China National Offshore Oil Corp.

HAI YANG SHI YOU 981

HN1188

P018922

Protective Relay Coordination Study

			External doc. no.			
Based on			Project	HAI YANG SHI YOU 981		
Prep.	MPE / T. Hagen	2009-02-12	Customer	China National Offshore Oil Corp.		
Appr.	MP / Harald Baumgarten	2009-02-12	Proj. no.	P018922		
Doc. kind	Report		Doc. des.		Ref. des.	
Title	Protective Relay Coordination Study					
			Resp. dept	MPE	Status	Approved
ABB	ABB AS		Doc. no.	3AJM000865-032	Lang. en	Rev. ind.
					Page	1
					No. of p.	61

List of content

1. Introduction

1.1 Scope and Objectives

This document contains the protective device coordination study for the 11kV, 690V and 480V power & distribution system within ABB scope of supply.

The breakers represented in the charts are limited to incomer breakers, transfer breakers , MCC feeders and transformer breakers in the electrical power distribution network. The breakers included can be seen on the Main Single Line diagram M40188-611-001-0 (page 6).

Settings for consumers are outside scope for this study and will be treated by low voltage switchboard documentation.

Time-current charts have been created to show selectivity. Only the protective devices necessary to show selectivity are presented in the charts.

The main purpose is to find the optimum relay settings with respect to overload and short-circuit current in order to disconnect only the faulted part of the network and to minimize the damage caused by heavy fault currents.

SKM Power Tools Captor version 6.0.3.0 is used as simulating tool.

1.2 Related Documents

Item	Document Title	Document Number	Rev
[1]	Overall One Line Diagram of Power System	M40188-611-001	A
[2]	Short Circuit Calculation	3AJM000865-030	A
[3]	Earth Fault Analysis	3AJM000865-031	-
[4]	Generator Technical Data Sheet	DBAA264728b	A
[5]	Generator requested data	E-mail Li Chun Lin, CNOOC 28th of May 2008	
[6]	Caterpillar Generator Data, APRIL 17, 2007	E-mail Li Chun Lin, CNOOC 21st of April, 2008	
[7]	MV transformer data-sheets	3AJM000865-052 3AJM000865-056 3AJM000865-062	A A B
[8]	LV transformer data-sheets	N080529 N080530	C C
[9]	Data for MV and VFD Cables	E-mail Wang Kehu, SWS: 4th of August 2008 18th of August 2008 4th of September 2008 23rd of September 2008	

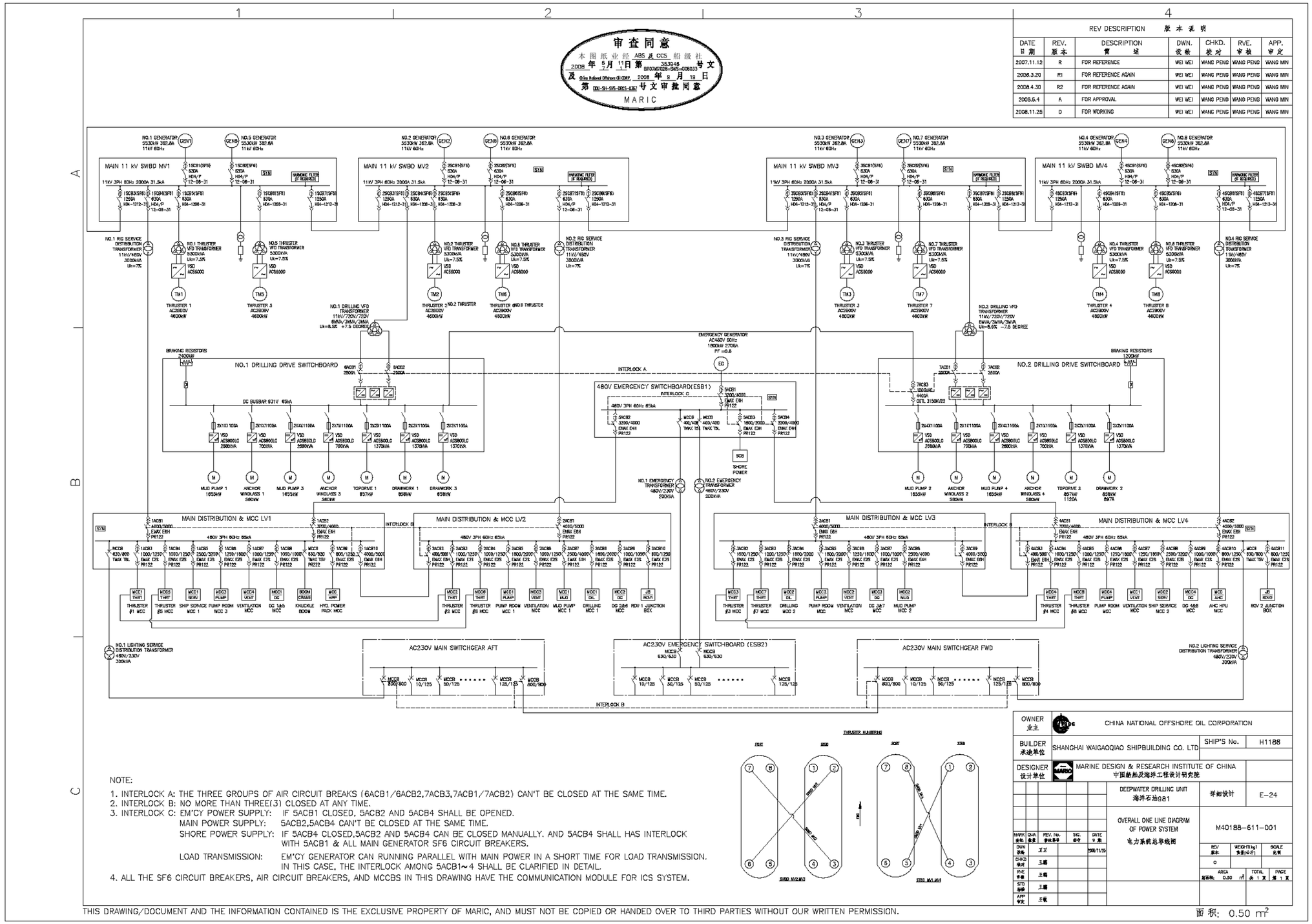
1.3 Definitions and Abbreviations

MV	Medium Voltage
LV	Low Voltage
SC	Short Circuit
SWBD	Switchboard
CB	Circuit Breaker
CT	Current Transformer
VT	Voltage Transformer
STW	Short Time Withstand Current
PORT	Portside
STBD	Starboard

2. Summary and Conclusion

- With the suggested relay settings presented in the setting table, selectivity in MV-system will be obtained.
- The main power components and cables studied are sufficient protected against damaging by overcurrent and short circuit currents.
- All corresponding breakers for same system type or for same MCC purpose shall have the same settings as the example studied. F.ex. feeder and incomer to MCC A is applicable also for B, C and D MCC.
- In general are incoming breaker protection devices in the swbds / dist. boards used as the main overload protection while the upstream feeding breaker act as a backup protection for an overload situation.. This is done to reduce the discrimination levels. For short circuit protection all feeding breakers are set to protect cables and components downstream.
- In general are all protections set as high as possible to give space for downstream protections and heavy motor starts / reacceleration. This is not obstructing the components and cables from being sufficient protected.
- No consumer breakers are shown at the curve charts. The biggest outgoing circuits at each board are however checked to ensure no obstacles to the settings presented in this study. The LV consumer protection settings must be compared with the settings herein to ensure that this statement is maintained.
- It must be considered that further breakers downstream of ABB equipment and outside the ABB scope of work has to be studied in detail to ensure continued discrimination.
- Reference is made to each diagram with its description for further details.

3. Overall Main Single Line Diagram



4. System protection

4.1 General Overview

The 11kV power system is equipped with the ABB REM 545 and REF 543 units with the following protective functions applied in this project:

Protection functions REM 545 and REF 543	ANSI	Function Block Code	Cubicle					
			Generator	Transfer	Transformer	Measuring/ Earthing system feeder		
Three-phase non-directional overcurrent protection	51 50/51 50/51	NOC3Low NOC3High NOC3Inst	x		x			
Three-phase directional overcurrent protection	67 67 67	DOC3Low DOC3High DOC3Inst		x				
Earth fault, non-directional	51N	NEF1Low	x		x	x		
Earth fault, directional	67N/51N 67N 67N	DEF1Low DEF1High DEF1Inst		x				
Residual overvoltage	59N	ROV1Low				x		
Undervoltage	27	UV3Low	x	x	x	x		
Overvoltage	59	OV3Low	x					
Stabilized three-phase differential protection for generators	87G	Diff6G	x					
Thermal overload protection (PT-100 elements)	49G/T		x		x			
Underfrequency or overfrequency protection	81	FREQ1St1-5	x	x				
Underexcitation protection	40	UE6Low	x					
Underpower or reverse power protection	32	UPOW6St1	x					
Negative phase-sequence protection	46	NPS3Low	x					

The protective device settings for 11kV switchboard are listed in chapter **Error! Reference source not found.**.

Settings for low voltage equipment will be documented in the low voltage switchboard documentation.

4.2 Short circuit fault level

Short circuit currents have been calculated and presented in [2].

The generator decaying current component for a high voltage three-phase short circuit fault is calculated according to the following formula:

$$i(t) = \left(I_k'' - I_k'\right) \cdot e^{-\frac{t}{t_d''}} + \left(I_k' - I_k\right) \cdot e^{-\frac{t}{t_d'}} + I_k \quad (1)$$

4.3 Protection philosophy

The basis for the relay settings for the 11kV switchboard protection relays are given in the sections below. In general, the settings are as high as possible, to allow for discrimination downstream. However, both the feeding cable and the equipment shall be protected according to applicable rules and equipment overcurrents withstand ratings, whichever is the lowest.

For decription of low voltage protection devices please refer to LV documentation.

4.3.1 Generator protection

Protection of the generators is provided by REM 545.

Basis for setting of the overcurrent protection

- Generator continuous overcurrent limit shall be set to 110-125% of I_n with a time delay of 20-120s.
- As a general rule, the generator overload withstand curve is $I_n^2t \approx 100$, where I_n is in pu. The relay must trip before this point is reached.
- The relay must ensure tripping of the generator's minimum sustained short circuit current.
- A three-phase short circuit current shall be disconnected within 1 second.

Basis for setting of the underfrequency protection

This function is set to trip the circuit breaker if the network frequency remains low for some seconds. The time delay must make allowance for the power system by means of the power management system to try to stabilize the frequency (load shedding etc.).

Basis for setting of the undervoltage and overvoltage protection

The undervoltage function is set to trip the breaker if the voltage remains unacceptably low for a certain period of time. Time delay must be longer than the short circuit trip time. The overvoltage protection is set to prevent abnormal and damaging voltage levels in the network.

Basis for setting of the differential protection

The stabilized differential relay function shall protect

- The generator against damage caused by internal faults (i.e. in stator windings)
- The cable against damage caused by cable faults.

Basis for setting of the underexcitation protection

The underexcitation protection protects the generator against unstable operation due to loss of excitation. Partial or total loss of excitation causes the generator to consume reactive power. The reactance of the system viewed from the machine terminal turns

negative. This can be detected by measuring the impedance of the system. Determination of the setting parameters are based on the following:

- *Offset:* This is set to $-x_d'/2$.
- *Diameter:* Normally set to the generator synchronous reactance x_d.
- *Displacement:* This setting can be used to adjust the sensitivity of the underexcitation protection. It can be either positive (close to the operating point) or negative (away from the operating point).

Basis for setting of the reverse power protection

For diesel generators running in parallel it is important to prevent the diesel from running as a motor. The reverse power protection can be set to max 15% of rated power.

Basis for the setting of the negative sequence (unbalance) protection

Based on IEC 34-1 table VII, generators shall be capable to operate on an unbalanced system system as long as $(I_2/I_n)^2 \times t = 20$ sec. is not exceeded. I_2 is the counter rotating component of stator current In and t is the time. Maximum continuous value for I_2 is 8%.

Basis for the setting of the earth fault protection

The power system / generators shall be protected for the following earth fault conditions:

- Earth fault in the switchboard
- Earth fault in the generator or feeder cable between the generator and the switchboard.

4.3.2 Measure unit

Basis for the setting of the Residual overvoltage protection

The ROV protection is utilized in order to detect earth fault on the switchboard itself and act as a back-up protection for the earth fault protection. It will also continously monitor the insulation level in all parts of the connected MV-system. The device is set time selective to the earth fault protection. Trip signals are transferred to generator and transfer units in case of swbd earth fault.

Busbar Undervoltage and Earth fault alarms are transferred to ICMS.

4.3.3 Transfer protection (between two MV switchboards)

The transfer breakers, (connection between two MV switchboards) are protected by REF 543 in each end. All transfer breakers, irrespective of if it is Master or Slave breaker has the same protections.

Basis for setting of the directional overcurrent and short circuit protection

The directional overcurrent and short circuit protection shall:

- isolate faulty switchboard by tripping the transfer feeder

- trip the transfer breakers (master and slave) if there is a short circuit in the cable between two MV switchboards.
- send blocking signal to prevent unnecessary tripping of breakers located further away from the location of the fault in order to not isolate more than the faulty part

1. Short circuit on transfer cable

Both directional overcurrent relays will see the fault and open after 200ms. Generator protection will also see the fault, but the fault is isolated before time setting of the generator relays have elapsed.

2. Short circuit on a switchboard connected to the transfer

Directional overcurrent relay in transfer breakers in the two adjacent switchboards will see the fault (together with all generator relays connected). This transfer breaker relay will trip the transfer connected to the faulty switchboard within 800ms (isolate the faulty switchboard). The generator relays connected to the faulty bus will also give trip signal to the two transfers at the same time. Generators connected to the isolated faulty part will trip in 1,0s. To avoid tripping of a transfer between two healthy switchboards, a “Block trip” signal is sent to the transfer not connected to the faulty bus.

3. Short circuit on a switchboard not connected to the transfer

As described above, to avoid unnecessary tripping, the transfer will receive a “Block trip” signal from the transfer connected to the faulty bus. If the fault is still present or no “Block trip” signal is received the transfer is tripped.

Basis for setting of the undervoltage protection

The undervoltage function is set to trip the transfer breakers if the voltage remains unacceptably low for a certain period of time. Time delay must be longer than the short circuit trip time.

Basis for the setting of the earth fault protection

The power system / transfers shall be protected for the following earth fault conditions:

- Earth fault in the switchboard
- Earth fault in the cable between each MV switchboard.

1. Earth fault in transfer cable

Directional earth fault relays in each end of cable will detect fault and trip transfer breakers.

2. Earth fault on a switchboard connected to the transfer

Directional earth fault relays will trip both transfers connected to the faulty bus. If the fault is still present, the residual overvoltage relay on the faulty bus will trip generator breakers connected to the faulty switchboard. To avoid tripping of a transfer between two healthy switchboards, a “Block trip” signal is sent to the transfer breakers not connected to the faulty bus.

3. Earth fault on switchboard not connected to the transfer

To avoid unnecessary tripping, the transfer will receive a “Block trip” signal from the transfer connected to the faulty bus. If the fault is still present or no “Block trip” signal is received the transfer is tripped.

4.3.4 Transformer protection

The transformers are protected with REF 543.

Basis for setting of the overload and short circuit protection

- The long time setting can be set to max 125% of rated current.
- The relay shall trip before the short circuit withstand limit is reached.
- The relay function is blocked if inrush current is detected.

The MV transformers are also equipped with PT100 elements which are used for monitoring winding temperature and will trip if high temperature is detected. These are connected to feeding breaker except thruster transformers which are connected to the drive.

Two alarm levels are set, the 1st is a pre-warning alarm and the 2nd is a critical alarm which trips the breaker. Settings are equal for all transformers.

Basis for setting of the undervoltage protection

The undervoltage function is set to trip the transformer breaker if the voltage remains unacceptably low for a certain period of time. Time delay must be longer than the short circuit trip time.

Basis for setting of the earth fault protection

With an earth fault in the transformer feeder (on primary side), the relay shall trip as fast as possible.

4.4 Time margins between successive protective devices

The selection of time intervals between successive relays for the short circuit current on 11kV area is based on the following:

Accuracy relay A	:	20 ms
Safety margin	:	100 ms
CB B opening time	:	55-60 ms
Accuracy relay B	:	20 ms
Minimum time delay:	:	200 ms

For the low voltage breakers time margins and tolerances are included in the curves. The selectivity between LV breakers is thus fulfilled if the curves are not overlapping each other.

4.5 General for Low Voltage breakers

Low voltage breakers feeding same type of MCC are only shown once if they have the same breaker and protection, and the same power cable size connected.
For example; The eight Thruster MCCs have the same settings for all feeders from LV1-4 since the feeders are connected with the same cable sizes. The discrimination is obtained and shown at the whole range of short circuit fault levels calculated at the Thruster MCCs.

Where similar MCCs not have the same cables or the same feeding breaker they are shown at separate chart

4.6 Cable current Ampacity

The cable current ampacity has been constructed with a nominal current @ 45 degree C (In) multiplied with an installation reduction factor of 0,85 according to [9].

5. Selectivity charts

5.1 Case 1: 11kV Power String to Thruster System

When reading the below description, reference is made to the next diagram page.

11kV Generators:
The generator protection is shown in the chart for one and two generator in operation. The generator decaying three phase short circuit current is shown by AC and AC+DC total, only for one generator.

As a general rule, the generator overload withstand curve is $I_N^2t \approx 100$, where I_N is in pu. "Gen SC" point represents the damage point for the generator and this point is shown at the transient (Xd') stage of the generator short circuit capability. The generator's sustained short circuit current is given in equation (1) and (2).
The overcurrent protection is set to 110% of Generator In based on the Rule requirement for generator overload - 110% overload for 1 hour. The generators are additionally protected against overload/overtemperature by PT100 elements wired to the MV breaker.

In general, the generator load must be controlled and monitored by the power management system (PMS) by reducing the load or execute preferential trip to consumers. The generators are not intended to be continous overloaded and it will be tripped by generator breaker if the load is not reduced by PMS.

11kV Transfer feeders:
Transfer feeder breakers have directional overcurrent protections (DOC) with two different settings:

- Set.1 is set to 0.8s and applies when the opposite transfer protective device does not detect any short circuit. This way the transfer protection will wait for protection devices in the supplied main switchboard to clear the short circuit.
- Set. 2 is set to 0.2s and applies when transfer feeders detects a short circuit at the same time i.e. during a cable fault. In this condition there is a short circuit in the transfer itself and discrimination with other protection devices are not applicable and thus not shown in the chart.

The short circuit protection is selective against the whole range of calculated short circuit fault currents by at least two generators. When only one generator on net, the transfer breaker will not trip since the short circuit currents is too small.
Since the transfer circuits have a rating of 1200A and each generator has a rating of 363A, it is decided to not have overload discrimination betwwen generators and transfer feeders. When the transfer circuit is fed by four or more generators the discrimination is however obtained.

11kV Transformer feeder:
The 11kV transformer feeder is set to protect the transformer and the transformer cables, primary and secondary in case of a short circuit.
The overcurrent protection is set to protect primary (11 kV) feeder cables to the transformer. Overcurrent protection of secondary cables will be done by the current limiting function in the drive controller which limits the output current referred to maximum motor rated current. This means that the transformer windings can not be overloaded in normal operation. Further, if a fault is detected in a VFD incoming unit this will stop the corresponding motor.

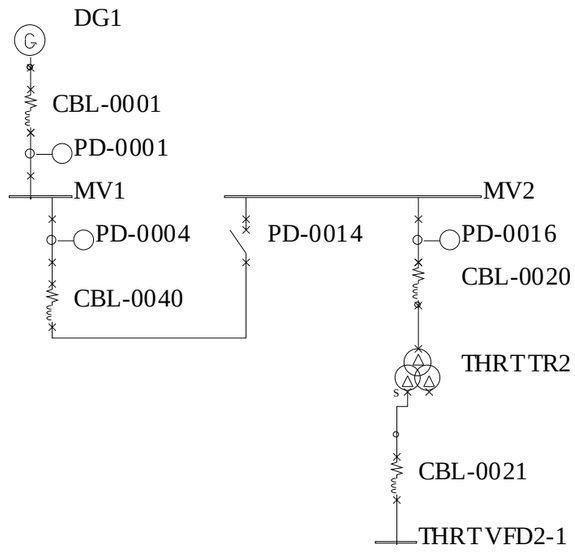
Further, it is thermal overload protection of the transformer by means of PT 100 temperature elements (L1, L2, L3) interfaced to the controller unit in the thruster VFD fed by the transformer.
The thermal overload protection is designed to protect the different transformer windings individually.

Conclusions:

- The generator and transformer are protected against overload
- All cables are protected with enough margins against overload and short circuit.

