$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$: Resistance
$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$: Reactance
$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$: Dispersal Load Factor
$CAP_{T1}, CAP_{T2}, CAP_{B1}$, CAP_{B2}, CAP_{B3} : Total Transformer Capacity of secondary substations
cosθ : Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nkawkaw BSP
Feeder Name	Mountains

: Input data in colored cells

Type-3

Maximum Current I_{max}
508A

Power factor (cosθ)
0.92

<Trank Line 1>

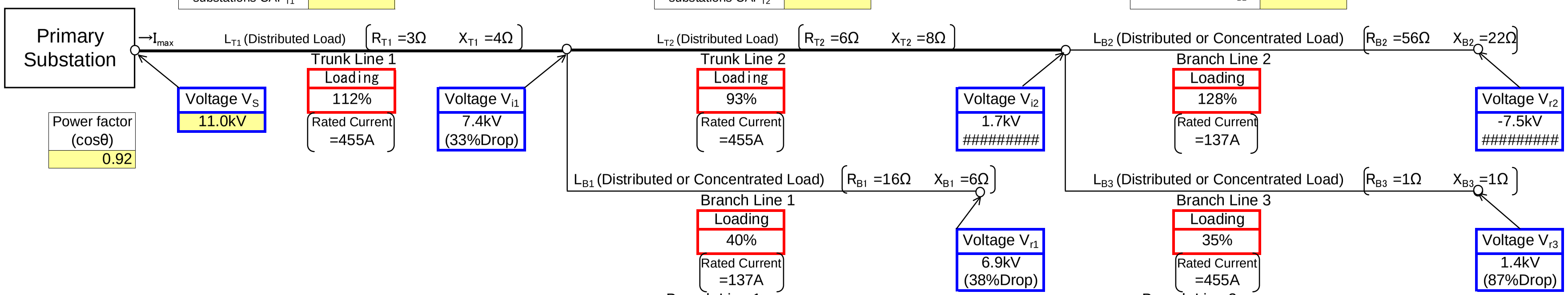
Load L_{T1}	31A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	11km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	500kVA	

<Trank Line 2>

Load L_{T2}	90A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	23km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	1465kVA	

<Branch Line 2>

Load L_{B2}	175A	
Line Type	Cu16mm2	No.16
Type of Load	Equality	
Line Length Len_{B1}	44km	
Total Transformer Capacity of secondary substations CAP_{B2}	2865kVA	



<Branch Line 1>

Load L_{B1}	55A	
Line Type	Cu16mm2	No.16
Type of Load	Sending Larger	
Line Length Len_{B1}	13km	
Total Transformer Capacity of secondary substations CAP_{B1}	900kVA	

<Branch Line 3>

Load L_{B3}	158A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B3}	3km	
Total Transformer Capacity of secondary substations CAP_{B3}	2575kVA	

=====Equation=====

$V_{i1} = V_s - 1.732\cdot(R_{T1}\cos\theta + X_{T1}\sin\theta)\cdot(L_{T1}\cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732\cdot(R_{T2}\cos\theta + X_{T2}\sin\theta)\cdot(L_{T2}\cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732\cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta)\cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732\cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta)\cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732\cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta)\cdot f_{B3}$

$L_{T1} = I_{max}\cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max}\cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max}\cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max}\cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max}\cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nkawkaw BSP
Feeder Name	Nkawkaw Town

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	37A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	2km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	200kVA	

<Trank Line 2>

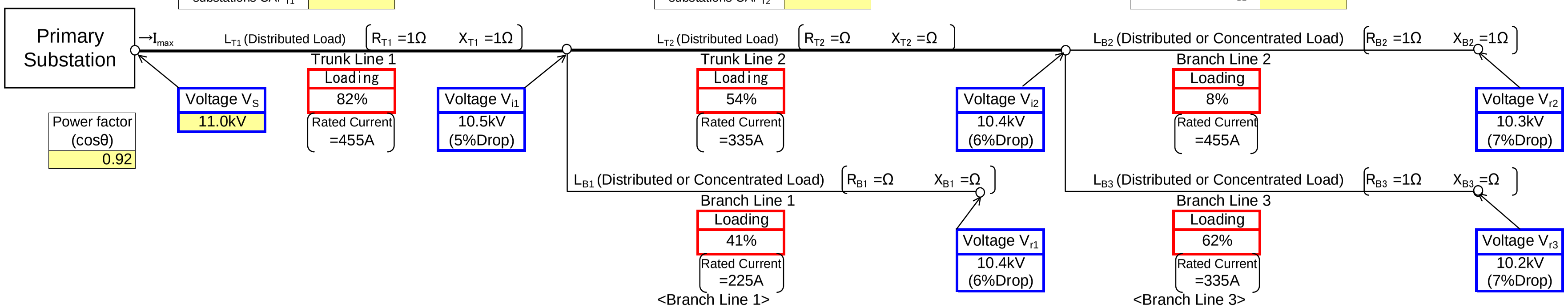
Load L_{T2}	A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T2}	1km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T2}		

<Branch Line 2>

Load L_{B2}	37A	
Line Type	AAC120mm2	No.7
Type of Load	Concentrated	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B2}	200kVA	

Maximum Current I_{max}
373A

Power factor (cosθ)
0.92



<Branch Line 1>

Load L_{B1}	92A	
Line Type	95ALXPLE(11kV)	No.21
Type of Load	Concentrated	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B1}	500kVA	

<Branch Line 3>

Load L_{B3}	208A	
Line Type	185ALXPLE(11kV)	No.24
Type of Load	Equality	
Line Length Len_{B3}	4km	
Total Transformer Capacity of secondary substations CAP_{B3}	1130kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nkawkaw BSP
Feeder Name	Nkawkaw Town

: Input data in colored cells

Type-3

Maximum Current I_{max}
373A

Power factor (cosθ)
0.92

<Trank Line 1>

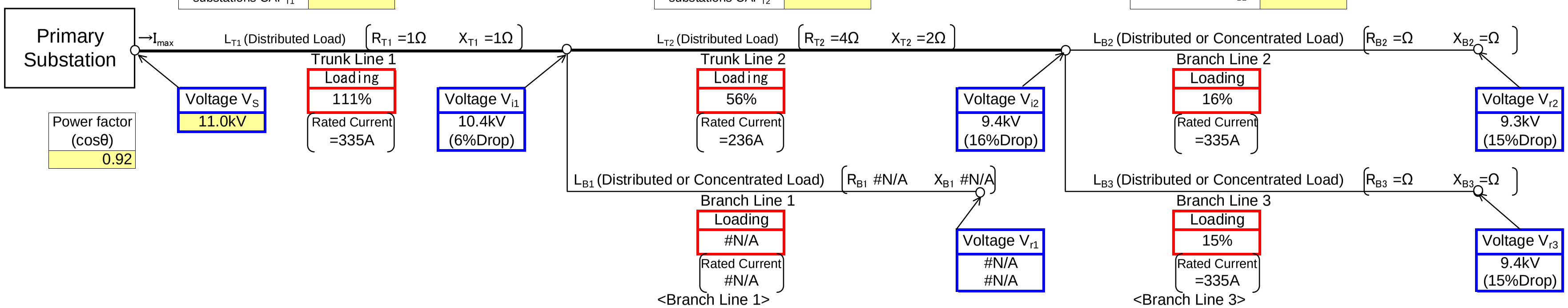
Load L_{T1}	185A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	6km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	1100kVA	

<Trank Line 2>

Load L_{T2}	84A	
Line Type	Cu35mm2	No.15
Line Legth Len_{T2}	5km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	500kVA	

<Branch Line 2>

Load L_{B2}	53A	
Line Type	185ALXPLE(11kV)	No.24
Type of Load	Concentrated	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B2}	315kVA	



<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B1}		

<Branch Line 3>

Load L_{B3}	51A	
Line Type	185ALXPLE(11kV)	No.24
Type of Load	Concentrated	
Line Length Len_{B3}	1km	
Total Transformer Capacity of secondary substations CAP_{B3}	300kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Kibi/Suhum

: Input data in colored cells

Type-2

Maximum Current I_{max}
205A

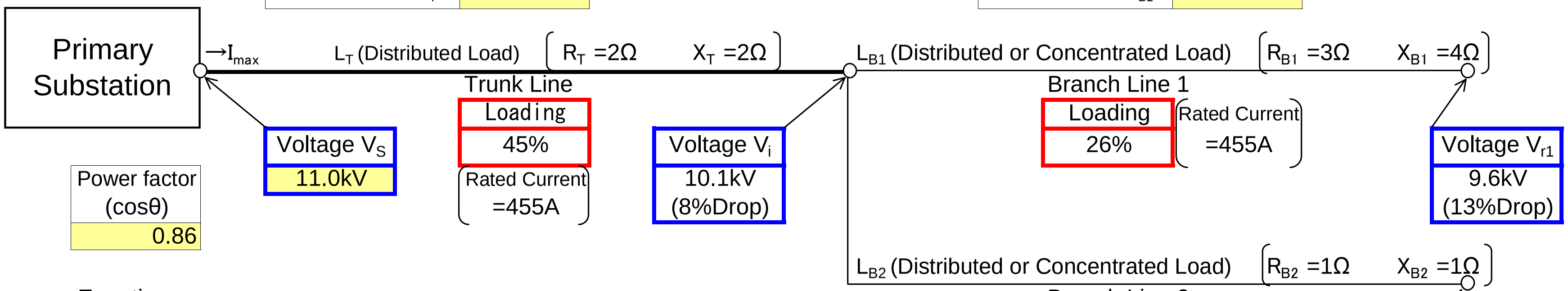
Power factor (cosθ)
0.86

<Trank Line>

Load L_T	A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	6km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T		

<Branch Line 1>

Load L_{B1}	119A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	12km	
Total Transformer Capacity of secondary substations CAP_{B1}	715kVA	



<Branch Line 2>

Load L_{B2}	86A	
Line Type	AAC120mm2	No.7
Type of Load	Concentrated	
Line Length Len_{B1}	4km	
Total Transformer Capacity of secondary substations CAP_{B2}	515kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage　I_{max} : Maximum Current　R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage　L_T : Load (Trunk line)　X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage　L_{B1} : Load (Branch Line 1)　cosθ : Power Factor

V_{r2} : Received Voltage　L_{B2} : Load (Branch Line 2)　f_T, f_{B1}, f_{B2} : Dispersal Load Factor　CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Kibi/Suhum

: Input data in colored cells

Type-2

Maximum Current I_{max}
205A

Power factor (cosθ)
0.86

<Trank Line>

Load L_T	157A	
Line Type	AAC150mm2	No.6
Line Legth Len_T	44km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	3430kVA	

<Branch Line 1>

Load L_{B1}	21A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	6km	
Total Transformer Capacity of secondary substations CAP_{B1}	450kVA	

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =9Ω X_T =15Ω)

