نتایج مشروح محاسبات رله های O/C

Company or Region Name = ZREC
Group or Checker Name = Group_1
Substation Name = Test_230kV_OK
Voltage = 230 / 63 kV
Calculation date & time = 2016 / 2 / 8 on Monday at 16:34:4
Transformer(s) Type = Autotransformer
S [Power Transformer(s) apparent power] = 160 MVA
Sbase = 100 MVA
Comment for this Calculation: محاسبات آزمايشي

..... Short circuit resaults : .....

Phase Fault Currents:

جریان خطای سه فاز دیده شده توسط رله فیدرهای خروجی در حالت ماکزیمم سطح اتصال کوتاه شبکه و حضور ترانس های موازی:
IF1(Substation) = 12.56 pu ===> 11510.35 A

جریان خطای سه فاز فیدرکوپلاژ در حالت ماکزیمم سطح اتصال کوتاه شبکه و حالت تک ترانسی بدون در نظر گرفتن اثر جریان تزریقی پست های مجاور متصل به فیدرهای خروجی:
IF2(Substation) = 7.81 pu ===> 7157.31 A

جریان خطای سه فاز فیدر سمت اولیه در حالت ماکزیمم سطح اتصال کوتاه شبکه بدون در نظر گرفتن اثر جریان تزریقی پست های مجاور متصل به فیدرهای خروجی:
IF3(Substation) = 31.86 pu ===> 7997.56 A

جریان خطای دو فاز فیدرهای خروجی در حالت مینیمم سطح اتصال کوتاه شبکه و حالت تک ترانسی:
IF4(Substation) = 4.51 pu ===> 4133.1 A

حاصل تقسیم جریان خطای دو فاز فیدرکوپلاژ بر تعداد ترانس ها در حالت مینیمم سطح اتصال کوتاه شبکه و حضور ترانس های موازی :
IF5(Substation) = 3.01 pu ===> 2758.45 A

جریان خطای دو فاز فیدر سمت اولیه در حالت مینیمم سطح اتصال کوتاه شبکه:
IF6(Substation) = 9.07 pu ===> 2276.77 A

جریان های اتصال کوتاه فازی مورد استفاده در محاسبات:

IPMax(1) = 11510.35 A
IPMax(2) = 7157.31 A
IPMax(3) = 7157.31 A
IPMax(4) = 7157.31 A
IPMax(5) = 7997.56 A

IPMin(1) = 4133.1 A
IPMin(2) = 2758.45 A

IPMin(3) = 2758.45 A
IPMin(4) = 2758.45 A
IPMin(5) = 2276.77 A

----------<< O/C Protection >>----------
Overcurrent Protective Relay R1(1) for 63 kV Outgoing feeder 'A1'

Relay Type: MCGG82
Selected Characteristic: SI
Generic Formula: T = (TMS/1) × {K / [(I/Is)^alfa -1]^Gama + Beta} = (TMS/1) × {0.14 / [(I/Is)^0.02 -1]^1 + 0}
alfa = 0.02 ; Beta = 0 ; Gama = 1 ; K = 0.14 ; M = 1

In = 1 A ; Relay Nominal Current

C.T Ratio = I1CT / I2CT = 800 / 1
Feeder type: Line
Connected to Section Nr. 1

IL Max = I(Load Max) = 560 A
I(LTR) = 549 A
Direction: Line side

Ibase = 916.43 A ; Base Current
If1(A1) = 12.58 pu = 11528.68 A ; Maximum 3-ph short circuit at forward Line beginning, seen by this Relay
If2(A1) = 7.545 pu = 6914.46 A ; Maximum 3-ph short circuit at forward Line end, seen by this Relay
If5(A1) = 1 pu = 916.43 A ; Minimum 2-ph short circuit, seen by this Relay

First Choice of Relay Current Setting: ISR(A1) = 0.5 × I(Load Max) = 280 A ; According to user selection
{ISR(A1) Should be <= Min[I1CT , I(LTR)]} ===> ISR(A1) = 280 A

Is = [ISR(A1) / 800] × In = 0.35 × In ; High Norm ===> 0.4 × In
ISR(A1) = 0.4 × 800 = 320 A