SC levels			
MV swbd:		**Thruster VSD:**	
	Referred to 11kV	Referred to 11kV	Referred to 1650V
Max I_k'' :	22kA	1,75kA	11,2kA
Min I_{k2} :	0,94kA	0,6kA	4,0kA

Tag no	Chart device		Description
DG1 80-EH0001A un. A04 80-EH0001A un. A04+06	G1A	=	Decaying generator short circuit current
	Gen SC	=	Generator overload withstand point
	PD-0001	=	Generator unit REM relay protection curve
	PD-0001X2	=	Generator unit REM relay protection curve – 2 generators connected
	CBL-0001	=	Generator cable withstand curve
80-EH0001A un. A01/08	PD-0004/14	=	Transfer unit REF relay protection curve
	CBL-0040	=	Transfer cable withstand curve
80-EH0001B un. B03	PD-0016	=	Feeder to Thruster transformer, REF prot. curve
	CBL-0020	=	Transformer primary cable withstand curve
58-ET0001C	THRT TR2:		Thruster transformer
	TX Inrush	=	Transformer half-peak inrush current / time
	Thermal	=	Transformer thermal ability to withstand short circuit
	Dynamic	=	Transformer ability to withstand the dynamic effects of a short circuit
	CBL-0021	=	Transformer secondary cable withstand curve



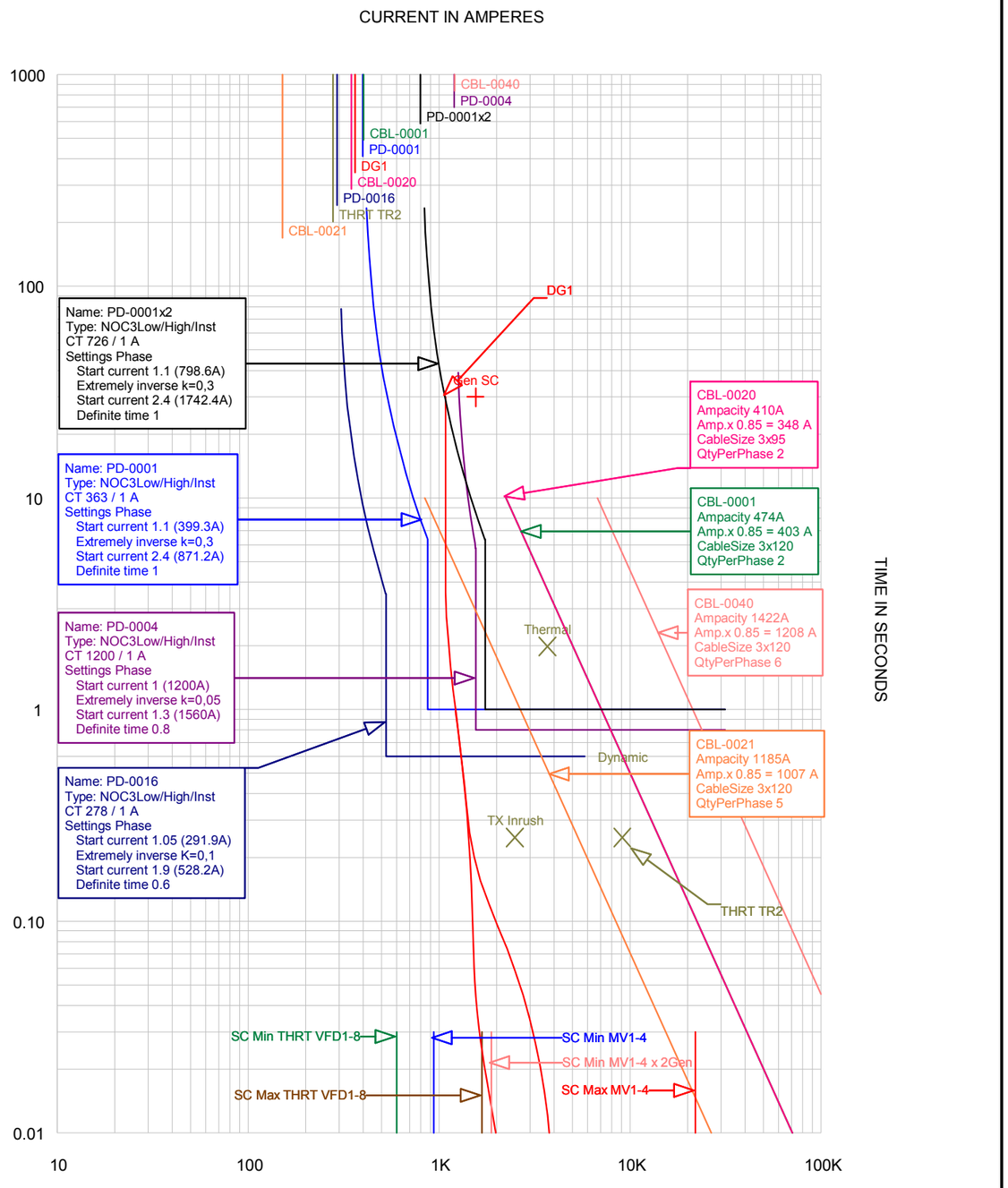


Chart 01.tcc Ref. Voltage: 11000 Current in Amps x 1

Doc. kind Report Title Protective Relay Coordination Study	Project HAI YANG SHI YOU 981 Customer China National Offshore Oil Corp. Proj. no. P018922				
ABB AS	Doc. no. 3AJM000865-032	Lang. en	Rev. ind.	Page 14 No. of p. 61	

5.2 Case 2: 11kV Power String to Drilling System

When reading the below description, reference is made to the next diagram page.

11kV Generators:
The generator protection is shown in the chart for one and two generator in operation. The generator decaying three phase short circuit current is shown by AC and AC+DC total, only for one generator.

As a general rule, the generator overload withstand curve is $I_N^2t \approx 100$, where I_N is in pu. "Gen SC" point represents the damage point for the generator and this point is shown at the transient (Xd') stage of the generator short circuit capability. The generator's sustained short circuit current is given in equation (1) and (2).
The overcurrent protection is set to 110% of In based on the Rule requirement for generator overload - 110% overload for 1 hour. The generators are additionally protected against overload/overtemperature by PT100 elements wired to the MV breaker.

In general, the generator load must be controlled and monitored by the power management system (PMS) by reducing the load or execute preferential trip to consumers. The generators are not intended to be continous overloaded and it will be tripped by generator breaker if the load is not reduced by PMS.

11kV Transfer feeders:
Transfer feeder breakers have directional overcurrent protections (DOC) with two different settings:

- Set.1 is set to 0.8s and applies when the next protective device downstream (REF A1) does not detect any short circuit. This way the transfer protection will wait for protection devices in the supplied main switchboard to clear the short circuit.
- Set. 2 is set to 0.2s and applies when transfer feeders detects a short circuit at the same time i.e. during a cable fault. In this condition there is a short circuit in the transfer itself and discrimination with other protection devices are not applicable and thus not shown in the chart.

The short circuit protection is selective against the whole range of calculated short circuit fault currents by at least two generators. When only one generator on net, the transfer breaker will not trip since the short circuit currents is too small.
Since the transfer circuits have a rating of 1200A and each generator has a rating of 363A, it is decided to not have overload discrimination betwwen generators and transfer feeders. When the transfer circuit is fed by four or more generators the discrimination is however obtained.

11kV Transformer feeder:
The 11kV transformer feeder is set to protect the transformer and the transformer cables, primary and secondary in case of a short circuit.
The transformer with its cables is protected against overload by the VSD 690V incomer protection. The 11kV feeding breaker acts as a backup protection for the VSD 690V incomer breaker in an overload situation but will also detect any overcurrents caused by fault in cables or transformer before it reach the short circuit level.

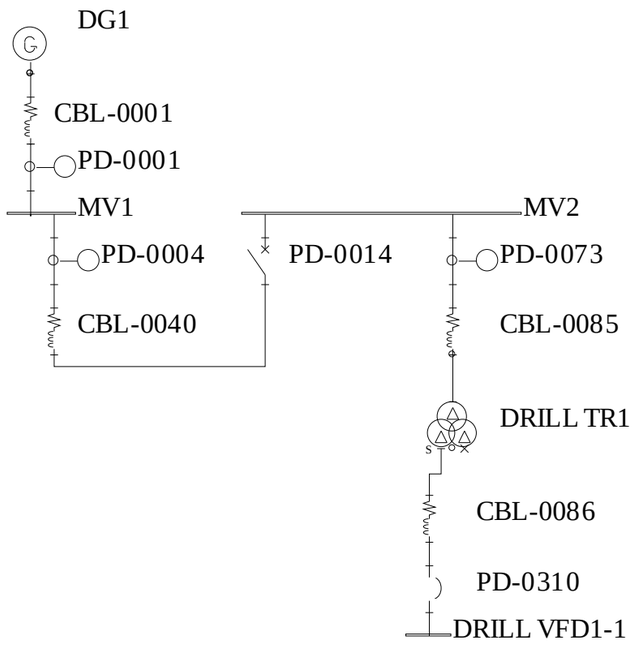
- PT100 elements are additionally used to protect the transformer for being overheated, these are connected to 11kV feeding breaker.

Conclusions:

- The generator and transformer are protected against overload
- All cables are protected with enough margins against overload and short circuit.

SC levels			
MV swbd:		Drilling VSD:	
	Referred to 11kV	Referred to 11kV	Referred to 720V
Max I_k'' :	22kA	1,63kA	24,9kA
Min I_{k2} :	0,94kA	0,57kA	8,8kA

Tag no	Chart device		Description
DG1	G1A	=	Decaying generator short circuit current
	Gen SC	=	Generator overload withstand point
80-EH0001A un. A04	PD-0001	=	Generator unit REM relay protection curve
80-EH0001A un. A04+06	PD-0001X2	=	Generator unit REM relay protection curve – 2 generators connected
	CBL-0001	=	Generator cable withstand curve
80-EH0001A un. A01/08	PD-0004/14	=	Transfer unit REF relay protection curve
	CBL-0040	=	Transfer cable withstand curve
80-EH0001B un. B07	PD-0073	=	Feeder to Drilling transformer, REF prot. curve
	CBL-0085	=	Transformer primary cable withstand curve
82-ET0002A	DRILL TR1:		Drilling transformer
	TX Inrush	=	Transformer half-peak inrush current / time
	Thermal	=	Transformer thermal ability to withstand short circuit
	Dynamic	=	Transformer ability to withstand the dynamic effects of a short circuit
	CBL-0086	=	Transformer secondary cable withstand curve



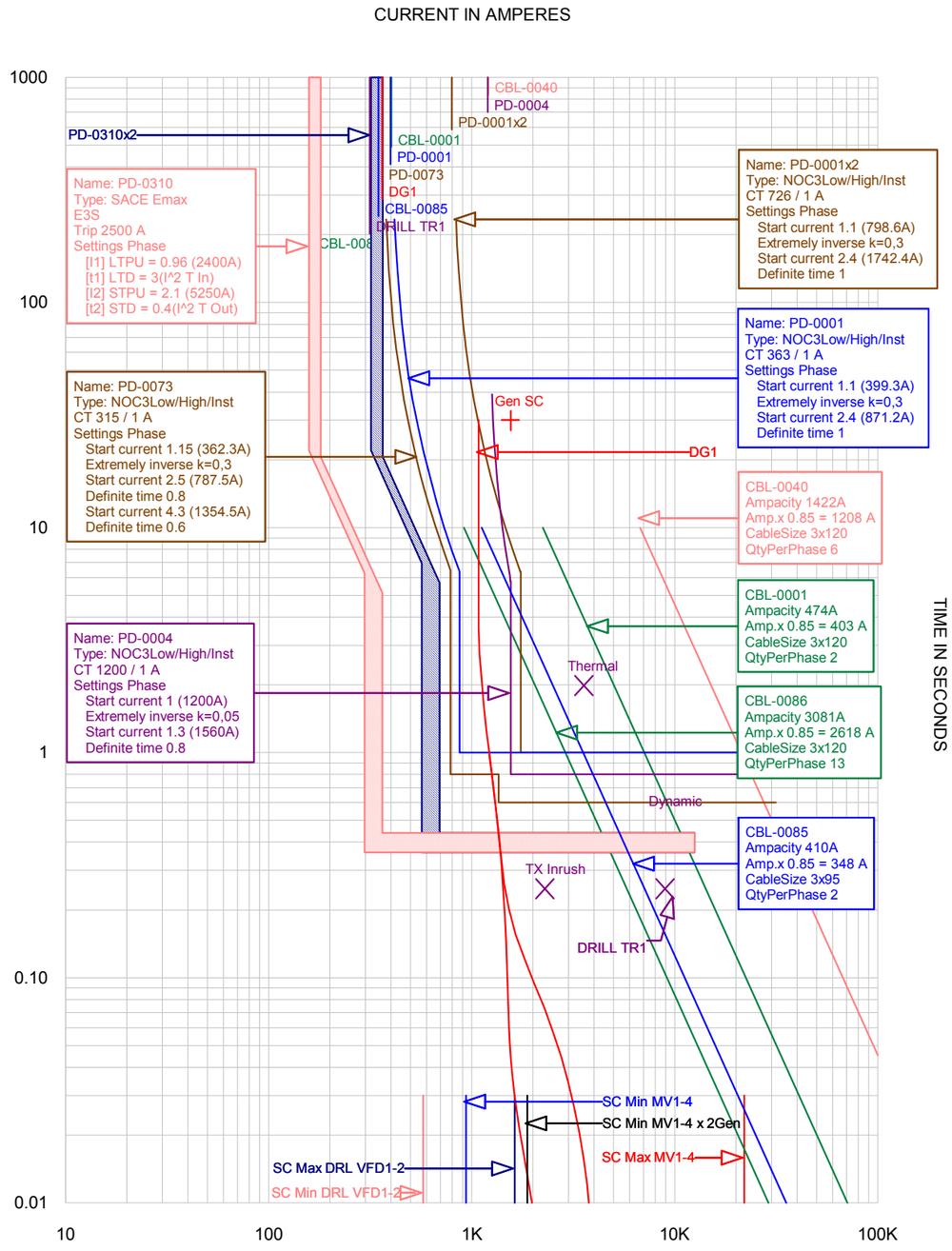


Chart 02.tcc Ref. Voltage: 11000 Current in Amps x 1

5.3 Case 3: 11kV Power String to Main 480V LV switchboards

When reading the below description, reference is made to the next diagram page.

11kV Generators:
The generator protection is shown in the chart for one and two generator in operation. The generator decaying three phase short circuit current is shown by AC and AC+DC total, only for one generator.

As a general rule, the generator overload withstand curve is $I_N^2t \approx 100$, where I_N is in pu. "Gen SC" point represents the damage point for the generator and this point is shown at the transient (Xd') stage of the generator short circuit capability. The generator's sustained short circuit current is given in equation (1) and (2).
The overcurrent protection is set to 110% of In based on the Rule requirement for generator overload - 110% overload for 1 hour. The generators are additionally protected against overload/overtemperature by PT100 elements wired to the MV breaker.

In general, the generator load must be controlled and monitored by the power management system (PMS) by reducing the load or execute preferential trip to consumers. The generators are not intended to be continous overloaded and it will be tripped by generator breaker if the load is not reduced by PMS.

11kV Transfer feeders:
Transfer feeder breakers have directional overcurrent protections (DOC) with two different settings:

- Set.1 is set to 0.8s and applies when the next protective device downstream (REF A1) does not detect any short circuit. This way the transfer protection will wait for protection devices in the supplied main switchboard to clear the short circuit.
- Set. 2 is set to 0.2s and applies when transfer feeders detects a short circuit at the same time i.e. during a cable fault. In this condition there is a short circuit in the transfer itself and discrimination with other protection devices are not applicable and thus not shown in the chart.

The short circuit protection is selective against the whole range of calculated short circuit fault currents by at least two generators. When only one generator on net, the transfer breaker will not trip since the short circuit currents is too small.
Since the transfer circuits have a rating of 1200A and each generator has a rating of 363A, it is decided to not have overload discrimination betwwen generators and transfer feeders. When the transfer circuit is fed by four or more generators the discrimination is however obtained.

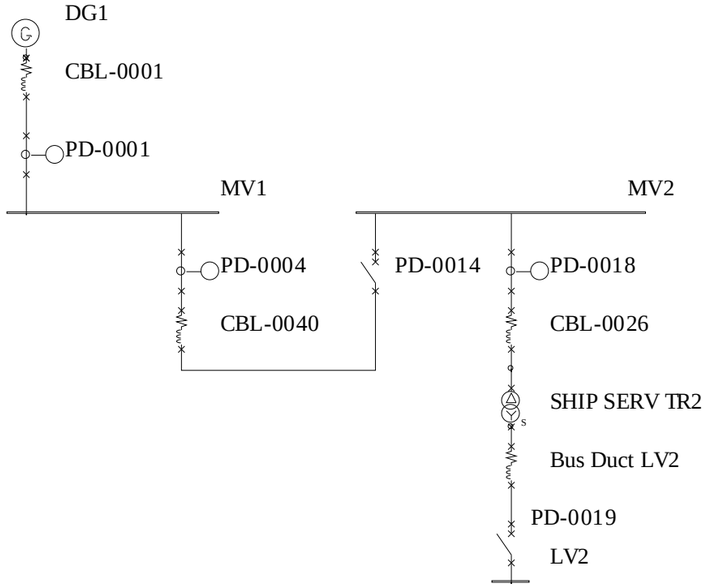
11kV Transformer feeder & 480V Incomer:
The 11kV transformer feeder is set to protect the transformer and the transformer cables, primary and secondary in case of a short circuit.
The transformer with its cables is protected against overload by the 480V incomer protection. PT100 elements are additionally used to protect the transformer for being overloaded/overheated, these are connected to 11kV feeding breaker. The 11kV feeding breaker acts as a backup protection for the 480V incomer breaker in an overload situation and will detect any overcurrents caused by fault in cables or the transformer before it reach the short circuit level. The 11kV feeder is set selective against incomer in order to avoid trip of both breakers.

Conclusions:

- The generator and transformer are protected against overload
- All cables are protected with enough margins against overload and short circuit.

SC levels			
MV swbd:		**LV1-4:**	
	Referred to 11kV	Referred to 11kV	Referred to 480V
Max I_k'' :	22kA	2,60kA	59,6kA
Min I_{k2} :	0,94kA	0,63kA	14,4kA

Tag no	Chart device		Description
DG1	G1A	=	Decaying generator short circuit current
	Gen SC	=	Generator overload withstand point
80-EH0001A un. A04	PD-0001	=	Generator unit REM relay protection curve
80-EH0001A un. A04+06	PD-0001X2	=	Generator unit REM relay protection curve – 2 generators connected
	CBL-0001	=	Generator cable withstand curve
80-EH0001A un. A01/08	PD-0004/14	=	Transfer unit REF relay protection curve
	CBL-0040	=	Transfer cable withstand curve
80-EH0001B un. B02	PD-0018	=	Feeder to Service transformer, REF prot. curve
	CBL-0026	=	Transformer primary cable withstand curve
82-ET0001B	SHIP SERV TR2:		Thruster transformer
	TX Inrush	=	Transformer half-peak inrush current / time
	Thermal	=	Transformer thermal ability to withstand short circuit
	Dynamic	=	Transformer ability to withstand the dynamic effects of a short circuit
82-EN0001B	PD-0019	=	Transformer LV incomer 480V Main LV Emax PR122 prot. curve



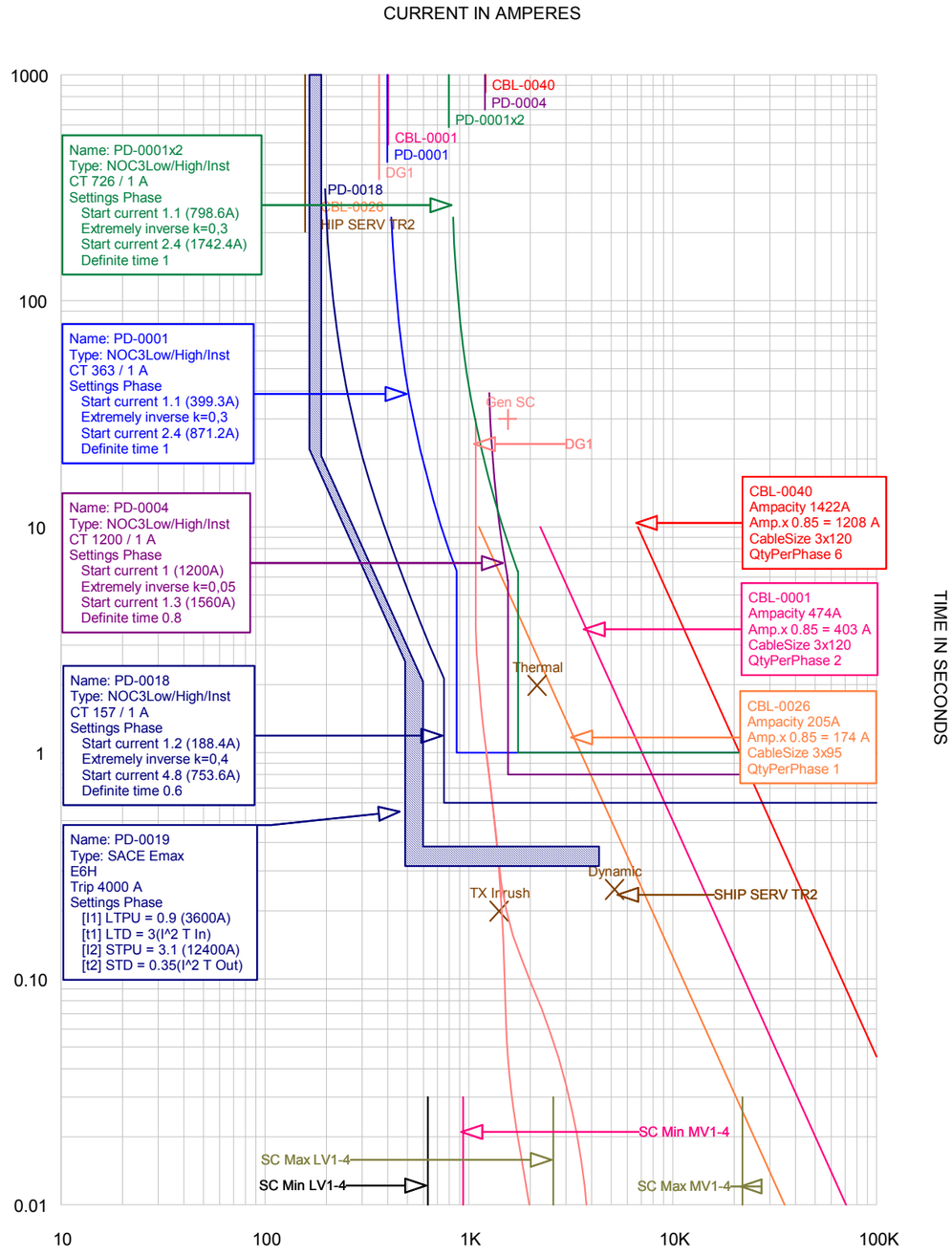


Chart 03.tcc Ref. Voltage: 11000 Current in Amps x 1

Doc. kind Report Title Protective Relay Coordination Study	Project HAI YANG SHI YOU 981 Customer China National Offshore Oil Corp. Proj. no. P018922				
ABB AS	Doc. no. 3AJM000865-032	Lang. en	Rev. ind.	Page 18 No. of p. 61	

5.4 Case 4: 11kV Power String from 480V Main LV to 480V Thruster MCC

When reading the below description, reference is made to the next diagram page.

