

Protection Study

US Steel Košice 6 kV System

April 2006

Rev. 2

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1 General

1.1. Scope

The company US Steel Košice in the Slovak Republic operates a 6 kV electrical network to supply its process plant. To supply unit ASU9 with electricity a new 6 kV substation (T80) will be built. The substation T80 will be fed by two new 40 MVA transformers from the 110 kV network

All motors bigger than 5 MW will be fed directly from the substation T80. All small motors and the 6 kV/0,4 kV transformers will be fed from another new substation (T81). The substation T81 will be fed from the substation T80 via two current limiting reactors in order to reduce its short circuit level.

There will be two emergency connections between the new substation T80 and the old substation T40 and between the new substation T81 and the old substation T46.

The neutral point of the 6 kV network is connected to ground through zero transformer and quenching choke.

For the new substations the short-circuit currents and the settings for the system protection are calculated.

1.2. Premises and assumptions

1.2.1. Basic information

The basic data of the supply system were taken from the following documents:

- Single line diagram. Ref.: "Substation T01 / T02 / T80", Drawing No.: 025.011551-4000(0), dated 27.06.2005

- Single line diagram. Ref.: "Substation T81", Drawing No.: 025.011551-4001(0) , dated 27.06.2005
- Data sheet of the current limiting reactors
- Data sheets of the transformers
- US Steel Kosice, Attachment 10: "Answers for questions placed 20.08.2005" (see Attachment 1)
- US Steel Kosice, "Technical data – ASU9 electrical part based on Report from the meeting dated 21.09.2005; Parameters of USSK networks" (see Attachment 2)

The data of the system elements used for the calculations are given in **table 1** and as single line in **figure 1**.

For the network analysis the following assumptions have been taken.

1.2.2. Cable systems

The data of the cable systems were taken from the German standard VDE 0276 and the technical catalogue of AEG Cable.

For grouping of cables an additional group rating factor is considered. The appropriate group rating factor for the current carrying capacity were taken from the German standard VDE 0276. The 6 kV cable systems are installed in air.

1.2.3. Transformers

Transformer data for the 110 kV/6.3 kV and 6 kV/0.4 kV transformers were taken from the transformer data sheets and are shown in **table 1**.

Tap settings of the low voltage transformers were not considered, so the transformers are regarded with rated ratio.

1.2.4. Loads

For short-circuit calculation the rated apparent power of the induction motors has to be considered.

The rated apparent power of the high voltage motors is calculated according to the following formula:

$$S_r = \sqrt{3} \cdot U_r \cdot I_r$$

where

S_r = rated apparent power

U_r = rated voltage

I_r = rated current of the motor

The low voltage motors at T81 are simulated as an equivalent motor. For the short circuit calculation is assumed that all low voltage motors are in operation.

For the motors additional assumptions are taken based on the international standard IEC 60909:

$$\frac{R_M}{X_M} = 0.10 \dots 0.15 \quad \text{for high voltage motors}$$

$$\frac{R_M}{X_M} = 0.42 \quad \text{for low voltage motors}$$

1.2.5. 110-kV-Network

The following fault level from the feeding 110 kV network was considered (see Attachment 2):

	Fault Level [kA]	R/X- Ratio
Maximum 3-phase short-circuit capacity	16.3	0.1
Minimum 3-phase short-circuit capacity	8.45	0.1

2 Short-circuit calculation

The short-circuit calculations are done according to the international standard IEC 60909. Non-motor loads, shunt impedances and the capacitances of cable systems and overhead lines are disregarded.

Maximum short-circuit values are calculated for operation with the maximum short-circuit values of the 110-kV-network and the maximum values at the existing busbars T40 and T46 and all motors in operation.

According to IEC 60909 the following parameters are used:

- voltage factor:

$$c = 1.1$$

- temperature of the conductors:

$$\vartheta = 20^{\circ}\text{C}$$

The minimum short-circuit values are calculated for operation with the minimum short-circuit values of the 110-kV-network. In addition no motors are in operation.

According to IEC 60909 the following parameters are used:

- voltage factor:

$$c = 1.0 \quad U_r > 1 \text{ kV}$$

$$c = 0.95 \quad U_r \leq 1 \text{ kV}$$

- temperature of the conductors:

$$\vartheta = 80^{\circ}\text{C}$$

The following values are determined for each calculation:

- initial symmetrical short-circuit current I''_k
- peak short-circuit current i_p

2.1. Maximum three phase short-circuit, normal operation

Normal operation is calculated, the interconnections to the existing plant (T40, T46) are open.

The calculated three phase short circuit currents are shown in **figure 2**.

The following short-circuit values at the different busbars are calculated:

busbar	$I''_k/i_{p \text{ perm.}}$	I''_k	i_p
	[kA]	[kA]	[kA]
6-kV-substations:			
T80	50/125	43.2	110.5
T81	31.5/80	26.1	65.1

All short-circuit currents are within the permissible range. The short-circuit limits of the system are not exceeded.

2.2. Maximum three phase short-circuit, operation with the interconnections to the existing plant closed

Interconnected operation to the existing plant is calculated, the interconnections to the existing plant (T40, T46) are closed.

The calculated three phase short circuit currents are shown in **figure 3**.

The following short-circuit values at the different busbars are calculated:

busbar	$I''_k/i_p \text{ perm.}$	I''_k	I_a	i_p
	[kA]	[kA]	[kA]	[kA]
6-kV-substations:				
T80	50/125	55.9	54.3	136.6
T81	31.5/80	31.0	30.2	74.1
T40		56.8	55.2	139.6
T46		33.0	32.2	81.4

The short-circuit level is exceeded at least for substation T80. Therefore this operation is not permissible.

2.3. Minimum two phase short-circuit

The minimum two phase short-circuit currents are calculated for normal operation with a minimal short-circuit current at the 110-kV-level.

The calculated short circuit currents are shown in **figure 4** and **table 6**.

They have to be considered for the protection relay settings, especially for the phase starting currents.

2.4. Thermal short-circuit withstand capability of cables

For calculation of the maximum allowed short-circuit time of the cable systems the results of the maximum three phase short circuit calculation (section 2.1) are used.

For thermal stresses the thermal short-circuit current I_{th} is important. I_{thr} means the rated short-circuit current for $t_{kr} = 1$ s.

The following relationship is between I_{th} and I_{thr} :

$$\begin{aligned} I_{th} &= I_{th,r} \cdot \sqrt{\frac{t_{k,r}}{t_k}} \\ &= I_{th,r} \cdot \sqrt{\frac{1s}{t_k}} \end{aligned}$$

The rated short-time current density S_{thr} for a maximum conductor temperature of 80°C is taken from IEC 865.

Using the cross-section of the cable systems I_{thr} is determined.

The maximum permissible initial symmetrical short-circuit current $I''_{k,max}$ may be calculated from

$$I''_{k,max} = I_{th} \cdot \frac{1}{\sqrt{m+n}}$$

The factor m considers the thermal effect of the of the D.C. component. It depends on the factor $\kappa = f(R/X)$ (IEC 60909), which indicates the effect of the D.C. component to the peak asymmetrical short-circuit current.

This factor depends on the fault location. It decreases with increasing distance between fault location and infeed. Values of κ lie between 1.0 and 2.0.

The factor n considers the thermal effect of the A.C. component. It depends on the ratio I_k''/I_k .

Based on the initial symmetrical short-circuit current through a cable system the maximum permissible short-circuit time for this cable system is calculated.

The maximum permissible short-circuit time $T_{k \text{ allow}}$ of the cable systems are shown in **figure 5** and **table 7**.

These maximum short-circuit times have to be considered when the settings of the system protection devices are determined.

Considering the fault clearing times which are given by the system protection (chapter 3), all cable systems have the ability to withstand the stresses due to short-circuit currents.

3 System Protection

3.1. Scope

This protection study is carried out to determine the protection settings for the medium voltage network.

The protection system shall operate as rapidly as possible, consistent with maintaining proper discrimination, to minimise damage to equipment and disturbance to the electrical system as a whole.

3.2. Principles of the system protection for medium voltage

For determination of the protection settings the following data has to be considered:

- operational currents
- Max. and min. short-circuit currents, which are flowing through the devices
- thermal short-circuit current of the cable systems combined with the fault clearing times
- Data of the induction motors (especially start-up time, and starting current)
- Data of the current transformers
- Type and setting range of the protection devices

The current settings of the protection devices are calculated according to the following relation:

$$I_{\text{sec}} = I_{\text{pr}} \cdot \frac{I_{\text{CT,sec}}}{I_{\text{CT,pr}}}$$

with

I_{sec} = current setting at the protection device

I_{pr} = primary current setting for the individual devices such as transformers, cable systems or motors

$I_{\text{CT,pr}}$ = primary rating of the current transformer

$I_{\text{CT,sec}}$ = secondary rating of the current transformer

The relation which has to be obeyed is:

$$I_{\text{op}} < I_{\text{pr}} < I''_{\text{k min}}$$

with

I_{op} = rated operating current

$I''_{\text{k min}}$ = minimum short-circuit current

Inrush current detection and filtering is recommended for transformer feeders. Thus it is guaranteed that inrush currents don't lead to an activation of the high set overcurrent stage. Inrush detection is only required on primary side of transformers.

Two overcurrent stages shall be set on the primary side of transformer feeders. In the instantaneous stage ($I >>$) faults on the primary side of the transformer are cleared within 50 ms. The instantaneous stage and the high set stage have definitive time characteristic. The high set stage ($I >$) serves as back up for faults on the secondary side of the transformer. It operates with the same time delay as the next downstream overcurrent time protection. The thermal overload function operates as an overload protection.

The grading times are selected to be 250 ms.

3.3. Details to protection settings

The settings of the protection devices are given in **tables 2 to 5**. Additional settings for motor feeders are incorporated in **table 3**. The settings for the differential protection may be seen from **table 5**.

All protection devices have been graded selectively.

Fault clearing times for busbar faults at substation T80 are 550 ms for substation T81 300 ms.

Additionally the following should be kept in mind:

- The settings of the short-circuit stage of transformer feeders were chosen, that the short-circuit current at the secondary side of the transformers are cleared by the low voltage circuit breaker. For failure of this circuit breaker, clearing is done by the protection device at the HV-side of the transformer using the $I >$ starting with a time setting of 500 ms

- Faults at the primary side of the transformer are cleared using the I>> starting with instantaneous operation.

For selected grading paths the grading diagrams are shown in **figures 7 to 14**.

3.4. Low voltage short-circuit protection

In addition to the medium voltage protection, the maximum allowable short-circuit settings of the different low voltage feeders is proposed.

The feeders are equipped with low voltage circuit breakers or thermal motor protection.

The calculated minimum phase to earth short-circuit currents for the longest feeders of a given cross section are shown in **figure 37**.

The grading of the feeders are shown in **figures 15 to 36**

The maximum settings for the different feeders are given below according to the cross section of the feeder cable system.

Feeder cross section [mm ²]	Max. feeder length [m]	Min. phase to earth short-circuit current [A]	Proposed short-circuit setting for breaker [A]	max short-circuit setting for breaker [A]	Time delay
2x3x150/70	110	8802	4000	7041	Instantaneous
3x50/35	120	1490	600	1192	Instantaneous
4x50	100	2145	600	1716	Instantaneous

4x6	110	228	100	182	Instantaneous
4x4	105	145	80	116	Instantaneous
4x2.5	110	86	40	69	Instantaneous
4x1.5	110	53	25	42	Instantaneous

3.5. Remarks

3.5.1. Medium voltage

According to the damage curve, the heavy starting logic needs to be applied for the MAC motor. Therefore a signal "machine is rotating" is required for the motor protection.

3.5.2. Low voltage

For some LV-feeders in the main distribution T81 the actual minimum short-circuit current is lower than the fixed short-circuit setting of the breaker.

For these feeders the possibility of lower settings for the short-circuit release have to be checked.

This comment applies to the following feeders:

Main distribution:

- M 24163, M24263
- M77820
- M11820, M16820
- M40100
- M71100, M71200
- W11706, W11707

- W11810
- W16810
- W70810, W77810

Tank farm:

- M73101, M73201

The required settings are given in the aforementioned table.

P A N / A E G - NETWORK CALCULATION PROGRAM (V8.2.3 / 13.08.04)

US Steel Kosice
110-/6-kV Network

DATA LIST BASIC NETWORK

NETWORK CONSTANTS

NETWORK FREQUENCY HZ 50.000

NETWORK RATED VOLTAGES

NODE		T80/4	T80_SS2A	T80_SS1A	
RATED VOLTAGE	KV	0.400	6.000	6.000	6.000
MIN. VOLTAGE	KV	0.380	0.000	0.000	5.800
MAX. VOLTAGE	KV	0.430	0.000	0.000	6.400

LINE CONSTANTS

TYPE	XLPE_AL	2XSFL2Y	N2XS2Y	N2XS2Y	N2XS2Y	N2XS2Y	N2XS2Y
PROFILE	3x1x500	3x1x240	3x1x120	6x1x185	6x1x240	6x1x400	12x1x400
TYPE IDENTIF. NO.	115002.	212402.	111201.	121851.	122401.	142001.	144001.
TYPE RATED VOLTAGE	KV	110.000	110.000	6.000	6.000	6.000	6.000
RATED CURRENT	KA	0.507	0.378	0.330	0.843	0.994	1.467
RESISTANCE	OHM/KM	0.060	0.075	0.153	0.050	0.038	0.024
REACTANCE	OHM/KM	0.178	0.640	0.109	0.051	0.049	0.046
OPERAT. CAPACITY	NF/KM	167.000	127.000	330.000	780.000	880.000	1100.000

TYPE	N2XS2Y	N2XS2Y	N2XS2Y
PROFILE	12x1x400	15x1x500	18x1x500
TYPE IDENTIF. NO.	244001.	155001.	165001.
TYPE RATED VOLTAGE	KV	6.000	6.000
RATED CURRENT	KA	2.771	3.823
RESISTANCE	OHM/KM	0.012	0.007
REACTANCE	OHM/KM	0.023	0.018
OPERAT. CAPACITY	NF/KM	2200.000	3050.000

LINES

ELEMENT IDENTIF. MARK	K_T2_T02	K_T1_T01	K_GAN1A	K_GAN2A	K_T181A	K_T2_T80	K_T80A12
NETWORK GROUP							
BEGIN	T02A_110	T01A_110	T81_A	T81_A	T81_A	T80_SS2A	_K000001
END	T2_02_HV	T1_01_HV	T81/4	T81/3	T81/2	T80/12	T80_SS2A
RATED VOLTAGE	KV	110.000	110.000	6.000	6.000	6.000	6.000
1. TYPE IDENTIF. NO.		115002.	115002.	111201.	111201.	165001.	165001.
1. LENGTH	KM	0.650	2.400	0.105	0.110	0.050	0.014

ELEMENT IDENTIF. MARK	K_T1_T80	K_T80T40	K_T81T46	K_BAC_A	K_COND	K_MAC_A	K_CHT802
NETWORK GROUP							
BEGIN	T80_SS1A	T80_SS1A	T81_A	T80_SS1A	T80_SS1A	T80_SS1A	T80/13
END	T80/1	_K000000	_K000008	T80/3	T80/5	T80/4	T80_SS2A
RATED VOLTAGE	KV	6.000	6.000	6.000	6.000	6.000	6.000
1. TYPE IDENTIF. NO.		165001.	165001.	121851.	122401.	122401.	144001.
1. LENGTH	KM	0.030	0.100	0.190	0.495	0.025	0.025

US Steel Kosice
110-/6-kV Network

DATA LIST BASIC NETWORK

LINES					
ELEMENT IDENTIF. MARK		K_CHT81B	K_CHT801	K_T81AB	K_CHT81A
NETWORK GROUP					
BEGIN		T81/9	T80/6	_K000009	T81/1
END		T81_B	T80_SS1A	T81_B	T81_A
RATED VOLTAGE	KV	6.000	6.000	6.000	6.000
1. TYPE IDENTIF. NO.		144001.	144001.	144001.	144001.
1. LENGTH	KM	0.545	0.025	0.007	0.550
TWO WINDING TRANSFORMERS					
ELEMENT IDENTIF. MARK		T_T1_81A	T_T2_02	T_T1_01	ST
GENERAT. UNIT IDEN. MARK					
NETWORK GROUP					
TERMINAL NODE	P	T81/2	T2_02_HV	T1_01_HV	T80_SS1A
TERMINAL NODE	S	T1_81ALV	T80/12	T80/1	_K000005
RATED VOLTAGE	P KV	6.300	110.000	110.000	6.000
RATED VOLTAGE	S KV	0.420	6.300	6.300	4.800
RATED POWER	MVA	2.500	40.000	40.000	32.330
IMPED. VOLTAGE DROP	%	6.000	10.700	10.700	2.000
SHORT CIRCUIT LOSSES	KW	12.250	192.000	192.000	210.000
NO LOAD LOSSES	KW	4.300	34.000	34.000	15.000
NO LOAD CURRENT	%	1.200	0.700	0.700	0.640
TAPPING RANGE	%	5.000	5.000	5.000	0.000
TAPPING ANGLE	DGR	0.000	0.000	0.000	0.000
MAX. TAPS NO. U/U+PH		2.000	2.000	2.000	0.000
TAP	U/U+PH	0.000	0.000	0.000	0.000
OP. VOLTAGE MAX.	KV	0.000	0.000	0.000	0.000
OP. CURRENT MAX.	KA	0.000	0.000	0.000	0.000
OP. POWER FACTOR		0.000	0.000	0.000	0.000
TAP-POS. NORMAL (PT)	%	0.000	0.000	0.000	0.000
POWERSTAT. W. AUTO-TAP		0.000	0.000	0.000	0.000
RLC-CIRCUIT					
ELEMENT IDENTIF. MARK		K_NET2	K_NET1		
NETWORK GROUP					
TERMINAL NODE	P	NET	NET		
TERMINAL NODE	S	T02A_110	T01A_110		
RATED VOLTAGE	KV	110.000	110.000		
RATED CURRENT	KA	1.000	1.000		
RESISTANCE	OHM	0.000	0.000		
REACTANCE	OHM	0.001	0.001		
CAPACITY	UF	0.000	0.000		