Checking: If5(A1) / ISR(A1) = 2.86

TMS(Final) = Max [User defined TMS or Calculated TMS] = 0 ; Low Norm ===> 0.05

Iinst = 0.8 × [If1(A1) / ISR(A1)] × Is = 28.82 × Is ; Norm ===> 29 × Is
Tinst = 0 sec; Norm ===> 0 sec
Checking: [(If1 - If2) / If1] × 100 = 40 %

Permissible Load according to Relay Current Setting:
I = 320 A
S = 34.9 MVA

----------<< O/C Protection >>----------

Overcurrent Protective Relay R1(2) for 63 kV Outgoing feeder 'A2'
Comment: << fgfdggdfd. >>

Relay Type: MCGG82
Selected Characteristic: SI
Generic Formula: T = (TMS/1) × {K / [(I/Is)^alfa -1]^Gama + Beta} = (TMS/1) × {0.14 / [(I/Is)^0.02 -1]^1 + 0}
alfa = 0.02 ; Beta = 0 ; Gama = 1 ; K = 0.14 ; M = 1

In = 1 A ; Relay Nominal Current

C.T Ratio = I1CT / I2CT = 800 / 1
Feeder type: Line
Connected to Section Nr. 1

IL Max = I(Load Max) = 489 A
I(LTR) = 489 A
Direction: Line side

Ibase = 916.43 A ; Base Current
If1(A2) = 12.58 pu = 11528.68 A ; Maximum 3-ph short circuit at forward Line beginning, seen by this Relay
If2(A2) = 1.484 pu = 1359.98 A ; Maximum 3-ph short circuit at forward Line end, seen by this Relay
If5(A2) = 0.8 pu = 733.14 A ; Minimum 2-ph short circuit, seen by this Relay

First Choice of Relay Current Setting: ISR(A2) = 1 × I(Load Max) = 489 A ; According to user selection
ISR(A2) >= I(LTR) Therefore: ISR(A2) = ILTR = 489 A
{ISR(A2) Should be <= Min[I1CT , I(LTR)]} ===> ISR(A2) = 489 A

Is = [ISR(A2) / 800] × In = 0.611 × In ; Low Norm ===> 0.6 × In
ISR(A2) = 0.6 × 800 = 480 A

Checking: If5(A2) / ISR(A2) = 1.53

TMS(Final) = Max [User defined TMS or Calculated TMS] = 0.05 ; High Norm ===> 0.075

Iinst = 0.9 × [If1(A2) / ISR(A2)] × Is = 21.62 × Is ; Norm ===> 22 × Is
Tinst = 0 sec; Norm ===> 0 sec
Checking: [(If1 - If2) / If1] × 100 = 88.2 %

Permissible Load according to Relay Current Setting:
I = 480 A
S = 52.4 MVA

----------<< O/C Protection >>----------
Overcurrent Protective Relay R1(3) for 63 kV Outgoing feeder 'A3'

Relay Type: MCGG82
Selected Characteristic: SI
Generic Formula: T = (TMS/1) × {K / [(I/Is)^alfa -1]^Gama + Beta} = (TMS/1) × {0.14 / [(I/Is)^0.02 -1]^1 + 0}
alfa = 0.02 ; Beta = 0 ; Gama = 1 ; K = 0.14 ; M = 1

In = 1 A ; Relay Nominal Current

C.T Ratio = I1CT / I2CT = 800 / 1
Feeder type: Reactor
Connected to Section Nr. 1

IL Max = I(Load Max) = 549 A
I(LTR) = 549 A
Direction: Busbar side

Ibase = 916.43 A ; Base Current
If3(A3) = 1 pu = 916.43 A ; Maximum 3-ph short circuit at reverse Line beginning (if any), seen by this Relay
If4(A3) = 1 pu = 916.43 A ; Maximum 3-ph short circuit at reverse Line end (if any), seen by this Relay
If5(A3) = 1.397 pu = 1280.25 A ; Minimum 2-ph short circuit, seen by this Relay

First Choice of Relay Current Setting: ISR(A3) = 1 × I(Load Max) = 549 A ; According to user selection
ISR(A3) >= I(LTR) Therefore: ISR(A3) = ILTR = 549 A
{ISR(A3) Should be <= Min[I1CT , I(LTR)]} ===> ISR(A3) = 549 A

Is = [ISR(A3) / 800] × In = 0.686 × In ; Low Norm ===> 0.65 × In
ISR(A3) = 0.65 × 800 = 520 A