480V Incomer:

The 480V incomer breaker shown at chart 4 is repeated to show the discrimination further downstream on 480V level. Incomer protection is set to protect the upstream transformer against overload.

480V Transfer:

The 480V transfer breaker has reduced setting compared with the current capability. This is required to discriminate and isolate the fault between the tie-connected bus and the incomer bus.

480V MCC feeder to Thruster MCCs::

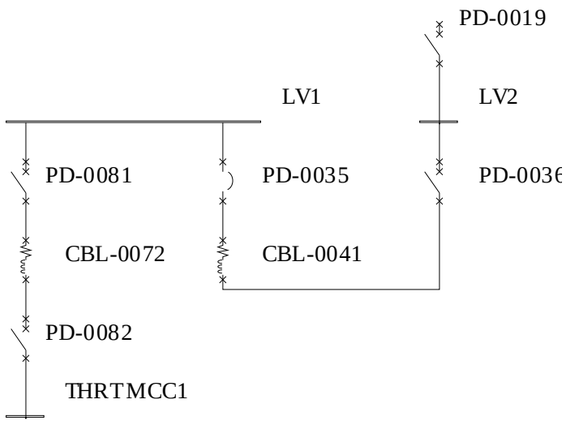
The MCC feeder is set to protect the cables to downstream MCC in case of an overload or a short circuit situation.

Conclusions:

- All cables are protected with enough margins against overload and short circuit.
- Discrimination between the 480V Main LV Incomer breaker, transfer feeders and the feeder to the downstream MCC are obtained.

SC levels		
480V Main LV1-4 swbd:		**480V Thruster MCC 1-8:**
	Referred to 480V	Referred to 480V
Max I_k'':	59,6kA	17,3kA
Min I_{k2}:	14,4kA	7,9kA

Tag no	Chart device		Description
82-EN0001B	PD-0019	=	Transformer incomer 480V Main LV, Emax PR122 prot. curve
82-EN0001B	PD-0036	=	Transfer breaker 480V Main LV, Emax PR122 prot. curve
	CBL-0041	=	Transfer cable withstand curve
82-EN0001A	PD-0081	=	Feeder to Thruster MCCs, Emax PR122 prot. curve
	CBL-0072	=	Feeder cable withstand curve
82-EN0003A	PD-0082	=	MCC incomer Load breaker (no protection)



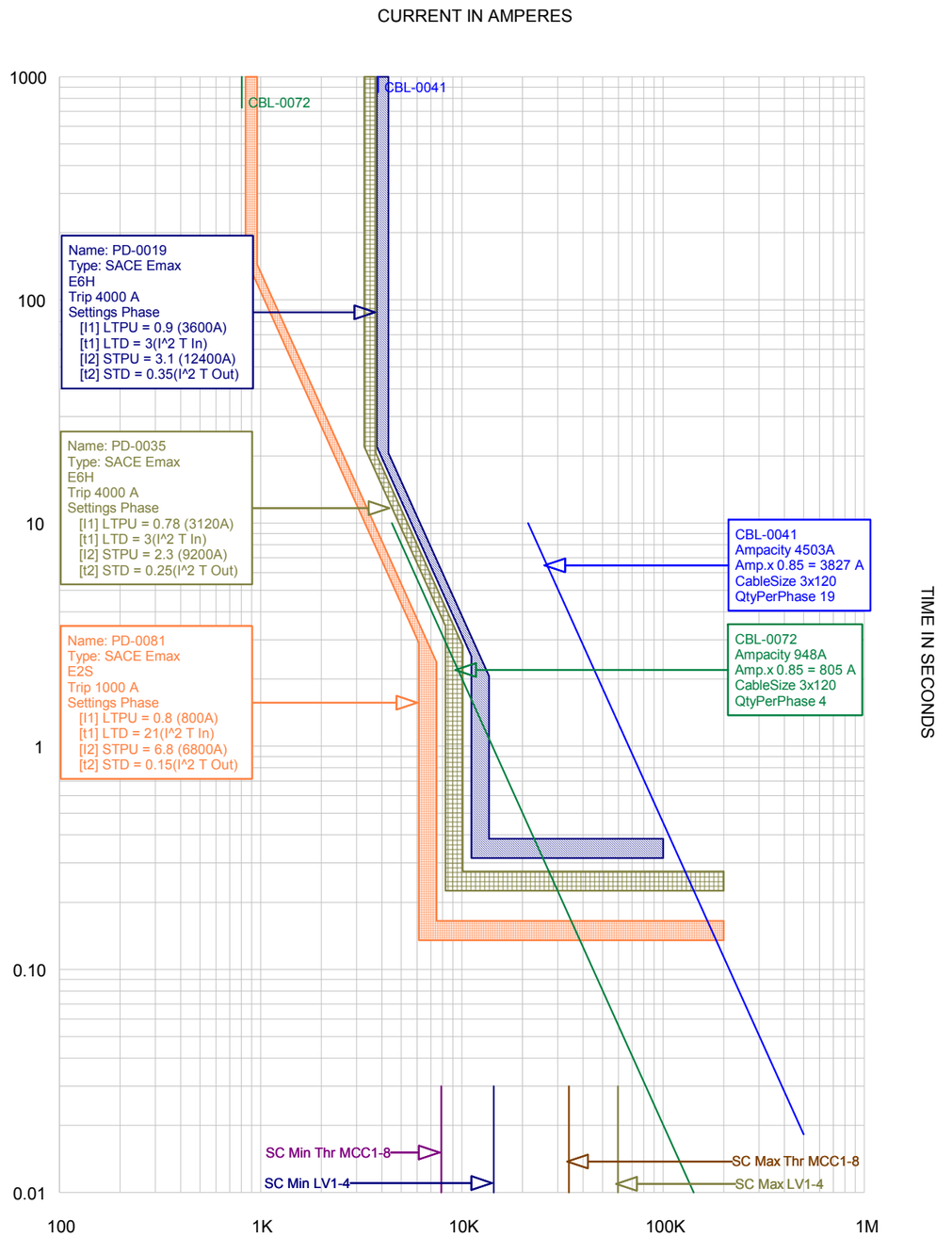


Chart 04.tcc Ref. Voltage: 480 Current in Amps x 1

5.5 Case 5: 11kV Power String from 480V Main LV to Ship Service MCCs

When reading the below description, reference is made to the next diagram page.

480V Incomer:

The 480V incomer breaker shown at chart 5 is repeated to show the discrimination further downstream on 480V level. Incomer protection is set to protect the upstream transformer against overload.

480V Transfer:

The 480V transfer breaker has reduced setting compared with the current capability. This is required to discriminate and isolate the fault between the tie-connected bus and the incomer bus.

480V MCC feeder to Ship service MCCs::

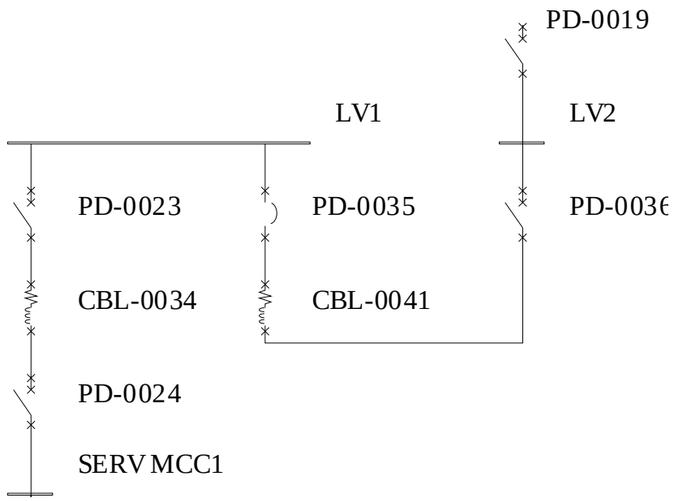
The MCC feeder is set to protect the cables to downstream MCC in case of an overload or a short circuit situation.

Conclusions:

- All cables are protected with enough margins against overload and short circuit.
- Discrimination between the 480V Main LV Incomer breaker, transfer feeders and the feeder to the downstream MCC are obtained.

SC levels		
480V Main LV1-4 swbd:		**480V Ship Service MCC 1-2:**
	Referred to 480V	Referred to 480V
Max I_k'' :	59,6kA	51,9kA
Min I_{k2} :	14,4kA	13,9kA

Tag no	Chart device		Description
82-EN0001B	PD-0019	=	Transformer incomer 480V Main LV, Emax PR122 prot. curve
82-EN0001B	PD-0036	=	Transfer breaker 480V Main LV, Emax PR122 prot. curve
	CBL-0041	=	Transfer cable withstand curve
82-EN0001A	PD-0023	=	Feeder to Ship Service MCCs, Emax PR122 prot. curve
	CBL-0034	=	Feeder cable withstand curve
82-EN0004A	PD-0024	=	MCC incomer Load breaker (no protection)



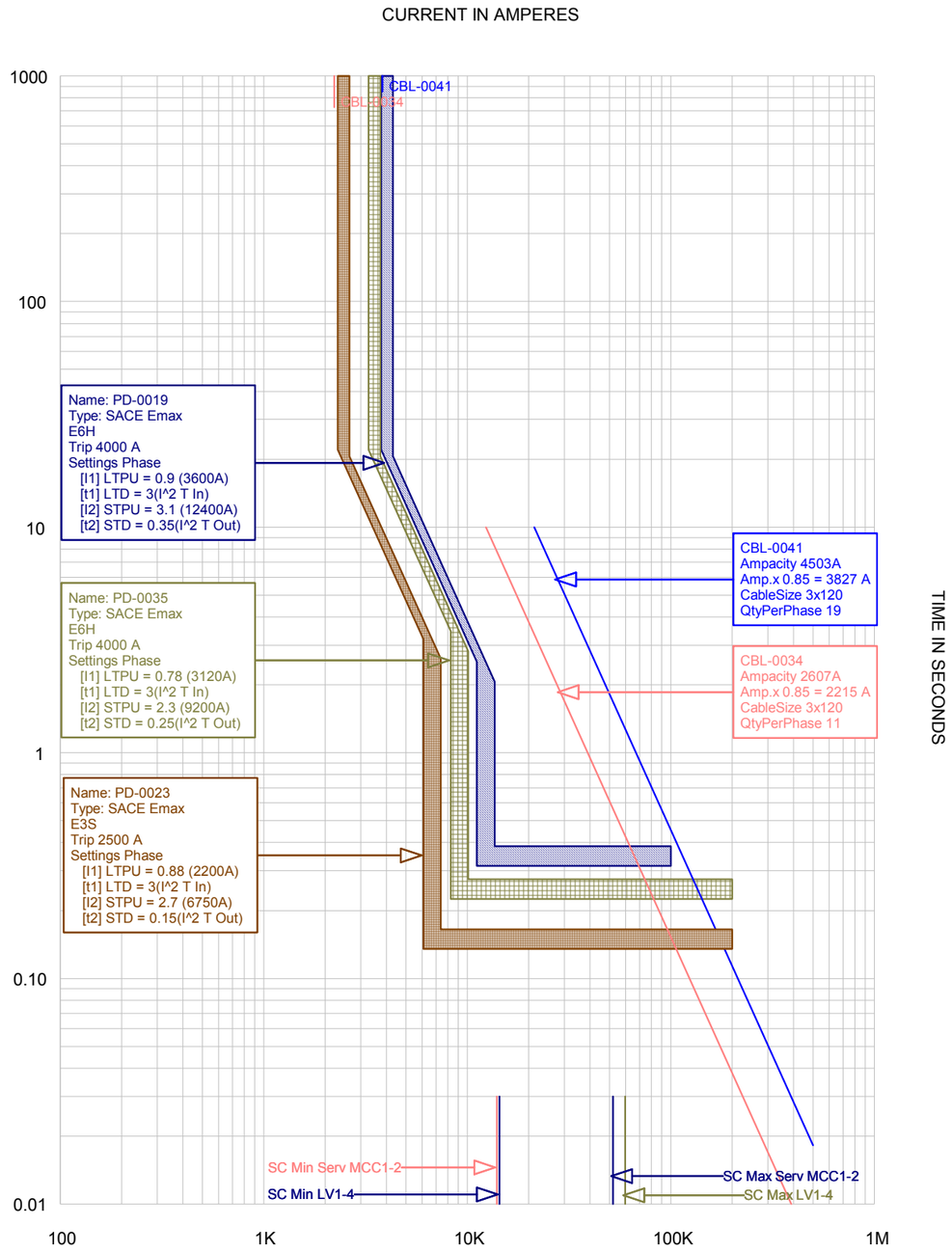


Chart 05.tcc Ref. Voltage: 480 Current in Amps x 1

5.6 Case 6: 11kV Power String from 480V Main LV to Pump MCC 2&3

When reading the below description, reference is made to the next diagram page.

480V Incomer:

The 480V incomer breaker shown at chart 6 is repeated to show the discrimination further downstream on 480V level. Incomer protection is set to protect the upstream transformer against overload.

480V Transfer:

The 480V transfer breaker has reduced setting compared with the current capability. This is required to discriminate and isolate the fault between the tie-connected bus and the incomer bus.

480V MCC feeder to Pump MCC 2&3:

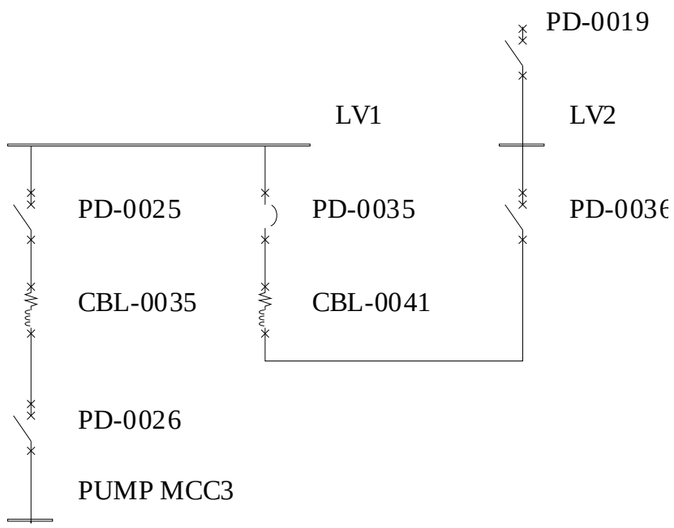
The MCC feeder is set to protect the cables to downstream MCC in case of an overload or a short circuit situation.

Conclusions:

- All cables are protected with enough margins against overload and short circuit.
- Discrimination between the 480V Main LV Incomer breaker, transfer feeders and the feeder to the downstream MCC are obtained.

SC levels		
480V Main LV1-4 swbd:		**480V Pump Room MCC 2 / 3:**
	Referred to 480V	Referred to 480V
Max I_k'' :	59,6kA	41,1kA
Min I_{k2} :	14,4kA	9,1kA

Tag no	Chart device		Description
82-EN0001B	PD-0019	=	Transformer incomer 480V Main LV, Emax PR122 prot. curve
82-EN0001B	PD-0036	=	Transfer breaker 480V Main LV, Emax PR122 prot. curve
	CBL-0041	=	Transfer cable withstand curve
82-EN0001A	PD-0025	=	Feeder to Pump Room MCC no 2 & 3, Emax PR122 prot. curve
	CBL-0035	=	Feeder cable withstand curve
82-EN0007A	PD-0026	=	MCC incomer Load breaker (no protection)



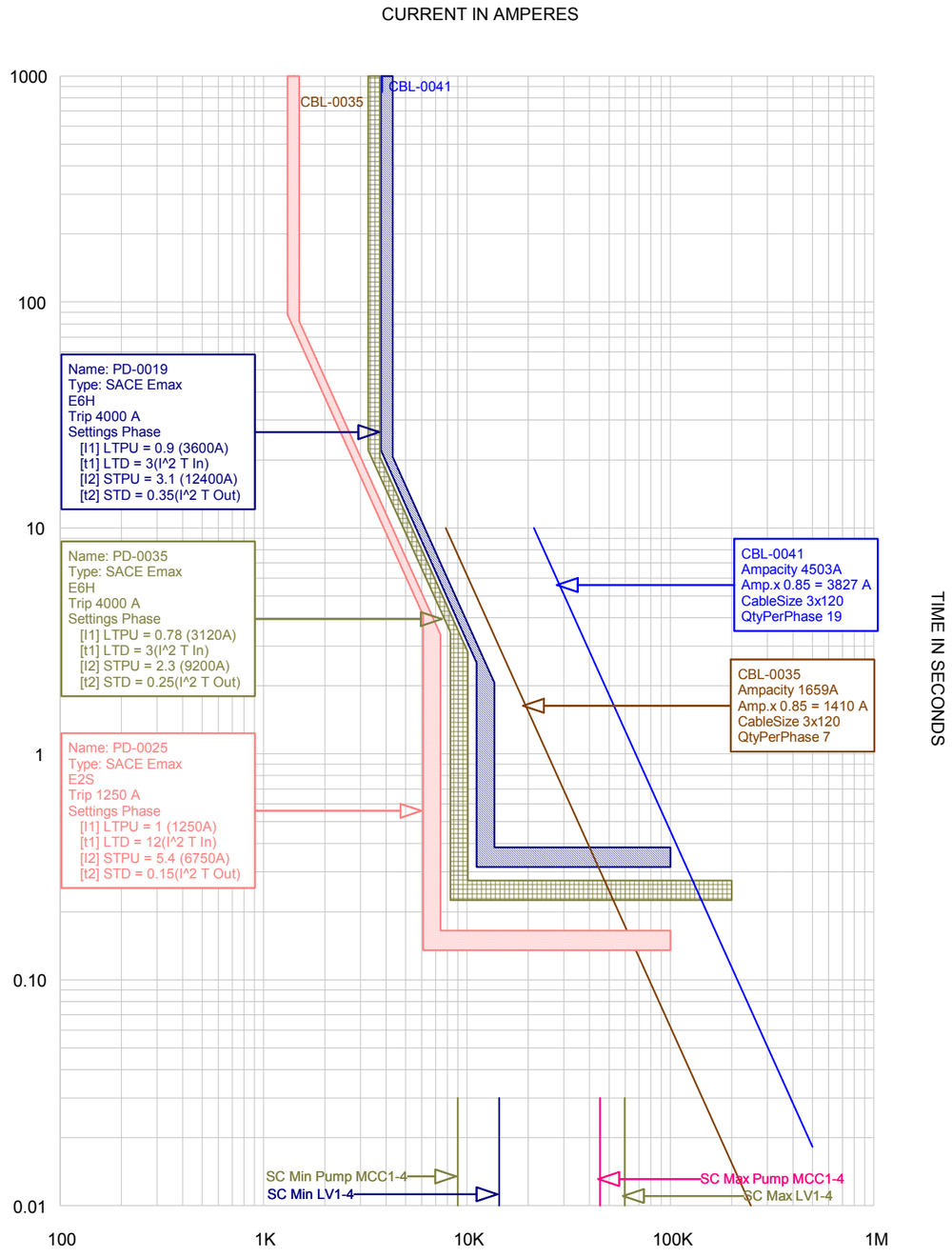


Chart 06.tcc Ref. Voltage: 480 Current in Amps x 1

5.7 Case 7: 11kV Power String from 480V Main LV to Vent. Room MCCs

When reading the below description, reference is made to the next diagram page.

480V Incomer:

The 480V incomer breaker shown at chart 7 is repeated to show the discrimination further downstream on 480V level. Incomer protection is set to protect the upstream transformer against overload.