US Steel Kosice
110-/6-kV Network

DATA LIST BASIC NETWORK

IMPEDANCE COILS

ELEMENT IDENTIF. MARK	CH6	CH5
NETWORK GROUP		
TERMINAL NODE P	T80/13	T80/6
TERMINAL NODE S	T81/9	T81/1
RATED VOLTAGE KV	6.300	6.300
RATED CURRENT KA	2.500	2.500
RATED VOLTAGE DROP %	3.750	3.750
SHORT CIRCUIT LOSSES KW	25.500	25.500

LOADS

ELEMENT IDENTIF. MARK	CAPACITO
NETWORK GROUP	
TERMINAL NODE	T80/5
RATED VOLTAGE KV	6.000
RATED POWER MVA	1.760
ACTIVE POWER MW	0.000
REACTIVE POWER MVAR	-1.600
POWER FACTOR COS PHI	0.000
ACT. IMPEDANCE LOAD %	0.000
REACT. IMPEDANCE LOAD %	100.000
IDENT. LOADFACT. CHANGE	C

ASYNCHRONOUS MOTORS

ELEMENT IDENTIF. MARK	M_T1_81A	GAN_1A	GAN_2A	BAC_A	MAC_A
NETWORK GROUP					
TERMINAL NODE	T1_81ALV	T81/4	T81/3	T80/3	T80/4
RATED VOLTAGE KV	0.400	6.000	6.000	6.000	6.000
REFERENCE POWER MVA	0.500	1.964	1.964	8.002	9.654
ACTIVE LOAD MW	0.300	1.700	1.700	6.700	8.600
REACTIVE LOAD MVA	0.000	0.000	0.000	0.000	0.000
POWER FACTOR COS PHI	0.900	0.905	0.905	0.860	0.915
IA / IN	5.000	5.600	5.600	3.950	5.550
PAIR OF POLS	2.000	1.000	1.000	1.000	2.000
RM / XM %	42.000	10.000	10.000	10.000	10.000
XG / XM %	0.000	0.000	0.000	0.000	0.000
IDENT. LOADFACT. CHANGE					

US Steel Kosice
110-/6-kV Network

DATA LIST BASIC NETWORK

INFINITE BUSSES		
ELEMENT IDENTIF. MARK		NET_MAX
NETWORK GROUP		
TERMINAL NODE		NET
RATED VOLTAGE	KV	110.000
TERMINAL VOLTAGE	KV	110.000
REFERENCE POWER	MVA	0.000
ACTIVE SUPPLY	MW	0.000
MISMATCH ACTIVE POWER %		100.000
MISMATCH REACT. POWER %		100.000
SK''	MVA	3411.000
IK''	KA	0.000
RM / XM	%	10.000
X0 / XM	%	0.000
R0 / X0	%	0.000

110kV-Substation	Cubicle: E15	Page 1
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Sub T80	Cubicle: L01	Page 1
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Sub T81 LV	Cubicle: F3-M1	Page 5
Sub T81 LV	Cubicle: F3-M2	Page 5
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Table 2a: Settings of the overcurrent protection devices, contents
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Table 2a: Settings of the overcurrent protection devices, contents
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Station: 110kV-Substation, Cubicle: E15, No. 2

Feeder to: T2
Current transformer: 200/1
Device: 7SJ61+7SD610 (definite time)

Is = I> =	700 A prim	I>> =	3000 A prim
I> =	3.50 A sek	I>> =	15.00 A sek
I> =	3.50 *Inom (1A)	I>> =	15.00 *Inom (1A)
		I>> =	4.29 *Is
t> =	0.8 s	t>> =	0.05 s

Earth fault settings:
Current transformer for earth faults: 200/1
Characteristic: definite time

Ie> =	700 A prim	Ie>> not used
Ie> =	3.50 A sek	
Ie> =	3.50 *Inom (1A)	
t =	0.3 s	

Remark: Inrush blocking

Station: 110kV-Substation, Cubicle: E21, No. 1

Feeder to: T1
Current transformer: 200/1
Device: 7SJ61+7SD610 (definite time)

Is = I> =	700 A prim	I>> =	3000 A prim
I> =	3.50 A sek	I>> =	15.00 A sek
I> =	3.50 *Inom (1A)	I>> =	15.00 *Inom (1A)
		I>> =	4.29 *Is
t> =	0.8 s	t>> =	0.05 s

Earth fault settings:
Current transformer for earth faults: 200/1
Characteristic: definite time

Ie> =	700 A prim	Ie>> not used
Ie> =	3.50 A sek	
Ie> =	3.50 *Inom (1A)	
t =	0.3 s	

Remark: Inrush blocking

Station: Sub T80, Cubicle: L01, No. 3

Feeder to: T1
Current transformer: 4000/1
Device: P130C+7SD610 (therm. Overload)

Is = Ib =	3680 A prim	I>> =	12000 A prim
Ib =	0.92 A sek	I>> =	3.00 A sek
Ib =	0.92 *Inom (1A)	I>> =	3.00 *Inom (1A)
		I>> =	3.26 *Is
tau =	40 min	t>> =	0.55 s

Remark:

Station: Sub T80, Cubicle: L02, No. 5

Feeder to: Starting Transformer MAC
Current transformer: 1250/1
Device: P130C+P122 (Motorprotection (characteristic: reziprok))

Is = Ib =	925 A prim	[49 / 49LR]
Ib =	0.74 A sek	
Ib =	0.74 *Inom (1A)	
t6Ie =	11.0 s	

I>> =	7500 A prim	[50]
I>> =	6.00 A sek	

I>> = 6.00 *Inom (1A)
I>> = 8.11 *Is
t>> = 0.05 s

I>>> = 125 A prim [50]
I>>> = 0.10 A sek
t>>> = 40.00 s

Remark:

Station: Sub T80, Cubicle: L03, No. 6

Feeder to: BAC
Current transformer: 750/1
Device: P130C (Motorprotection (characteristic: reziprok))

Is = Ib = 773 A prim [49 / 49LR]
Ib = 1.03 A sek
Ib = 1.03 *Inom (1A)
t6Ie = 9.0 s

I>> = 7500 A prim [50]
I>> = 10.00 A sek
I>> = 10.00 *Inom (1A)
I>> = 9.71 *Is
t>> = 0.05 s

I>>> = 1155 A prim [50 / Running up time monitoring]
I>>> = 1.54 A sek
t>>> = 25.00 s

I> = 2130 A prim [50 for locked rotor protection]
I> = 2.83 A sek
t> = 17.00 s

Remark:

Station: Sub T80, Cubicle: L04, No. 7

Feeder to: MAC
Current transformer: 1000/1
Device: P130C (Motorprotection (characteristic: reziprok))

Is = Ib = 930 A prim [49 / 49LR]
Ib = 0.93 A sek
Ib = 0.93 *Inom (1A)
t6Ie = 11.0 s

I>> = 8000 A prim [50]
I>> = 8.00 A sek
I>> = 8.00 *Inom (1A)
I>> = 8.60 *Is
t>> = 0.05 s

I>>> = 1394 A prim [50 / Running up time monitoring]
I>>> = 1.40 A sek
t>>> = 40.00 s

I> = 2787 A prim [50 for locked rotor protection]
I> = 2.79 A sek
t> = 36.00 s

Remark:

Station: Sub T80, Cubicle: L05, No. 8

Feeder to: Capacitor Bank
Current transformer: 250/1
Device: P130C (therm. Overload)

Is = Ib = 200 A prim I>> = 5000 A prim
Ib = 0.80 A sek I>> = 20.00 A sek

Table 2b: Settings of the overcurrent protection devices

$I_b = 0.80 \cdot I_{nom} (1A)$ $I_{>>} = 20.00 \cdot I_{nom} (1A)$
 $I_{>>} = 25.00 \cdot I_s$
 $\tau = 20 \text{ min}$ $t_{>>} = 0.1 \text{ s}$
 Remark:

Station: Sub T80, Cubicle: L06, No. 9

Feeder to: Feeder 1 to T81
 Current transformer: 2500/1
 Device: P130C (therm. Overload)

$I_s = I_b = 2500 \text{ A prim}$ $I_{>>} = 6250 \text{ A prim}$
 $I_b = 1.00 \text{ A sek}$ $I_{>>} = 2.50 \text{ A sek}$
 $I_b = 1.00 \cdot I_{nom} (1A)$ $I_{>>} = 2.50 \cdot I_{nom} (1A)$
 $I_{>>} = 2.50 \cdot I_s$
 $\tau = 10 \text{ min}$ $t_{>>} = 0.3 \text{ s}$
 Remark:

Station: Sub T80, Cubicle: L08, No. 10

Feeder to: Feeder to T40
 Current transformer: 4000/1
 Device: P130C (definite time)

$I_s = I_{>} = 9600 \text{ A prim}$ $I_{>>} \text{ not used}$
 $I_{>} = 2.40 \text{ A sek}$
 $I_{>} = 2.40 \cdot I_{nom} (1A)$
 $t_{>} = 0.55 \text{ s}$
 Remark:

Station: Sub T80, Cubicle: L12, No. 4

Feeder to: T2
 Current transformer: 4000/1
 Device: P130C+7SD610 (therm. Overload)

$I_s = I_b = 3680 \text{ A prim}$ $I_{>>} = 12000 \text{ A prim}$
 $I_b = 0.92 \text{ A sek}$ $I_{>>} = 3.00 \text{ A sek}$
 $I_b = 0.92 \cdot I_{nom} (1A)$ $I_{>>} = 3.00 \cdot I_{nom} (1A)$
 $I_{>>} = 3.26 \cdot I_s$
 $\tau = 40 \text{ min}$ $t_{>>} = 0.55 \text{ s}$
 Remark:

Station: Sub T80, Cubicle: L13, No. 11

Feeder to: Feeder 2 to T81
 Current transformer: 2500/1
 Device: P130C (therm. Overload)

$I_s = I_b = 2500 \text{ A prim}$ $I_{>>} = 6250 \text{ A prim}$
 $I_b = 1.00 \text{ A sek}$ $I_{>>} = 2.50 \text{ A sek}$
 $I_b = 1.00 \cdot I_{nom} (1A)$ $I_{>>} = 2.50 \cdot I_{nom} (1A)$
 $I_{>>} = 2.50 \cdot I_s$
 $\tau = 10 \text{ min}$ $t_{>>} = 0.3 \text{ s}$
 Remark:

Station: Sub T81 LV, Cubicle: F1, No. 18

Feeder to: Transformer T1 2,5 MVA
 Current transformer: 4000/5
 Device: MerlinGerin 5A (Low voltage circuit breaker)

Is = I> =	3600 A prim	I>> =	10000 A prim
I> =	4.50 A sek	I>> =	12.50 A sek
I> =	0.90 *Inom (5A)	I>> =	2.50 *Inom (5A)
		I>> =	2.78 *Is

Tc =	20 s	t>> =	0.4 s
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Remark:

Station: Sub T81 LV, Cubicle: F2-M13100, No. 20

Feeder to: M13100
 Current transformer: 100/1
 Device: MerlinGerin MA100+GV2-ME5 (Low voltage motor protection (class 10A))

Is = I> =	99 A prim	I>> =	800 A prim
I> =	0.99 A sek	I>> =	8.00 A sek
I> =	0.99 *Inom (1A)	I>> =	8.00 *Inom (1A)
		I>> =	8.08 *Is
		t>> =	0.02 s

Remark:

Station: Sub T81 LV, Cubicle: F2-M13200, No. 21

Feeder to: M13200
 Current transformer: 100/1
 Device: MerlinGerin MA100+GV2-ME5 (Low voltage motor protection (class 10A))

Is = I> =	99 A prim	I>> =	800 A prim
I> =	0.99 A sek	I>> =	8.00 A sek
I> =	0.99 *Inom (1A)	I>> =	8.00 *Inom (1A)
		I>> =	8.08 *Is
		t>> =	0.02 s

Remark:

Station: Sub T81 LV, Cubicle: F2-M14100, No. 22

Feeder to: M14100
 Current transformer: 100/1
 Device: MerlinGerin MA100+GV2-ME5 (Low voltage motor protection (class 10A))

Is = I> =	54 A prim	I>> =	600 A prim
I> =	0.54 A sek	I>> =	6.00 A sek
I> =	0.54 *Inom (1A)	I>> =	6.00 *Inom (1A)
		I>> =	11.11 *Is
		t>> =	0.02 s

Remark:

Station: Sub T81 LV, Cubicle: F2-M14200, No. 23

Feeder to: M14200
 Current transformer: 100/1
 Device: MerlinGerin MA100+GV2-ME5 (Low voltage motor protection (class 10A))

Is = I> =	54 A prim	I>> =	600 A prim
I> =	0.54 A sek	I>> =	6.00 A sek
I> =	0.54 *Inom (1A)	I>> =	6.00 *Inom (1A)
		I>> =	11.11 *Is
		t>> =	0.02 s

Remark:

Station: Sub T81 LV, Cubicle: F2-Q1, No. 19

Feeder to: Feeder
Current transformer: 400/1
Device: MerlinGerin 5A (Low voltage circuit breaker)

Is = I> =	400 A prim	I>> =	4000 A prim
I> =	1.00 A sek	I>> =	10.00 A sek
I> =	1.00 *Inom (1A)	I>> =	10.00 *Inom (1A)
		I>> =	10.00 *Is
Tc =	20 s	t>> =	0.3 s

Remark:

Station: Sub T81 LV, Cubicle: F3-M11803, No. 24

Feeder to: M11803
Current transformer: 1/1
Device: Telemec GV2-LRD07 (Low voltage motor protection (class 10A))

Is = I> =	2 A prim	I>> =	34 A prim
I> =	2.20 A sek	I>> =	33.50 A sek
I> =	2.20 *Inom (1A)	I>> =	33.50 *Inom (1A)
		I>> =	15.23 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Sub T81 LV, Cubicle: F3-M16803, No. 25

Feeder to: M16803
Current transformer: 1/1
Device: Telemec GV2-LRD07 (Low voltage motor protection (class 10A))

Is = I> =	2 A prim	I>> =	34 A prim
I> =	2.20 A sek	I>> =	33.50 A sek
I> =	2.20 *Inom (1A)	I>> =	33.50 *Inom (1A)
		I>> =	15.23 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Sub T81 LV, Cubicle: F3-M24182, No. 26

Feeder to: M24182
Current transformer: 1/1
Device: Telemec GV2-LRD07 (Low voltage motor protection (class 10A))

Is = I> =	2 A prim	I>> =	34 A prim
I> =	2.20 A sek	I>> =	33.50 A sek
I> =	2.20 *Inom (1A)	I>> =	33.50 *Inom (1A)
		I>> =	15.23 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Sub T81 LV, Cubicle: F3-M24282, No. 27

Feeder to: M24282
Current transformer: 1/1
Device: Telemec GV2-LRD07 (Low voltage motor protection (class 10A))

Is = I> =	2 A prim	I>> =	34 A prim
I> =	2.20 A sek	I>> =	33.50 A sek
I> =	2.20 *Inom (1A)	I>> =	33.50 *Inom (1A)
		I>> =	15.23 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Sub T81 LV, Cubicle: F3-M77803, No. 28

Feeder to: M77803
Current transformer: 1/1
Device: Telemec GV2-LRD07 (Low voltage motor protection (class 10A))

Is = I> =	2 A prim	I>> =	34 A prim
I> =	2.20 A sek	I>> =	33.50 A sek
I> =	2.20 *Inom (1A)	I>> =	33.50 *Inom (1A)
		I>> =	15.23 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Sub T81 LV, Cubicle: F3-MG24101, No. 29

Feeder to: MG24101
Current transformer: 630/1
Device: MerlinGerin STR23SE (Low voltage circuit breaker)

Is = I> =	473 A prim	I>> =	4410 A prim	I>>2 =	6930 A prim
I> =	0.75 A sek	I>> =	7.00 A sek	I>>2 =	11.00 A sek
I> =	0.75 *Inom (1A)	I>> =	7.00 *Inom (1A)	I>>2 =	11.00 *Inom (1A)
		I>> =	9.33 *Is	I>>2 =	14.67 *Is
Tc =	10 s	t>> =	0.05 s	t>>2 =	0.01 s

Remark:

Station: Sub T81 LV, Cubicle: F4-M24163, No. 30

Feeder to: M24163
Current transformer: 1/1
Device: Telemec GV2-LRD14 (Low voltage motor protection (class 10A))

Is = I> =	8 A prim	I>> =	138 A prim
I> =	8.20 A sek	I>> =	138.00 A sek
I> =	8.20 *Inom (1A)	I>> =	138.00 *Inom (1A)
		I>> =	16.83 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Sub T81 LV, Cubicle: F4-M24263, No. 31

Feeder to: M24263
Current transformer: 1/1
Device: Telemec GV2-LRD14 (Low voltage motor protection (class 10A))

Is = I> =	8 A prim	I>> =	138 A prim
I> =	8.20 A sek	I>> =	138.00 A sek
I> =	8.20 *Inom (1A)	I>> =	138.00 *Inom (1A)
		I>> =	16.83 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Sub T81 LV, Cubicle: F4-M77820, No. 32

Feeder to: M77820
Current transformer: 1/1
Device: Telemec GV2-LRD10 (Low voltage motor protection (class 10A))

Is = I> =	6 A prim	I>> =	78 A prim
I> =	6.00 A sek	I>> =	78.00 A sek
I> =	6.00 *Inom (1A)	I>> =	78.00 *Inom (1A)
		I>> =	13.00 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Sub T81 LV, Cubicle: F4-MG24201, No. 33

Feeder to: MG24201
Current transformer: 630/1
Device: MerlinGerin STR23SE (Low voltage circuit breaker)

Is = I> =	473 A prim	I>> =	4410 A prim	I>>2 =	6930 A prim
I> =	0.75 A sek	I>> =	7.00 A sek	I>>2 =	11.00 A sek
I> =	0.75 *Inom (1A)	I>> =	7.00 *Inom (1A)	I>>2 =	11.00 *Inom (1A)
		I>> =	9.33 *Is	I>>2 =	14.67 *Is
Tc =	10 s	t>> =	0.05 s	t>>2 =	0.01 s

Remark:

Station: Sub T81 LV, Cubicle: F5-M11820, No. 34

Feeder to: M11820
Current transformer: 1/1
Device: Telemec GV2-LRD3355 (Low voltage motor protection (class 10A))