Trunk Line

Loading
39%

(Rated Current =530A)

Voltage V_S
9.6kV

Voltage V_i
5.5kV (43%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =2Ω X_{B1} =2Ω)

Branch Line 1

Loading
5%

(Rated Current =455A)

Voltage V_{r1}
5.4kV (43%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =3Ω X_{B2} =4Ω)

Branch Line 2

Loading
6%

(Rated Current =455A)

Voltage V_{r2}
5.3kV (44%Drop)

<Branch Line 2>

Load L_{B2}	27A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	11km	
Total Transformer Capacity of secondary substations CAP_{B2}	600kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Kibi/Suhum

: Input data in colored cells

Type-2

<Trank Line>

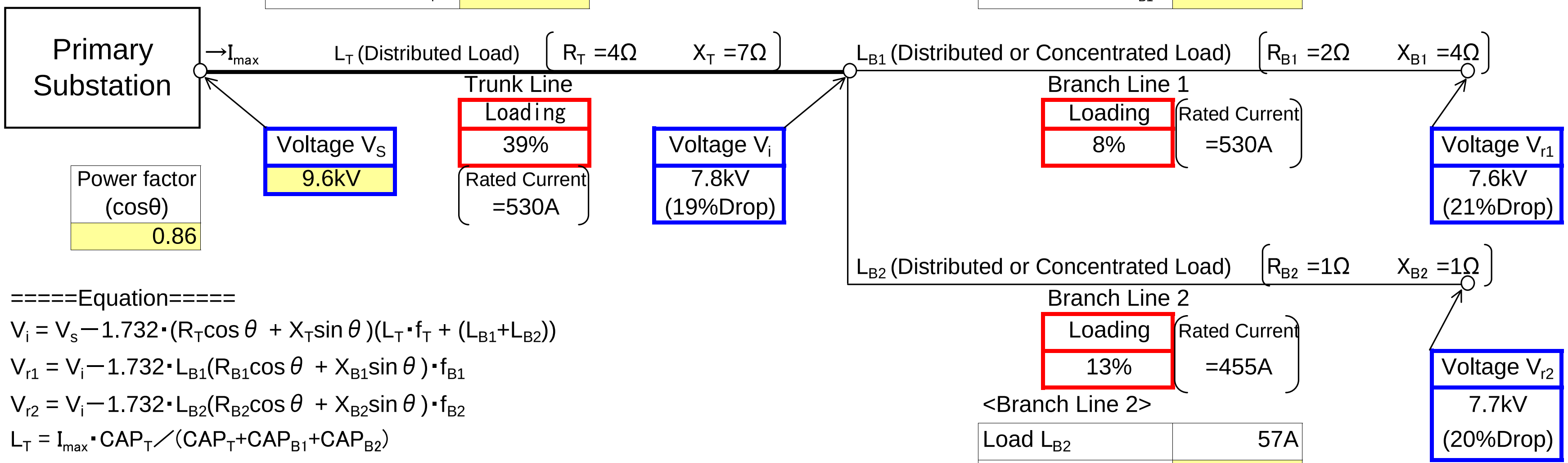
Load L_T	105A	
Line Type	AAC150mm2	No.6
Line Legth Len_T	20km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	2245kVA	

<Branch Line 1>

Load L_{B1}	43A	
Line Type	AAC150mm2	No.6
Type of Load	Equality	
Line Length Len_{B1}	12km	
Total Transformer Capacity of secondary substations CAP_{B1}	915kVA	

Maximum Current I_{max}
205A

Power factor (cosθ)
0.86



<Branch Line 2>

Load L_{B2}	57A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B2}	1230kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Tafo

: Input data in colored cells

Type-3

Maximum Current I_{max}
250A

Power factor (cosθ)
0.86

<Trank Line 1>

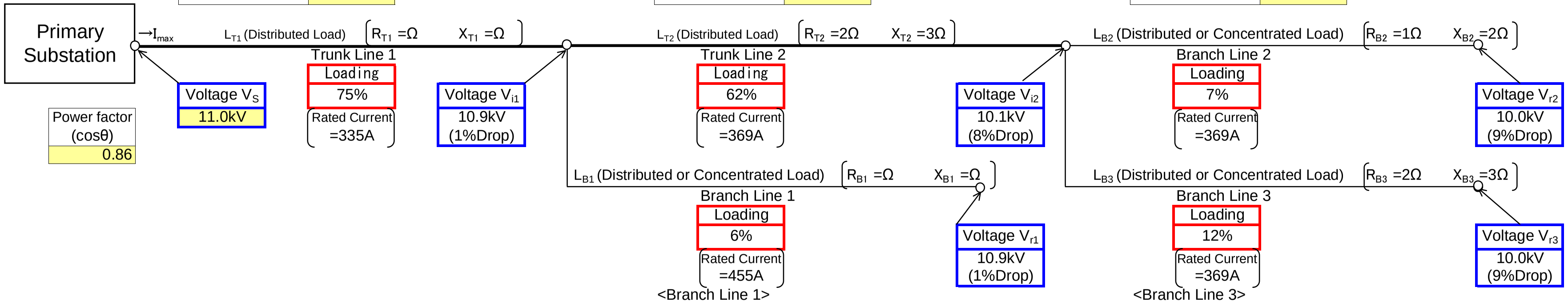
Load L_{T1}	17A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	1km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	200kVA	

<Trank Line 2>

Load L_{T2}	137A	
Line Type	Cu70mm2	No.14
Line Legth Len_{T2}	7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	1615kVA	

<Branch Line 2>

Load L_{B2}	27A	
Line Type	Cu70mm2	No.14
Type of Load	Concentrated	
Line Length Len_{B1}	4km	
Total Transformer Capacity of secondary substations CAP_{B2}	315kVA	



<Branch Line 1>

Load L_{B1}	27A	
Line Type	AAC120mm2	No.7
Type of Load	Concentrated	
Line Length Len_{B1}	1km	
Total Transformer Capacity of secondary substations CAP_{B1}	315kVA	

<Branch Line 3>

Load L_{B3}	42A	
Line Type	Cu70mm2	No.14
Type of Load	Equality	
Line Length Len_{B3}	7km	
Total Transformer Capacity of secondary substations CAP_{B3}	500kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Tafo

: Input data in colored cells

Type-3

Maximum Current I_{max}
250A

Power factor (cosθ)
0.86

<Trank Line 1>

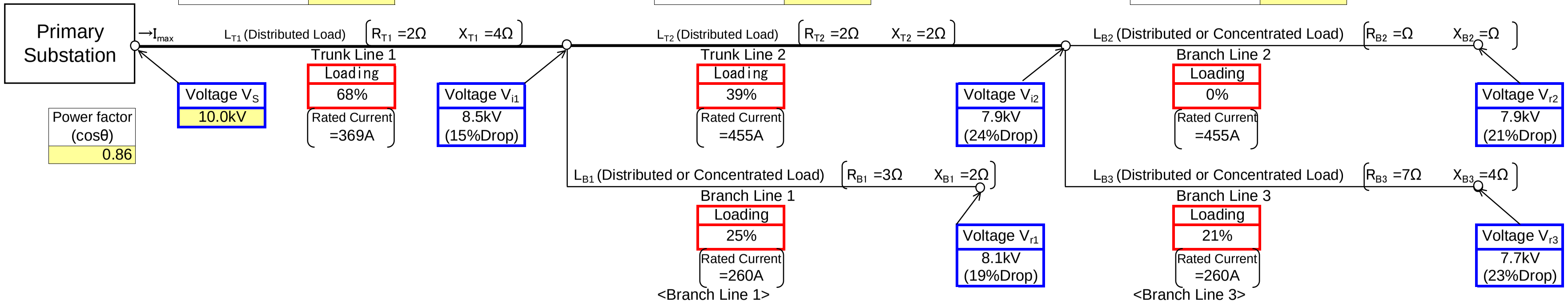
Load L_{T1}	39A	
Line Type	Cu70mm2	No.14
Line Legth Len_{T1}	8km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	575kVA	

<Trank Line 2>

Load L_{T2}	91A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	6km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	1350kVA	

<Branch Line 2>

Load L_{B2}	A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	km	
Total Transformer Capacity of secondary substations CAP_{B2}		



<Branch Line 1>

Load L_{B1}	66A	
Line Type	AAC50mm2	No.11
Type of Load	Received Larger	
Line Length Len_{B1}	6km	
Total Transformer Capacity of secondary substations CAP_{B1}	980kVA	

<Branch Line 3>

Load L_{B3}	54A	
Line Type	AAC50mm2	No.11
Type of Load	Sending Larger	
Line Length Len_{B3}	11km	
Total Transformer Capacity of secondary substations CAP_{B3}	800kVA	

=====Equation=====

$V_{i1} = V_s - 1.732\cdot(R_{T1}\cos\theta + X_{T1}\sin\theta)\cdot(L_{T1}\cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732\cdot(R_{T2}\cos\theta + X_{T2}\sin\theta)\cdot(L_{T2}\cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732\cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta)\cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732\cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta)\cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732\cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta)\cdot f_{B3}$

$L_{T1} = I_{max}\cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max}\cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max}\cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max}\cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max}\cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Tafo

: Input data in colored cells

Type-3

Maximum Current I_{max}	250A
Power factor (cosθ)	0.86

<Trank Line 1>

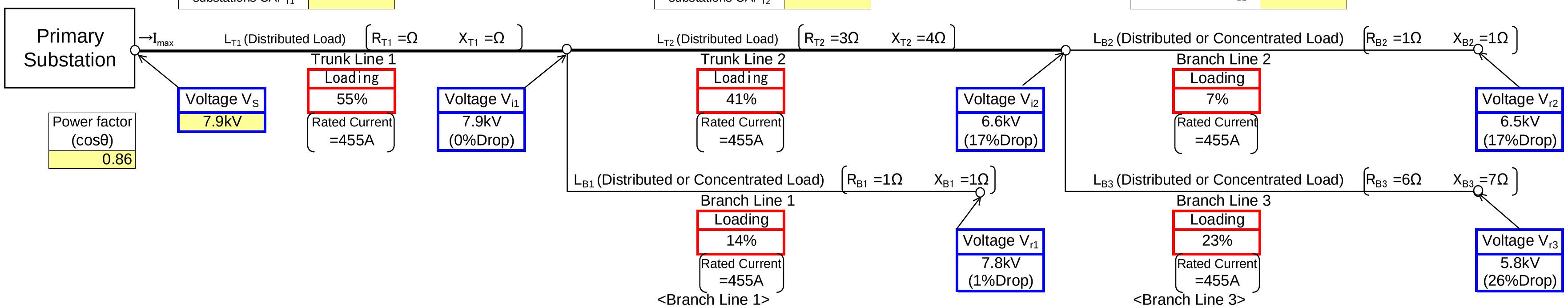
Load L_{T1}	A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}		

<Trank Line 2>

Load L_{T2}	50A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	11km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	575kVA	