480V Transfer:

The 480V transfer breaker has reduced setting compared with the current capability. This is required to discriminate and isolate the fault between the tie-connected bus and the incomer bus.

480V MCC feeder to Vent. Room MCCs:

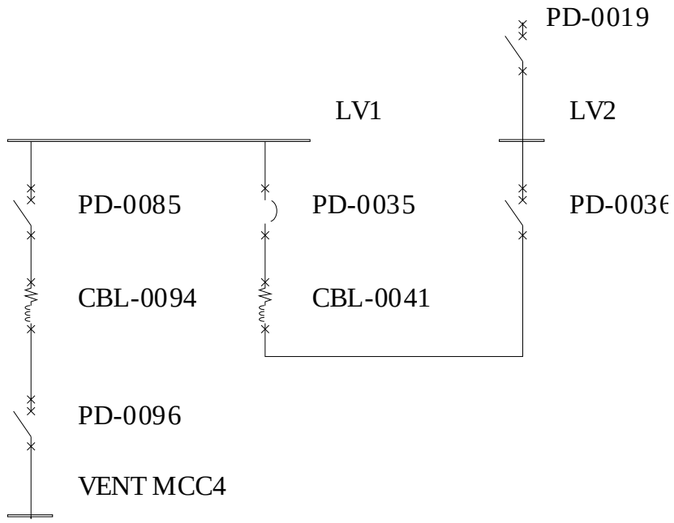
The MCC feeder is set to protect the cables to downstream MCC in case of an overload or a short circuit situation.

Conclusions:

- All cables are protected with enough margins against overload and short circuit.
- Discrimination between the 480V Main LV Incomer breaker, transfer feeders and the feeder to the downstream MCC are obtained.

SC levels		
480V Main LV1-4 swbd:		**480V Vent Room MCC 1-4:**
	Referred to 480V	Referred to 480V
Max I_k'' :	59,6kA	40,5kA
Min I_{k2} :	14,4kA	10,7kA

Tag no	Chart device		Description
82-EN0001B	PD-0019	=	Transformer incomer 480V Main LV, Emax PR122 prot. curve
82-EN0001B	PD-0036	=	Transfer breaker 480V Main LV, Emax PR122 prot. curve
	CBL-0041	=	Transfer cable withstand curve
82-EN0001A	PD-0085	=	Feeder to Vent Room MCCs, Emax PR122 prot. curve
	CBL-0094	=	Feeder cable withstand curve
82-EN0008A	PD-0096	=	MCC incomer Load breaker (no protection)



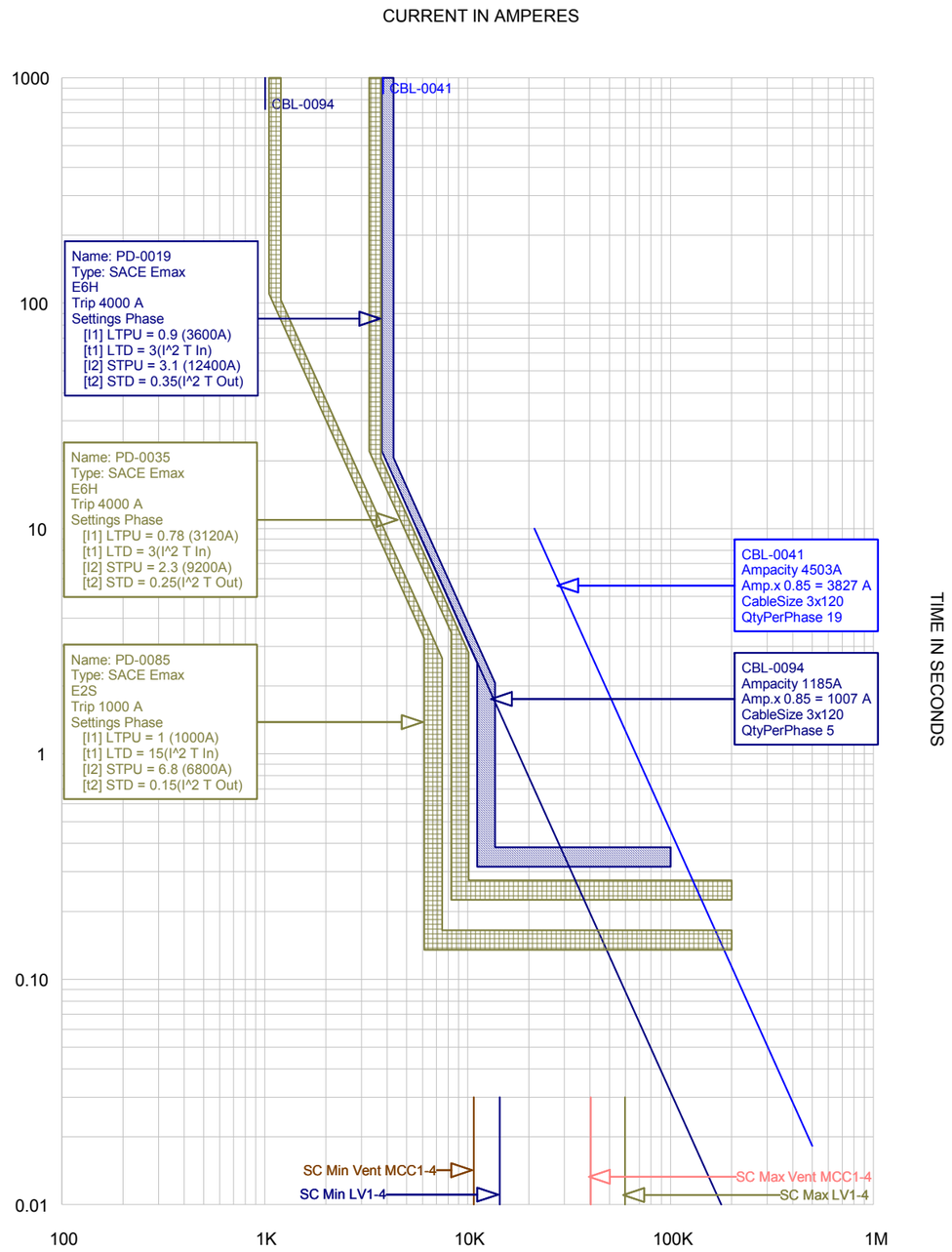


Chart 07.tcc Ref. Voltage: 480 Current in Amps x 1

5.8 Case 8: 11kV Power String from 480V Main LV to DG MCCs

When reading the below description, reference is made to the next diagram page.

480V Incomer:

The 480V incomer breaker shown at chart 8 is repeated to show the discrimination further downstream on 480V level. Incomer protection is set to protect the upstream transformer against overload.

480V Transfer:

The 480V transfer breaker has reduced setting compared with the current capability. This is required to discriminate and isolate the fault between the tie-connected bus and the incomer bus.

480V MCC feeder to DG MCCs:

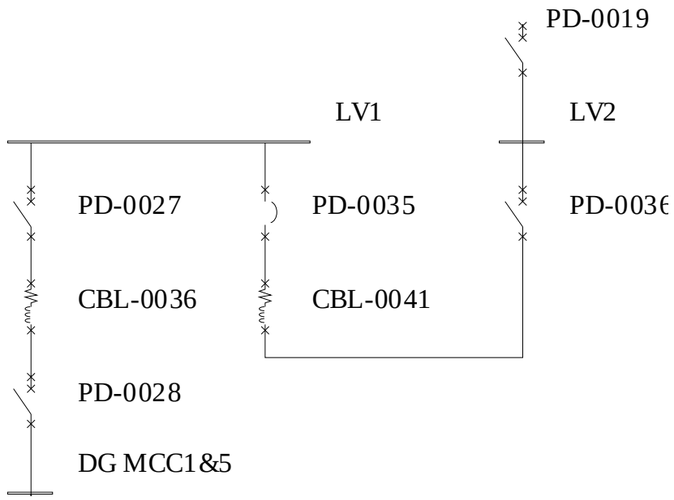
The MCC feeder is set to protect the cables to downstream MCC in case of an overload or a short circuit situation.

Conclusions:

- All cables are protected with enough margins against overload and short circuit.
- Discrimination between the 480V Main LV Incomer breaker, transfer feeders and the feeder to the downstream MCC are obtained.

SC levels		
480V Main LV1-4 swbd:		**480V DG MCC 1-4:**
	Referred to 480V	Referred to 480V
Max I_k'' :	59,6kA	52,0kA
Min I_{k2} :	14,4kA	13,7kA

Tag no	Chart device		Description
82-EN0001B	PD-0019	=	Transformer incomer 480V Main LV, Emax PR122 prot. curve
82-EN0001B	PD-0036	=	Transfer breaker 480V Main LV, Emax PR122 prot. curve
	CBL-0041	=	Transfer cable withstand curve
82-EN0001A	PD-0027	=	Feeder to DG MCCs, Emax PR122 prot. curve
	CBL-0036	=	Feeder cable withstand curve
82-EN0005A	PD-0028	=	MCC incomer Load breaker (no protection)



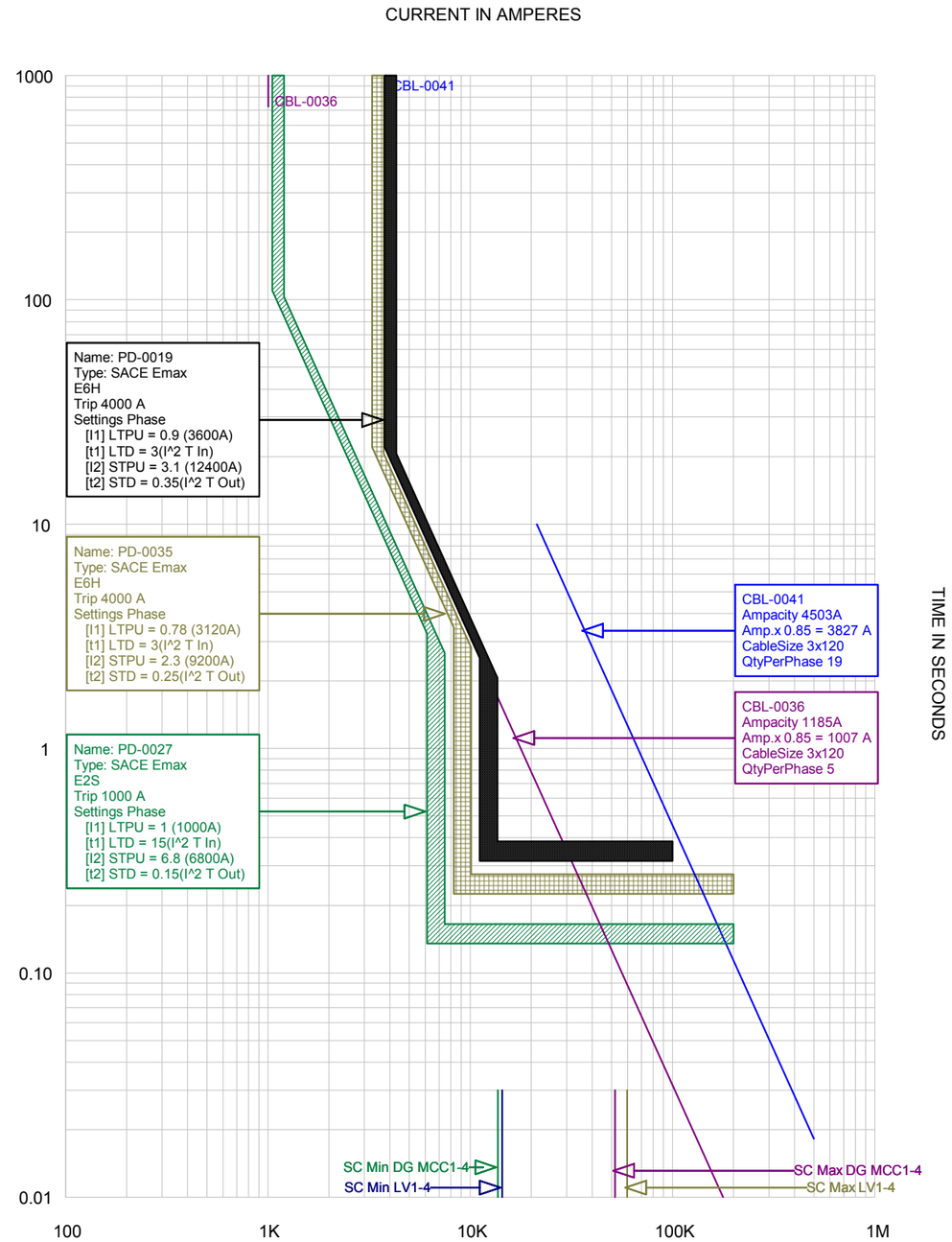


Chart 08.tcc Ref. Voltage: 480 Current in Amps x 1

5.9 Case 9: 11kV Power String from 480V Main LV to Knuckle Boom MCC

When reading the below description, reference is made to the next diagram page.

480V Incomer:

The 480V incomer breaker shown at chart 9 is repeated to show the discrimination further downstream on 480V level. Incomer protection is set to protect the upstream transformer against overload.

480V Transfer:

The 480V transfer breaker has reduced setting compared with the current capability. This is required to discriminate and isolate the fault between the tie-connected bus and the incomer bus.

480V MCC feeder to Knuckle Boom MCC:

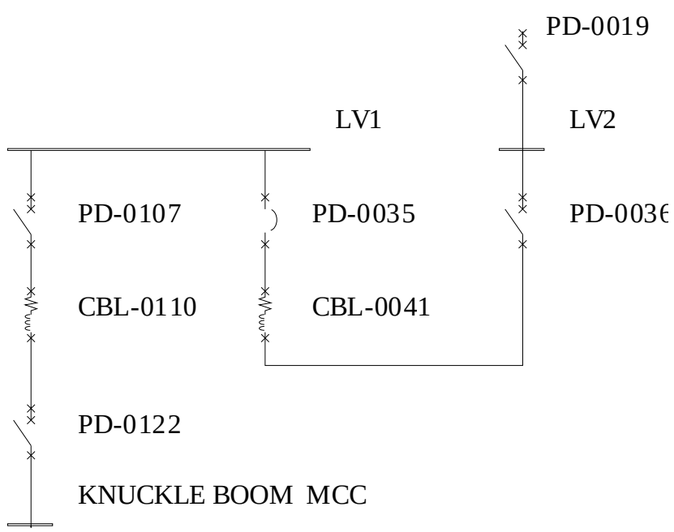
The MCC feeder is set to protect the cables to downstream MCC in case of an overload or a short circuit situation.

Conclusions:

- All cables are protected with enough margins against overload and short circuit.
- Discrimination between the 480V Main LV Incomer breaker, transfer feeders and the feeder to the downstream MCC are obtained.

SC levels		
480V Main LV1-4 swbd:		**480V Knuckle Boom:**
	Referred to 480V	Referred to 480V
Max I_k'' :	59,6kA	21,0kA
Min I_{k2} :	14,4kA	9,0kA

Tag no	Chart device		Description
82-EN0001B	PD-0019	=	Transformer incomer 480V Main LV, Emax PR122 prot. curve
82-EN0001B	PD-0036	=	Transfer breaker 480V Main LV, Emax PR122 prot. curve
	CBL-0041	=	Transfer cable withstand curve
82-EN0001A	PD-0107	=	Feeder to Knuckle Boom, Emax PR122 prot. curve
	CBL-0110	=	Feeder cable withstand curve
Knuckle Boom	PD-0122	=	MCC incomer Load breaker (no protection)



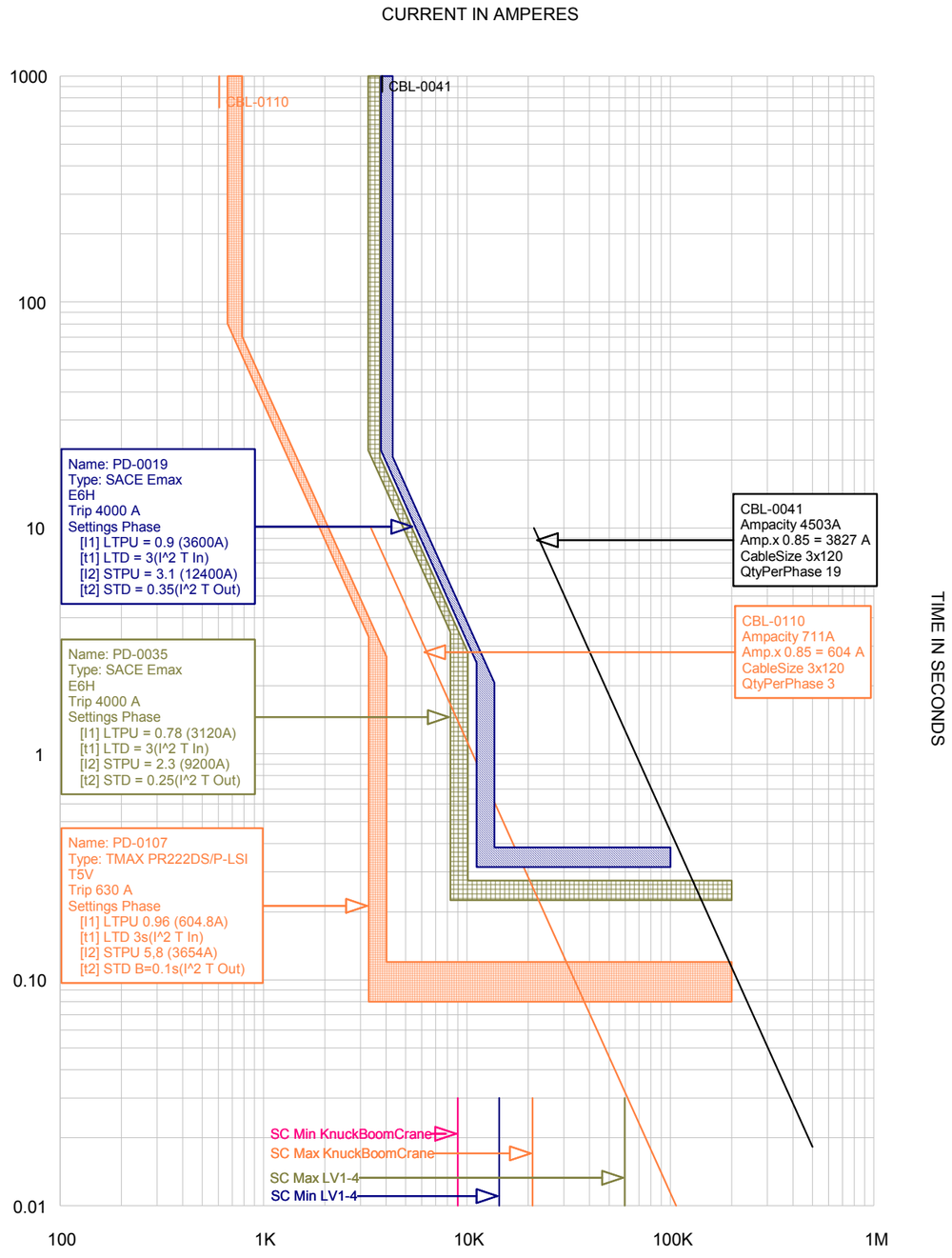


Chart 09.tcc Ref. Voltage: 480 Current in Amps x 1

5.10 Case 10: 11kV Power String from 480V Main LV to HPU MCCs

When reading the below description, reference is made to the next diagram page.

480V Incomer:

The 480V incomer breaker shown at chart 10 is repeated to show the discrimination further downstream on 480V level. Incomer protection is set to protect the upstream transformer against overload.

480V Transfer:

The 480V transfer breaker has reduced setting compared with the current capability. This is required to discriminate and isolate the fault between the tie-connected bus and the incomer bus.

480V MCC feeder to HPU MCCs:

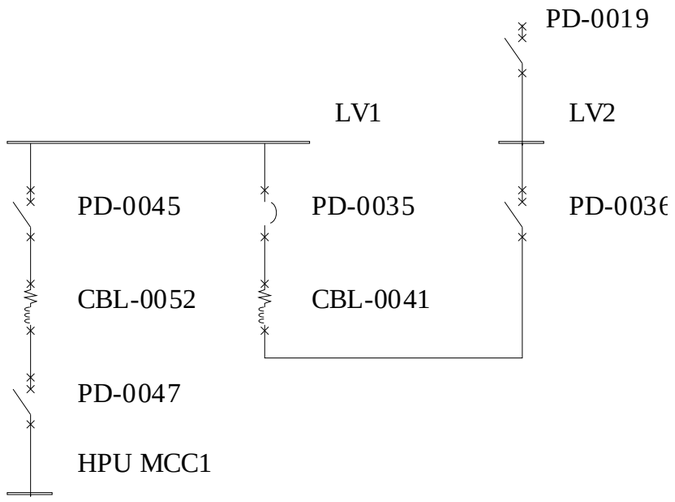
The MCC feeder is set to protect the cables to downstream MCC in case of an overload or a short circuit situation.

Conclusions:

- All cables are protected with enough margins against overload and short circuit.
- Discrimination between the 480V Main LV Incomer breaker, transfer feeders and the feeder to the downstream MCC are obtained.