Is = I> =	35 A prim	I>> =	416 A prim
I> =	35.00 A sek	I>> =	416.00 A sek
I> =	35.00 *Inom (1A)	I>> =	416.00 *Inom (1A)
		I>> =	11.89 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Sub T81 LV, Cubicle: F5-M16820, No. 35

Feeder to: M16820
Current transformer: 1/1
Device: Telemec GV2-LRD3355 (Low voltage motor protection (class 10A))

Is = I> =	35 A prim	I>> =	416 A prim
I> =	35.00 A sek	I>> =	416.00 A sek
I> =	35.00 *Inom (1A)	I>> =	416.00 *Inom (1A)
		I>> =	11.89 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Sub T81 LV, Cubicle: F5-M40100, No. 36

Feeder to: M40100
Current transformer: 1/1
Device: Telemec GV2-LRD22 (Low voltage motor protection (class 10A))

Is = I> =	20 A prim	I>> =	327 A prim
I> =	20.00 A sek	I>> =	327.00 A sek
I> =	20.00 *Inom (1A)	I>> =	327.00 *Inom (1A)
		I>> =	16.35 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Sub T81 LV, Cubicle: F6-M71100, No. 37

Feeder to: M71100
Current transformer: 1/1
Device: Telemec GV2-LRD21 (Low voltage motor protection (class 10A))

Is = I> =	14 A prim	I>> =	223 A prim
I> =	13.80 A sek	I>> =	223.00 A sek
I> =	13.80 *Inom (1A)	I>> =	223.00 *Inom (1A)
		I>> =	16.16 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Sub T81 LV, Cubicle: F6-M71200, No. 38

Feeder to: M71200
Current transformer: 1/1
Device: Telemec GV2-LRD21 (Low voltage motor protection (class 10A))

Is = I> =	14 A prim	I>> =	223 A prim
I> =	13.80 A sek	I>> =	223.00 A sek
I> =	13.80 *Inom (1A)	I>> =	223.00 *Inom (1A)
		I>> =	16.16 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Sub T81 LV, Cubicle: F7-M61100, No. 39

Feeder to: M61100
Current transformer: 150/1
Device: MerlinGerin MA150+GV2-ME5 (Low voltage motor protection (class 10A))

Is = I> =	90 A prim	I>> =	1350 A prim
I> =	0.60 A sek	I>> =	9.00 A sek
I> =	0.60 *Inom (1A)	I>> =	9.00 *Inom (1A)
		I>> =	15.00 *Is
		t>> =	0.01 s

Remark: I>> fixed by circuit-breaker

Station: Sub T81 LV, Cubicle: F8-M61200, No. 40

Feeder to: M61200
Current transformer: 150/1
Device: MerlinGerin MA150+GV2-ME5 (Low voltage motor protection (class 10A))

Is = I> =	90 A prim	I>> =	1350 A prim
I> =	0.60 A sek	I>> =	9.00 A sek
I> =	0.60 *Inom (1A)	I>> =	9.00 *Inom (1A)
		I>> =	15.00 *Is
		t>> =	0.01 s

Remark: I>> fixed by circuit-breaker

Station: Sub T81 LV, Cubicle: F9-M70803, No. 41

Feeder to: M70803
Current transformer: 1/1
Device: Telemec GV2-LRD16 (Low voltage motor protection (class 10A))

Is = I> =	2 A prim	I>> =	34 A prim
I> =	2.20 A sek	I>> =	33.50 A sek
I> =	2.20 *Inom (1A)	I>> =	33.50 *Inom (1A)
		I>> =	15.23 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Sub T81 LV, Cubicle: F9-M70820, No. 42

Feeder to: M70820
Current transformer: 1/1
Device: Telemec GV2-LRD10 (Low voltage motor protection (class 10A))

Is = I> =	6 A prim	I>> =	78 A prim
I> =	6.00 A sek	I>> =	78.00 A sek
I> =	6.00 *Inom (1A)	I>> =	78.00 *Inom (1A)
		I>> =	13.00 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Sub T81 LV, Cubicle: F9-W11706, No. 43

Feeder to: W11706
Current transformer: 1/1
Device: Telemec GV2-LRD16 (Low voltage motor protection (class 10A))

Is = I> =	12 A prim	I>> =	170 A prim
I> =	12.00 A sek	I>> =	170.00 A sek
I> =	12.00 *Inom (1A)	I>> =	170.00 *Inom (1A)
		I>> =	14.17 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Sub T81 LV, Cubicle: F9-W11810, No. 44

Feeder to: W11810
Current transformer: 1/1
Device: Telemec GV2-P32 (Low voltage motor protection (class 10A))

Is = I> =	17 A prim	I>> =	416 A prim
I> =	17.30 A sek	I>> =	416.00 A sek
I> =	17.30 *Inom (1A)	I>> =	416.00 *Inom (1A)
		I>> =	24.05 *Is
		t>> =	0.02 s

Remark:

Station: Sub T81 LV, Cubicle: F9-W16810, No. 45

Feeder to: W16810
Current transformer: 1/1
Device: Telemec GV2-P32 (Low voltage motor protection (class 10A))

Is = I> =	29 A prim	I>> =	416 A prim
I> =	29.00 A sek	I>> =	416.00 A sek
I> =	29.00 *Inom (1A)	I>> =	416.00 *Inom (1A)
		I>> =	14.00 *Is
		t>> =	0.02 s

Remark:

Station: Sub T81 LV, Cubicle: F9-W11707, No. 46

Feeder to: W11707
Current transformer: 1/1
Device: Telemec GV2-LRD16 (Low voltage motor protection (class 10A))

Is = I> =	12 A prim	I>> =	170 A prim
I> =	12.00 A sek	I>> =	170.00 A sek
I> =	12.00 *Inom (1A)	I>> =	170.00 *Inom (1A)
		I>> =	14.17 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Sub T81 LV, Cubicle: F9-W24160, No. 47

Feeder to: W24160
Current transformer: 1/1
Device: (Low voltage circuit breaker)

Is = I> =	4 A prim	I>> =	40 A prim
I> =	4.30 A sek	I>> =	40.00 A sek
I> =	4.30 *Inom (1A)	I>> =	40.00 *Inom (1A)
		I>> =	9.30 *Is

Tc =	10 s	t>> =	0.02 s
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Remark:

Station: Sub T81 LV, Cubicle: F9-W24260, No. 48

Feeder to: W24260
Current transformer: 1/1
Device: (Low voltage circuit breaker)

Is = I> =	4 A prim	I>> =	40 A prim
I> =	4.30 A sek	I>> =	40.00 A sek
I> =	4.30 *Inom (1A)	I>> =	40.00 *Inom (1A)
		I>> =	9.30 *Is

Tc =	10 s	t>> =	0.02 s
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Remark:

Station: Sub T81 LV, Cubicle: F9-W70706, No. 49

Feeder to: W70706
Current transformer: 1/1
Device: Telemec GV2-LRD05 (Low voltage motor protection (class 10A))

Is = I> =	1 A prim	I>> =	40 A prim
I> =	1.00 A sek	I>> =	40.00 A sek
I> =	1.00 *Inom (1A)	I>> =	40.00 *Inom (1A)
		I>> =	40.00 *Is

t>> =	0.02 s
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Remark: I>> fixed by circuit-breaker

Station: Sub T81 LV, Cubicle: F9-W70810, No. 50

Feeder to: W70810
Current transformer: 1/1
Device: Telemec GV2-P32 (Low voltage circuit breaker)

Is = I> =	15 A prim	I>> =	416 A prim
I> =	15.00 A sek	I>> =	416.00 A sek
I> =	15.00 *Inom (1A)	I>> =	416.00 *Inom (1A)
		I>> =	27.73 *Is

Tc =	10 s	t>> =	0.02 s
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Remark:

Station: Sub T81 LV, Cubicle: F9-W77706, No. 51

Feeder to: W77706

Current transformer: 1/1

Device: Telemec GV2-LRD05 (Low voltage motor protection (class 10A))

Is = I> =	1 A prim	I>> =	40 A prim
I> =	1.20 A sek	I>> =	40.00 A sek
I> =	1.20 *Inom (1A)	I>> =	40.00 *Inom (1A)
		I>> =	33.33 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Sub T81 LV, Cubicle: F9-W77810, No. 52

Feeder to: W77810

Current transformer: 1/1

Device: Telemec GV2-P32 (Low voltage circuit breaker)

Is = I> =	15 A prim	I>> =	416 A prim
I> =	15.00 A sek	I>> =	416.00 A sek
I> =	15.00 *Inom (1A)	I>> =	416.00 *Inom (1A)
		I>> =	27.73 *Is
Tc =	10 s	t>> =	0.02 s

Remark:

Station: Sub T81, Cubicle: L01, No. 12

Feeder to: Feeder 1 to T80

Current transformer: 2500/1

Device: P130C (therm. Overload)

Is = Ib =	2500 A prim	I>> =	6250 A prim
Ib =	1.00 A sek	I>> =	2.50 A sek
Ib =	1.00 *Inom (1A)	I>> =	2.50 *Inom (1A)
		I>> =	2.50 *Is
tau =	10 min	t>> =	0.3 s

Remark:

Station: Sub T81, Cubicle: L02, No. 13

Feeder to: Transformer T1 2.5 MVA

Current transformer: 250/1

Device: P130C (therm. Overload)

Is = Ib =	230 A prim	I>> =	1000 A prim	I>>2 =	4500 A prim
Ib =	0.92 A sek	I>> =	4.00 A sek	I>>2 =	18.00 A sek
Ib =	0.92 *Inom (1A)	I>> =	4.00 *Inom (1A)	I>>2 =	18.00 *Inom (1A)
		I>> =	4.35 *Is	I>>2 =	19.57 *Is
tau =	40 min	t>> =	0.5 s	t>>2 =	0.05 s

Remark: Inrush blocking

Station: Sub T81, Cubicle: L03, No. 14

Feeder to: GAN
Current transformer: 250/1
Device: P130C (Motorprotection (characteristic: reziprok))

Is = Ib = 190 A prim [49 / 49LR]
Ib = 0.76 A sek
Ib = 0.76 *Inom (1A)
t6Ie = 11.0 s

I>> = 2000 A prim [50]
I>> = 8.00 A sek
I>> = 8.00 *Inom (1A)
I>> = 10.53 *Is
t>> = 0.05 s

I>>> = 284 A prim [50 / Running up time monitoring]
I>>> = 1.14 A sek
t>>> = 20.00 s

I> = 741 A prim [50 for locked rotor protection]
I> = 2.96 A sek
t> = 10.00 s

Remark:

Station: Sub T81, Cubicle: L04, No. 15

Feeder to: GAN
Current transformer: 250/1
Device: P130C (Motorprotection (characteristic: reziprok))

Is = Ib = 190 A prim [49 / 49LR]
Ib = 0.76 A sek
Ib = 0.76 *Inom (1A)

t6Ie = 11.0 s

I>> = 2000 A prim [50]
I>> = 8.00 A sek
I>> = 8.00 *Inom (1A)
I>> = 10.53 *Is
t>> = 0.05 s

I>>> = 284 A prim [50 / Running up time monitoring]
I>>> = 1.14 A sek
t>>> = 20.00 s

I> = 741 A prim [50 for locked rotor protection]
I> = 2.96 A sek
t> = 10.00 s

Remark:

Station: Sub T81, Cubicle: L05, No. 16

Feeder to: Fedder to T46
Current transformer: 2500/1
Device: P130C (definite time)

Is = I> = 3000 A prim	I>> = 5500 A prim
I> = 1.20 A sek	I>> = 2.20 A sek
I> = 1.20 *Inom (1A)	I>> = 2.20 *Inom (1A)
	I>> = 1.83 *Is
t> = 1.0 s	t>> = 0.3 s

Remark:

Station: Sub T81, Cubicle: L09, No. 17

Feeder to: Feeder 1 to T80
Current transformer: 2500/1
Device: P130C (therm. Overload)

Is = Ib =	2500 A prim	I>> =	6250 A prim
Ib =	1.00 A sek	I>> =	2.50 A sek
Ib =	1.00 *Inom (1A)	I>> =	2.50 *Inom (1A)
		I>> =	2.50 *Is
tau =	10 min	t>> =	0.3 s

Remark:

Station: Tank Farm LV LV, Cubicle: F1-Q1, No. 53

Feeder to: Main Distribution
Current transformer: 800/5
Device: MerlinGerin 5A (Low voltage circuit breaker)

Is = I> =	800 A prim	I>> =	4800 A prim
I> =	5.00 A sek	I>> =	30.00 A sek
I> =	1.00 *Inom (5A)	I>> =	6.00 *Inom (5A)
		I>> =	6.00 *Is
Tc =	20 s	t>> =	0.3 s

Remark:

Station: Tank Farm LV, Cubicle: F1-Q3, No. 54

Feeder to: Feeder 2 400A
Current transformer: 400/1
Device: MerlinGerin STR23SE (Low voltage circuit breaker)

Is = I> =	400 A prim	I>> =	4000 A prim
I> =	1.00 A sek	I>> =	10.00 A sek
I> =	1.00 *Inom (1A)	I>> =	10.00 *Inom (1A)
		I>> =	10.00 *Is
Tc =	20 s	t>> =	0.3 s

Remark:

Station: Tank Farm LV, Cubicle: F2-M44001, No. 55

Feeder to: M44001
Current transformer: 1/1
Device: (Low voltage motor protection (class 10A))

Is = I> =	22 A prim	I>> =	80 A prim
I> =	22.00 A sek	I>> =	80.00 A sek
I> =	22.00 *Inom (1A)	I>> =	80.00 *Inom (1A)
		I>> =	3.64 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Tank Farm LV, Cubicle: F2-M48001, No. 56

Feeder to: M48001
Current transformer: 1/1
Device: (Low voltage motor protection (class 10A))

Is = I> =	65 A prim	I>> =	400 A prim
I> =	65.00 A sek	I>> =	400.00 A sek
I> =	65.00 *Inom (1A)	I>> =	400.00 *Inom (1A)
		I>> =	6.15 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Tank Farm LV, Cubicle: F2-M63001, No. 57

Feeder to: M63001
Current transformer: 1/1
Device: (Low voltage motor protection (class 10A))

Is = I> =	6 A prim	I>> =	40 A prim
I> =	6.00 A sek	I>> =	40.00 A sek
I> =	6.00 *Inom (1A)	I>> =	40.00 *Inom (1A)
		I>> =	6.67 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Tank Farm LV, Cubicle: F2-M64201, No. 60

Feeder to: M64201
Current transformer: 100/1
Device: Gerin MA150 (Low voltage circuit breaker)

Is = I> =	91 A prim	I>> =	900 A prim
I> =	0.91 A sek	I>> =	9.00 A sek
I> =	0.91 *Inom (1A)	I>> =	9.00 *Inom (1A)
		I>> =	9.89 *Is
Tc =	20 s	t>> =	0.02 s

Remark:

Station: Tank Farm LV, Cubicle: F2-M72001, No. 61

Feeder to: M72001
Current transformer: 1/1
Device: Telemec GV2-LRD3353 (Low voltage motor protection (class 10A))

Is = I> =	27 A prim	I>> =	416 A prim
I> =	27.10 A sek	I>> =	416.00 A sek
I> =	27.10 *Inom (1A)	I>> =	416.00 *Inom (1A)
		I>> =	15.35 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Tank Farm LV, Cubicle: F2-M74101, No. 62

Feeder to: M74101
Current transformer: 1/1
Device: NS80MA80-LRD3359 (Low voltage motor protection (class 10A))

Is = I> =	38 A prim	I>> =	480 A prim
I> =	38.00 A sek	I>> =	480.00 A sek
I> =	38.00 *Inom (1A)	I>> =	480.00 *Inom (1A)
		I>> =	12.63 *Is
		t>> =	0.01 s

Remark:

Station: Tank Farm LV, Cubicle: F2-M74201, No. 63

Feeder to: M74201
Current transformer: 1/1
Device: NS80MA80-LRD3359 (Low voltage motor protection (class 10A))

Is = I> =	38 A prim	I>> =	480 A prim
I> =	38.00 A sek	I>> =	480.00 A sek
I> =	38.00 *Inom (1A)	I>> =	480.00 *Inom (1A)
		I>> =	12.63 *Is
		t>> =	0.01 s

Remark:

Station: Tank Farm LV, Cubicle: F2-W73101, No. 64

Feeder to: W73101
Current transformer: 1/1
Device: (Low voltage circuit breaker)

Is = I> =	26 A prim	I>> =	400 A prim
I> =	26.00 A sek	I>> =	400.00 A sek
I> =	26.00 *Inom (1A)	I>> =	400.00 *Inom (1A)
		I>> =	15.38 *Is
Tc =	10 s	t>> =	0.02 s

Remark:

Station: Tank Farm LV, Cubicle: F2M62001, No. 58

Feeder to: M62001
Current transformer: 1/1
Device: Telemec GV2-LRD3353 (Low voltage motor protection (class 10A))

Is = I> =	27 A prim	I>> =	416 A prim
I> =	27.10 A sek	I>> =	416.00 A sek
I> =	27.10 *Inom (1A)	I>> =	416.00 *Inom (1A)
		I>> =	15.35 *Is
		t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Tank Farm LV, Cubicle: F2M64101, No. 59

Feeder to: M64101
Current transformer: 100/1
Device: MerlinGerin MA150 (Low voltage circuit breaker)

Is = I> =	91 A prim	I>> =	900 A prim
I> =	0.91 A sek	I>> =	9.00 A sek
I> =	0.91 *Inom (1A)	I>> =	9.00 *Inom (1A)
		I>> =	9.89 *Is
Tc =	20 s	t>> =	0.02 s

Remark:

Station: Tank Farm LV, Cubicle: F3-M73101, No. 65

Feeder to: M73101
Current transformer: 1/1
Device: MerlinGerin TM 40D (Low voltage circuit breaker)

Is = I> =	32 A prim	I>> =	480 A prim
I> =	32.20 A sek	I>> =	480.00 A sek
I> =	32.20 *Inom (1A)	I>> =	480.00 *Inom (1A)
		I>> =	14.91 *Is
Tc =	10 s	t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Tank Farm LV, Cubicle: F4-M73201, No. 66