<Branch Line 2>

Load L_{B2}	30A	
Line Type	AAC120mm2	No.7
Type of Load	Sending Larger	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B2}	350kVA	



<Branch Line 1>

Load L_{B1}	65A	
Line Type	AAC120mm2	No.7
Type of Load	Sending Larger	
Line Length Len_{B1}	4km	
Total Transformer Capacity of secondary substations CAP_{B1}	750kVA	

<Branch Line 3>

Load L_{B3}	104A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B3}	20km	
Total Transformer Capacity of secondary substations CAP_{B3}	1200kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Tafo

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	110A	
Line Type	Cu70mm2	No.14
Line Legth Len_{T1}	23km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	1565kVA	

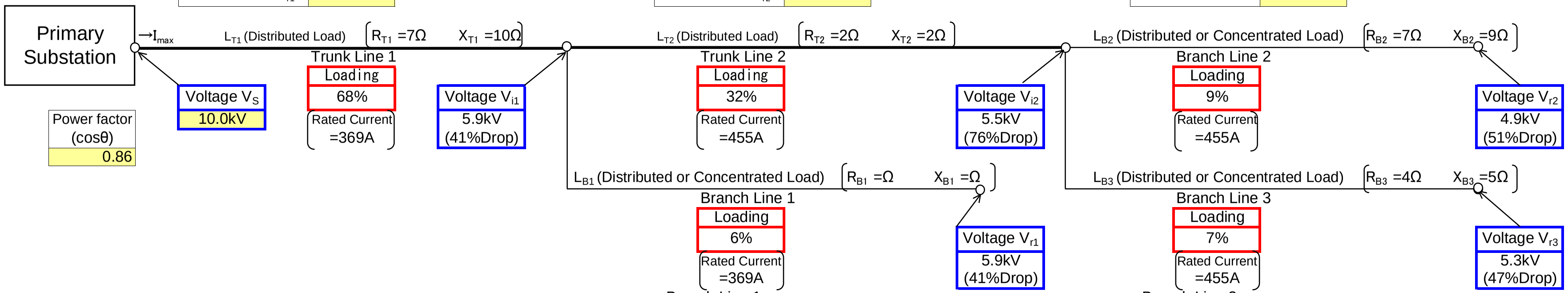
<Trank Line 2>

Load L_{T2}	43A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	7km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	615kVA	

<Branch Line 2>

Load L_{B2}	42A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	26km	
Total Transformer Capacity of secondary substations CAP_{B2}	600kVA	

Maximum Current I_{max}
250A



<Branch Line 1>

Load L_{B1}	22A	
Line Type	Cu70mm2	No.14
Type of Load	Received Larger	
Line Length Len_{B1}	km	
Total Transformer Capacity of secondary substations CAP_{B1}	315kVA	

<Branch Line 3>

Load L_{B3}	32A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B3}	14km	
Total Transformer Capacity of secondary substations CAP_{B3}	450kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage
V_{i1} : Interim Voltage
V_{i2} : Interim Voltage
V_{r1} : Received Voltage
V_{r2} : Received Voltage
V_{r3} : Received Voltage

I_{max} : Maximum Current
L_{T1} : Load (Trunk line 1)
L_{T2} : Load (Trunk line 2)
L_{B1} : Load (Branch Line 1)
L_{B2} : Load (Branch Line 2)
L_{B3} : Load (Branch Line 3)

$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$: Resistance
$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$: Reactance
$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$: Dispersal Load Factor
$CAP_{T1}, CAP_{T2}, CAP_{B1}, CAP_{B2}, CAP_{B3}$: Total Transformer Capacity of secondary substations
cosθ : Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	OPASS

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	21A
Line Type	AAC120mm2 No.7
Line Legth Len_T	4km
Type of Distributed Load	Received Larger
Total Transformer Capacity of secondary substations CAP_T	1205kVA

<Branch Line 1>

Load L_{B1}	18A
Line Type	AAC120mm2 No.7
Type of Load	Equality
Line Length Len_{B1}	2km
Total Transformer Capacity of secondary substations CAP_{B1}	1015kVA

Maximum Current I_{max}	40A
Power factor (cosθ)	0.86

Primary Substation

$\rightarrow I_{max}$ L_T (Distributed Load) (R_T =1Ω X_T =1Ω)

Trunk Line

Loading
9%

(Rated Current =455A)

Voltage V_S
11.0kV

Voltage V_i
10.9kV (1%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =Ω X_{B1} =1Ω)

Branch Line 1

Loading
4%

(Rated Current =455A)

Voltage V_{r1}
10.9kV (1%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =1Ω X_{B2} =Ω)

Branch Line 2

Loading
1%

(Rated Current =260A)

Voltage V_{r2}
10.9kV (1%Drop)

<Branch Line 2>

Load L_{B2}	2A
Line Type	AAC50mm2 No.11
Type of Load	Concentrated
Line Length Len_{B1}	1km
Total Transformer Capacity of secondary substations CAP_{B2}	100kVA

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor

V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	K'dua-Mangoase

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	128A	
Line Type	AAC150mm2	No.6
Line Legth Len_T	16km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	800kVA	

<Branch Line 1>

Load L_{B1}	88A	
Line Type	AAC100mm2	No.8
Type of Load	Equality	
Line Length Len_{B1}	40km	
Total Transformer Capacity of secondary substations CAP_{B1}	550kVA	

Maximum Current I_{max}	216A
Power factor (cosθ)	0.81

Primary Substation

$\rightarrow I_{max}$

L_T (Distributed Load) (R_T =3Ω X_T =5Ω)

Trunk Line

Loading
41%

(Rated Current =530A)

Voltage V_S
33.0kV

Voltage V_i
31.5kV (5%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =12Ω X_{B1} =15Ω)

Branch Line 1

Loading
22%

(Rated Current =405A)

Voltage V_{r1}
30.1kV (9%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} #N/A X_{B2} #N/A)

Branch Line 2

Loading
#N/A

(Rated Current #N/A)

Voltage V_{r2}
#N/A
#N/A

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor
V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Koforidua
Feeder Name	Power House

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	58A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_T	2km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_T	2380kVA	

<Branch Line 1>

Load L_{B1}	76A	
Line Type	185ALXPLE(11kV)	No.24
Type of Load	Sending Larger	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B1}	3125kVA	

Maximum Current I_{max}	145A

Power factor (cosθ)	0.87

Primary Substation

$\rightarrow I_{max}$ L_T (Distributed Load) (R_T =Ω X_T =Ω)

Trunk Line

Loading
43%

(Rated Current =335A)

Voltage V_S
11.0kV

Voltage V_i
10.9kV (1%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =Ω X_{B1} =Ω)

Branch Line 1

Loading
23%

(Rated Current =335A)

Voltage V_{r1}
10.9kV (1%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =6Ω X_{B2} =2Ω)

Branch Line 2

Loading
8%

(Rated Current =137A)

Voltage V_{r2}
10.9kV (1%Drop)

<Branch Line 2>

Load L_{B2}	11A	
Line Type	Cu16mm2	No.16
Type of Load	Sending Larger	
Line Length Len_{B1}	5km	
Total Transformer Capacity of secondary substations CAP_{B2}	450kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage	L_T : Load (Trunk line)	X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	cosθ : Power Factor
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	f_T, f_{B1}, f_{B2} : Dispersal Load Factor

CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Koforidua
Feeder Name	Estate Junction

: Input data in colored cells

Type-3

Maximum Current I_{max}
140A

Power factor (cosθ)
0.87

<Trank Line 1>

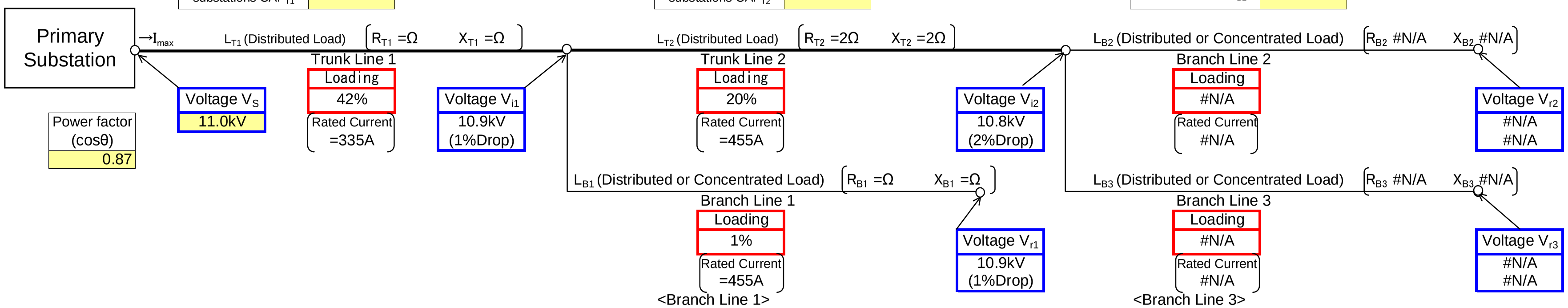
Load L_{T1}	65A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	2km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	2030kVA	

<Trank Line 2>

Load L_{T2}	68A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	2130kVA	

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B2}		



<Branch Line 1>

Load L_{B1}	6A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	1km	
Total Transformer Capacity of secondary substations CAP_{B1}	200kVA	

<Branch Line 3>

Load L_{B3}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B3}		
Total Transformer Capacity of secondary substations CAP_{B3}		

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	Koforidua
Feeder Name	Accra Rd

: Input data in colored cells

Type-3

Maximum Current I_{max}
202A

Power factor (cosθ)
0.87

Primary Substation

<Trank Line 1>

Load L_{T1}	63A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	3km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	1815kVA	

<Trank Line 2>

Load L_{T2}	117A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	7km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	3390kVA	

<Branch Line 2>

Load L_{B2}	22A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B2}	630kVA	

$\rightarrow I_{max}$

L_{T1} (Distributed Load) R_{T1} =Ω X_{T1} =Ω

Trunk Line 1: Loading 60%; Rated Current =335A

Voltage V_s: 11.0kV

Voltage V_{i1}: 10.8kV (2%Drop)

L_{T2} (Distributed Load) R_{T2} =2Ω X_{T2} =3Ω

Trunk Line 2: Loading 42%; Rated Current =455A

Voltage V_{i2}: 10.4kV (5%Drop)

L_{B2} (Distributed or Concentrated Load) R_{B2} =1Ω X_{B2} =1Ω

Branch Line 2: Loading 5%; Rated Current =455A

Voltage V_{r2}: 10.4kV (6%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} #N/A X_{B1} #N/A

Branch Line 1: Loading #N/A; Rated Current #N/A

Voltage V_{r1}: #N/A #N/A

L_{B3} (Distributed or Concentrated Load) R_{B3} #N/A X_{B3} #N/A

Branch Line 3: Loading #N/A; Rated Current #N/A

Voltage V_{r3}: #N/A #N/A

<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B1}		

<Branch Line 3>

Load L_{B3}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B3}		
Total Transformer Capacity of secondary substations CAP_{B3}		