SC levels	
480V Main LV1-4 swbd:	**480V HPU MCC 1-2:**
Referred to 480V	Referred to 480V
Max I_k'' : 59,6kA	25,3kA
Min I_{k2} : 14,4kA	9,5kA

Tag no	Chart device		Description
82-EN0001B	PD-0019	=	Transformer incomer 480V Main LV, Emax PR122 prot. curve
82-EN0001B	PD-0036	=	Transfer breaker 480V Main LV, Emax PR122 prot. curve
	CBL-0041	=	Transfer cable withstand curve
82-EN0001A	PD-0045	=	Feeder to HPU MCCs, Emax PR122 prot. curve
	CBL-0052	=	Feeder cable withstand curve
82-EN0010A	PD-0047	=	MCC incomer Load breaker (no protection)



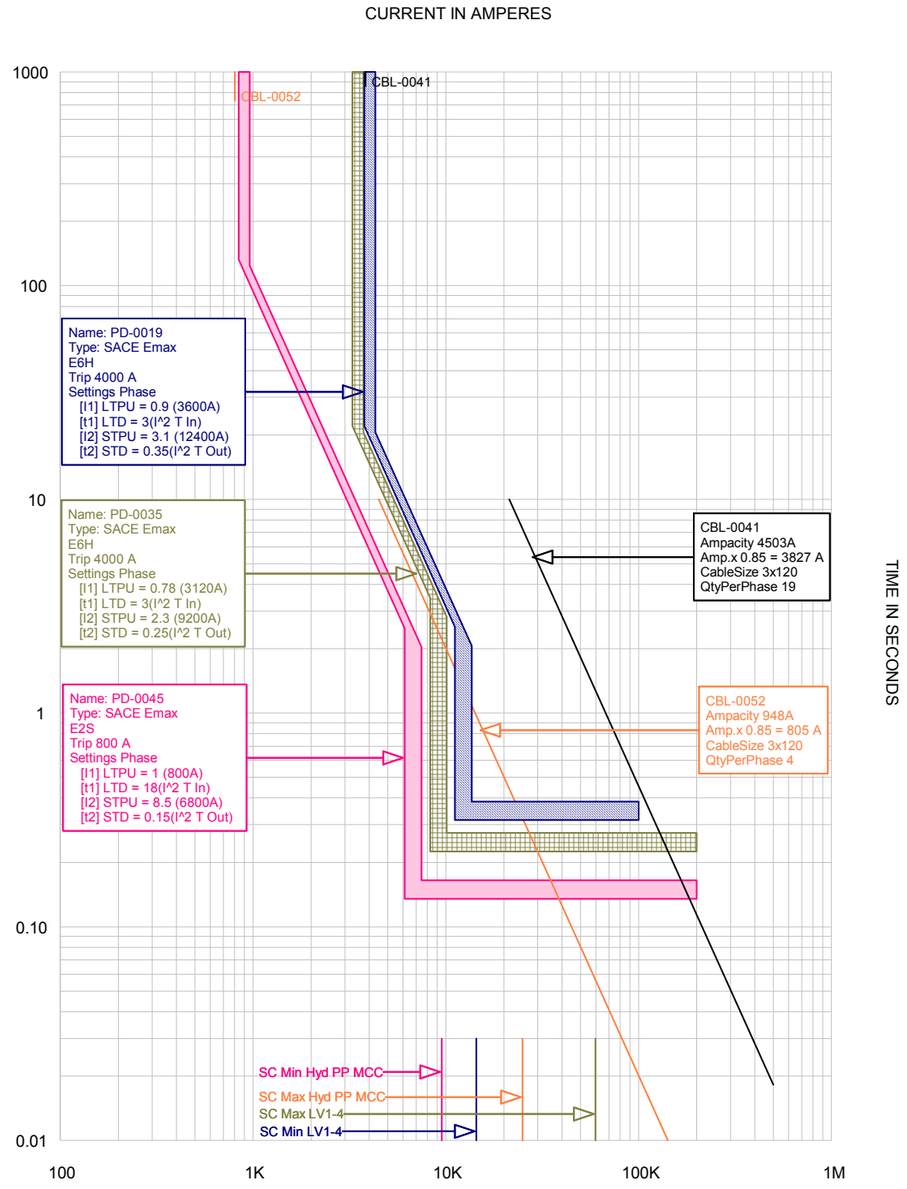


Chart 10.tcc Ref. Voltage: 480 Current in Amps x 1

5.11 Case 11: 11kV Power String from 480V Main LV to Pump MCCs

When reading the below description, reference is made to the next diagram page.

480V Incomer:

The 480V incomer breaker shown at chart 11 is repeated to show the discrimination further downstream on 480V level. Incomer protection is set to protect the upstream transformer against overload.

480V Transfer:

The 480V transfer breaker has reduced setting compared with the current capability. This is required to discriminate and isolate the fault between the tie-connected bus and the incomer bus.

480V MCC feeder to Pump MCCs:

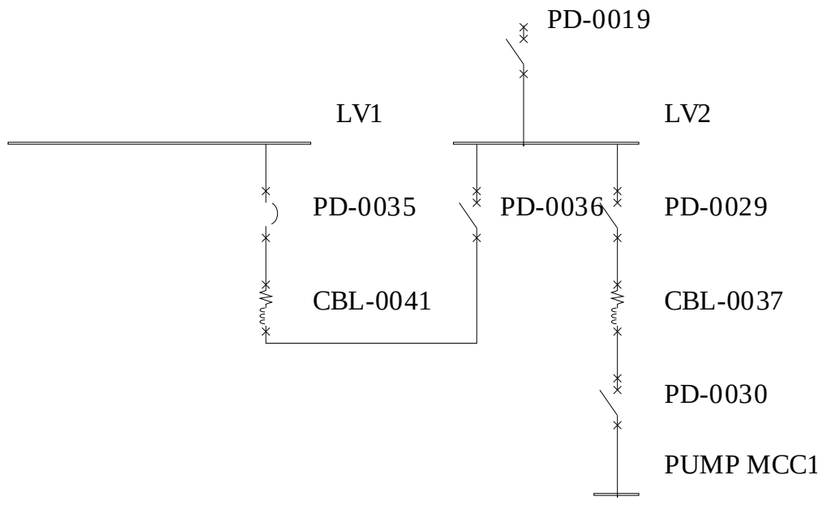
The MCC feeder is set to protect the cables to downstream MCC in case of an overload or a short circuit situation.

Conclusions:

- All cables are protected with enough margins against overload and short circuit.
- Discrimination between the 480V Main LV Incomer breaker, transfer feeders and the feeder to the downstream MCC are obtained.

SC levels		
480V Main LV1-4 swbd:		**480V Pump Room MCC 1 / 4:**
	Referred to 480V	Referred to 480V
Max I_k'' :	59,6kA	44,6kA
Min I_{k2} :	14,4kA	11,4kA

Tag no	Chart device		Description
82-EN0001B	PD-0019	=	Transformer incomer 480V Main LV, Emax PR122 prot. curve
82-EN0001B	PD-0036	=	Transfer breaker 480V Main LV, Emax PR122 prot. curve
	CBL-0041	=	Transfer cable withstand curve
82-EN0001B	PD-0029	=	Feeder to Pump Room MCC no 1 & 4, Emax PR122 prot. curve
	CBL-0037	=	Feeder cable withstand curve
82-EN0007B	PD-0030	=	MCC incomer Load breaker (no protection)



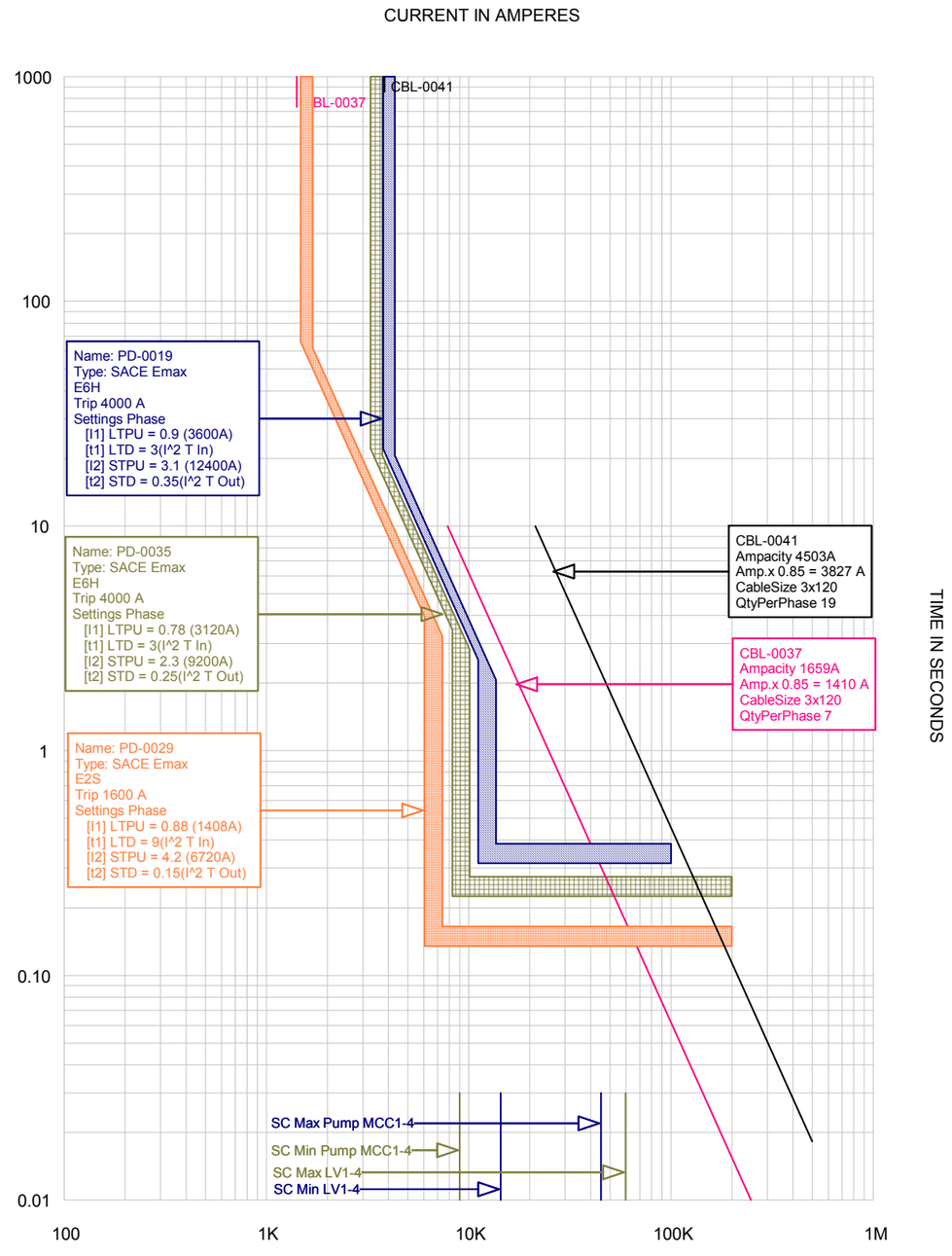


Chart 11.tcc Ref. Voltage: 480 Current in Amps x 1

Doc. kind Report Title Protective Relay Coordination Study	Project HAI YANG SHI YOU 981 Customer China National Offshore Oil Corp. Proj. no. P018922				
ABB AS	Doc. no. 3AJM000865-032	Lang. en	Rev. ind.	Page 34 No. of p. 61	

5.12 Case 12: 11kV Power String from 480V Main LV to Mud Pump MCCs

When reading the below description, reference is made to the next diagram page.

480V Incomer:

The 480V incomer breaker shown at chart 12 is repeated to show the discrimination further downstream on 480V level. Incomer protection is set to protect the upstream transformer against overload.

480V Transfer:

The 480V transfer breaker has reduced setting compared with the current capability. This is required to discriminate and isolate the fault between the tie-connected bus and the incomer bus.

480V MCC feeder to Mud Pump MCCs:

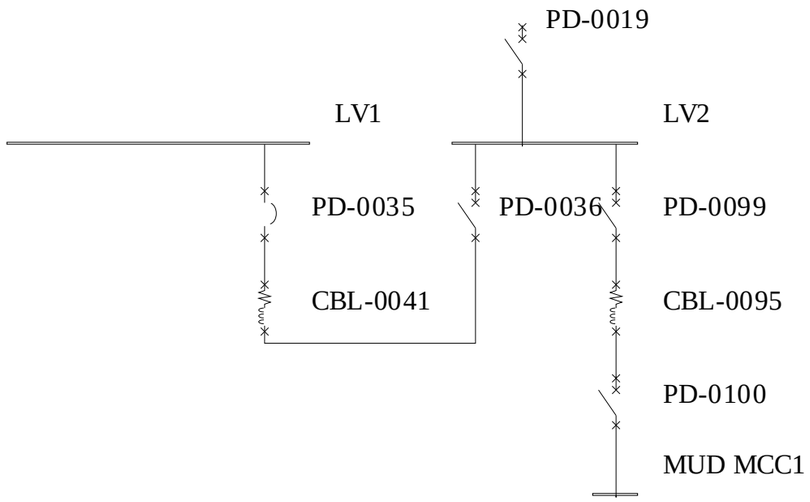
The MCC feeder is set to protect the cables to downstream MCC in case of an overload or a short circuit situation.

Conclusions:

- All cables are protected with enough margins against overload and short circuit.
- Discrimination between the 480V Main LV Incomer breaker, transfer feeders and the feeder to the downstream MCC are obtained.

SC levels		
480V Main LV1-4 swbd:		**480V Mud Pump MCC 1 / 2:**
	Referred to 480V	Referred to 480V
Max I_k'' :	59,6kA	53,7kA
Min I_{k2} :	14,4kA	13,8kA

Tag no	Chart device		Description
82-EN0001B	PD-0019	=	Transformer incomer 480V Main LV, Emax PR122 prot. curve
82-EN0001B	PD-0036	=	Transfer breaker 480V Main LV, Emax PR122 prot. curve
	CBL-0041	=	Transfer cable withstand curve
82-EN0001B	PD-0099	=	Feeder to Mud Pump Room MCC no 1 & 2, Emax PR122 prot. curve
	CBL-0095	=	Feeder cable withstand curve
82-EN0009A	PD-0100	=	MCC incomer Load breaker (no protection)



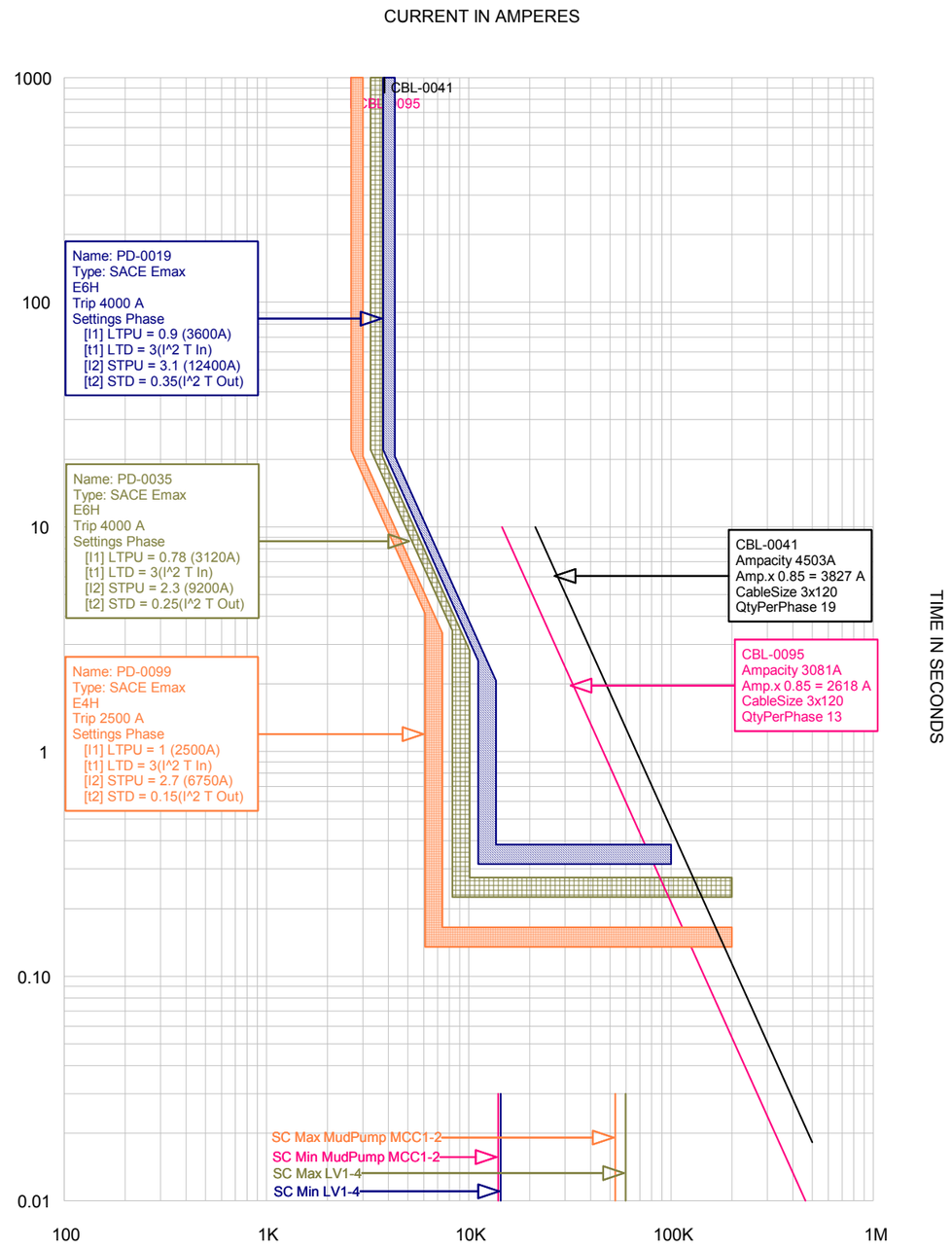


Chart 12.tcc Ref. Voltage: 480 Current in Amps x 1

5.13 Case 13: 11kV Power String from 480V Main LV to Drilling MCCs

When reading the below description, reference is made to the next diagram page.

480V Incomer:

The 480V incomer breaker shown at chart 13 is repeated to show the discrimination further downstream on 480V level. Incomer protection is set to protect the upstream transformer against overload.

480V Transfer:

The 480V transfer breaker has reduced setting compared with the current capability. This is required to discriminate and isolate the fault between the tie-connected bus and the incomer bus.

480V MCC feeder to Drilling MCCs:

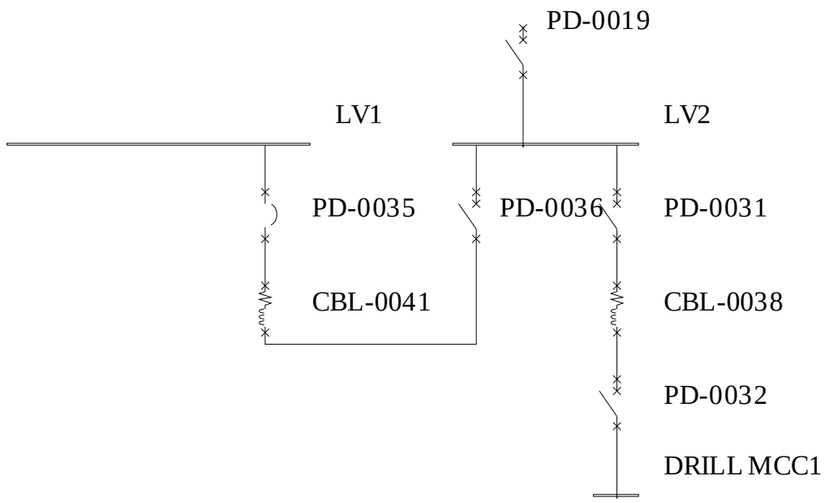
The MCC feeder is set to protect the cables to downstream MCC in case of an overload or a short circuit situation.

Conclusions:

- All cables are protected with enough margins against overload and short circuit.
- Discrimination between the 480V Main LV Incomer breaker, transfer feeders and the feeder to the downstream MCC are obtained.