Feeder to: M73201
Current transformer: 1/1
Device: MerlinGerin TM 40D (Low voltage circuit breaker)

Is = I> =	32 A prim	I>> =	480 A prim
I> =	32.20 A sek	I>> =	480.00 A sek
I> =	32.20 *Inom (1A)	I>> =	480.00 *Inom (1A)
		I>> =	14.91 *Is
Tc =	10 s	t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Station: Tank Farm LV, Cubicle: F5-M44001, No. 67

Feeder to: M44001
Current transformer: 1/1
Device: (Low voltage circuit breaker)

Is = I> =	32 A prim	I>> =	480 A prim
I> =	32.20 A sek	I>> =	480.00 A sek
I> =	32.20 *Inom (1A)	I>> =	480.00 *Inom (1A)
		I>> =	14.91 *Is
Tc =	10 s	t>> =	0.02 s

Remark: I>> fixed by circuit-breaker

Additional Settings for motor feeders P130C:

Settings for substation T80, Cubicle L02 (starting transformer, MAC):

Motor Protection	Enabled	
Starting	$K \cdot I_{ref}$	$1.1 I_b$ [49 / 49 LR]
Startup	I_{stUp}	$1.5 I_b$ [49 / 49 LR]
Mapping of heat transfer	Tau after st.-up	60 s *) [49 / 49 LR]
Mapping of cooling	Tau mach. running	50 min [49 / 49 LR]
	Tau mach. stopped	3 hours [49 / 49 LR]
Start-ups	Perm. No.st.-ups	2cold, 1warm [48 / 66]
Unbalance protection	Enabled	[46]
Starting current	I_{neg}	$0,1 I_{nom}$
Time delay	T_{ineg}	20 s
Under voltage protection	Enabled	[27]
Operation mode	delta	
Starting	$U_{<}$	$0,80 U_{nom}$
Time delay	$t_{U<}$	10 s
Starting	$U_{<<}$	$0,70 U_{nom}$
Time delay	$t_{U<<}$	1 s

*) Values are unknown and are approximated, they need to be corrected with the actual data from the motor manufacturer

Thermal overload protection Motorprotection (characteristic: reziprok))

$$\begin{aligned}
 I_s &= I_b = 925 \text{ A prim} & [49 / 49LR] \\
 I_b &= 0.74 \cdot I_{nom} \text{ (1A)} \\
 t_{6Ie} &= 11.0 \text{ s}
 \end{aligned}$$

Settings for substation T80, Cubicle L04 (MAC):

Motor Protection	Enabled	
Starting	$K \cdot I_{ref} >$	$1.1 I_b$ [49 / 49 LR]
Startup	$I_{stUp} >$	$2.0 I_b$ [49 / 49 LR]
Mapping of heat transfer	Tau after st.-up	$60 \text{ s } ^*)$ [49 / 49 LR]
Mapping of cooling	Tau mach. running	50 min [49 / 49 LR]
	Tau mach. stopped	3 hours [49 / 49 LR]
Start-ups	Perm. No.st.-ups	2cold, 1warm [48 / 66]
Unbalance protection	Enabled	[46]
Starting current	$I_{neg} >$	$0,1 I_{nom}$
Time delay	T_{ineg}	20 s
Under voltage protection	Enabled	[27]
Operation mode	Delta	
Starting	$U <$	$0,80 U_{nom}$
Time delay	$tU <$	10 s
Starting	$U <<$	$0,70 U_{nom}$
Time delay	$tU <<$	1 s

*) Values are unknown and are approximated, they need to be corrected with the actual data from the motor manufacturer

Thermal Overload Protection (Motorprotection (characteristic: reziprok))

$$\begin{aligned}
 I_s &= I_b = 930 \text{ A prim} & [49 / 49LR] \\
 I_b &= 0.93 \cdot I_{nom} (1A) \\
 t_{6Ie} &= 11.0 \text{ s}
 \end{aligned}$$

$$I_{>>>} = 1394 \text{ A prim} \quad [50 / \text{Running up time monitoring}]$$

Table 3: Additional settings for motor feeders
Page 2

I>>> = 1.40 A sek
t>>> = 40.00 s

I> = 2787 A prim [50 for locked rotor protection]
I> = 2.79 A sek
t> = 36.00 s

Settings for substation T80, Cubicle L03 (BAC):

Motor Protection	Enabled	
Starting	$K \cdot I_{ref}$	1.1 I_b [49 / 49 LR]
Startup	I_{stUp}	2.0 I_b [49 / 49 LR]
Mapping of heat transfer	Tau after st.-up	60 s [49 / 49 LR]
Mapping of cooling	Tau mach. running	50 min [49 / 49 LR]
	Tau mach. stopped	3 hours [49 / 49 LR]
Start-ups	Perm. No.st.-ups	3cold, 2warm [48 / 66]
Unbalance protection	Enabled	[46]
Starting current	I_{neg}	0,1 I_{nom}
Time delay	T_{ineg}	20 s
Under voltage protection	Enabled	[27]
Operation mode	Delta	
Starting	$U <$	0,80 U_{nom}
Time delay	$tU <$	10 s
Starting	$U <<$	0,70 U_{nom}
Time delay	$tU <<$	1 s

*) Values are unknown and are approximated, they need to be corrected with the actual data from the motor manufacturer

Thermal Overload Protection (Motorprotection (characteristic: reziprok))

$I_s = I_b = 773 \text{ A prim}$ [49 / 49LR]
 $I_b = 1.03 \text{ A sek}$
 $I_b = 1.03 \cdot I_{nom} (1A)$
 $t_{6Ie} = 9.0 \text{ s}$

I>>> = 1155 A prim [50 / Running up time monitoring]
I>>> = 1.54 A sek
t>>> = 25.00 s

I> = 2130 A prim [50 for locked rotor protection]
I> = 2.83 A sek
t> = 17.00 s

Settings for substation T81, Cubicle L03 and L04 (GAN):

Motor Protection	Enabled	
Starting	$K \cdot I_{ref} >$	$1.1 I_b$ [49 / 49 LR]
Startup	$I_{stUp} >$	$2.0 I_b$ [49 / 49 LR]
Mapping of heat transfer	Tau after st.-up	60 s *) [49 / 49 LR]
Mapping of cooling	Tau mach. Running	50 min [49 / 49 LR]
	Tau mach. Stopped	3 hours [49 / 49 LR]
Start-ups	Perm. No.st.-ups	2cold, 1warm [48 / 66]
Unbalance protection	Enabled	[46]
Starting current	$I_{neg} >$	$0,1 I_{nom}$
Time delay	T_{ineg}	20 s
Under voltage protection	Enabled	[27]
Operation mode	delta	
Starting	$U <$	$0,80 U_{nom}$
Time delay	$t_{U <}$	10 s
Starting	$U <<$	$0,70 U_{nom}$
Time delay	$t_{U <<}$	1 s

*) Values are unknown and are approximated, they need to be corrected with the actual data from the motor manufacturer

Thermal Overload Protection (Motorprotection (characteristic: reziprok))

$$\begin{aligned}
 I_s &= I_b = 190 \text{ A prim} & [49 / 49LR] \\
 I_b &= 0.76 \text{ A sek} \\
 I_b &= 0.76 \cdot I_{nom} \text{ (1A)} \\
 t_{6Ie} &= 11.0 \text{ s}
 \end{aligned}$$

$$I_{>>>} = 284 \text{ A prim} \quad [50 / \text{Running up time monitoring}]$$

Table 3: Additional settings for motor feeders

19.04.2006 16:19

I>>> = 1.14 A sek
t>>> = 20.00 s

I> = 741 A prim [50 for locked rotor protection]
I> = 2.96 A sek
t> = 10.00 s

Earth-fault settings for all cubicles with P130C:

[Function 67N / 32 N]

Function	Power	$\cos \varphi$
Displacement voltage	VNE>	$0.3 U_{\text{nom}}$
Timer	tVNE>	1s
Frequency	f/fnom	1
Cable type current transformer		60/1
Starting current	IE,w>	$0.002 I_{E,\text{nom}}$

Differential protection 7SD610:

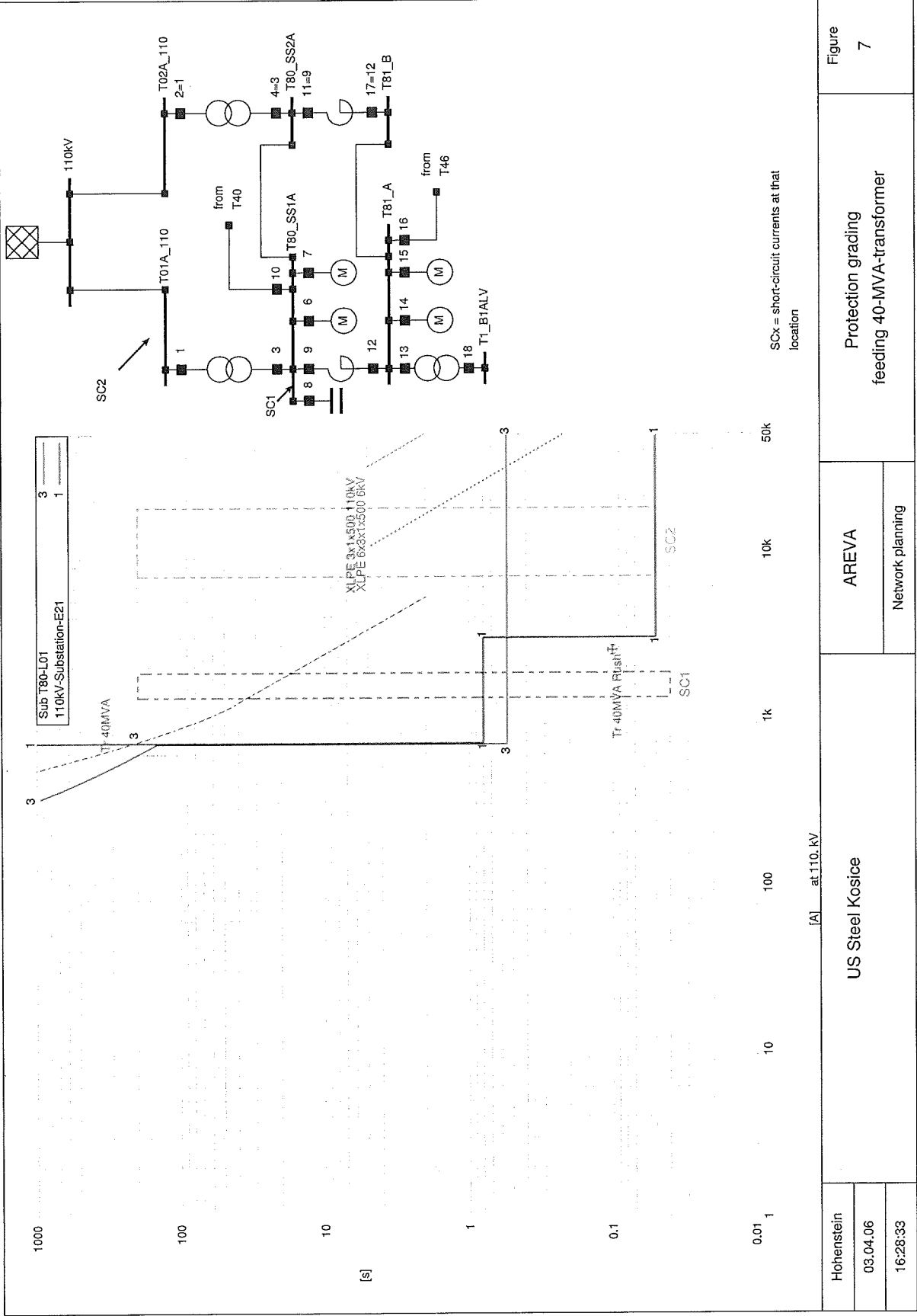
Settings for substation T01, Cubicle E21 and substation T02, cubicle E15:

	Current transformer	200/1
0253	E% ALF / ALF N	10 %
0254	E% K ALF N	20 %
0145	TRANSFORMER	Yes
1106	OPERATION POWER	50 MVA
1161	VECTOR GROUP U	0
1162	VECTOR GROUP I	0
1103	FullScaleVolt.	109,725 kV
1104	FullScaleCurr.	262,4 A
2301	INRUSH REST	On
2305	MAX INRUSH PEAK	15 A
2303	CROSSBLOCKING	Yes
2310	CROSSBLK 2HM	∞
1210	I-Diff>	0,65 A
1213	I-Diff> SWITCH ON	0,65 A
1217	T-DELAY I-Diff	0,00s
1218	T3I0 1Phas	∞
1233	I-Diff>>	10,0 A
1225	I-Diff>> SWITCH ON	10 A
2621	50-B2 delay	0,8 s

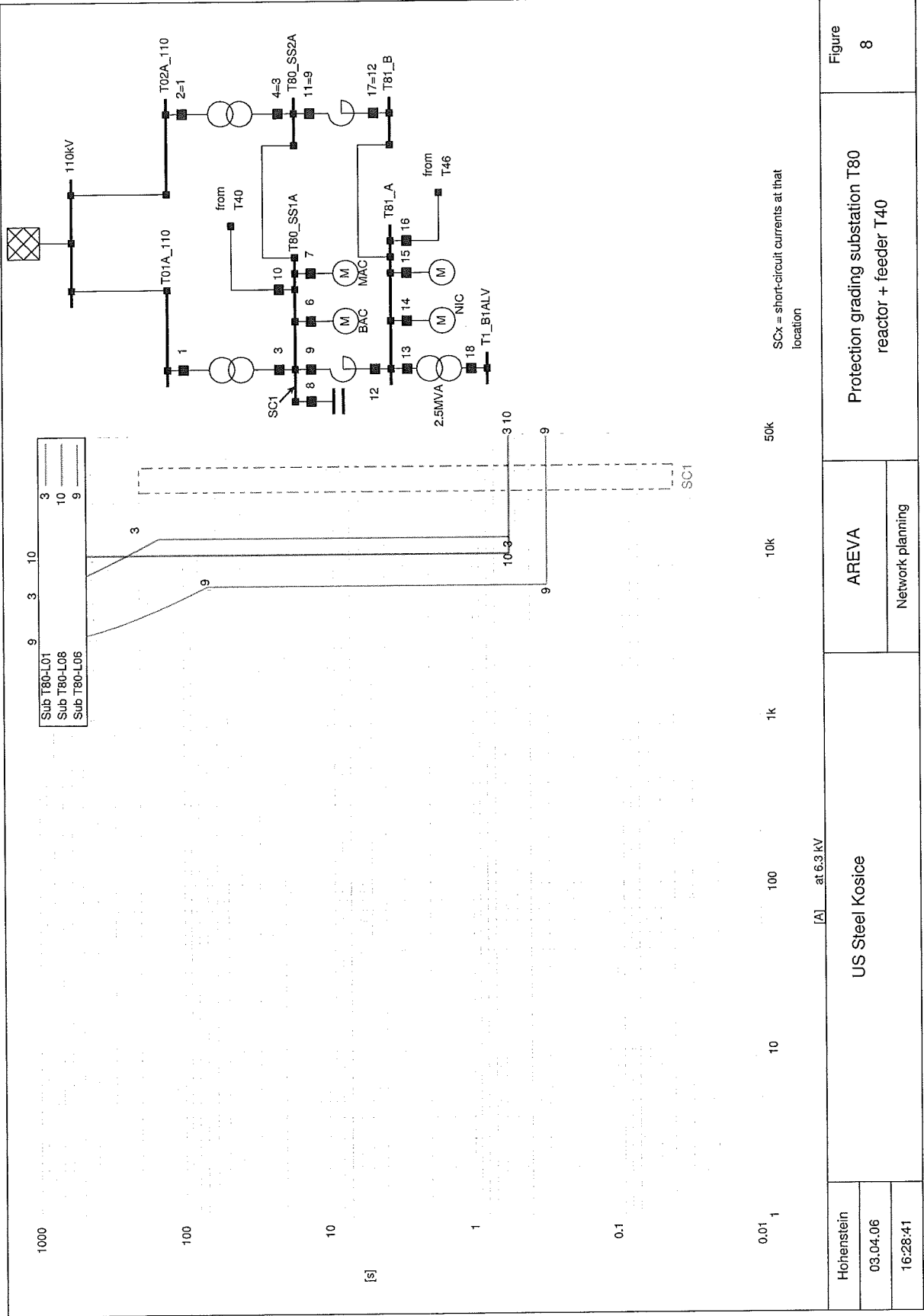
Differential protection 7SD610:

Settings for substation T80, Cubicles L01 and L12:

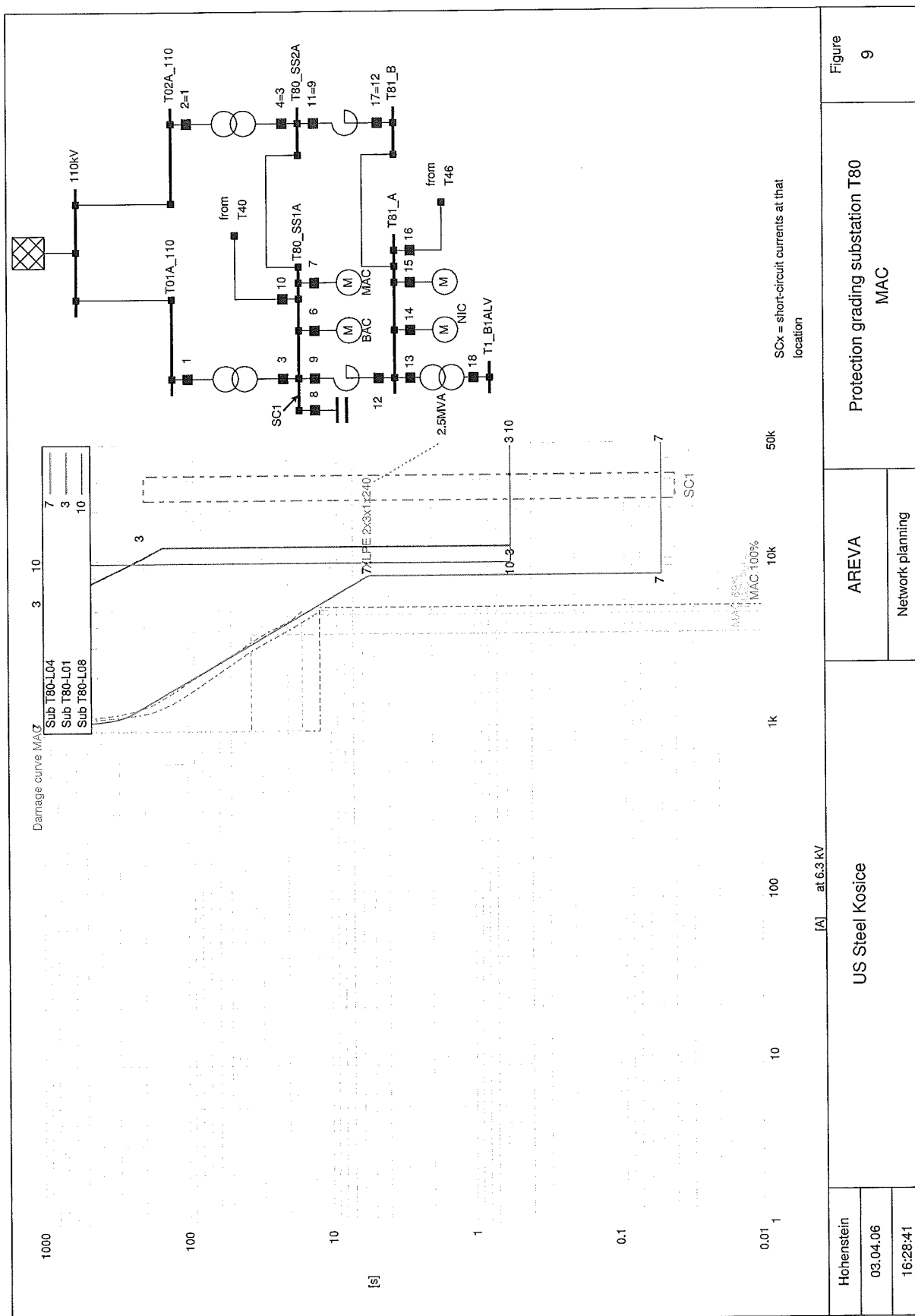
	Current transformer	4000/1
0253	E% ALF / ALF N	5 %
0254	E% K ALF N	15 %
0145	TRANSFORMER	Yes
1106	OPERATION POWER	50 MVA
1161	VECTOR GROUP U	1
1162	VECTOR GROUP I	1
1103	FullScaleVolt.	6,3 kV
1104	FullScaleCurr.	4582,1 A
2301	INRUSH REST	On
2305	MAX INRUSH PEAK	15 A
2303	CROSSBLOCKING	Yes
2310	CROSSBLK 2HM	∞
1210	I-Diff>	0,65 A
1213	I-Diff> SWITCH ON	0,65 A
1217	T-DELAY I-Diff	0,00s
1218	T3I0 1Phas	∞
1233	I-Diff>>	10 A
1225	I-Diff>> SWITCH ON	10 A



Hohenstein 03.04.06 16:28:33	US Steel Kosice		AREVA Network planning	Protection grading feeding 40-MVA-transformer	Figure 7

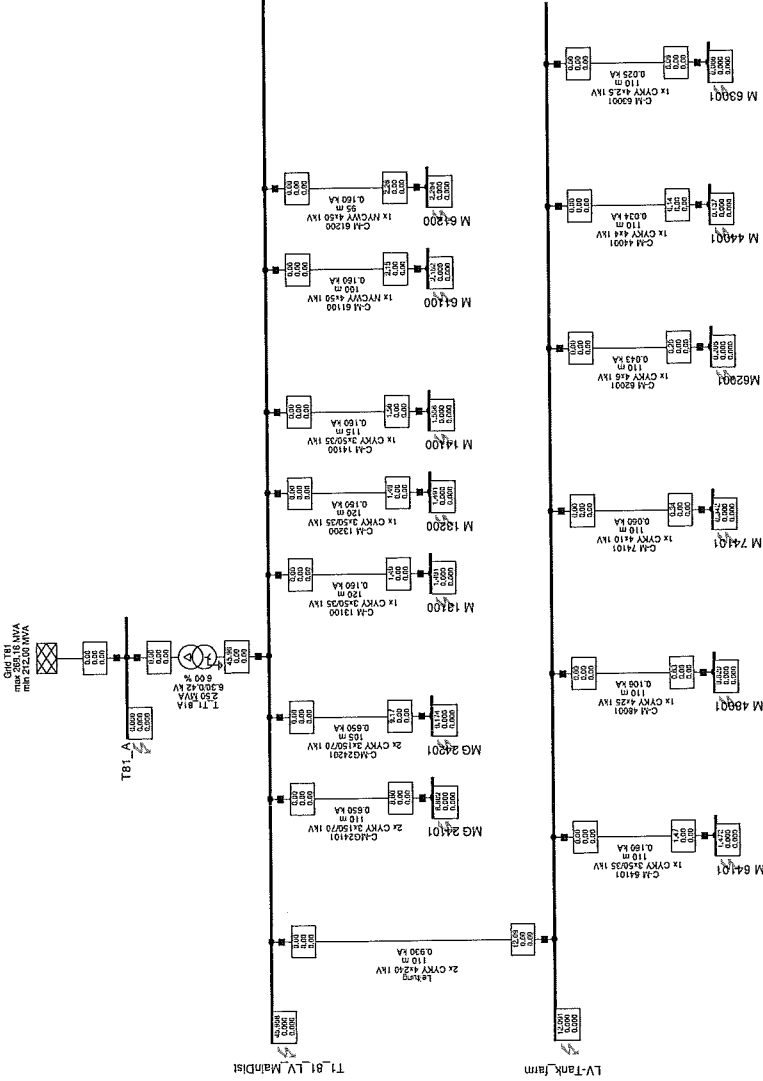


	[A] 310.3 KV	US Steel Kosice	AREVA	Protection grading substation T80 reactor + feeder T40	Figure 8
Hohenstein					
03.04.06					
16:28:41	Network planning				

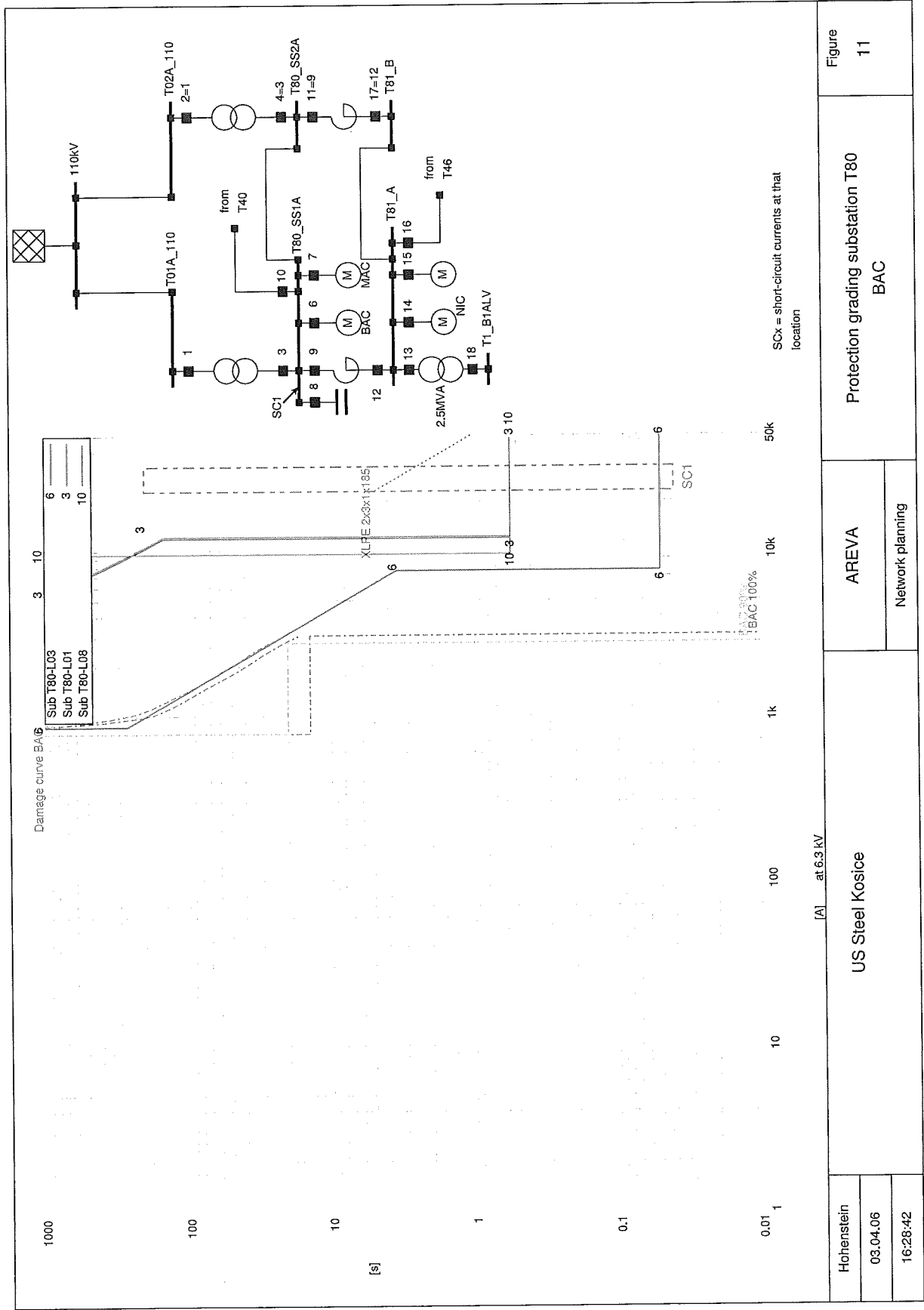


Project: US Steel Graphic: Kosice Date: 4/3/2006 Annex: Figure 37	US Steel Koalce LV feeders	AREVA	PowerFactory 13.2.304

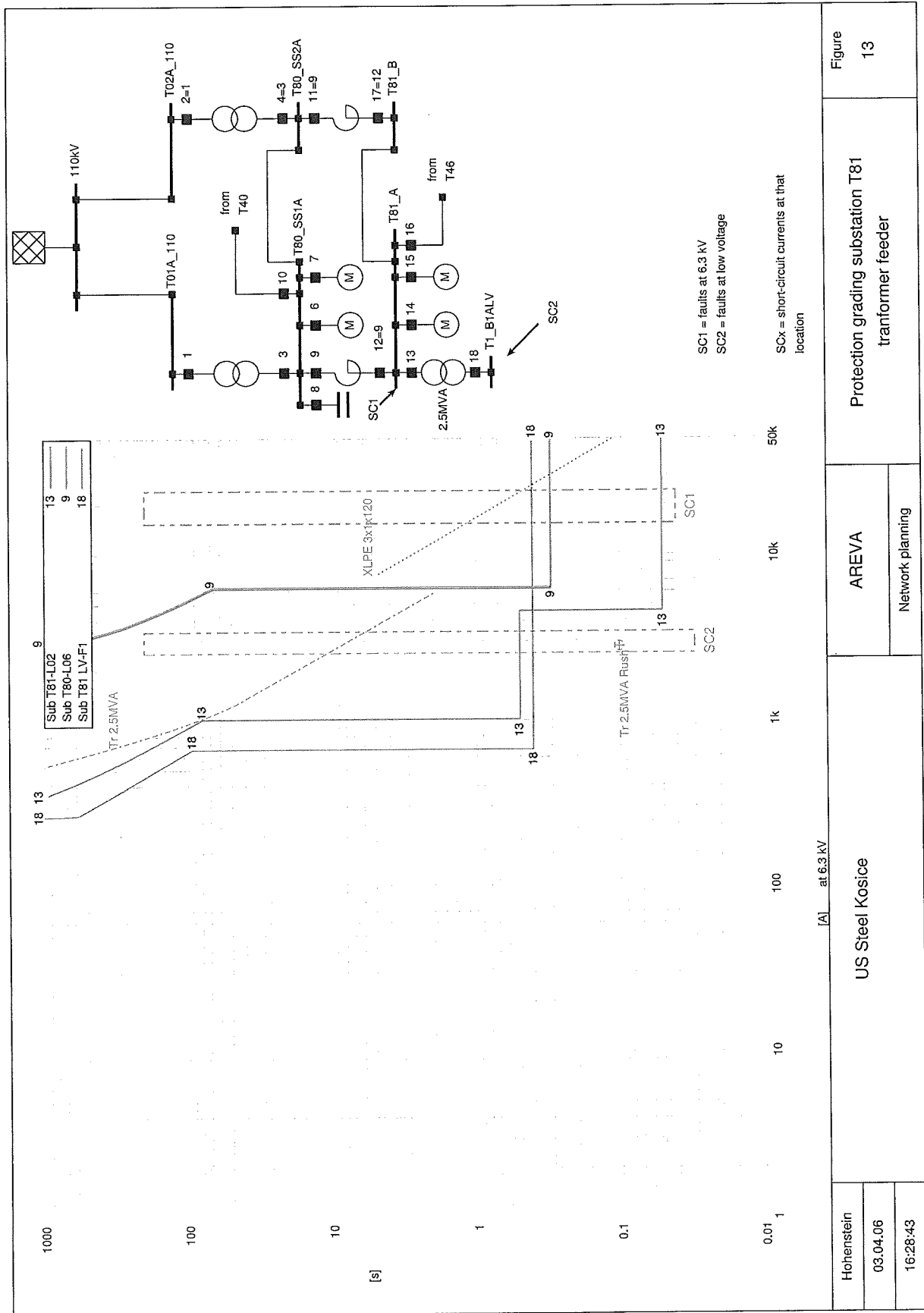
Min. Single Phase to Ground acc. to IEC	Branches
Short Circuit Nodes	
Initial Short-Circuit Current A [kA]	Initial Short-Circuit Current A [kA]
Initial Short-Circuit Current B [kA]	Initial Short-Circuit Current B [kA]
Initial Short-Circuit Current C [kA]	Initial Short-Circuit Current C [kA]