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Koforidua
Feeder Name	Old Estate

: Input data in colored cells

Type-3

Maximum Current I_{max}
87A

Power factor (cosθ)
0.87

<Trank Line 1>

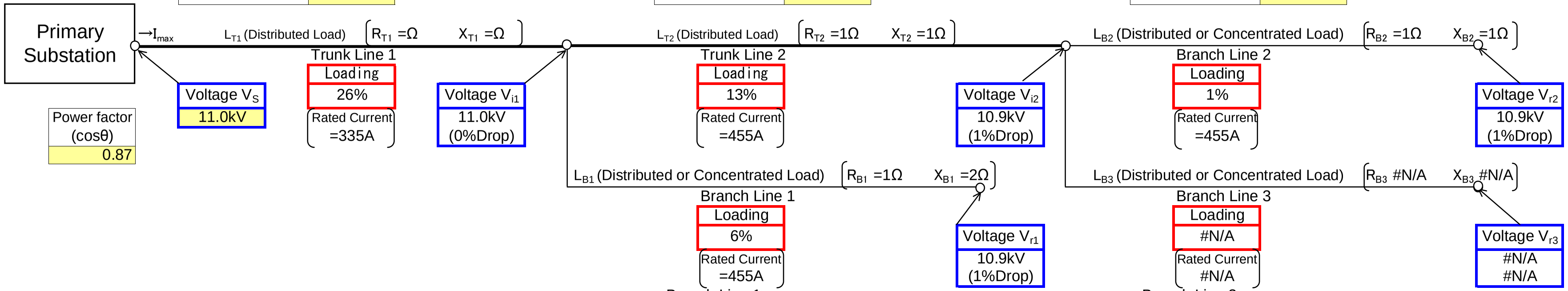
Load L_{T1}	16A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	1km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}	615kVA	

<Trank Line 2>

Load L_{T2}	40A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	4km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	1545kVA	

<Branch Line 2>

Load L_{B2}	5A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B2}	200kVA	



<Branch Line 1>

Load L_{B1}	26A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	4km	
Total Transformer Capacity of secondary substations CAP_{B1}	1030kVA	

<Branch Line 3>

Load L_{B3}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B3}		
Total Transformer Capacity of secondary substations CAP_{B3}		

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Koforidua
Feeder Name	St. Joseph

: Input data in colored cells

Type-2

<Trank Line>

Load L_T	63A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	16km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	4515kVA	

<Branch Line 1>

Load L_{B1}	3A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	1km	
Total Transformer Capacity of secondary substations CAP_{B1}	200kVA	

Maximum Current I_{max}: 66A

Power factor (cosθ): 0.87

Primary Substation

$\rightarrow I_{max}$ L_T (Distributed Load) (R_T =4Ω X_T =6Ω)

Trunk Line — Loading: 15% (Rated Current =455A)

Voltage V_S: 11.0kV

Voltage V_i: 10.5kV (5%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =Ω X_{B1} =Ω)

Branch Line 1 — Loading: 1% (Rated Current =455A)

Voltage V_{r1}: 10.5kV (5%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} #N/A X_{B2} #N/A)

Branch Line 2 — Loading: #N/A (Rated Current #N/A)

Voltage V_{r2}: #N/A #N/A

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage I_{max} : Maximum Current R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage L_T : Load (Trunk line) X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage L_{B1} : Load (Branch Line 1) cosθ : Power Factor

V_{r2} : Received Voltage L_{B2} : Load (Branch Line 2) f_T, f_{B1}, f_{B2} : Dispersal Load Factor CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Tafo BSP
Feeder Name	Asesewa

: Input data in colored cells

Type-3

Maximum Current I_{max}
19A

Power factor (cosθ)
0.81

<Trank Line 1>

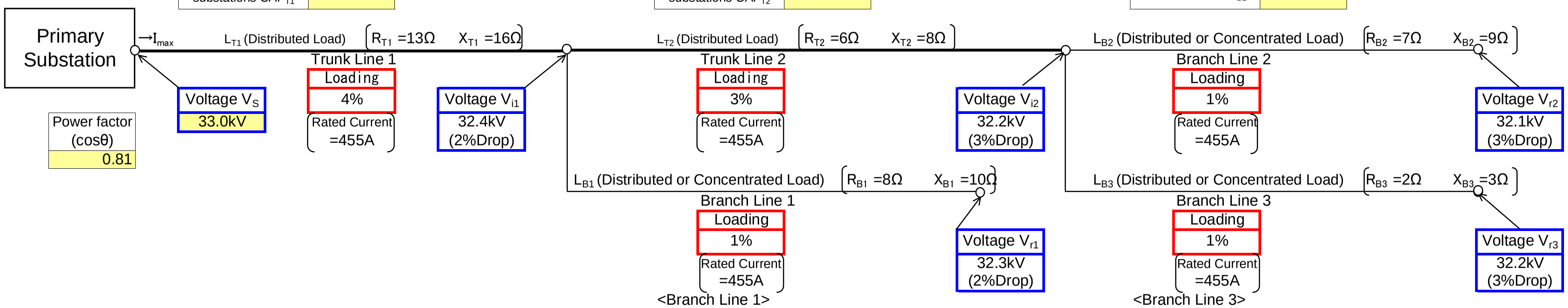
Load L_{T1}	2A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	46km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	250kVA	

<Trank Line 2>

Load L_{T2}	4A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	23km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	550kVA	

<Branch Line 2>

Load L_{B2}	4A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	25km	
Total Transformer Capacity of secondary substations CAP_{B2}	650kVA	



<Branch Line 1>

Load L_{B1}	6A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	28km	
Total Transformer Capacity of secondary substations CAP_{B1}	900kVA	

<Branch Line 3>

Load L_{B3}	4A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B3}	9km	
Total Transformer Capacity of secondary substations CAP_{B3}	600kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$, CAP_{B2}, CAP_{B3} : Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ : Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Akwatia BSP
Feeder Name	Akwatia

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	A	
Line Type	95CuPILC(11kV)	No.20
Line Legth Len_{T1}	1km	
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{T1}		

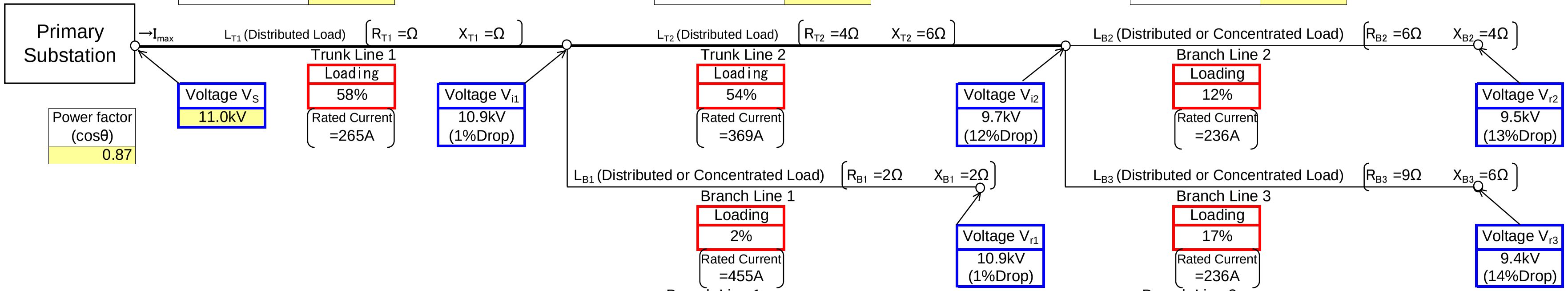
<Trank Line 2>

Load L_{T2}	73A	
Line Type	Cu70mm2	No.14
Line Legth Len_{T2}	14km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	2980kVA	

<Branch Line 2>

Load L_{B2}	28A	
Line Type	Cu35mm2	No.15
Type of Load	Equality	
Line Length Len_{B1}	8km	
Total Transformer Capacity of secondary substations CAP_{B2}	1165kVA	

Maximum Current I_{max}
153A



Power factor (cosθ)
0.87

<Branch Line 1>

Load L_{B1}	11A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	7km	
Total Transformer Capacity of secondary substations CAP_{B1}	450kVA	

<Branch Line 3>

Load L_{B3}	41A	
Line Type	Cu35mm2	No.15
Type of Load	Sending Larger	
Line Length Len_{B3}	13km	
Total Transformer Capacity of secondary substations CAP_{B3}	1665kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Akwatia BSP
Feeder Name	Asamankese

: Input data in colored cells

Type-2

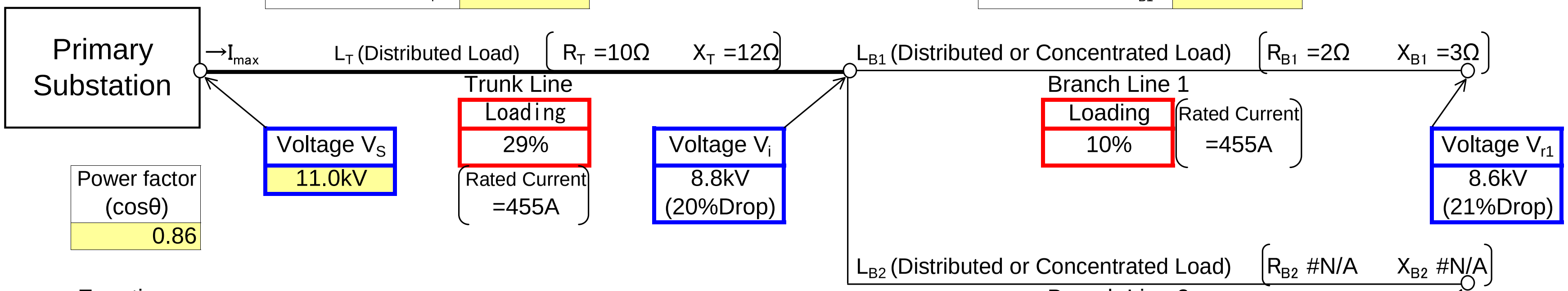
Maximum Current I_{max}
130A

<Trank Line>

Load L_T	84A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	35km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	3415kVA	

<Branch Line 1>

Load L_{B1}	46A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	8km	
Total Transformer Capacity of secondary substations CAP_{B1}	1895kVA	



Power factor (cosθ)
0.86

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage — I_{max} : Maximum Current — R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage — L_T : Load (Trunk line) — X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage — L_{B1} : Load (Branch Line 1) — cosθ : Power Factor
V_{r2} : Received Voltage — L_{B2} : Load (Branch Line 2) — f_T, f_{B1}, f_{B2} : Dispersal Load Factor — CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nsawam Stn N
Feeder Name	Adoagyiri