SC levels		
480V Main LV1-4 swbd:		**480V Drilling MCC 1 / 2:**
	Referred to 480V	Referred to 480V
Max I_k'' :	59,6kA	37,1kA
Min I_{k2} :	14,4kA	11,7kA

Tag no	Chart device		Description
82-EN0001B	PD-0019	=	Transformer incomer 480V Main LV, Emax PR122 prot. curve
82-EN0001B	PD-0036	=	Transfer breaker 480V Main LV, Emax PR122 prot. curve
	CBL-0041	=	Transfer cable withstand curve
82-EN0001B	PD-0031	=	Feeder to Drilling MCC no 1 & 2, Emax PR122 prot. curve
	CBL-0038	=	Feeder cable withstand curve
82-EN0006A	PD-0032	=	MCC incomer Load breaker (no protection)



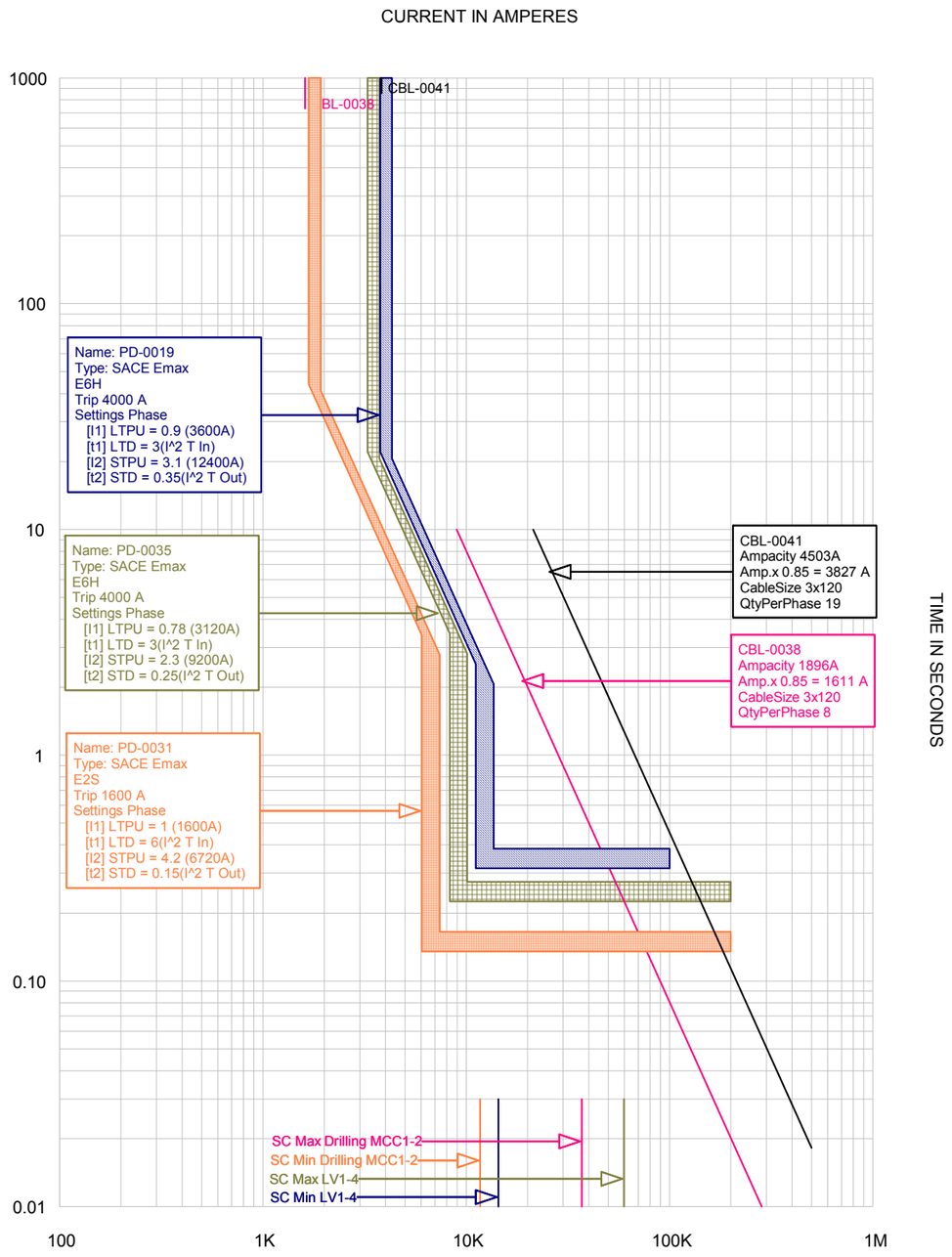


Chart 13.tcc Ref. Voltage: 480 Current in Amps x 1

5.14 Case 14: Power String from 480V Main LV to 480V Emergency MCC

When reading the below description, reference is made to the next diagram page.

Normal mode

480V Incomer:
The 480V incomer breaker shown at chart 14 is repeated to show the discrimination further downstream on 480V level. Incomer protection is set to protect the upstream transformer against overload.

480V Transfer:
The 480V transfer breaker has reduced setting compared with the current capability. This is required to discriminate and isolate the fault between the tie-connected bus and the incomer bus.

480V MCC feeder to Emergency MCC:
The MCC feeder is set to protect the cables to the emergency MCC in case of an overload or a short circuit situation. The protection is also set with correct discrimantion against upstream transfer and incomer breakers on the 480V Main LV switchboards.

Emergency mode:

Emergency Generator:
The generator decaying three phase short circuit current is shown by AC and AC+DC total.

As a general rule, the generator overload withstand curve is $I_N^2t \approx 100$, where I_N is in pu. "Gen SC" point represents the damage point for the generator and this point is shown at the transient (Xd') stage of the generator short circuit capability. The generator's sustained short circuit current is given in equation (1) and (2).
The overcurrent protection is set to 110% of In based on the Rule requirement for generator overload - 110% overload for 1 hour.

In general, the generator load must be controlled and monitored by the power management system (PMS) by reducing the load or execute preferential trip to non-essential consumers. The generator is not intended to be continous overloaded and it will be tripped by generator breaker if the load is not reduced by PMS.

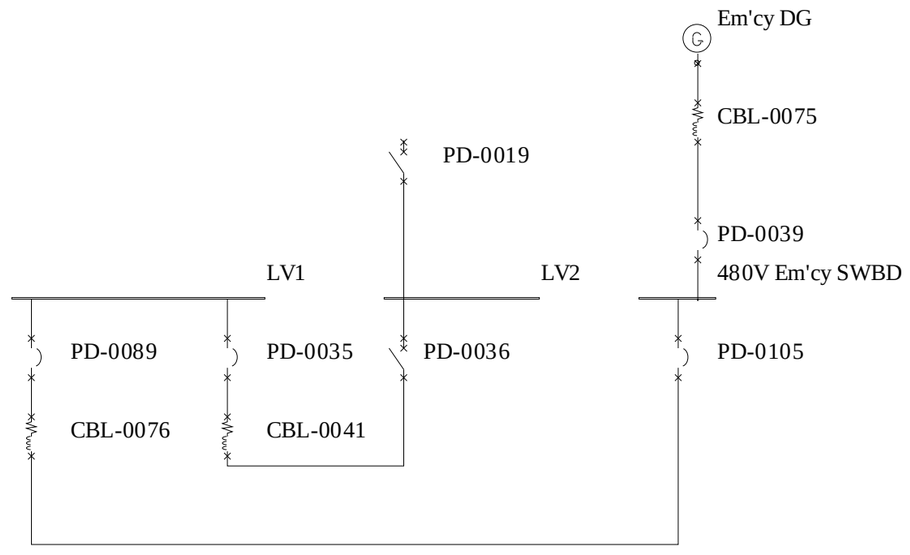
480V Emergency feeder to480V Main LV – transient case:
The MCC feeder is set to protect the cables to the main LV in case of an overload or a short circuit situation.
Reference is also made to ABS Rules for Mobile Drilling units 2006 part 4 - Ch. 4.3.2 item 5.9.4

Conclusions:

- All cables are protected with enough margins against overload and short circuit.
- Discrimination between the 480V Main LV Incomer breaker, transfer feeders, feeder to Emergency MCC and the Emergency Incomer breaker are obtained in both power directions.

SC levels		
480V Main LV1-4 swbd:		**480V Emergency MCC:**
	Referred to 480V	Referred to 480V
Max I_k'' :	59,6kA	46,1kA
Min I_{k2} :	14,4kA	13,2kA

Tag no	Chart device		Description
82-EN0001B	PD-0019	=	Transformer incomer 480V Main LV, Emax PR122 prot. curve
82-EN0001B	PD-0036	=	Transfer breaker 480V Main LV, Emax PR122 prot. curve
	CBL-0041	=	Transfer cable withstand curve
82-EN0001B	PD-0089	=	Transfer breaker to Emergency MCC, Emax PR122 prot. curve
	CBL-0076	=	Feeder cable withstand curve
Emergency Generator	Em'cy DG	=	Decaying generator short circuit current
	Gen SC	=	Generator overload withstand point
84-EN0001	PD-0039	=	Generator Incomer, Emax PR122 prot. curve
	CBL-0075	=	Generator cable withstand curve
84-EN0001	PD-0105	=	Transfer breaker to 480V Main LV1, Emax PR122 prot. curve



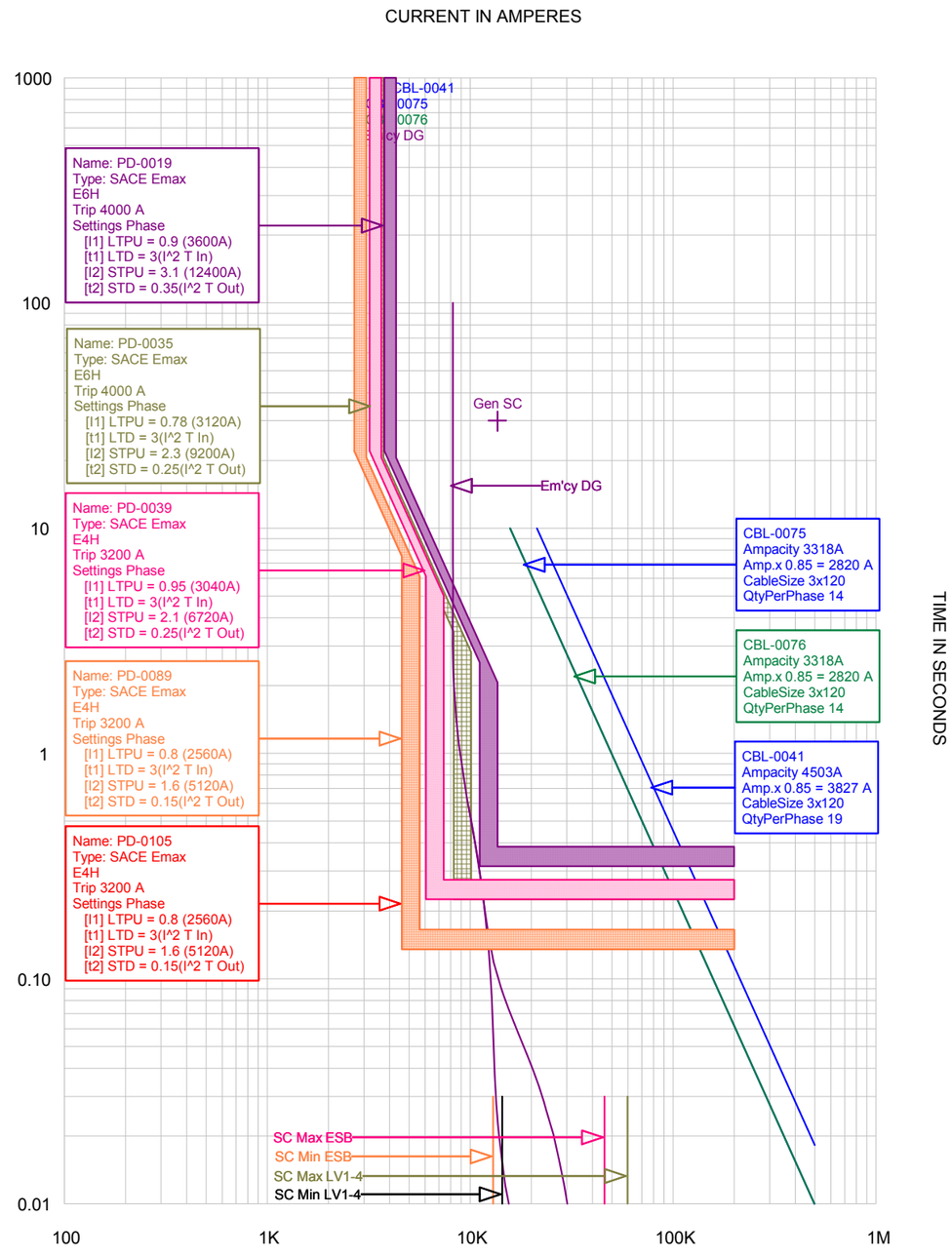


Chart 14.tcc Ref. Voltage: 480 Current in Amps x 1

5.15 Case 15: 480V Power String to Emergency 230V Distribution Boards

When reading the below description, reference is made to the next diagram page.

Emergency Generator:

The generator decaying three phase short circuit current is shown by AC and AC+DC total.

As a general rule, the generator overload withstand curve is $I_N^2t \approx 100$, where I_N is in pu. "Gen SC" point represents the damage point for the generator and this point is shown at the transient (Xd') stage of the generator short circuit capability. The generator's sustained short circuit current is given in equation (1) and (2).
The overcurrent protection is set to 110% of In based on the Rule requirement for generator overload - 110% overload for 1 hour.

In general, the generator load must be controlled and monitored by the power management system (PMS) by reducing the load or execute preferential trip to non-essential consumers. The generator is not intended to be continous overloaded and it will be tripped by generator breaker if the load is not reduced by PMS.

480V/230V Emergency Transformer feeder:

The 480V transformer feeder is set to protect the 480/230V transformer and the transformer cables, primary and secondary in case of a short circuit or an overload situation..

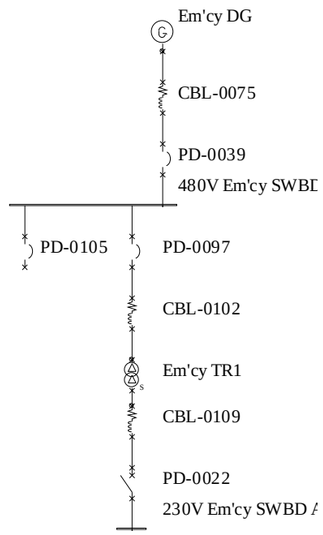
Transformer PT100 elements are available for connection to PMS.

Conclusions:

- All cables are protected with enough margins against overload and short circuit.
- Discrimination between the Emergency Incomer breaker, the 480V transfer breaker and the 480/230V transfomer feeder are obtained in overload and short circuit situations.

SC levels			
Emergency 480V swbd:		**Emergency 230V swbd:**	
	Referred to 480V	Referred to 480V	Referred to 230V
Max I_k'' :	46,1kA	3,8kA	7,9kA
Min I_{k2} :	13,2kA	2,83kA	5,9kA

Tag no	Chart device		Description
Emergency Generator	Em'cy DG	=	Decaying generator short circuit current
	Gen SC	=	Generator overload withstand point
84-EN0001	PD-0039	=	Generator Incomer, Emax PR122 prot. curve
	CBL-0075	=	Generator cable withstand curve
84-EN0001	PD-0105	=	Transfer breaker to 480V Main LV1, Emax PR122 prot. curve
84-EN0001	PD-0097	=	Transformer feeder to 230V Emergency DB, Emax PR122 prot. curve
	CBL-0102	=	Transformer primary cable withstand curve
84-ET0001A	Em'cy TR1:		Emergency distribution transformer
	TX Inrush	=	Transformer half-peak inrush current / time
	Thermal	=	Transformer thermal ability to withstand short circuit
	Dynamic	=	Transformer ability to withstand the dynamic effects of a short circuit
84-EL0001	PD-0022	=	Transformer incomer 230V Emergency DB, (no protection)
	CBL-0109	=	Transformer secondary cable withstand curve



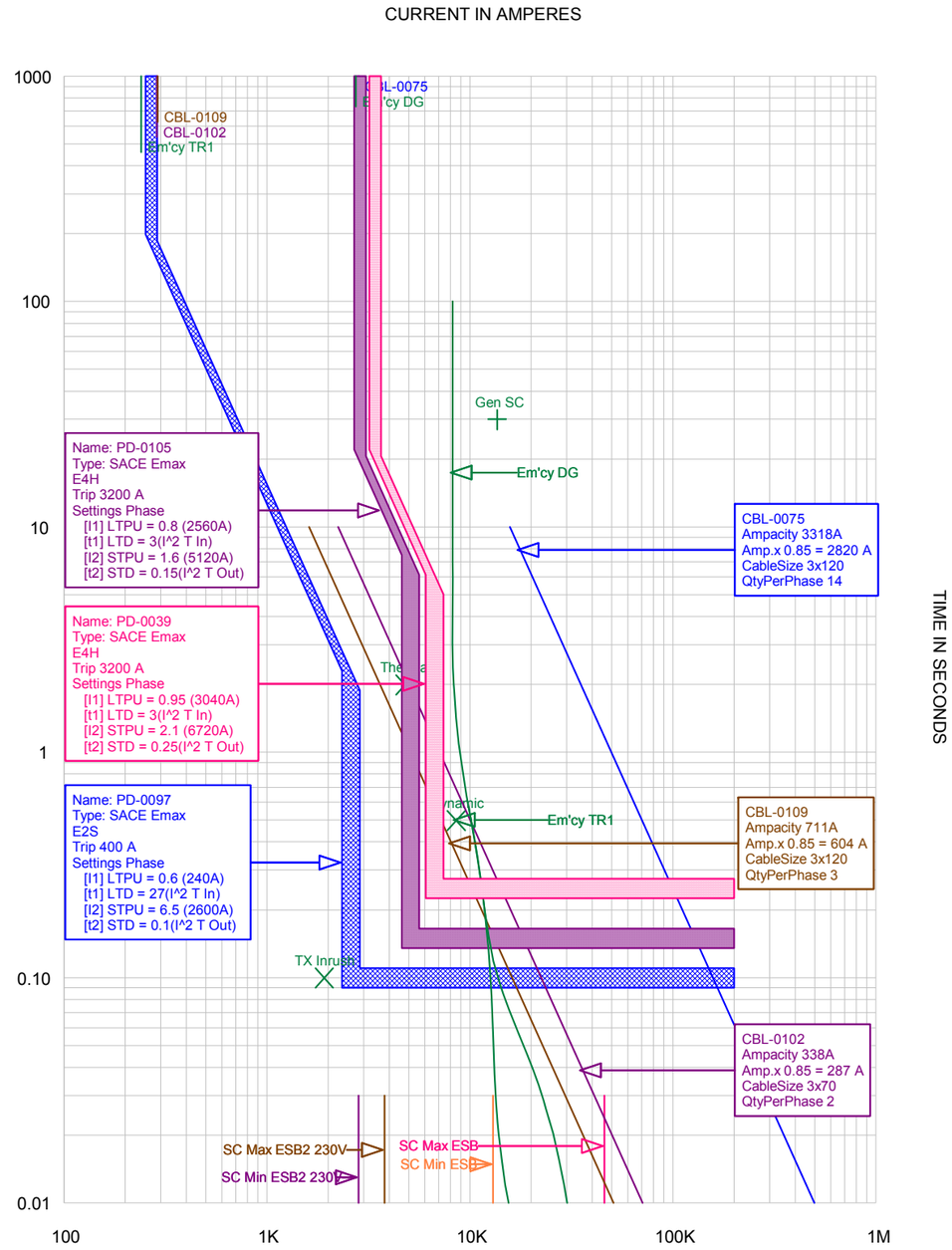


Chart 15.tcc Ref. Voltage: 480 Current in Amps x 1

5.16 Case 16: 480V Power String to Pontoon 230V Distribution Boards

When reading the below description, reference is made to the next diagram page.

480V Incomer:
The 480V incomer breaker shown at chart 14 is repeated to show the discrimination further downstream on 480V level. Incomer protection is set to protect the upstream transformer against overload.

480V Transfer:
The 480V transfer breaker has reduced setting compared with the current capability. This is required to discriminate and isolate the fault between the tie-connected bus and the incomer bus.

480V/230V Main Transformer feeder:
The 480V transformer feeder is set to protect the 480/230V transformer and the transformer cables, primary and secondary in case of a short circuit or an overload situation..

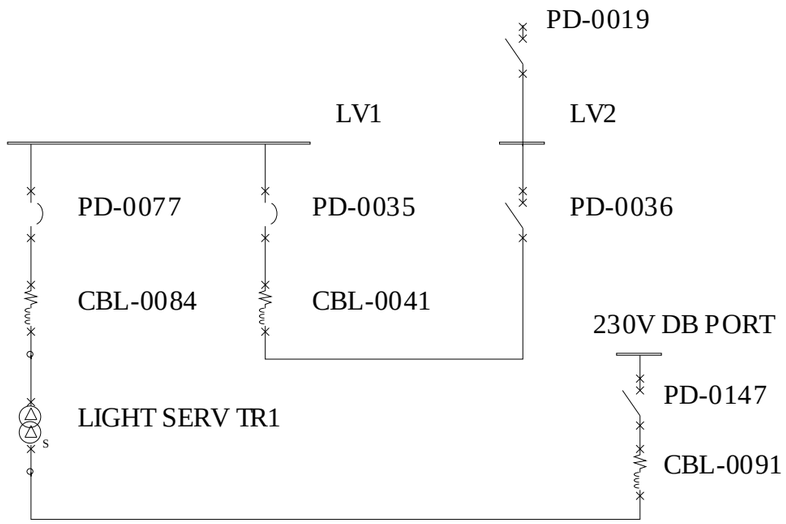
Transformer PT100 elements are available for connection to PMS.

Conclusions:

- All cables are protected with enough margins against overload and short circuit.
- Discrimination between the 480V Main LV Incomer breaker, transfer feeders and the 480/230V transfomer feeder are obtained in overload and short circuit situations.