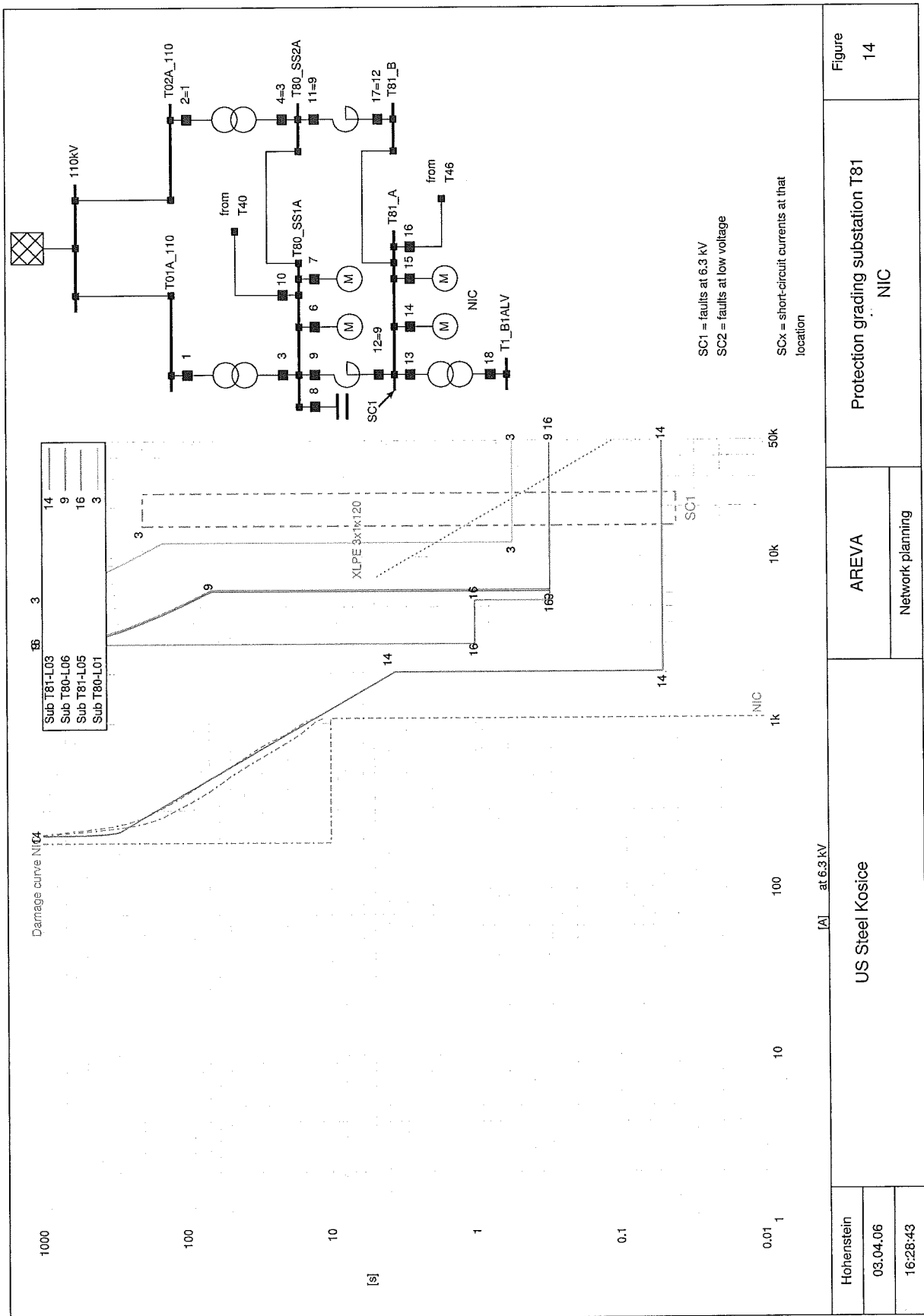


Diagram

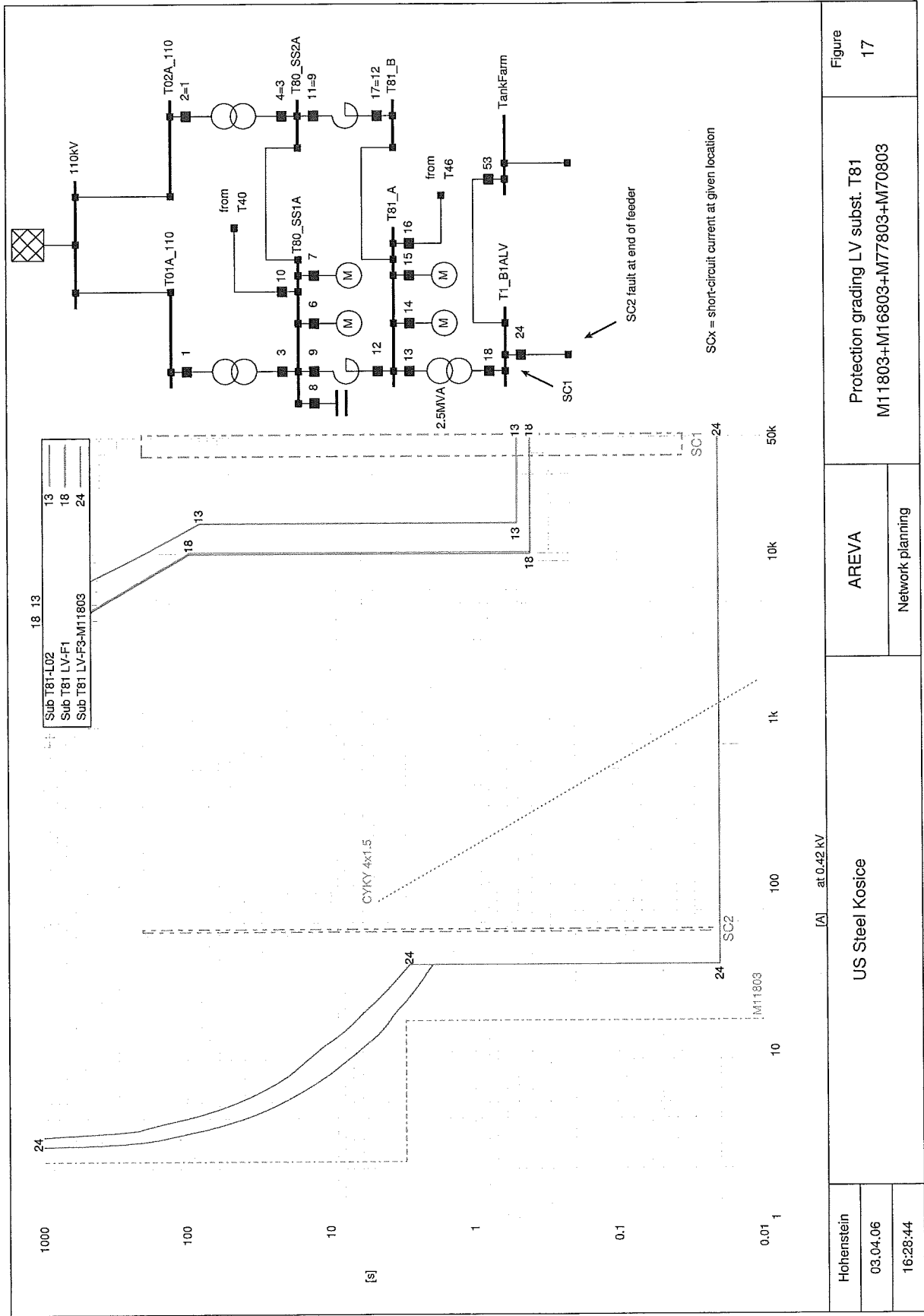


Hohenstein	US Steel Kosice	AREVA	Protection grading substation T80 BAC	Figure 11
03.04.06				
16:28:42		Network planning		

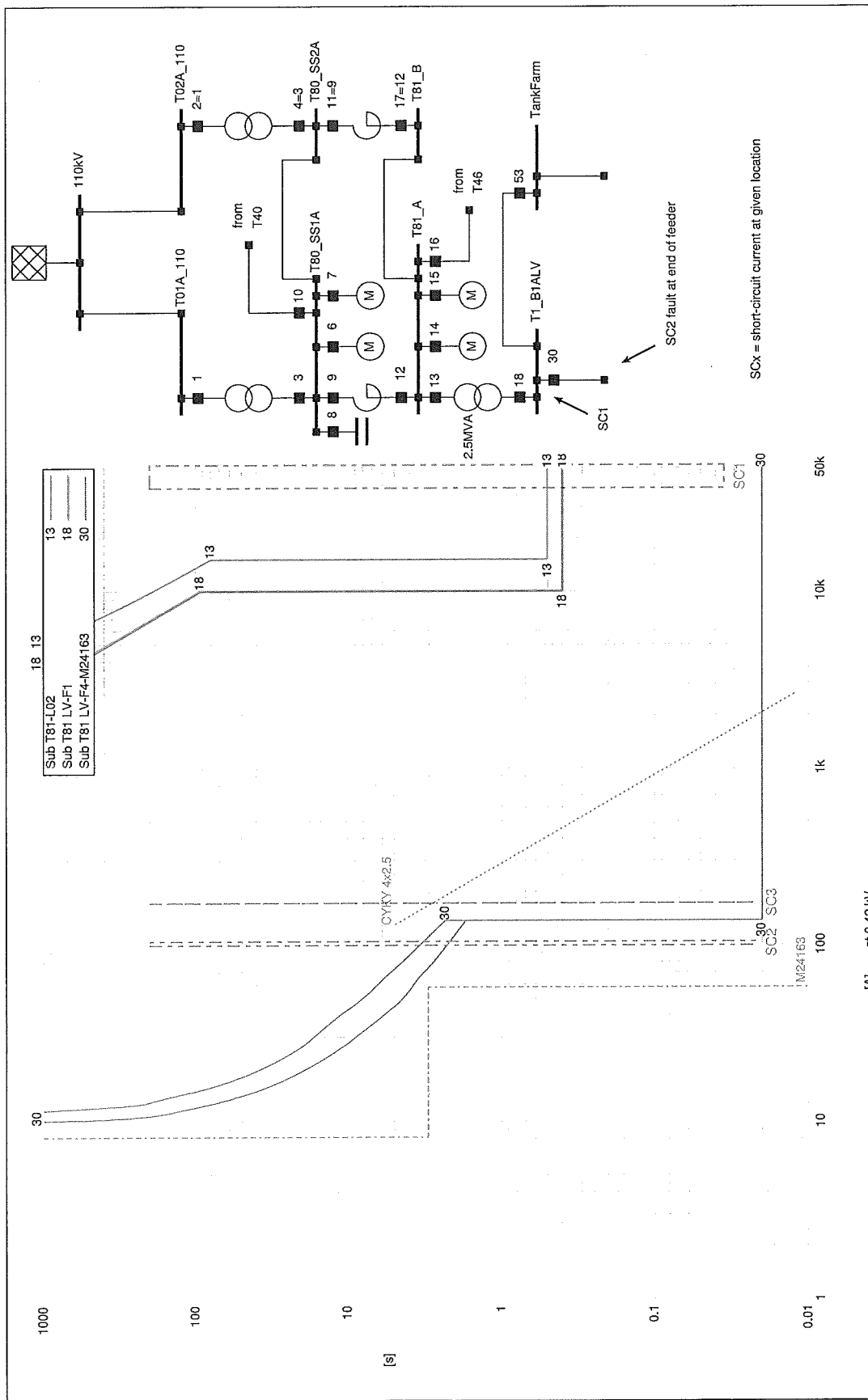




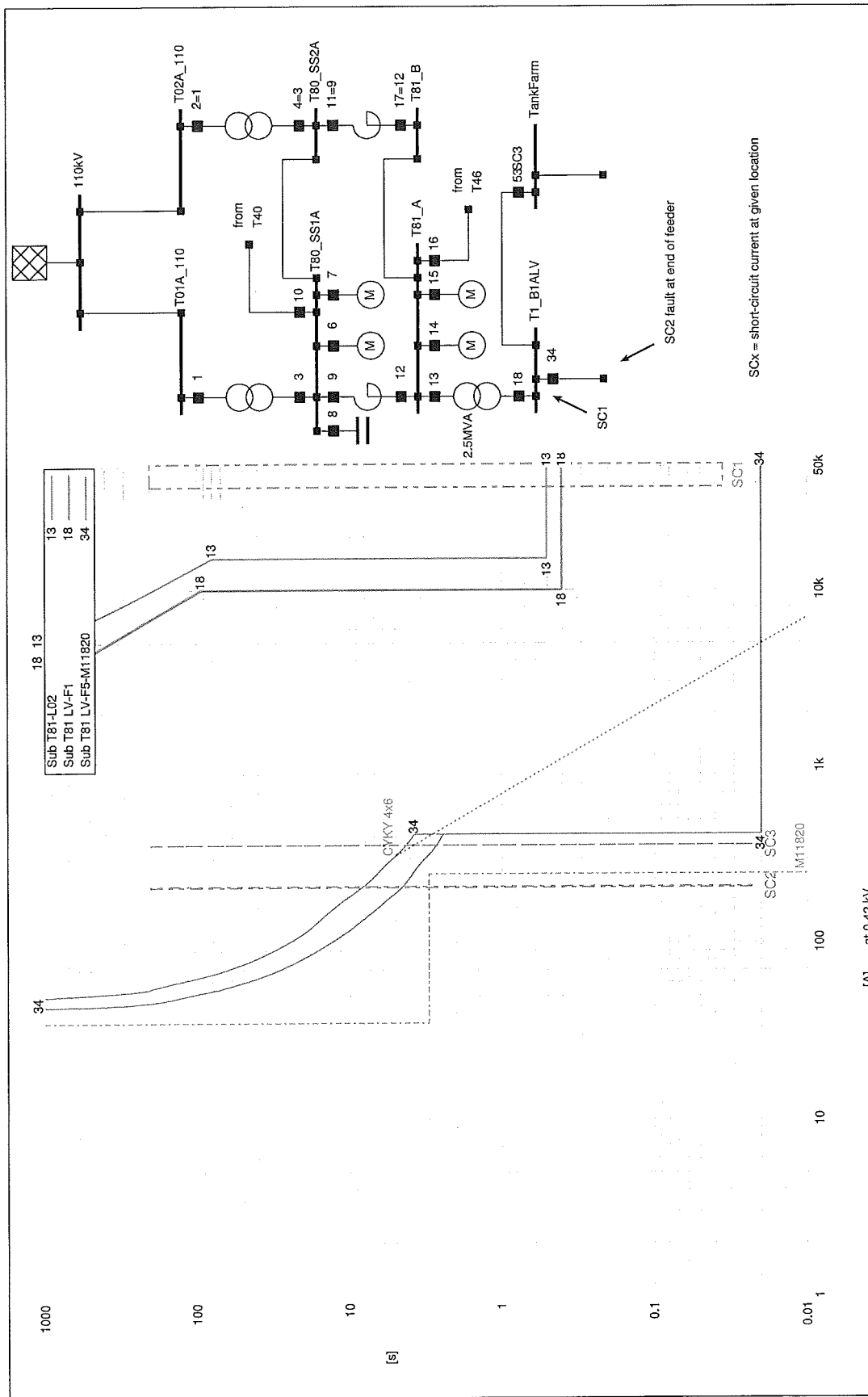
Hohenstein		US Steel Kosice	AREVA	Protection grading substation T81 NIC	Figure 14
03.04.06					
16:28:43					



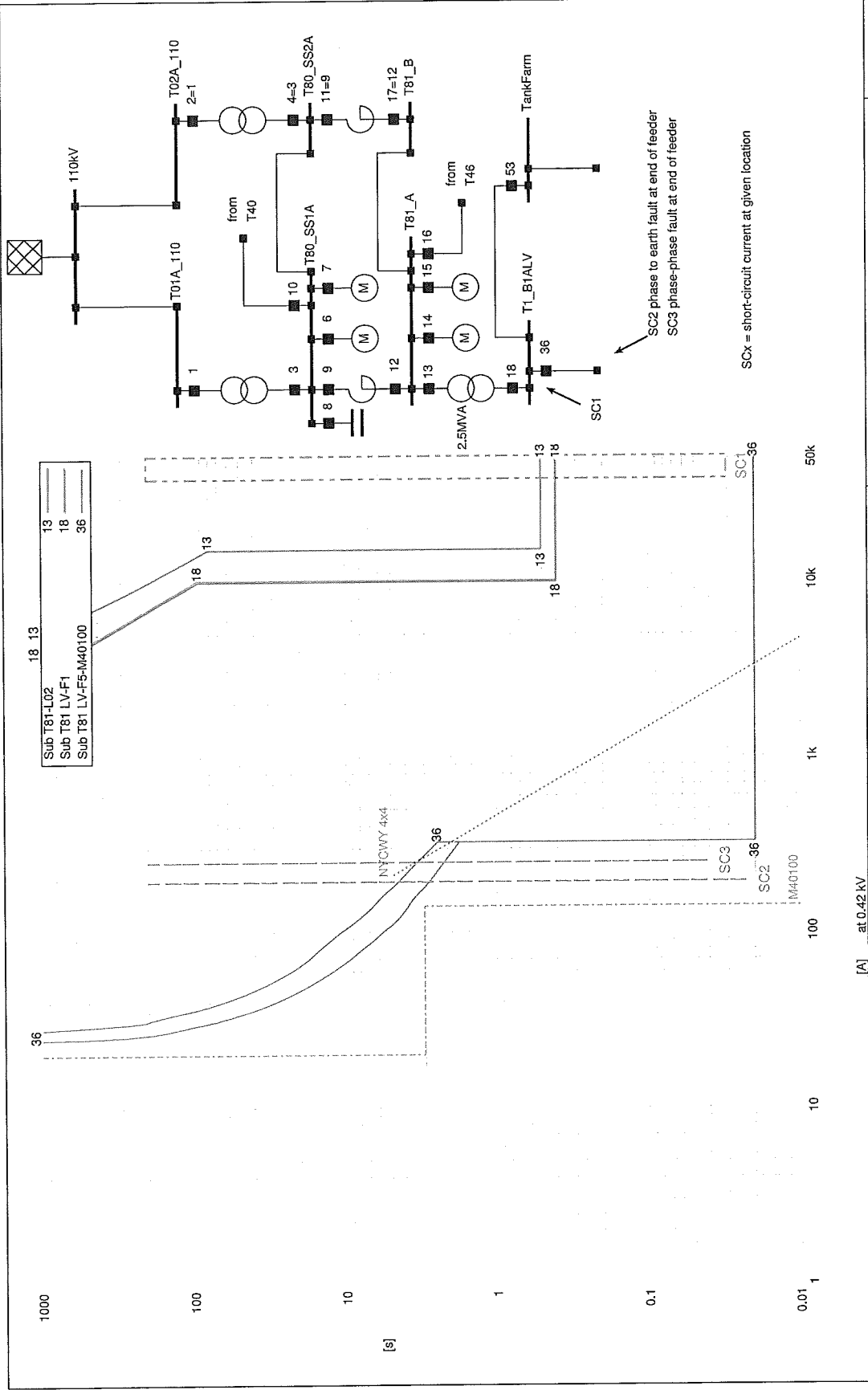
US Steel Kosice		AREVA	Protection grading LV subst. T81 M11803+M16803+M77803+M70803	Figure 17
		Network planning		
Hohenstein				
03.04.06				
16:28:44				



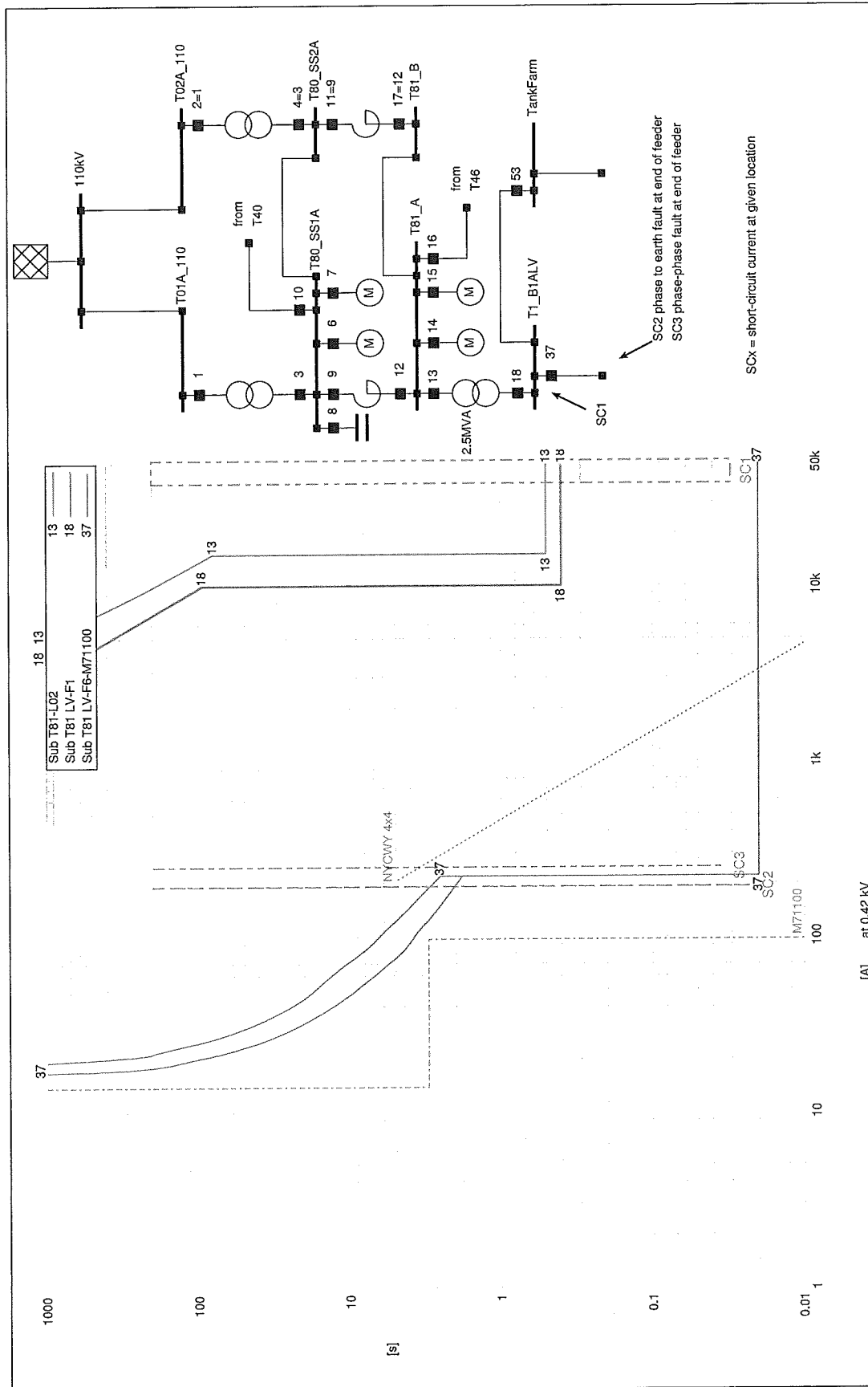
[A] 80.42 KV		US Steel Kosice	AREVA	Protection grading LV subst. T81 M24163+M24263	Figure 19
Hohenstein					
03.04.06					
16:28:45					