: Input data in colored cells

Type-2

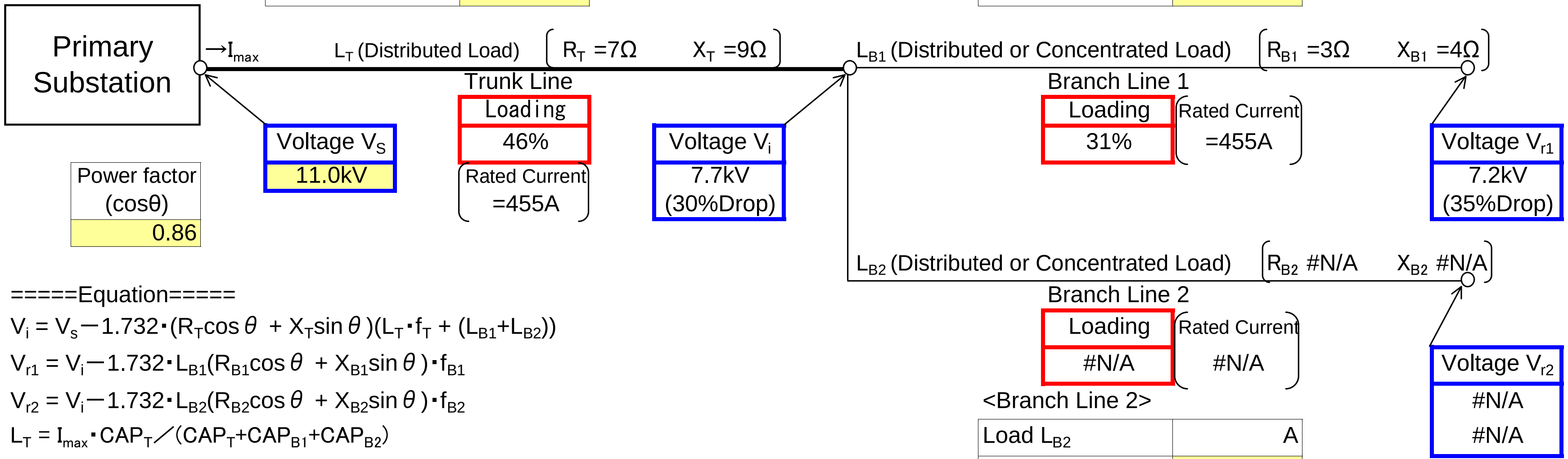
Maximum Current I_{max}
210A

<Trank Line>

Load L_T	70A	
Line Type	AAC120mm2	No.7
Line Legth Len_T	26km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_T	200kVA	

<Branch Line 1>

Load L_{B1}	140A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	11km	
Total Transformer Capacity of secondary substations CAP_{B1}	400kVA	



Power factor (cosθ)
0.86

<Branch Line 2>

Load L_{B2}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B2}		

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T \cos\theta + X_T \sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T + CAP_{B1} + CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T + CAP_{B1} + CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

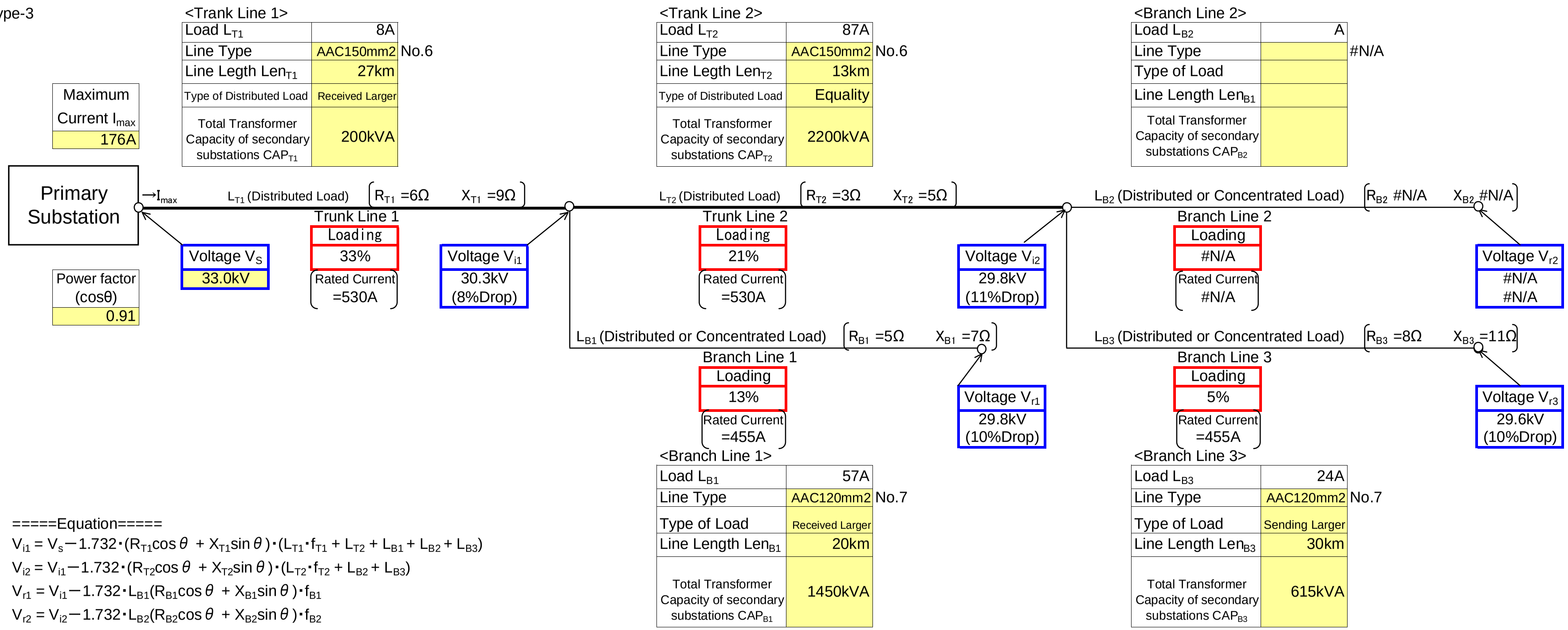
V_s : Supply Voltage I_{max} : Maximum Current R_T, R_{B1}, R_{B2} : Resistance
V_i : Interim Voltage L_T : Load (Trunk line) X_T, X_{B1}, X_{B2} : Reactance
V_{r1} : Received Voltage L_{B1} : Load (Branch Line 1) cosθ : Power Factor
V_{r2} : Received Voltage L_{B2} : Load (Branch Line 2) f_T, f_{B1}, f_{B2} : Dispersal Load Factor $CAP_T, CAP_{B1}, CAP_{B2}$: Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Akwatia
Feeder Name	Oda

: Input data in colored cells

Type-3



=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}, CAP_{B2}, CAP_{B3}	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)		
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Akwatia BSP
Feeder Name	Oda

: Input data in colored cells

Type-3

Maximum Current I_{max}: 176A

Power factor (cosθ): 0.91

Primary Substation

→I_{max}

Voltage V_s: 29.8kV

<Trank Line 1>

Load L_{T1}	A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	3km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T1}		

L_{T1} (Distributed Load) (R_{T1} =1Ω X_{T1} =1Ω)

Trunk Line 1: Loading 39%, Rated Current =455A

Voltage V_{i1}: 29.4kV (1%Drop)

<Trank Line 2>

Load L_{T2}	72A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	56km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	1700kVA	

L_{T2} (Distributed Load) (R_{T2} =15Ω X_{T2} =20Ω)

Trunk Line 2: Loading 35%, Rated Current =455A

Voltage V_{i2}: 24.2kV (19%Drop)

<Branch Line 2>

Load L_{B2}	68A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	40km	
Total Transformer Capacity of secondary substations CAP_{B2}	1600kVA	

L_{B2} (Distributed or Concentrated Load) (R_{B2} =11Ω X_{B2} =14Ω)

Branch Line 2: Loading 15%, Rated Current =455A

Voltage V_{r2}: 23.0kV (23%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =4Ω X_{B1} =6Ω)

Branch Line 1: Loading 3%, Rated Current =455A

Voltage V_{r1}: 29.4kV (1%Drop)

<Branch Line 1>

Load L_{B1}	15A	
Line Type	AAC120mm2	No.7
Type of Load	Sending Larger	
Line Length Len_{B1}	16km	
Total Transformer Capacity of secondary substations CAP_{B1}	350kVA	

L_{B3} (Distributed or Concentrated Load) (R_{B3} =2Ω X_{B3} =2Ω)

Branch Line 3: Loading 5%, Rated Current =455A

Voltage V_{r3}: 24.1kV (19%Drop)

<Branch Line 3>

Load L_{B3}	21A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B3}	7km	
Total Transformer Capacity of secondary substations CAP_{B3}	500kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Oda
Feeder Name	Town

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	17A
Line Type	185ALXPLE(11kV) No.24
Line Legth Len_{T1}	1km
Type of Distributed Load	Received Larger
Total Transformer Capacity of secondary substations CAP_{T1}	500kVA

<Trank Line 2>

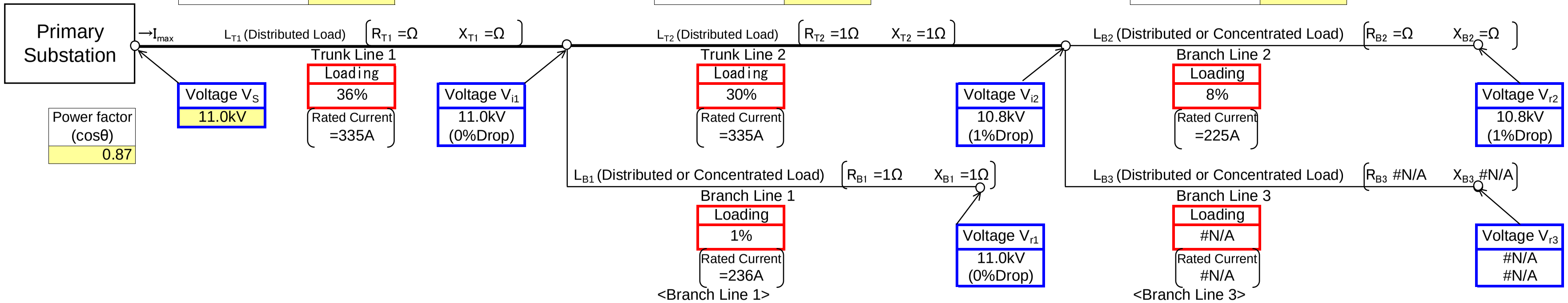
Load L_{T2}	82A
Line Type	185ALXPLE(11kV) No.24
Line Legth Len_{T2}	6km
Type of Distributed Load	Equality
Total Transformer Capacity of secondary substations CAP_{T2}	2330kVA