SC levels			
480V Main LV1-4 swbd:		**Main 230V swbd:**	
	Referred to 480V	Referred to 480V	Referred to 230V
Max I_k'' :	59,6kA	5,0kA	10,6kA
Min I_{k2} :	14,4kA	2,9kA	6,1kA

Tag no	Chart device		Description
82-EN0001B	PD-0019	=	Transformer incomer 480V Main LV, Emax PR122 prot. curve
82-EN0001B	PD-0036	=	Transfer breaker 480V Main LV, Emax PR122 prot. curve
	CBL-0041	=	Transfer cable withstand curve
82-EN0001A	PD-0077	=	Transformer feeder to 230V Main DB, Emax PR122 prot. curve
	CBL-0084	=	Transformer primary cable withstand curve
82-ET0003A	Light Serv. TR1:		Emergency distribution transformer
	TX Inrush	=	Transformer half-peak inrush current / time
	Thermal	=	Transformer thermal ability to withstand short circuit
	Dynamic	=	Transformer ability to withstand the dynamic effects of a short circuit
82-EL0001A	PD-0147	=	Transformer incomer 230V Main DB, (no protection)
	CBL-0091	=	Transformer secondary cable withstand curve



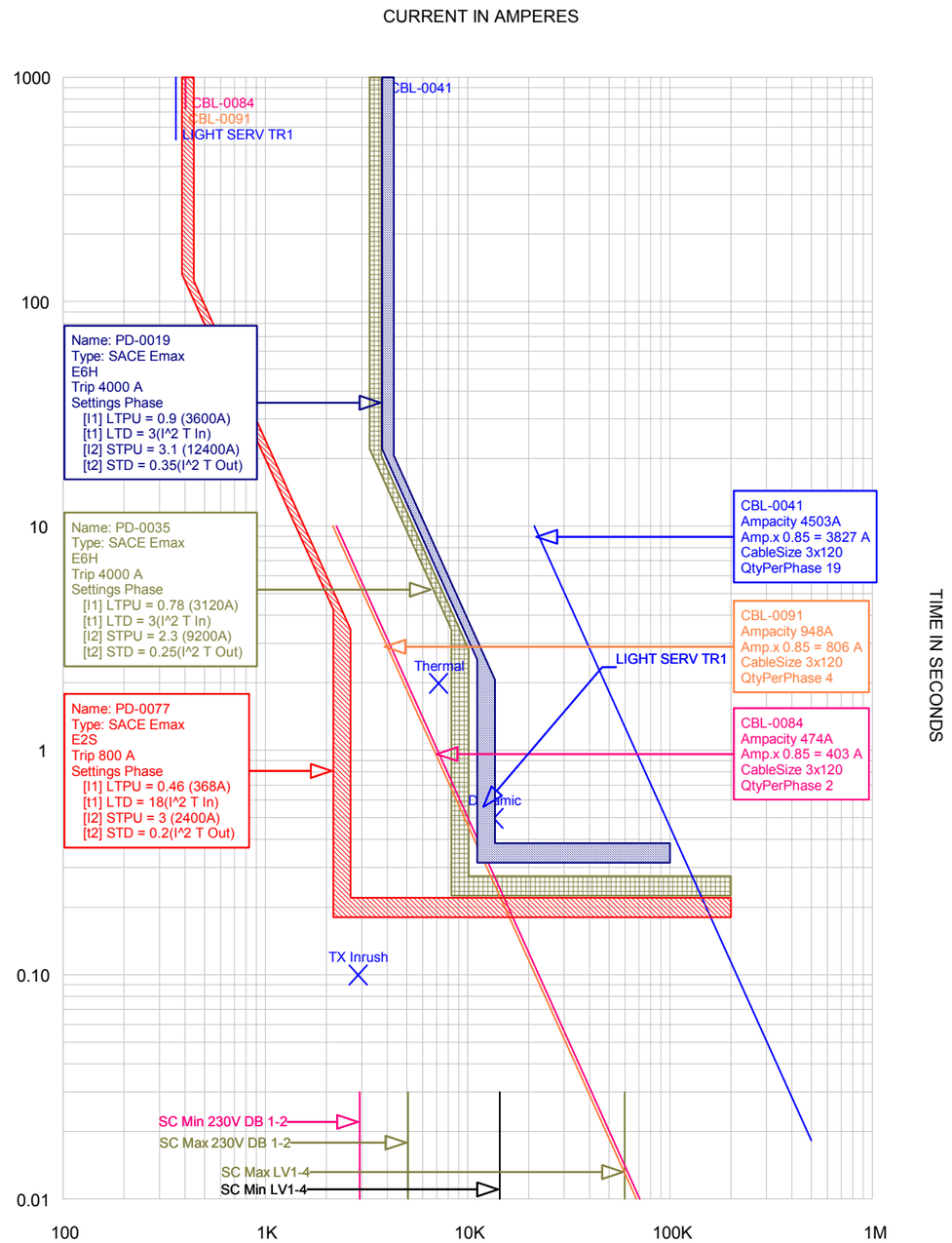


Chart 16.tcc Ref. Voltage: 480 Current in Amps x 1

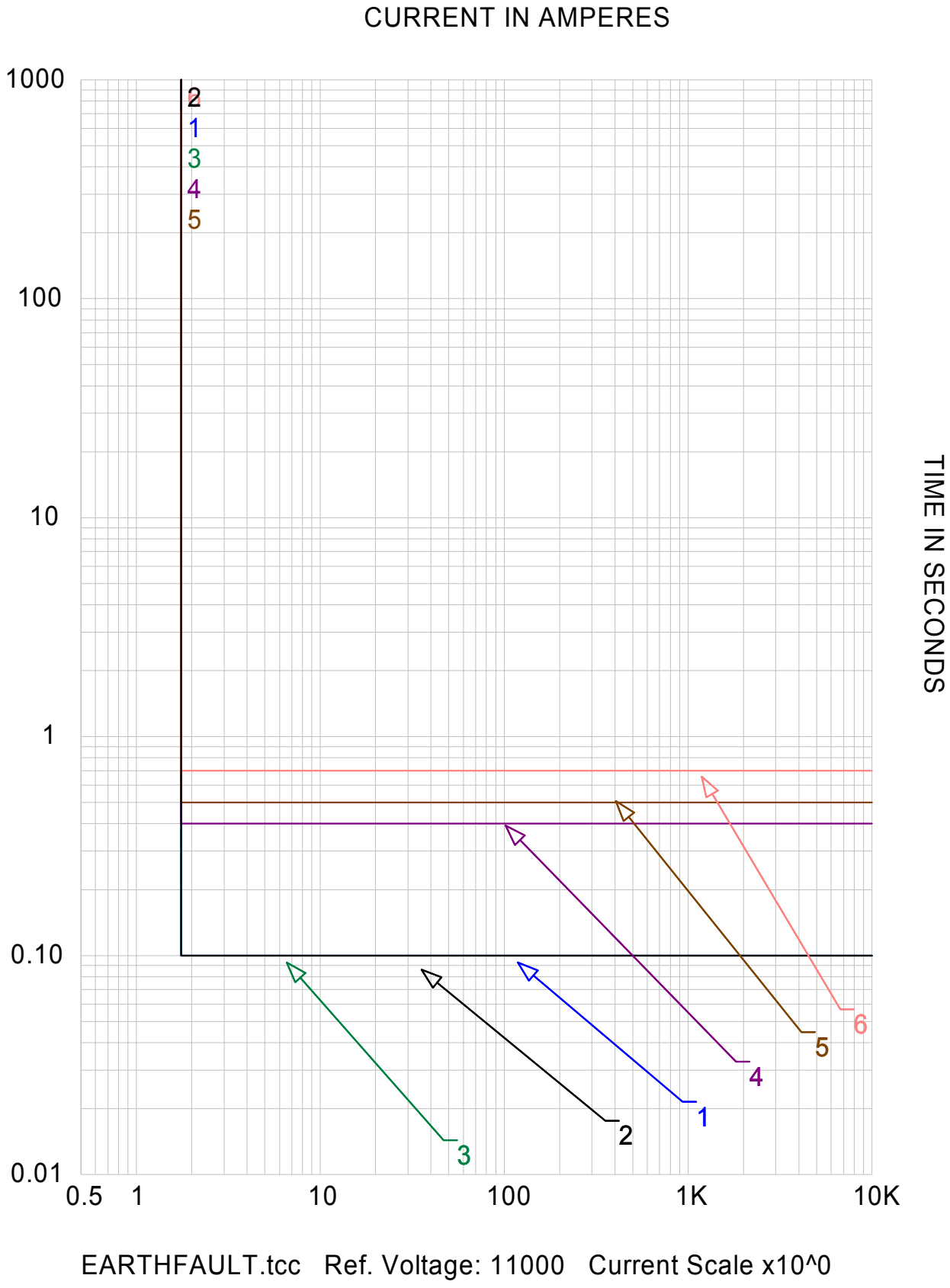
Doc. kind Report Title Protective Relay Coordination Study	Project HAI YANG SHI YOU 981 Customer China National Offshore Oil Corp. Proj. no. P018922				
ABB AS	Doc. no. 3AJM000865-032	Lang. en	Rev. ind.	Page 44 No. of p. 61	

5.17 Case 17: Earth fault protection for 11kV switchboards

The earth fault protection philosophy is described in section 4 System protection. To provide selectivity, the following time delays are applied:

Fault in	Protection function	Action	Time delay [s]	Curve ref.
Generator or its cables	Non-directional earth fault relay in feeder	Trip generator CB and de-excitate generator	0,1	1
Transformer primary side or its feeding cables	Non-directional earth fault relay in feeder	Trip transformer CB	0,1	2
Transfer cables between MV switchboards	Directional earth fault relay in both ends of cable	Trip transfer CB's	0,1	3
Switchboard	Directional earth fault relay in opposite transfer feeders	Opposite feeder trips and send intertrip to incoming transfer breaker on the faulty switchboard. Faulty switchboard is then isolated from healthy part of network.	0,4	4
	Residual overvoltage relay on faulty switchboard	Act as backup protection for the transfer breaker directional earth fault protection. Faulty switchboard is then isolated from healthy part of network.	0,5	5
		Trip generator CB's connected to faulty bus and de-excitate the generator. Faulty switchboard is then completely isolated.	0,7	6

The time-current chart shows the time delays and selectivity. Selectivity are obtained for an earth fault situation in the high voltage system.



6. Setting tables

6.1 11kV Switchboards – Generator incomer

Rated power	S_n=	6912	kVA	CT Ratio	I_{CT}=	400/1	A
Rated voltage	U_n=	11000	V	Ring CT Ratio	I_{RCT}=	70/1	A
Rated current	I_n=	363	A	VT Ratio	U_{CT}=	$11000/\frac{110}{\sqrt{3}}$	V
Power factor	cos φ =	0,8					
				Scaling factor	I_{CT} / I_n=	1,10	

IEEE 51	IEC 3I>	Desc. Three-phase non-directional overcurrent				Code NOC3Low
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 7 [1]	2	-	-	-	Trip	
Start current (I>)	0,10 - 5,00	1,1	× I_n	399,3	A		
Operating time	0,05 - 300,00	NA	s	-	-		at DT mode
Time multiplier (k)	0,05 - 1,00	0,3	-	-	-		at IDMT mode

[1] Operation mode: 0 = Not in use 1 = Definite time 2 = Extremely inv. 3 = Very inv. 4 = Normal inv. 5 = Long time inv. 6 = RI-type inv. 7 = RD-type inv.

IEEE 50	IEC 3I>>	Desc. Three-phase non-directional overcurrent				Code NOC3High
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 2 [1]	1	-	-	-	Trip	
Start current (I>)	0,10 - 40,00	2,4	× I_n	871,2	A		
Operating time	0,05 - 300,00	1,0	s	-	-		at DT mode

[1] Operation mode: 0 = Not in use 1 = Definite time 2 = Instantaneous

IEEE 87G	IEC 3ΔI> and 3ΔI>>	Desc. Three-phase differential current				Code Diff6G
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Basic setting ($\Delta I/I_n$)	5 - 50	10	%	36,3	A	Trip	Lowest ΔI / I_n to cause trip
Starting ratio	10 - 50	15	%	54,5			Slope of sec line of oper. char.
Turn-point 1	0,0 - 1,0	0	× I_n	0	A		Between first and sec line
Turn-point 2	1,0 - 3,0	1	× I_n	363	A		Between sec and third line
Inst. setting (ΔI>>)	5 - 30	15	× I_n	5445	A		

IEEE 32	IEC P>←	Desc. Three-phase reverse power				Code UPOW6St1
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Power setting	1,0 - 200,0	10	%S_n	691	kVA	Trip	
Operation mode	0 - 1 [1]	1	-	-	-		
Operate time	0,04 - 300,00	3	s	-	-		
Wait time	0,0 - 60,0	1	s	-	-		Waiting time after closing cb
Disable mode	0 - 1 [2]	0	-	-	-		

[1] Operation mode: 0 = Underpower 1 = Reverse power
[2] Disable mode: 0 = OFF 1 = ON

IEEE 40	IEC X<<	Desc. Three-phase underexcitation				Code UE6High
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Circle offset	÷ 10,0 - 10,0	0	pu	-	-	Trip	Dist. of top of imp. circle from R-axis
Circle diameter	0,01 - 60,00	2,5	pu	-	-		
Circle displacement	÷ 10,0 - 10,0	0	pu	-	-		Displ. of center of imp. circle from X-axis
Operate time	0,06 - 10,00	3	s	-	-		

IEEE 81U	IEC f<	Desc. Three-phase underfrequency				Code Freq1St1
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 6 [1)]	1	-	-	-	Trip	
Voltage limit	0,30 - 0,90	0,3	× U_n	3300	V		Undervoltage limit for blocking
Start frequency	25,00 - 75,00	54	Hz	-	-		Start value for U/O frequency protection
Operate time 1	0,10 - 200,00	5	s	-	-		For U/O frequency protection
Start df/dt	0,2 - 10,0	NA	Hz/s	-	-		Start value for freq. rate of change
Operate time 2	0,12 - 120,00	NA	s	-	-		Timer for df/dt or U/O frequency prot.

[1)] Operation mode: 0 = Not in use 1 = f</f> 1 timer 2 = f</f> 2 timers 3 = f</f> or df/dt> 4 = f</f> and df/dt> 5 = f</f> or df/dt< 6 = f</f> and df/dt<

IEEE 46	IEC I_2>	Desc. Negative-phase-sequence				Code NPS3Low
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 2 [1)]	2	-	-	-	Trip	
Start value	0,01 - 0,50	0,08	× I_n	29,0	A		
Operate time	0,1 - 120,0	-	s	-	-		For definite time
K	5,0 - 100,0	20	-	-	-		Operating characteristic constant $(I_2)^2t$
Start delay	0,1 - 60,0	1	s	-	-		Definite start time in inverse time mode
Minimum time	0,1 - 120,0	2	s	-	-		Definite minimum operate time
Maximum time	500 - 1000	1000	s	-	-		Max operate time
Cooling time	5 - 10000	1000	s	-	-		Time required to cool the machine

[1)] Operation mode: 0 = Not in use 1 = Definite time 2 = Inverse time

IEEE 27	IEC U<	Desc. Three-phase undervoltage				Code UV3Low
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 2 [1)]	1	-	-	-	Trip	
Start voltage	0,30 - 1,20	0,6	× U_n	6600	V		
Operate time	0,1 - 120,0	3,0	s	-	-		at DT mode
Time multiplier	0,1 - 1,0	NA	-	-	-		at IDMT mode

[1)] Operation mode: 0 = Not in use 1 = Definite time 2 = Curve

Group 1

IEEE 59	IEC U>>	Desc. Three-phase overvoltage				Code OV3Low
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 1 [1)]	1	-	-	-		
Start voltage	0,10 - 1,60	1,2	$\times U_n$	13200	V	Alarm	
Operate time	0,05 - 300,0	0,6	s	-	-		at DT mode

[1)] Operation mode: 0 = Not in use 1 = Definite time

Group 2 – CB Open or Withdrawn

IEEE 59	IEC U>>	Desc. Three-phase overvoltage				Code OV3Low
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 1 [1)]	1	-	-	-		
Start voltage	0,10 - 1,60	1,2	$\times U_n$	13200	V	Alarm	
Operate time	0,05 - 300,0	0,1	s	-	-		at DT mode

[1)] Operation mode: 0 = Not in use 1 = Definite time

IEEE 51N	IEC I0>	Desc. Earth fault, non-directional				Code NEF1Low
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 7 [*)]	1	-		-		
Start current	1,0 - 100,0	2,0	$\%I_{n0}$	1,4	A	Trip	I_{n0} = Primary value of Ring CT
Operating time	0,05 – 300,00	0,1	s	-	-		at DT mode
Time multiplier	0,05 - 1,00	NA	s	-	-		at IDMT mode

[1)] Operation mode: 0 = Not in use 1 = Definite time 2 = Extremely inverse 3=normal inverse
4= Normal inv 5 = Long time inv 6 = RI-type inv 7 = RD-type inv

IEEE 51	IEC 3I>>→	Desc. Three-phase directional overcurrent				Code DOC6High
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0-2 [1)]	1	-		-		
Start current (I>)	0,05..40,00	1,4	$\times I_n$	508	A		
Operating time	0,05-300,00	1,5	s	-	-		at DT mode
Basic angle φ_b	0..90	30	°		°	Trip	
Oper. direction	0 or 1 [2)]	1					
Earth fault protection	0 or 1 [3)]	0					
Nondir. Operation	0 or 1 [3)]	0					

[1)] Operation mode: 0 = Not in use 1 = Definite time 2 = Instantaneous
[2)] Oper. direction 0=Forward 1=Reverse
[3)] Earth fault pr 0=DIsabled 1=Enabled

IEEE 40	IEC U/f>	Desc. Three-phase overexcitation	Code OE1High

Parameter	Setting			Set value		Function	Remark
	Range	Set point	Unit		Unit		
U/f start DT	1.00-2.00	1,2	XU/f		-		
U/f start IDMT	1.00-2.00	1,1	XU/f			Trip	
U max cont.	0.80-1.60	1	xUn				
Operate time	0.100-600.00	0,1	s				
K	0.1-100.0	3					
Maximum time	500-10000	1000	s				
Constant delay	0.1-120.0	0,8	s				
Cooling time	5-10000	600	s				

IEEE 32	IEC S> →	Desc. Three-phase directional overpower	Code OPOW6St3

Parameter	Setting			Set value		Function	Remark
	Range	Set point	Unit		Unit		
Power setting	1.0..200.0	80	%Sn	5530	kVA		
Angle	-90..90	90	°			Trip	
Operating time	0.04..300.00	0.1	s				

6.2 11kV Switchboards – Transfer breakers

Rated current	I_n=	1200	A	CT Ratio	I_{CT}=	1200/1	A
Rated voltage	U_n=	11000	V	Ring CT Ratio	I_{CT}=	70/1	A
				Scaling factor	I_{CT} / I_N=	1	

IEEE 51	IEC 3I> →	Desc. Three-phase directional overcurrent				Code DOC6Low
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 7 [1)]	2	-	-	-	Trip transfer	
Start current (I>)	0,05 - 40,00	1.0	× I_n	1200	A		
Operating time	0,05 - 300,00	-	s	-	-		at DT mode
Time multiplier (k)	0,05 - 1,00	0,05	-	-	-		at IDMT mode
Basic angle φ_b	0 - 90	60	°	-	-		
Oper. direction	0 - 1 [2)]	0		-	-		
Earth fault protection	0 - 1 [3)]	0		-	-		

[1)] Operation mode: 0 = Not in use; 1 = Definite time; 2 = Extremely inv.; 3 = Very inv.; 4 = Normal inv.; 5 = Long time inv.; 6 = RI-type inv.; 7 = RD-type inv.
[2)] Oper. direction 0=Forward 1=Reverse
[3)] Earth fault prot / Nondir. Operation 0=DIsabled 1=Enabled

Setting group 1

IEEE 51	IEC 3I>> →	Desc. Three-phase directional overcurrent				Code DOC6High
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 2 [1)]	1	-	-	-	Trip transfer	
Start current (I>)	0,05 - 40,00	1,3	× I_n	1560	A		
Operating time	0,05 - 300,00	0,8	s	-	-		at DT mode
Basic angle φ_b	0 - 90	60	°	-	-		
Oper. direction	0 - 1 [2)]	0		-	-		
Earth fault protection	0 - 1 [3)]	0		-	-		
Nondir. Operation	0 - 1 [3)]	0		-	-		

[1)] Operation mode: 0 = Not in use; 1 = Definite time; 2 = Instantaneous
[2)] Oper. direction 0=Forward 1=Reverse
[3)] Earth fault prot / Nondir. Operation 0=DIsabled 1=Enabled

Setting group 2 (For short circuit on cable between switchboards)

IEEE 51	IEC 3I>> →	Desc. Three-phase directional overcurrent				Code DOC6High
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 2 [1)]	1	-	-	-	Trip transfer	
Start current (I>)	0,05 - 40,00	1,3	× I_n	1560	A		
Operating time	0,05 - 300,00	0,2	s	-	-		at DT mode
Basic angle φ_b	0 - 90	60	°	-	-		
Oper. direction	0 - 1 [2)]	0		-	-		
Earth fault protection	0 - 1 [3)]	0		-	-		
Nondir. Operation	0 - 1 [3)]	0		-	-		

[1)] Operation mode: 0 = Not in use; 1 = Definite time; 2 = Instantaneous
[2)] Oper. direction 0=Forward 1=Reverse
[3)] Earth fault prot / Nondir. Operation 0=DIsabled 1=Enabled

IEEE 27	IEC U<	Desc. Three-phase undervoltage				Code UV3Low
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 2 [1)]	1	-	-	-	Trip	
Start voltage	0,30 - 1,20	0,6	× U_n	6600	V		
Operate time	0,1 - 120,0	2,0	s	-	-		at DT mode
Time multiplier	0,1 - 1,0	NA	-	-	-		at IDMT mode