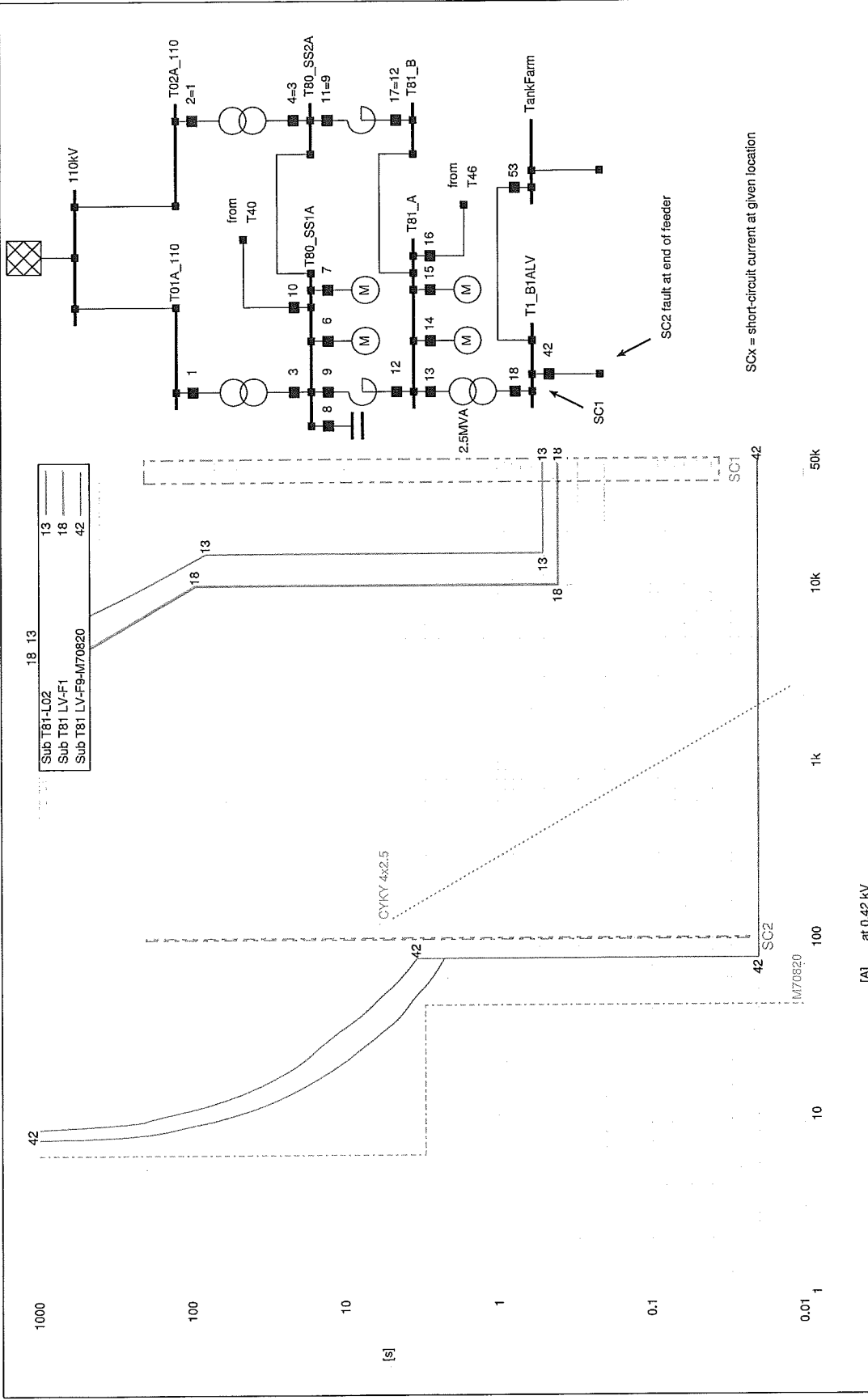
US Steel Kosice		AREVA	Protection grading LV subst. T81 M11820+M16820	Figure 21
Hohenstein				
03.04.06				
16:28:46		Network planning		



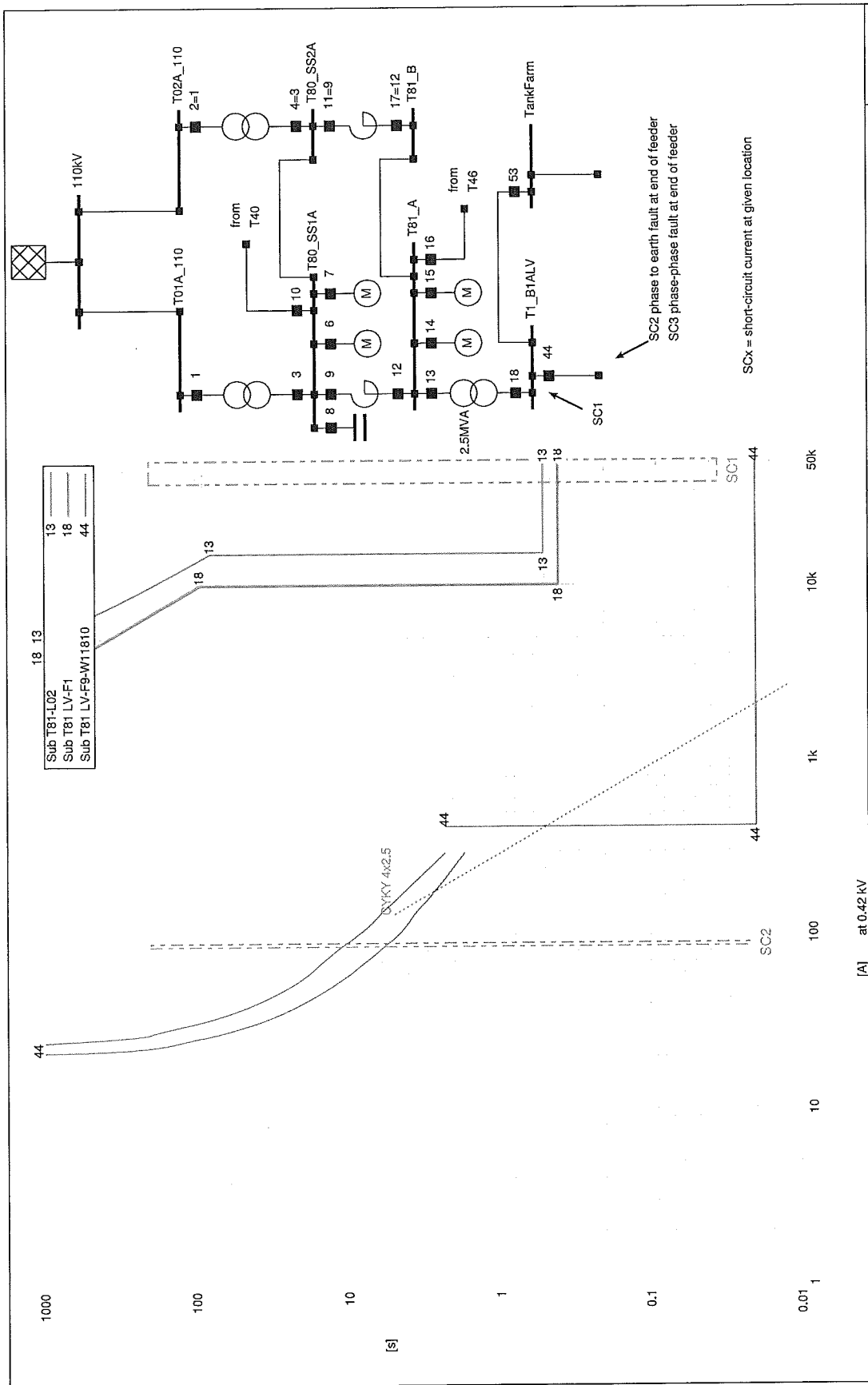
US Steel Kosice		AREVA	Protection grading LV subst. T81 M40100	Figure 22
		Network planning		
Hohenstein				
03.04.06				
16:28:46				



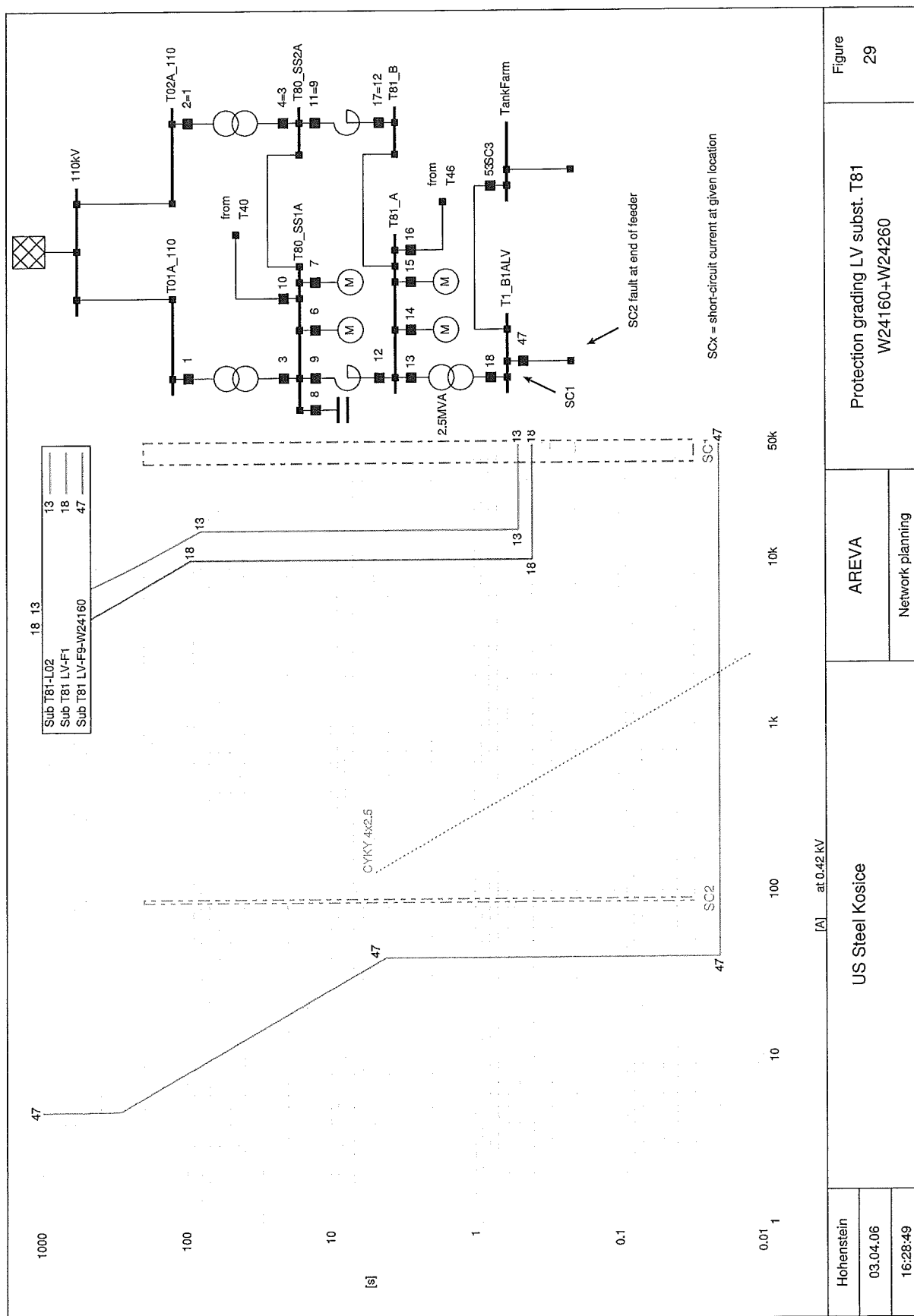
Hohenstein	US Steel Kosice	AREVA	Protection grading LV subst. T81 M71100+M71200	Figure 23
03.04.06				
16:28:47				

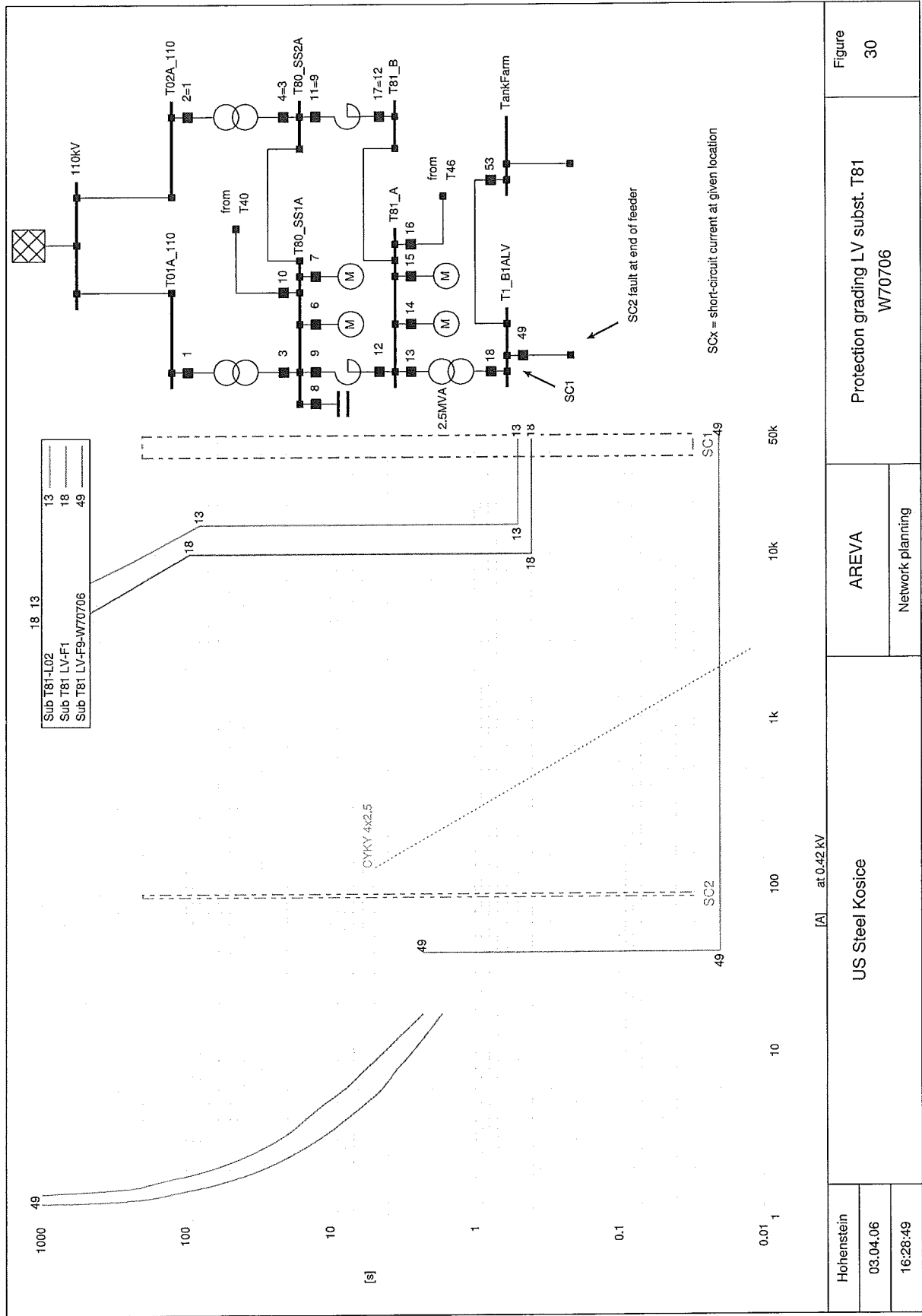


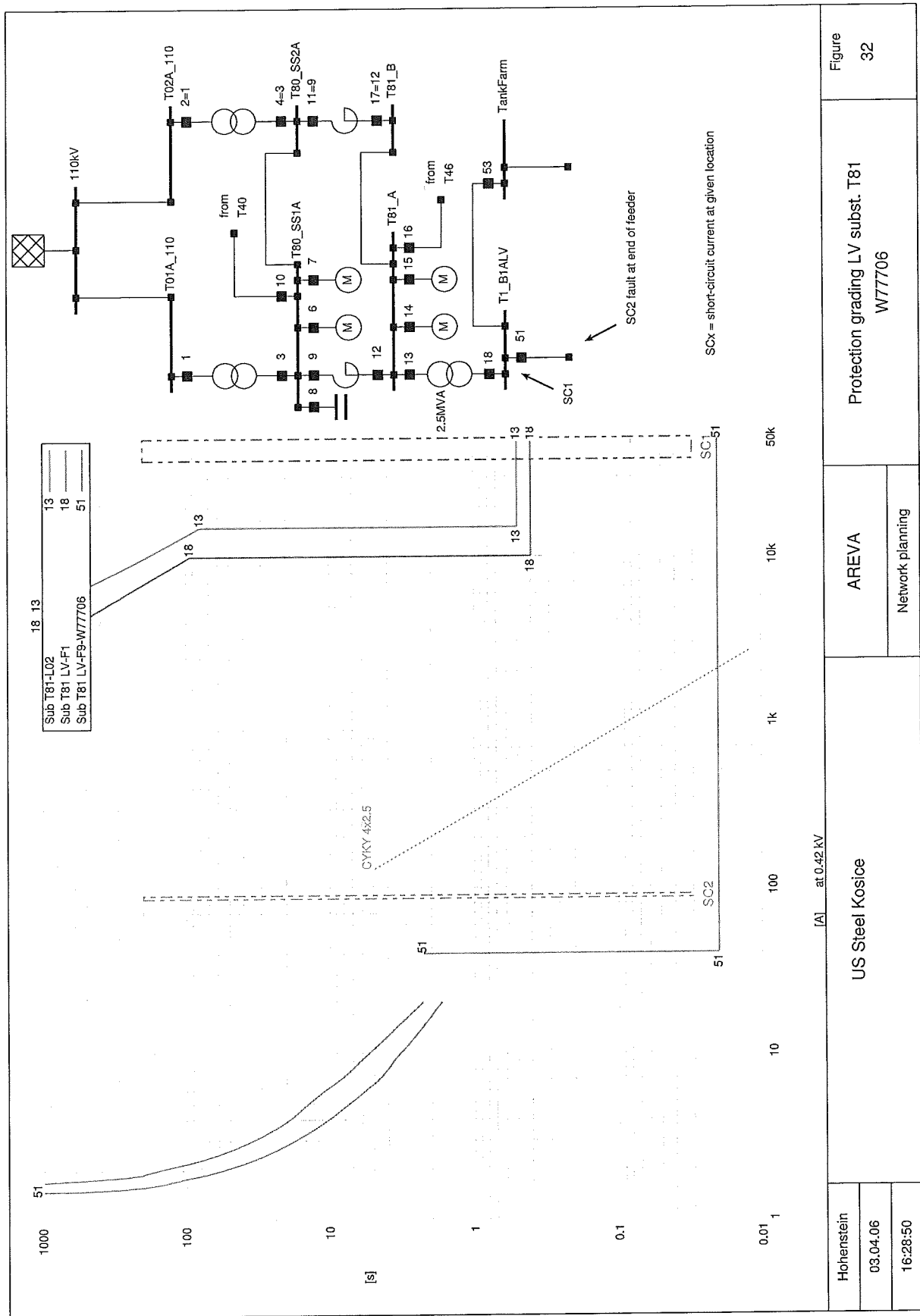
US Steel Kosice		AREVA	Protection grading LV subst. T81 M70820	Figure 25
Hohenstein	03.04.06			
16:28:47		Network planning		