Checking: If5(A2) / ISR(A3) = 1.41

TMS according to required Relay Operating time for Faults in the Reverse Line beginning (Zone 1):
TMS3 = 0.4 × 1 / {0.14 / [(If3(A3) / ISR(A3)) ^ 0.02 - 1] + 0} = 0.033
TMS according to required Relay Operating time for Faults in the Reverse Line End (Zone 2):
TMS4 = 0.8 × 1 / {0.14 / [(If4(A3) / ISR(A3)) ^ 0.02 - 1] + 0} = 0.065

Coordination with Line O/C Relays:
T(A1) = 0.05 / 1 × {0.14 / [(If3(A3) / ISR(A1)) ^ 0.02 - 1] + 0} = 0.094 sec
T(A3) = T(A1) + 0.4 = 0.494 sec
TMS (A3) = 0.494 × 1 / {0.14 / [(If3(A3) / ISR(A3)) ^ 0.02 - 1] + 0} = 0.226

Coordination with Line O/C Relays:
T(A2) = 0.075 / 1 × {0.14 / [(If3(A3) / ISR(A2)) ^ 0.02 - 1] + 0} = 0.16 sec
T(A3) = T(A2) + 0.4 = 0.56 sec
TMS (A3) = 0.56 × 1 / {0.14 / [(If3(A3) / ISR(A3)) ^ 0.02 - 1] + 0} = 0.256

TMS(Final) = Max [User defined TMS or Calculated TMS] = 0.256 ; Best Norm ===> 0.25

Iinst = 0.95 × [If3(A3) / ISR(A3)] × Is = 1.67 × Is ; Norm ===> 2 × Is
Tinst = 0 sec; Norm ===> 0 sec

Permissible Load according to Relay Current Setting:
I = 520 A
S = 56.7 MVA

----------<< O/C Protection >>----------
Overcurrent Protective Relay R1(4) for 63 kV Outgoing feeder 'A4'

Relay Type: MCGG62
Selected Characteristic: SI
Generic Formula: T = (TMS/1) × {K / [(I/Is)^alfa -1]^Gama + Beta} = (TMS/1) × {0.14 / [(I/Is)^0.02 -1]^1 + 0}
alfa = 0.02 ; Beta = 0 ; Gama = 1 ; K = 0.14 ; M = 1

In = 1 A ; Relay Nominal Current

C.T Ratio = I1CT / I2CT = 800 / 1
Feeder type: Cap-Bank
Connected to Section Nr. 2

IL Max = I(Load Max) = 549 A
I(LTR) = 549 A
Direction: NonDirectional

Ibase = 916.43 A ; Base Current
If1(A4) = 12.58 pu = 11528.68 A ; Maximum 3-ph short circuit at forward Line beginning, seen by this Relay
If2(A4) = 3.84 pu = 3519.09 A ; Maximum 3-ph short circuit at forward Line end, seen by this Relay
If3(A4) = 1 pu = 916.43 A ; Maximum 3-ph short circuit at reverse Line beginning (if any), seen by this Relay
If4(A4) = 1 pu = 916.43 A ; Maximum 3-ph short circuit at reverse Line end (if any), seen by this Relay
If5(A4) = 1.29 pu = 1182.19 A ; Minimum 2-ph short circuit, seen by this Relay

First Choice of Relay Current Setting: ISR(A4) = 1.2 × I(Load Max) = 658.8 A ; According to user selection
ISR(A4) >= I(LTR) Therefore: ISR(A4) = ILTR = 549 A
{ISR(A4) Should be <= Min[I1CT , I(LTR)]} ===> ISR(A4) = 549 A

Is = [ISR(A4) / 800] × In = 0.686 × In ; Low Norm ===> 0.65 × In
ISR(A4) = 0.65 × 800 = 520 A

Checking: If5(A2) / ISR(A4) = 1.41

Coordination with Line O/C Relays:
T(A1) = 0.05 / 1 × {0.14 / [(If3(A4) / ISR(A1)) ^ 0.02 - 1] + 0} = 0.329 sec
T(A4) = T(A1) + 0.4 = 0.729 sec
TMS (A4) = 0.729 × 1 / {0.14 / [(If3(A4) / ISR(A4)) ^ 0.02 - 1] + 0} = 0.059

Coordination with Line O/C Relays:
T(A2) = 0.075 / 1 × {0.14 / [(If3(A4) / ISR(A2)) ^ 0.02 - 1] + 0} = 0.807 sec
T(A4) = T(A2) + 0.4 = 1.207 sec
TMS (A4) = 1.207 × 1 / {0.14 / [(If3(A4) / ISR(A4)) ^ 0.02 - 1] + 0} = 0.098