<Branch Line 2>

Load L_{B2}	17A
Line Type	95ALXPLE(11kV) No.21
Type of Load	Equality
Line Length Len_{B1}	1km
Total Transformer Capacity of secondary substations CAP_{B2}	500kVA

Maximum Current I_{max}
120A

Power factor (cosθ)
0.87



<Branch Line 1>

Load L_{B1}	3A
Line Type	Cu35mm2 No.15
Type of Load	Received Larger
Line Length Len_{B1}	2km
Total Transformer Capacity of secondary substations CAP_{B1}	100kVA

<Branch Line 3>

Load L_{B3}	A
Line Type	#N/A
Type of Load	
Line Length Len_{B3}	
Total Transformer Capacity of secondary substations CAP_{B3}	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Oda
Feeder Name	Achiase

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T1}	3km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}		

<Trank Line 2>

Load L_{T2}	38A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	5km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	900kVA	

<Branch Line 2>

Load L_{B2}	78A	
Line Type	Cu35mm2	No.15
Type of Load	Sending Larger	
Line Length Len_{B1}	4km	
Total Transformer Capacity of secondary substations CAP_{B2}	1850kVA	

Maximum Current I_{max}: 116A

Power factor (cosθ): 0.87

Primary Substation

$\rightarrow I_{max}$

Voltage V_s: 11.0kV

L_{T1} (Distributed Load) R_{T1} =Ω X_{T1} =Ω

Trunk Line 1 — Loading 35% — Rated Current =335A

Voltage V_{i1}: 10.9kV (1%Drop)

L_{T2} (Distributed Load) R_{T2} =1Ω X_{T2} =2Ω

Trunk Line 2 — Loading 35% — Rated Current =455A

Voltage V_{i2}: 10.5kV (4%Drop)

L_{B2} (Distributed or Concentrated Load) R_{B2} =3Ω X_{B2} =2Ω

Branch Line 2 — Loading 33% — Rated Current =236A

Voltage V_{r2}: 10.4kV (6%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} #N/A X_{B1} #N/A

Branch Line 1 — Loading #N/A — Rated Current #N/A

Voltage V_{r1}: #N/A #N/A

L_{B3} (Distributed or Concentrated Load) R_{B3} #N/A X_{B3} #N/A

Branch Line 3 — Loading #N/A — Rated Current #N/A

Voltage V_{r3}: #N/A #N/A

<Branch Line 1>

Load L_{B1}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B1}		
Total Transformer Capacity of secondary substations CAP_{B1}		

<Branch Line 3>

Load L_{B3}	A	
Line Type		#N/A
Type of Load		
Line Length Len_{B3}		
Total Transformer Capacity of secondary substations CAP_{B3}		

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage
V_{i1} : Interim Voltage
V_{i2} : Interim Voltage
V_{r1} : Received Voltage
V_{r2} : Received Voltage
V_{r3} : Received Voltage

I_{max} : Maximum Current
L_{T1} : Load (Trunk line 1)
L_{T2} : Load (Trunk line 2)
L_{B1} : Load (Branch Line 1)
L_{B2} : Load (Branch Line 2)
L_{B3} : Load (Branch Line 3)

$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$: Resistance
$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$: Reactance
$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$: Dispersal Load Factor
$CAP_{T1}, CAP_{T2}, CAP_{B1}, CAP_{B2}, CAP_{B3}$: Total Transformer Capacity of secondary substations
cosθ : Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Oda
Feeder Name	Achiase

: Input data in colored cells

Type-3

Maximum Current I_{max}
116A

Power factor (cosθ)
0.87

<Trank Line 1>

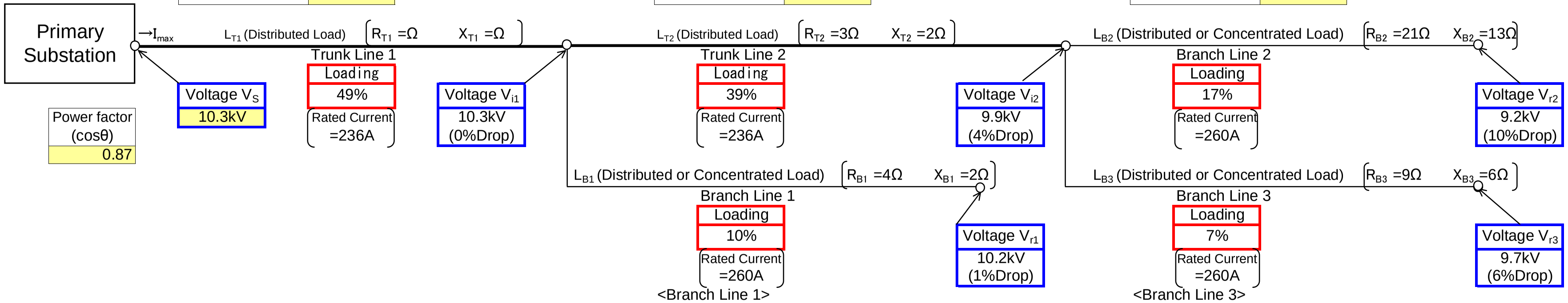
Load L_{T1}	A	
Line Type	Cu35mm2	No.15
Line Legth Len_{T1}		
Type of Distributed Load		
Total Transformer Capacity of secondary substations CAP_{T1}		

<Trank Line 2>

Load L_{T2}	29A	
Line Type	Cu35mm2	No.15
Line Legth Len_{T2}	4km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	815kVA	

<Branch Line 2>

Load L_{B2}	44A	
Line Type	AAC50mm2	No.11
Type of Load	Sending Larger	
Line Length Len_{B1}	34km	
Total Transformer Capacity of secondary substations CAP_{B2}	1215kVA	



<Branch Line 1>

Load L_{B1}	25A	
Line Type	AAC50mm2	No.11
Type of Load	Equality	
Line Length Len_{B1}	6km	
Total Transformer Capacity of secondary substations CAP_{B1}	700kVA	

<Branch Line 3>

Load L_{B3}	18A	
Line Type	AAC50mm2	No.11
Type of Load	Equality	
Line Length Len_{B3}	15km	
Total Transformer Capacity of secondary substations CAP_{B3}	500kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Oda
Feeder Name	Sawmill

: Input data in colored cells

Type-2

Maximum Current I_{max}
90A

Power factor (cosθ)
0.87

<Trank Line>

Load L_T	37A	
Line Type	Cu35mm2	No.15
Line Legth Len_T	2km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_T	2115kVA	

<Branch Line 1>

Load L_{B1}	22A	
Line Type	Cu35mm2	No.15
Type of Load	Sending Larger	
Line Length Len_{B1}	1km	
Total Transformer Capacity of secondary substations CAP_{B1}	1250kVA	

Primary Substation

→I_{max} L_T (Distributed Load) (R_T =1Ω X_T =1Ω)

Trunk Line

Loading
38%

(Rated Current =236A)

Voltage V_S
11.0kV

Voltage V_i
10.8kV (2%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =Ω X_{B1} =Ω)

Branch Line 1

Loading
9%

(Rated Current =236A)

Voltage V_{r1}
10.8kV (2%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =1Ω X_{B2} =1Ω)

Branch Line 2

Loading
12%

(Rated Current =260A)

Voltage V_{r2}
10.7kV (2%Drop)

<Branch Line 2>

Load L_{B2}	31A	
Line Type	AAC50mm2	No.11
Type of Load	Received Larger	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B2}	1750kVA	

=====Equation=====

$V_i = V_s - 1.732 \cdot (R_T\cos\theta + X_T\sin\theta)(L_T \cdot f_T + (L_{B1}+L_{B2}))$

$V_{r1} = V_i - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_i - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$L_T = I_{max} \cdot CAP_T / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_T+CAP_{B1}+CAP_{B2})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_T+CAP_{B1}+CAP_{B2})$

$I_{max} = L_T + L_{B1} + L_{B2}$

V_s : Supply Voltage I_{max} : Maximum Current R_T, R_{B1}, R_{B2} : Resistance

V_i : Interim Voltage L_T : Load (Trunk line) X_T, X_{B1}, X_{B2} : Reactance

V_{r1} : Received Voltage L_{B1} : Load (Branch Line 1) cosθ : Power Factor

V_{r2} : Received Voltage L_{B2} : Load (Branch Line 2) f_T, f_{B1}, f_{B2} : Dispersal Load Factor CAP_T, CAP_{B1}, CAP_{B2} : Total Transformer Capacity of secondary substations

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nkawkaw BSP
Feeder Name	Donkorkrom

: Input data in colored cells

Type-3

Maximum Current I_{max}
20A

<Trank Line 1>

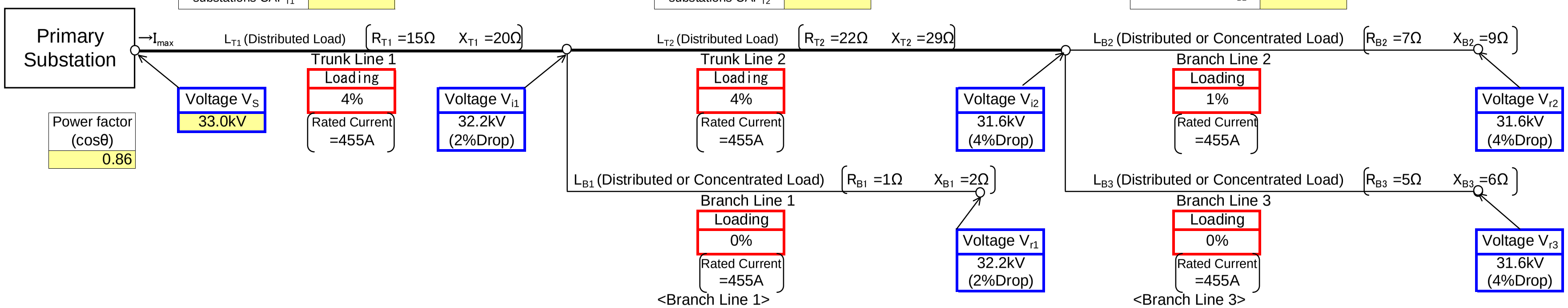
Load L_{T1}	2A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	56km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	450kVA	

<Trank Line 2>

Load L_{T2}	12A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	80km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	3265kVA	

<Branch Line 2>

Load L_{B2}	3A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	26km	
Total Transformer Capacity of secondary substations CAP_{B2}	700kVA	



<Branch Line 1>

Load L_{B1}	1A	
Line Type	AAC120mm2	No.7
Type of Load	Concentrated	
Line Length Len_{B1}	5km	
Total Transformer Capacity of secondary substations CAP_{B1}	400kVA	

<Branch Line 3>

Load L_{B3}	2A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B3}	17km	
Total Transformer Capacity of secondary substations CAP_{B3}	600kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A - *Power System Analysis for existing system using Macro demand forecast* -