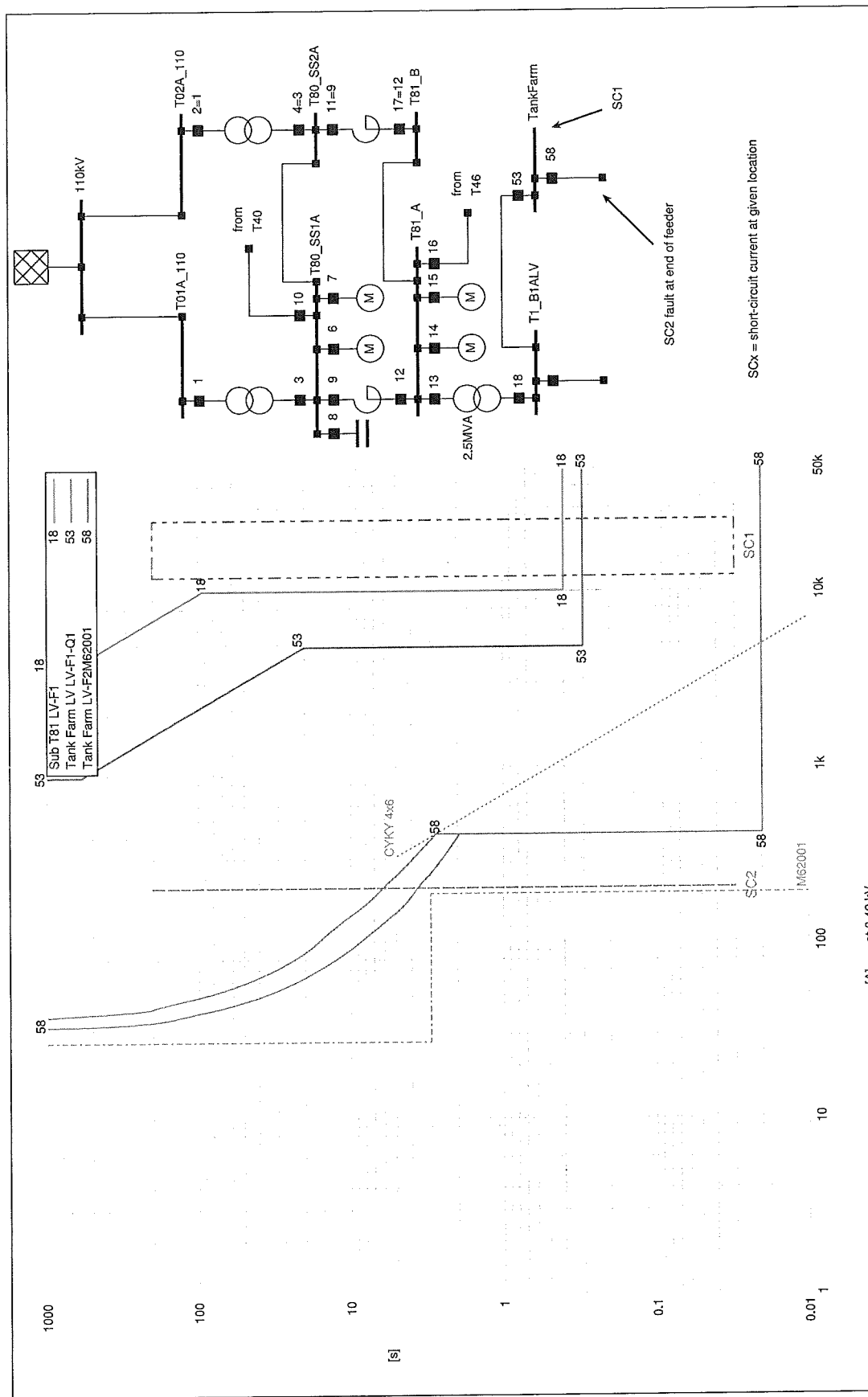


Hohenstein	US Steel Kosice	AREVA	Protection grading LV subst. T81 W11810	Figure 27
03.04.06				
16:28:48				

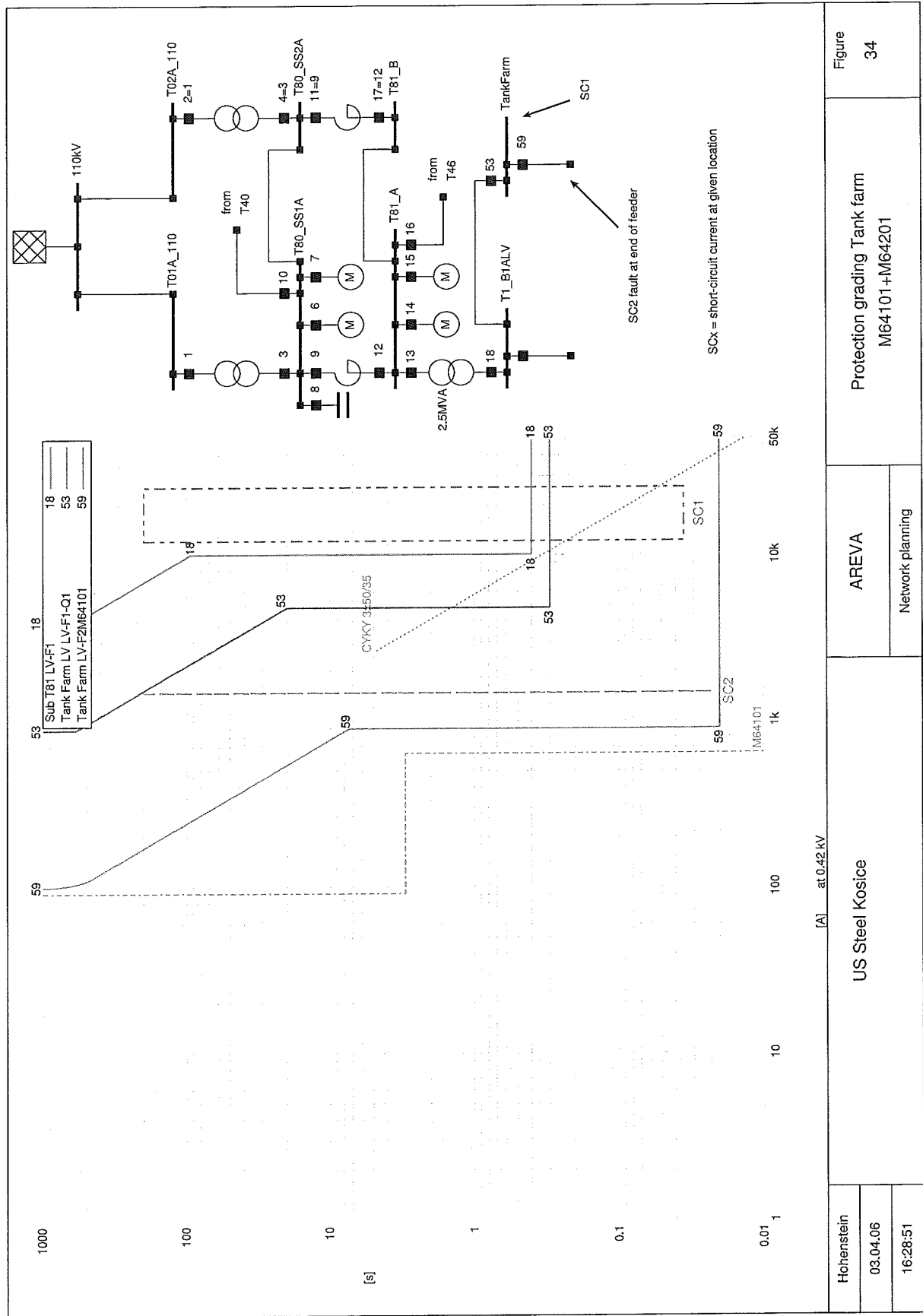


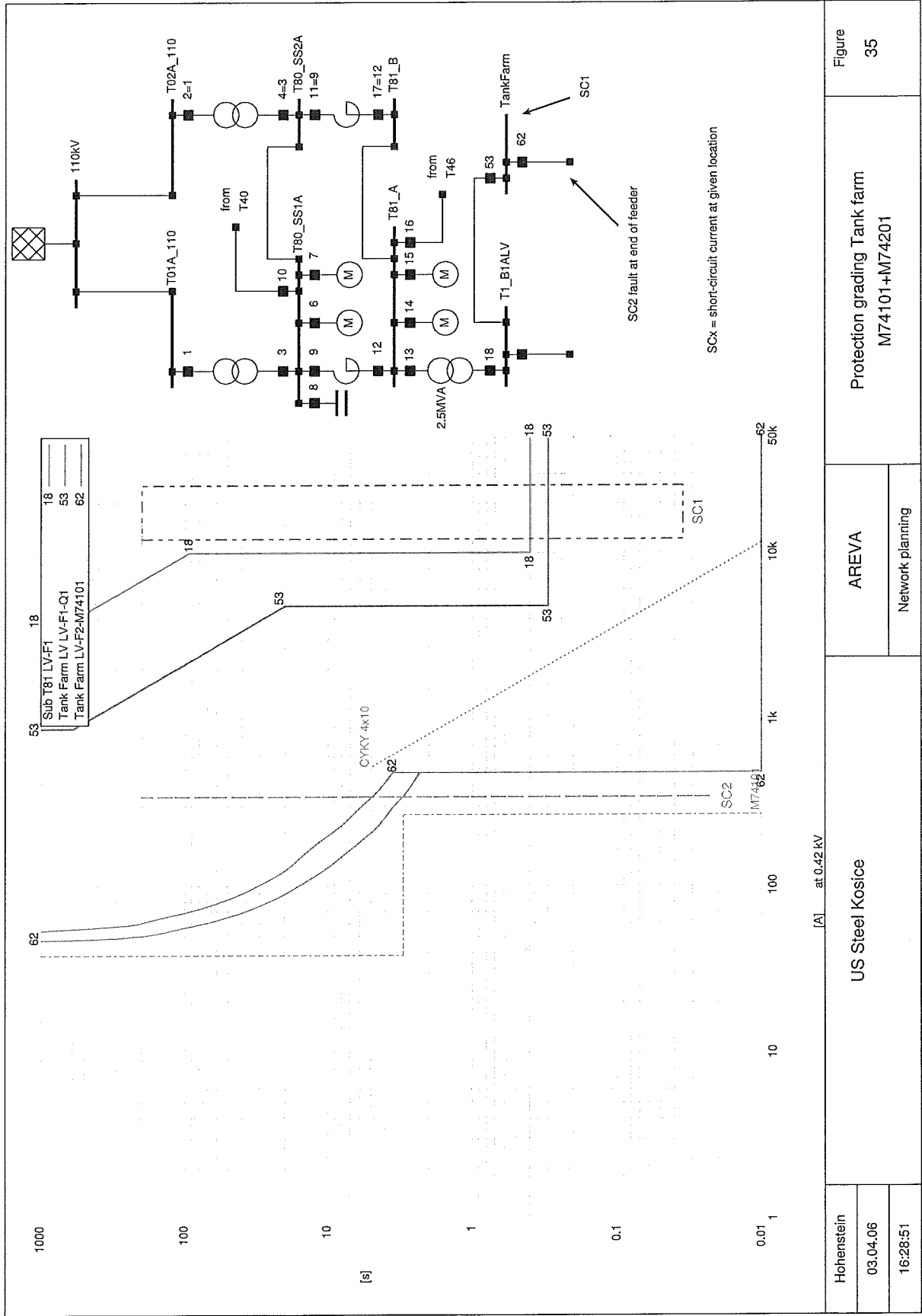




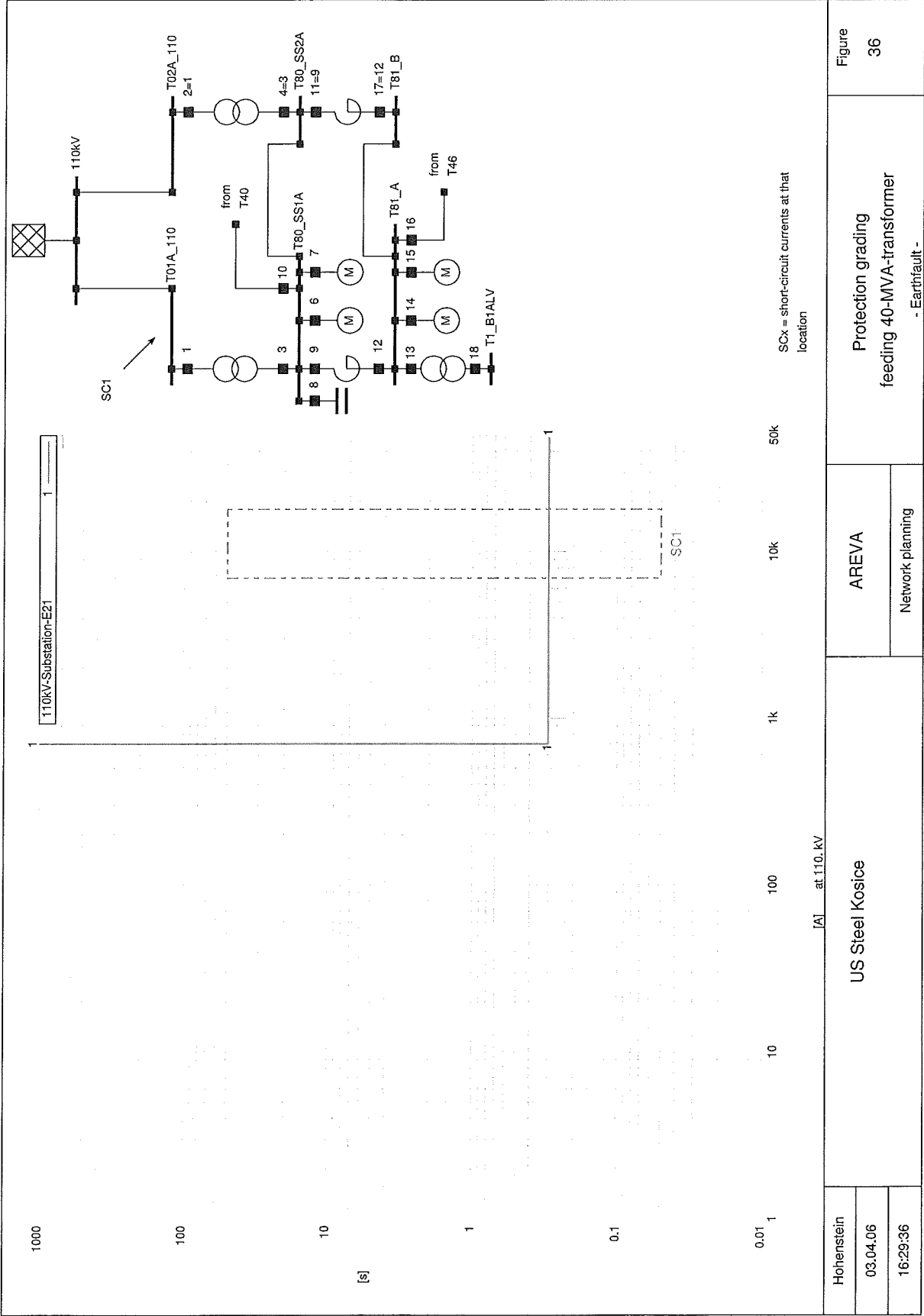


Hohenstein	US Steel Kosice at 0.42 kV	AREVA	Protection grading Tank farm M62001+M72001	Figure 33
03.04.06				
16:28:51		Network planning		





Hohenstein	US Steel Kosice	AREVA	Protection grading Tank farm M74101+M74201	Figure 35
03.04.06				
16:28:51		Network planning		



Hohenstein	US Steel Kosice	AREVA	Protection grading feeding 40-MVA-transformer - Earthfault -	Figure 36
03.04.06				
16:29:36		Network planning		