[1)] Operation mode: 0 = Not in use 1 = Definite time 2 = Curve

Setting group 1

IEEE 51N	IEC I_0> →	Desc. Earth fault, directional				Code DEF2Low
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 5 [1)]	1	-	-	-	Trip	
Operation criteria	0 - 5 [2)]	0	-	-	-		
Operation direction	0 - 1 [3)]	0	-	-	-		
Basic angle φ_b	0 - 3 [4)]	2	-	-30°	-		
Operation charact.	0 - 1 [5)]	1	-	-	-		
Start current	1,0 - 25,0	2,0	%I_{n0}	1,4	A		I_{n0}=Primary value of Ring CT
Start voltage	2,0 - 100,0	2,5	%U_n	275	V		
Operating time	0,1 - 300,00	0,4	s	-	-		at DT mode
Time multiplier	0,05 - 1,00	NA	-	-	-		at IDMT mode
Intermittent E/F	0 - 1 [6)]	0	-	-	-		

[1)] Operation mode: 0 = Not in use 1 = Definite time 2 = Extremely inv. 3 = Very inv. 4 = Normal inv. 5 = Long time inv.
[2)] Operation criteria 0=BasicAng & U0 1=Basic Ang 2=I0Sin/Cos&U0 3=I0Sin/Cos 4=Non-dir I0 5=Non-dir U0
[3)] Oper direction 0=Forward 1=Reverse
[4)] Basic Angle φ_b 0=-90° 1=-60° 2=-30° 3=0°
[5)] Oper.charact. 0=I0Sin(φ) 1=I0Cos(φ)
[6)] Intermittent e/f 0=Not active 1=Active

Setting group 2 (For earth fault on cable between switchboards)

IEEE 51N	IEC I_0> →	Desc. Earth fault, directional				Code DEF2Low
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 5 [1)]	1	-	-	-	Trip	
Operation criteria	0 - 5 [2)]	0	-	-	-		
Operation direction	0 - 1 [3)]	0	-	-	-		
Basic angle φ_b	0 - 3 [4)]	2	-	-30°	-		
Operation charact.	0 - 1 [5)]	1	-	-	-		
Start current	1,0 - 25,0	2,0	%I_{n0}	1,4	A		I_{n0}=Primary value of Ring CT
Start voltage	2,0 - 100,0	2,5	%U_n	275	V		
Operating time	0,1 - 300,00	0,1	s	-	-		at DT mode
Time multiplier	0,05 - 1,00	NA	-	-	-		at IDMT mode
Intermittent E/F	0 - 1 [6)]	0	-	-	-		

[1)] Operation mode: 0 = Not in use 1 = Definite time 2 = Extremely inv. 3 = Very inv. 4 = Normal inv. 5 = Long time inv.
[2)] Operation criteria 0=BasicAng & U0 1=Basic Ang 2=I0Sin/Cos&U0 3=I0Sin/Cos 4=Non-dir I0 5=Non-dir U0
[3)] Oper direction 0=Forward 1=Reverse
[4)] Basic Angle φ_b 0=-90° 1=-60° 2=-30° 3=0°
[5)] Oper.charact. 0=I0Sin(φ) 1=I0Cos(φ)
[6)] Intermittent e/f 0=Not active 1=Active

IEEE 81U	IEC f<	Desc. Three-phase underfrequency	Code Freq1St1

Parameter	Setting			Set value		Function	Remark
	Range	Set point	Unit		Unit		
Operation mode	0 - 6[1)]	1	-	-	-	Trip	
Voltage limit	0,30 - 0,90	0,3	$\times U_n$	3300	V		Undervoltage limit for blocking
Start frequency	25,00 - 75,00	54	Hz	-	-		Start value for U/O frequency protection
Operate time 1	0,10 - 200,00	4	s	-	-		For U/O frequency protection
Start df/dt	0,2 - 10,0	NA	Hz/s	-	-		Start value for freq. rate of change
Operate time 2	0,12 - 120,00	NA	s	-	-		Timer for df/dt or U/O frequency prot.

[1)] Operation mode: 0 = Not in use 1 = f</f> 1 timer 2 = f</f> 2 timers 3 = f</f> or df/dt>
4 = f</f> and df/dt> 5 = f</f> or df/dt< 6 = f</f> and df/dt<

6.3 11kV Switchboard – Bus Measure / Earthing Transformer

Rated voltage	U_n= 11000 V		
		VT Ratio	U_{CT}= $11000/\frac{110}{\sqrt{3}}/\frac{110}{3}$ V

For trip and block of Transfer Breakers

IEEE 59N	IEC U_0>	Desc. Residual Overvoltage				Code ROV1Low
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 1 *)	1	-	-	-	Trip transfer	
Start voltage	2,0 – 20,0	25	%U_n	1587	V		
Operating time	0,05 – 300,00	0,5	s	-	-		at DT mode

*) Operation mode: 0 = Not in use 1 = Definite time

For trip and block of Generators

IEEE 59N	IEC U_0>	Desc. Residual Overvoltage				Code ROV1High
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 1 *)	1	-	-	-	Trip Generators	
Start voltage	2,0 – 20,0	25	%U_n	1587	V		
Operating time	0,05 – 300,00	0,7	s	-	-		at DT mode

*) Operation mode: 0 = Not in use 1 = Definite time

6.4 11kV Switchboard – Feeder to Thruster Transformer 11/1,65kV

Rated power	S_n=	5300	kVA	CT Ratio	I_{CT}=	300/1	A
Rated voltage	U_n=	11000	V	Ring CT Ratio	I_{RCT}=	70/1	A
Rated current	I_n=	278	A				
Power factor	cos φ =	0,8		Scaling factor	I_{CT} / I_n=	1,08	

IEEE 51	IEC 3I>	Desc. Three-phase non-directional overcurrent				Code NOC3Low
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 7 [1)]	2	-	-	-	Trip	
Start current (I>)	0,10 - 5,00	1,05	× I_n	292	A		
Operating time	0,05 - 300,00	NA	s	-	-		at DT mode
Time multiplier (k)	0,05 - 1,00	0,1	-	-	-		at IDMT mode

[1)] Operation mode: 0 = Not in use 1 = Definite time 2 = Extremely inv. 3 = Very inv. 4 = Normal inv. 5 = Long time inv. 6 = RI-type inv. 7 = RD-type inv.

IEEE 50	IEC 3I>>	Desc. Three-phase non-directional overcurrent				Code NOC3High
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 2 [1)]	1	-	-	-	Trip	
Start current (I>)	0,10 - 40,00	1,9	× I_n	528	A		
Operating time	0,05 - 300,00	0,6	s	-	-		at DT mode

[1)] Operation mode: 0 = Not in use 1 = Definite time 2 = Instantaneous

IEEE 27	IEC U<	Desc. Three-phase undervoltage				Code UV3Low
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 2 [1)]	1	-	-	-	Trip	
Start voltage	0,30 - 1,20	0,6	× U_n	6600	V		
Operate time	0,1 - 120,0	1,2	s	-	-		at DT mode
Time multiplier	0,1 - 1,0	NA	-	-	-		at IDMT mode

[1)] Operation mode: 0 = Not in use 1 = Definite time 2 = Curve

IEEE 51N	IEC I_0>	Desc. Earth fault, non-directional				Code NEF1Low
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 7 [*)]	1	-	-	-	Trip	
Start current	1,0 - 100,0	2,0	%I_{n0}	1,4	A		I_{n0}=Primary value of Ring CT
Operating time	0,05 - 300,00	0,1	s	-	-		at DT mode
Time multiplier	0,05 - 1,00	NA	s	-	-		at IDMT mode

[1)] Operation mode: 0 = Not in use 1 = Definite time 2 = Extremely inverse 3=normal inverse 4= Normal inv 5 = Long time inv 6 = RI-type inv 7 = RD-type inv

PT100 for thruster transformers are connected to thruster drive.

IEEE 49	IEC	Desc. Transformer PT100 elements						Code -
Windings	Setting Range	Level 1	Unit	Function	Level 2	Unit	Function	Remark
2U1, 2V1, 2W1	-50°..180°	140	°C	Alarm	150	°C	Trip	
3U1, 3V1, 3W1	-50°..180°	140	°C	Alarm	150	°C	Trip	

6.5 11kV Switchboard – Feeder to Drilling Transformer 11/0,72kV

Rated power	S_n=	6000	kVA	CT Ratio	I_{CT}=	400/1	A
Rated voltage	U_n=	11000	V	Ring CT Ratio	I_{RCT}=	70/1	A
Rated current	I_n=	315	A				
Power factor	cos φ =	0,8		Scaling factor	I_{CT} / I_n=	1,27	

IEEE 51	IEC 3I>	Desc. Three-phase non-directional overcurrent	Code NOC3Low

Parameter	Setting Range	Setting Set point	Setting Unit	Set value	Set value Unit	Function	Remark
Operation mode	0 - 7 [1)]	2	-	-	-	Trip	
Start current (I>)	0,10 - 5,00	1,15	× I_n	362	A		
Operating time	0,05 - 300,00	NA	s	-	-		at DT mode
Time multiplier (k)	0,05 - 1,00	0,3	-	-	-		at IDMT mode

[1)] Operation mode: 0 = Not in use 1 = Definite time 2 = Extremely inv. 3 = Very inv. 4 = Normal inv. 5 = Long time inv. 6 = RI-type inv. 7 = RD-type inv.

IEEE 50	IEC 3I>>	Desc. Three-phase non-directional overcurrent	Code NOC3High

Parameter	Setting Range	Setting Set point	Setting Unit	Set value	Set value Unit	Function	Remark
Operation mode	0 - 2 [1)]	1	-	-	-	Trip	
Start current (I>)	0,10 - 40,00	2,5	× I_n	787	A		
Operating time	0,05 - 300,00	0,8	s	-	-		at DT mode

[1)] Operation mode: 0 = Not in use 1 = Definite time 2 = Instantaneous

IEEE 50	IEC 3I>>	Desc. Three-phase non-directional overcurrent	Code NOC3Inst

Parameter	Setting Range	Setting Set point	Setting Unit	Set value	Set value Unit	Function	Remark
Operation mode	0 - 2 [1)]	1	-	-	-	Trip	
Start current (I>)	0,10 - 40,00	4,3	× I_n	1354	A		
Operating time	0,05 - 300,00	0,6	s	-	-		at DT mode

[1)] Operation mode: 0 = Not in use 1 = Definite time 2 = Instantaneous

IEEE 27	IEC U<	Desc. Three-phase undervoltage	Code UV3Low

Parameter	Setting Range	Setting Set point	Setting Unit	Set value	Set value Unit	Function	Remark
Operation mode	0 - 2 [1)]	1	-	-	-	Trip	
Start voltage	0,30 - 1,20	0,6	× U_n	6600	V		
Operate time	0,1 - 120,0	1,2	s	-	-		at DT mode
Time multiplier	0,1 - 1,0	NA	-	-	-		at IDMT mode

[1)] Operation mode: 0 = Not in use 1 = Definite time 2 = Curve

IEEE 51N	IEC I_0>	Desc. Earth fault, non-directional	Code NEF1Low

Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 7 *)	1	-	-	-	Trip	
Start current	1,0 - 100,0	2,0	$\%I_{n0}$	1,4	A		I_{n0}=Primary value of Ring CT
Operating time	0,05 - 300,00	0,1	s	-	-		at DT mode
Time multiplier	0,05 - 1,00	NA	s	-	-		at IDMT mode

*) Operation mode: 0 = Not in use 1 = Definite time 2 = Extremely inverse 3=normal inverse
4= Normal inv 5 = Long time inv 6 = RI-type inv 7 = RD-type inv

IEEE 49	IEC	Desc. Transformer PT100 elements	Code -

Windings	Setting Range	Level 1	Unit	Function	Level 2	Unit	Function	Remark
2U1, 2V1, 2W1	-50°..180°	140	°C	Alarm	150	°C	Trip	
3U1, 3V1, 3W1	-50°..180°	140	°C	Alarm	150	°C	Trip	

6.6 11kV Switchboard – Feeder to Ship Service Transformer 11/0,48kV

Rated power	S_n=	3000	kVA	CT Ratio	I_{CT}=	200/1	A
Rated voltage	U_n=	11000	V	Ring CT Ratio	I_{RCT}=	70/1	A
Rated current	I_n=	157	A				
Power factor	cos φ =	0,8		Scaling factor	I_{CT} / I_n=	1,27	

IEEE 51	IEC 3I>	Desc. Three-phase non-directional overcurrent				Code NOC3Low
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 7 [1)]	2	-	-	-	Trip	
Start current (I>)	0,10 - 5,00	1,2	× I_n	188,4	A		
Operating time	0,05 - 300,00	NA	s	-	-		at DT mode
Time multiplier (k)	0,05 - 1,00	0,4	-	-	-		at IDMT mode

[1)] Operation mode: 0 = Not in use 1 = Definite time 2 = Extremely inv. 3 = Very inv. 4 = Normal inv. 5 = Long time inv. 6 = RI-type inv. 7 = RD-type inv.

IEEE 50	IEC 3I>>	Desc. Three-phase non-directional overcurrent				Code NOC3High
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 2 [1)]	1	-	-	-	Trip	
Start current (I>)	0,10 - 40,00	4,8	× I_n	753	A		
Operating time	0,05 - 300,00	0,6	s	-	-		at DT mode

[1)] Operation mode: 0 = Not in use 1 = Definite time 2 = Instantaneous

IEEE 27	IEC U<	Desc. Three-phase undervoltage				Code UV3Low
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 2 [1)]	1	-	-	-	Trip	
Start voltage	0,30 - 1,20	0,6	× U_n	6600	V		
Operate time	0,1 - 120,0	1,2	s	-	-		at DT mode
Time multiplier	0,1 - 1,0	NA	-	-	-		at IDMT mode

[1)] Operation mode: 0 = Not in use 1 = Definite time 2 = Curve

IEEE 51N	IEC I_0>	Desc. Earth fault, non-directional				Code NEF1Low
Parameter	Setting Range	Set point	Unit	Set value	Unit	Function	Remark
Operation mode	0 - 7 [*)]	1	-	-	-	Trip	
Start current	1,0 - 100,0	2,0	%I_{n0}	1,4	A		I_{n0}=Primary value of Ring CT
Operating time	0,05 - 300,00	0,1	s	-	-		at DT mode
Time multiplier	0,05 - 1,00	NA	s	-	-		at IDMT mode

[1)] Operation mode: 0 = Not in use 1 = Definite time 2 = Extremely inverse 3=normal inverse 4= Normal inv 5 = Long time inv 6 = RI-type inv 7 = RD-type inv

IEEE 49	IEC	Desc. Transformer PT100 elements						Code -
Windings	Setting Range	Level 1	Unit	Function	Level 2	Unit	Function	Remark
2U1, 2V1, 2W1	-50°..180°	140	°C	Alarm	150	°C	Trip	

6.7 480V Switchboards – Distribution breaker settings

LV Breakers					Applicable for:	
Name/Type	Description		Frame/Sensor/Plug	Settings	Breakers	SWBD
PD-0019 Static Trip	ABB SACE Emax PR122/P L-S-I	E6H	5000A 4000A	[I1] LTPU = 0.9 (3600A) [t1] LTD = 3(I^2 T In) [I2] STPU = 3.1 (12400A) [t2] STD = 0.35(I^2 T Out)	Incomer Breaker	LV1/2/3/4
PD-0035 Static Trip	ABB SACE Emax PR122/P L-S-I	E6H	5000A 4000A	[I1] LTPU = 0.78 (3120A) [t1] LTD = 3(I^2 T In) [I2] STPU = 2.3 (9200A) [t2] STD = 0.25(I^2 T Out)	Transfer Breaker	LV1/2/3/4
PD-0081 Static Trip	ABB SACE Emax PR122/P L-S-I	E2S	1250A 1000A	[I1] LTPU = 0.8 (800A) [t1] LTD = 21(I^2 T In) [I2] STPU = 6.8 (6800A) [t2] STD = 0.15(I^2 T Out)	Feeder to Thruster MCC 1-8	LV1/2/3/4
PD-0023 Static Trip	ABB SACE Emax PR122/P L-S-I	E3S	3200A 2500A	[I1] LTPU = 0.88 (2200A) [t1] LTD = 3(I^2 T In) [I2] STPU = 2.7 (6750A) [t2] STD = 0.15(I^2 T Out)	Feeder to Service MCC 1-2	LV1/2/3/4
PD-0025 Static Trip	ABB SACE Emax PR122/P L-S-I	E2S	1600A 1250A	[I1] LTPU = 1 (1250A) [t1] LTD = 12(I^2 T In) [I2] STPU = 5.4 (6750A) [t2] STD = 0.15(I^2 T Out)	Feeder to Pump MCC 2&3	LV1/2/3/4
PD-0027 Static Trip	ABB SACE Emax PR122/P L-S-I	E2S	1000A 1000A	[I1] LTPU = 1 (1000A) [t1] LTD = 15(I^2 T In) [I2] STPU = 6.8 (6800A) [t2] STD = 0.15(I^2 T Out)	Feeder to DG MCC 1-4	LV1/2/3/4
PD-0029 Static Trip	ABB SACE Emax PR122/P L-S-I	E2S	2000A 1600A	[I1] LTPU = 0.88 (1408A) [t1] LTD = 9(I^2 T In) [I2] STPU = 4.2 (6720A) [t2] STD = 0.15(I^2 T Out)	Feeder to Pump MCC 1&4	LV1/2/3/4
PD-0031 Static Trip	ABB SACE Emax PR122/P L-S-I	E2S	2000A 1600A	[I1] LTPU = 1 (1600A) [t1] LTD = 6(I^2 T In) [I2] STPU = 4.2 (6720A) [t2] STD = 0.15(I^2 T Out)	Feeder to Drilling MCC 1-2	LV1/2/3/4
PD-0039 Static Trip	ABB SACE Emax PR122/P L-S-I	E4H	4000A 3200A	[I1] LTPU = 0.95 (3040A) [t1] LTD = 3(I^2 T In) [I2] STPU = 2.1 (6720A) [t2] STD = 0.25(I^2 T Out)	Emergency Generator Incomer Breaker	Emergency SWBD
PD-0045 Static Trip	ABB SACE Emax PR122/P L-S-I	E2S	1250A 800A	[I1] LTPU = 1 (800A) [t1] LTD = 18(I^2 T In) [I2] STPU = 8.5 (6800A) [t2] STD = 0.15(I^2 T Out)	Feeder to HPU MCC 1-2	LV1/2/3/4

PD-0077 Static Trip	ABB SACE Emax PR122/P L-S-I	E2S	800A 800A	[I1] LTPU = 0.46 (368A) [t1] LTD = 18(I^2 T In) [I2] STPU = 3 (2400A) [t2] STD = 0.2(I^2 T Out)	Feeder to 480/230V 300kVA Main Transformer	LV1/2/3/4
PD-0085 Static Trip	ABB SACE Emax PR122/P L-S-I	E2S	1250A 1000A	[I1] LTPU = 1 (1000A) [t1] LTD = 15(I^2 T In) [I2] STPU = 6.8 (6800A) [t2] STD = 0.15(I^2 T Out)	Feeder to Vent.Room MCC 1-4	LV1/2/3/4
PD-0089 Static Trip	ABB SACE Emax PR122/P L-S-I	E4H	4000A 3200A	[I1] LTPU = 0.8 (2560A) [t1] LTD = 3(I^2 T In) [I2] STPU = 1.6 (5120A) [t2] STD = 0.15(I^2 T Out)	Feeder to Emergency SWBD	LV1/4
PD-0097 Static Trip	ABB SACE Emax PR122/P L-S-I	E2S	800A 400A	[I1] LTPU = 0.6 (240A) [t1] LTD = 27(I^2 T In) [I2] STPU = 6.5 (2600A) [t2] STD = 0.1(I^2 T Out)	Feeder to 480/230V 200kVA Emergency transformer	Emergency SWBD
PD-0099 Static Trip	ABB SACE Emax PR122/P L-S-I	E4H	4000A 2500A	[I1] LTPU = 1 (2500A) [t1] LTD = 3(I^2 T In) [I2] STPU = 2.7 (6750A) [t2] STD = 0.15(I^2 T Out)	Feeder to Mud MCC 1-2	LV1/2/3/4
PD-0105 Static Trip	ABB SACE Emax PR122/P L-S-I	E4H	4000A 3200A	[I1] LTPU = 0.8 (2560A) [t1] LTD = 3(I^2 T In) [I2] STPU = 1.6 (5120A) [t2] STD = 0.15(I^2 T Out)	Feeder to Main LV1&4	Emergency SWBD
PD-0107 Static Trip	ABB S1 TMAX PR222DS/P-LSI MCCB T5/T6 L/V	T5V	630A 630A	[I1] LTPU 0.96 (604.8A) [t1] LTD 3s(I^2 T In) [I2] STPU 5,8 (3654A) [t2] STD B=0.1s(I^2 T Out)	Feeder to Knuckle Boom MCC	LV1/2/3/4

7. Revision

Rev. ind.	Page (P) Chapt.(C)	Description	Date Dept./Init.
-		New document – Issued for Approval	2008-02-12 MPE / TrHa