Substation Name	Nkawkaw BSP
Feeder Name	New Abirem

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	10A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	27km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	1150kVA	

<Trank Line 2>

Load L_{T2}	26A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	60km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	3055kVA	

<Branch Line 2>

Load L_{B2}	6A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	16km	
Total Transformer Capacity of secondary substations CAP_{B2}	700kVA	

Maximum Current I_{max}
71A

Primary Substation

$\rightarrow I_{max}$

Power factor (cosθ)
0.86

Voltage V_S 33.0kV

L_{T1} (Distributed Load) R_{T1} =7Ω X_{T1} =10Ω

Trunk Line 1 Loading 16% Rated Current =455A

Voltage V_{i1} 31.7kV (4%Drop)

L_{T2} (Distributed Load) R_{T2} =17Ω X_{T2} =21Ω

Trunk Line 2 Loading 12% Rated Current =455A

Voltage V_{i2} 29.9kV (10%Drop)

L_{B2} (Distributed or Concentrated Load) R_{B2} =4Ω X_{B2} =6Ω

Branch Line 2 Loading 1% Rated Current =455A

Voltage V_{r2} 29.8kV (10%Drop)

L_{B1} (Distributed or Concentrated Load) R_{B1} =6Ω X_{B1} =8Ω

Branch Line 1 Loading 2% Rated Current =455A

Voltage V_{r1} 31.6kV (4%Drop)

L_{B3} (Distributed or Concentrated Load) R_{B3} =11Ω X_{B3} =14Ω

Branch Line 3 Loading 5% Rated Current =455A

Voltage V_{r3} 29.7kV (10%Drop)

<Branch Line 1>

Load L_{B1}	7A	
Line Type	AAC120mm2	No.7
Type of Load	Equality	
Line Length Len_{B1}	23km	
Total Transformer Capacity of secondary substations CAP_{B1}	800kVA	

<Branch Line 3>

Load L_{B3}	22A	
Line Type	AAC120mm2	No.7
Type of Load	Sending Larger	
Line Length Len_{B3}	39km	
Total Transformer Capacity of secondary substations CAP_{B3}	2600kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	CAP_{T1}, CAP_{T2}, CAP_{B1}	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nkawkaw BSP
Feeder Name	New Abirem

: Input data in colored cells

Type-3

Maximum Current I_{max}	71A
Power factor (cosθ)	0.91

<Trank Line 1>

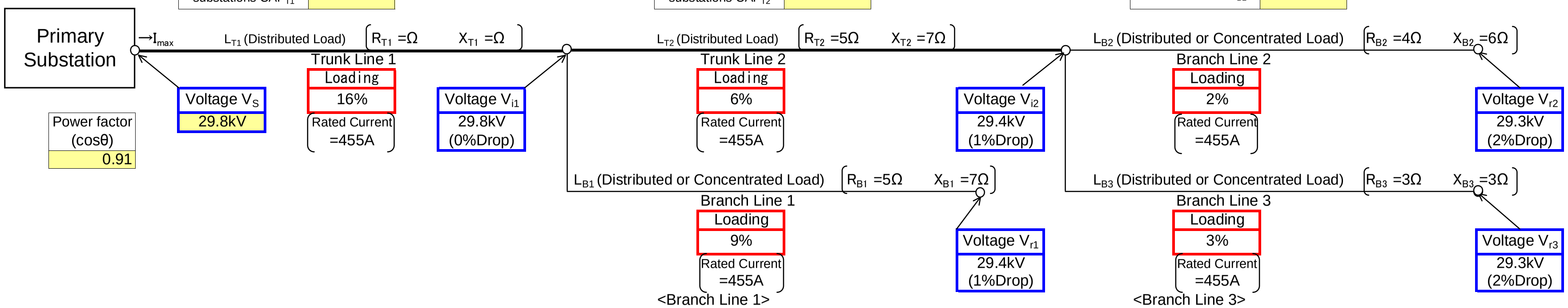
Load L_{T1}	A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	1km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T1}		

<Trank Line 2>

Load L_{T2}	8A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	18km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	250kVA	

<Branch Line 2>

Load L_{B2}	9A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	16km	
Total Transformer Capacity of secondary substations CAP_{B2}	300kVA	



<Branch Line 1>

Load L_{B1}	42A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	19km	
Total Transformer Capacity of secondary substations CAP_{B1}	1350kVA	

<Branch Line 3>

Load L_{B3}	12A	
Line Type	AAC120mm2	No.7
Type of Load	Concentrated	
Line Length Len_{B3}	9km	
Total Transformer Capacity of secondary substations CAP_{B3}	400kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nkawkaw BSP
Feeder Name	Enyiresi

: Input data in colored cells

Type-3

Maximum Current I_{max}
7A

Power factor (cosθ)
0.86

<Trank Line 1>

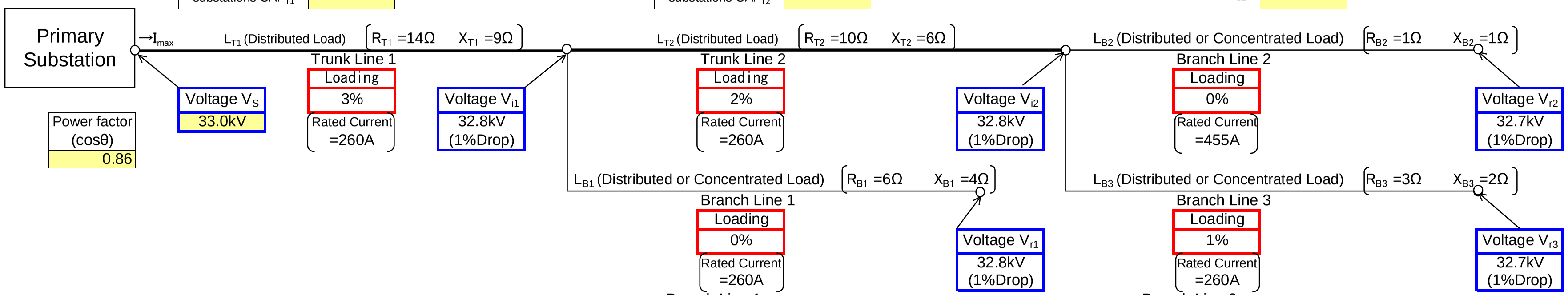
Load L_{T1}	1A	
Line Type	AAC50mm2	No.11
Line Legth Len_{T1}	23km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	250kVA	

<Trank Line 2>

Load L_{T2}	2A	
Line Type	AAC50mm2	No.11
Line Legth Len_{T2}	17km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	300kVA	

<Branch Line 2>

Load L_{B2}	2A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B1}	4km	
Total Transformer Capacity of secondary substations CAP_{B2}	300kVA	



<Branch Line 1>

Load L_{B1}	1A	
Line Type	AAC50mm2	No.11
Type of Load	Concentrated	
Line Length Len_{B1}	10km	
Total Transformer Capacity of secondary substations CAP_{B1}	200kVA	

<Branch Line 3>

Load L_{B3}	1A	
Line Type	AAC50mm2	No.11
Type of Load	Sending Larger	
Line Length Len_{B3}	5km	
Total Transformer Capacity of secondary substations CAP_{B3}	250kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nkawkaw BSP
Feeder Name	Novotex

: Input data in colored cells

Type-3

<Trank Line 1>

Load L_{T1}	27A	
Line Type	AAC50mm2	No.11
Line Legth Len_{T1}	9km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	1700kVA	

<Trank Line 2>

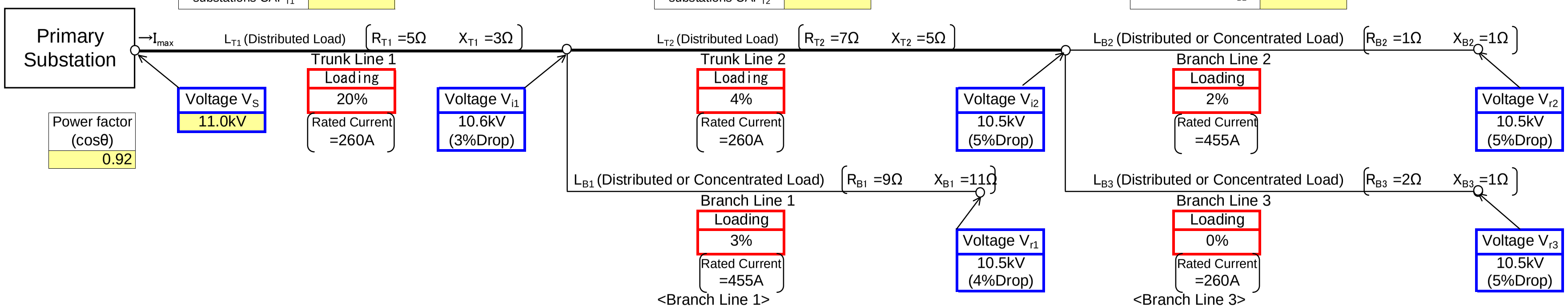
Load L_{T2}	2A	
Line Type	AAC50mm2	No.11
Line Legth Len_{T2}	12km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T2}	150kVA	

<Branch Line 2>

Load L_{B2}	7A	
Line Type	AAC120mm2	No.7
Type of Load	Sending Larger	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B2}	450kVA	

Maximum Current I_{max}
53A

Power factor (cosθ)
0.92



<Branch Line 1>

Load L_{B1}	15A	
Line Type	AAC120mm2	No.7
Type of Load	Sending Larger	
Line Length Len_{B1}	31km	
Total Transformer Capacity of secondary substations CAP_{B1}	965kVA	

<Branch Line 3>

Load L_{B3}	1A	
Line Type	AAC50mm2	No.11
Type of Load	Concentrated	
Line Length Len_{B3}	3km	
Total Transformer Capacity of secondary substations CAP_{B3}	50kVA	

=====Equation=====

$V_{i1} = V_s - 1.732\cdot(R_{T1}\cos\theta + X_{T1}\sin\theta)\cdot(L_{T1}\cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732\cdot(R_{T2}\cos\theta + X_{T2}\sin\theta)\cdot(L_{T2}\cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732\cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta)\cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732\cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta)\cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732\cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta)\cdot f_{B3}$

$L_{T1} = I_{max}\cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max}\cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max}\cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max}\cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max}\cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nkawkaw BSP
Feeder Name	Mountains

: Input data in colored cells

Type-3

Maximum Current I_{max}: 250A

Power factor (cosθ): 0.92

<Trank Line 1>

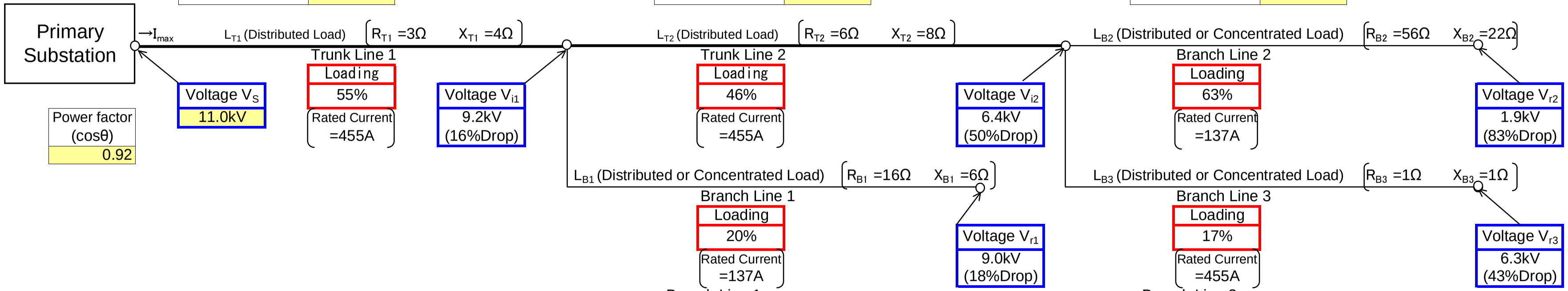
Load L_{T1}	15A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	11km	
Type of Distributed Load	Sending Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	500kVA	

<Trank Line 2>

Load L_{T2}	44A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T2}	23km	
Type of Distributed Load	Equality	
Total Transformer Capacity of secondary substations CAP_{T2}	1465kVA	

<Branch Line 2>

Load L_{B2}	86A	
Line Type	Cu16mm2	No.16
Type of Load	Equality	
Line Length Len_{B1}	44km	
Total Transformer Capacity of secondary substations CAP_{B2}	2865kVA	



<Branch Line 1>

Load L_{B1}	27A	
Line Type	Cu16mm2	No.16
Type of Load	Sending Larger	
Line Length Len_{B1}	13km	
Total Transformer Capacity of secondary substations CAP_{B1}	900kVA	

<Branch Line 3>

Load L_{B3}	78A	
Line Type	AAC120mm2	No.7
Type of Load	Received Larger	
Line Length Len_{B3}	3km	
Total Transformer Capacity of secondary substations CAP_{B3}	2575kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nkawkaw BSP
Feeder Name	Nkawkaw Town

: Input data in colored cells

Type-3

Maximum Current I_{max}
190A

Power factor (cosθ)
0.92

Primary Substation

<Trank Line 1>

Load L_{T1}	19A	
Line Type	AAC120mm2	No.7
Line Legth Len_{T1}	2km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T1}	200kVA	

<Trank Line 2>

Load L_{T2}	A	
Line Type	185ALXPLE(11kV)	No.24
Line Legth Len_{T2}	1km	
Type of Distributed Load	Received Larger	
Total Transformer Capacity of secondary substations CAP_{T2}		

<Branch Line 2>

Load L_{B2}	19A	
Line Type	AAC120mm2	No.7
Type of Load	Concentrated	
Line Length Len_{B1}	3km	
Total Transformer Capacity of secondary substations CAP_{B2}	200kVA	

$\rightarrow I_{max}$

L_{T1} (Distributed Load) (R_{T1} =1Ω X_{T1} =1Ω)

Trunk Line 1: Loading 42%, Rated Current =455A

Voltage V_S: 11.0kV

Voltage V_{i1}: 10.7kV (2%Drop)

L_{T2} (Distributed Load) (R_{T2} =Ω X_{T2} =Ω)

Trunk Line 2: Loading 27%, Rated Current =335A

Voltage V_{i2}: 10.7kV (3%Drop)

L_{B2} (Distributed or Concentrated Load) (R_{B2} =1Ω X_{B2} =1Ω)

Branch Line 2: Loading 4%, Rated Current =455A

Voltage V_{r2}: 10.6kV (3%Drop)

L_{B1} (Distributed or Concentrated Load) (R_{B1} =Ω X_{B1} =Ω)

Branch Line 1: Loading 21%, Rated Current =225A

Voltage V_{r1}: 10.7kV (3%Drop)

L_{B3} (Distributed or Concentrated Load) (R_{B3} =1Ω X_{B3} =Ω)

Branch Line 3: Loading 32%, Rated Current =335A

Voltage V_{r3}: 10.6kV (4%Drop)

<Branch Line 1>

Load L_{B1}	47A	
Line Type	95ALXPLE(11kV)	No.21
Type of Load	Concentrated	
Line Length Len_{B1}	2km	
Total Transformer Capacity of secondary substations CAP_{B1}	500kVA	

<Branch Line 3>

Load L_{B3}	106A	
Line Type	185ALXPLE(11kV)	No.24
Type of Load	Equality	
Line Length Len_{B3}	4km	
Total Transformer Capacity of secondary substations CAP_{B3}	1130kVA	

=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

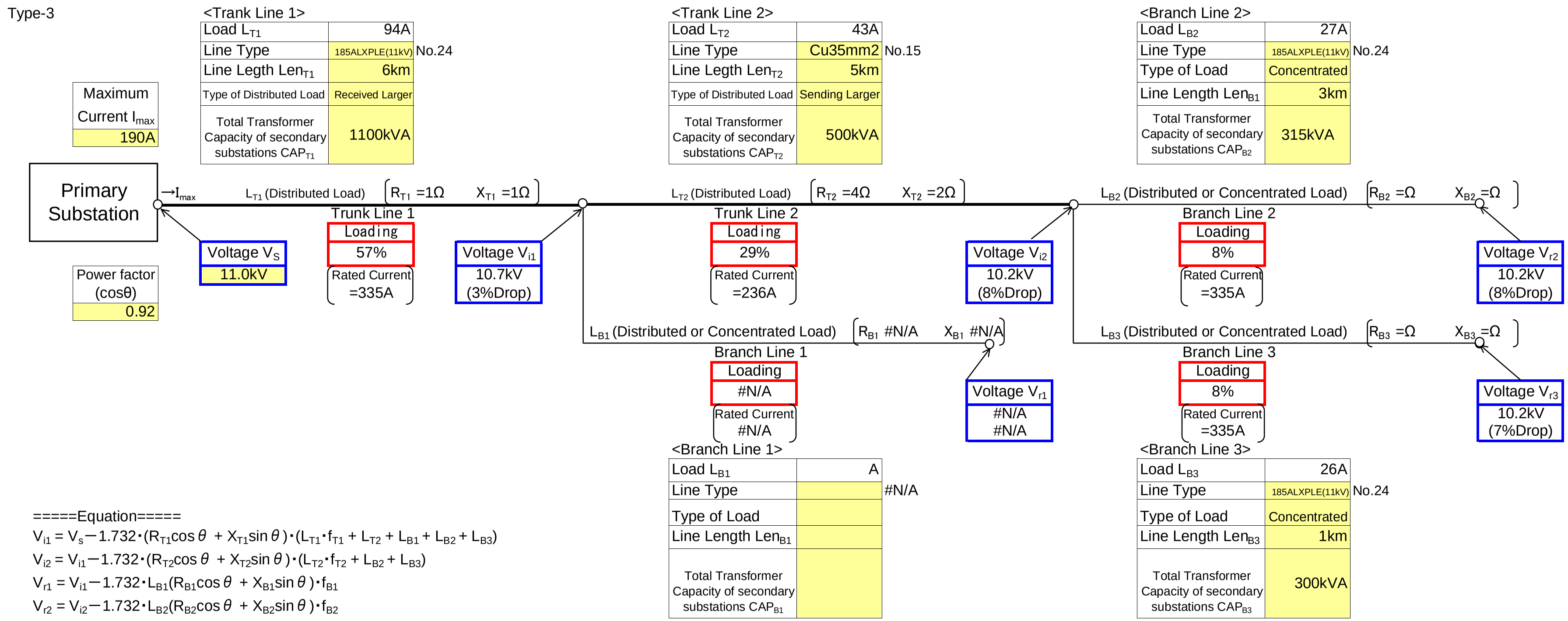
$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s : Supply Voltage	I_{max} : Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1} : Interim Voltage	L_{T1} : Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2} : Interim Voltage	L_{T2} : Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1} : Received Voltage	L_{B1} : Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2} : Received Voltage	L_{B2} : Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3} : Received Voltage	L_{B3} : Load (Branch Line 3)	cosθ	: Power Factor

Power System Analysis for Step A *- Power System Analysis for existing system using Macro demand forecast -*

Substation Name	Nkawkaw BSP
Feeder Name	Nkawkaw Town

: Input data in colored cells



=====Equation=====

$V_{i1} = V_s - 1.732 \cdot (R_{T1}\cos\theta + X_{T1}\sin\theta) \cdot (L_{T1} \cdot f_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3})$

$V_{i2} = V_{i1} - 1.732 \cdot (R_{T2}\cos\theta + X_{T2}\sin\theta) \cdot (L_{T2} \cdot f_{T2} + L_{B2} + L_{B3})$

$V_{r1} = V_{i1} - 1.732 \cdot L_{B1}(R_{B1}\cos\theta + X_{B1}\sin\theta) \cdot f_{B1}$

$V_{r2} = V_{i2} - 1.732 \cdot L_{B2}(R_{B2}\cos\theta + X_{B2}\sin\theta) \cdot f_{B2}$

$V_{r3} = V_{i2} - 1.732 \cdot L_{B3}(R_{B3}\cos\theta + X_{B3}\sin\theta) \cdot f_{B3}$

$L_{T1} = I_{max} \cdot CAP_{T1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{T2} = I_{max} \cdot CAP_{T2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B1} = I_{max} \cdot CAP_{B1} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B2} = I_{max} \cdot CAP_{B2} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$L_{B3} = I_{max} \cdot CAP_{B3} / (CAP_{T1}+CAP_{T2}+CAP_{B1}+CAP_{B2}+CAP_{B3})$

$I_{max} = L_{T1} + L_{T2} + L_{B1} + L_{B2} + L_{B3}$

V_s	: Supply Voltage	I_{max}	: Maximum Current	$R_{T1}, R_{T2}, R_{B1}, R_{B2}, R_{B3}$	: Resistance
V_{i1}	: Interim Voltage	L_{T1}	: Load (Trunk line 1)	$X_{T1}, X_{T2}, X_{B1}, X_{B2}, X_{B3}$	: Reactance
V_{i2}	: Interim Voltage	L_{T2}	: Load (Trunk line 2)	$f_{T1}, f_{T2}, f_{B1}, f_{B2}, f_{B3}$	: Dispersal Load Factor
V_{r1}	: Received Voltage	L_{B1}	: Load (Branch Line 1)	$CAP_{T1}, CAP_{T2}, CAP_{B1}$	: Total Transformer Capacity of secondary substations
V_{r2}	: Received Voltage	L_{B2}	: Load (Branch Line 2)	CAP_{B2}, CAP_{B3}	
V_{r3}	: Received Voltage	L_{B3}	: Load (Branch Line 3)	cosθ	: Power Factor