TMS(Final) = Max [User defined TMS or Calculated TMS] = 0.098 ; Best Norm ===> 0.1

Iinst = 0.7 × [If1(A4) / ISR(A4)] × Is = 15.52 × Is ; Norm ===> 16 × Is
Tinst = 0 sec; Norm ===> 0 sec
Checking: [(If1 - If2) / If1] × 100 = 69.5 %

Permissible Load according to Relay Current Setting:
I = 520 A
S = 56.7 MVA

----------<< O/C Protection >>----------
Overcurrent Protective Relay R2(1) for 63 KV at Buscoupler feeder 'Bus_LV_1'

Relay Type: MCGG82
Selected Characteristic: SI
Generic Formula: T = (TMS/1) × {K / [(I/Is)^alfa -1]^Gama + Beta} = (TMS/1) × {0.14 / [(I/Is)^0.02 -1]^1 + 0}
alfa = 0.02 ; Beta = 0 ; Gama = 1 ; K = 0.14 ; M = 1

In = 1 A ; Relay Nominal Current

C.T Ratio = I1CT / I2CT = 2000 / 1
Feeder type: Bus-Coupler_LV
Connected to Section Nr. 1

In(Transformer 63 kV side) = 160000 / (63 × 3^0.5) = 1466.29 A

ISR(Bus_LV_1) = 1.1 × In(Transformer 63 kV side) = 1612.92 A

Is = [ISR(Bus_LV_1) / 2000] × In = 0.806 × In ; Best Norm ===> 0.8 × In

IPMax(A3) = 7157.31 A
TR(A3) = TMS(A3) / 1 × {0.14 / [(IPMax(A3) / ISR(A3)) ^ 0.02 - 1] + 0} = 0.65 sec ; Operating time for the Slowest Relay from lower layers
TR(Bus_LV_1) = TR(A3) + 0.4 = 1.05 sec

TMS = TR(Bus_LV_1) × 1 / {0.14 / [(IPMax(A3) / ISR(Bus_LV_1)) ^ 0.02 - 1] + 0} = 0.228 ; High Norm ===> 0.25

Iinst = Infinity
Tinst = 0 sec; Norm ===> 0 sec

Permissible Load according to Relay Current Setting:
I = 1600 A
S = 174 MVA

----------<< O/C Protection >>----------
Overcurrent Protective Relay R3(1) for 63 KV at Incoming feeder 'Incoming_1'

Relay Type: MCGG62
Selected Characteristic: SI
Generic Formula: T = (TMS/1) × {K / [(I/Is)^alfa -1]^Gama + Beta} = (TMS/1) × {0.14 / [(I/Is)^0.02 -1]^1 + 0}
alfa = 0.02 ; Beta = 0 ; Gama = 1 ; K = 0.14 ; M = 1

In = 1 A ; Relay Nominal Current

C.T Ratio = I1CT / I2CT = 2000 / 1
Feeder type: Trans.
Connected to Section Nr. 1

In(Transformer 63 kV side) = 160000 / (63 × 3^0.5) = 1466.29 A

ISR(Incoming_1) = 1.2 × In(Transformer 63 kV side) = 1759.55 A

Is = [ISR(Incoming_1) / 2000] × In = 0.88 × In ; Best Norm ===> 0.9 × In

IPMax(Bus_LV_1) = 7157.31 A
TR(Bus_LV_1) = TMS(Bus_LV_1) / 1 × {0.14 / [(IPMax(Bus_LV_1) / ISR(Bus_LV_1)) ^ 0.02 - 1] + 0} = 1.151 sec ; Operating time for the Slowest Relay from lower layers
TR(Incoming_1) = TR(Bus_LV_1) + 0.4 = 1.551 sec

TMS = TR(Incoming_1) × 1 / {0.14 / [(IPMax(Bus_LV_1) / ISR(Incoming_1)) ^ 0.02 - 1] + 0} = 0.31 ; High Norm ===> 0.325

Iinst = Infinity
Tinst = 0 sec; Norm ===> 0 sec

Permissible Load according to Relay Current Setting:
I = 1800 A
S = 196 MVA

----------<< O/C Protection >>----------
Overcurrent Protective Relay R3(2) for 63 KV at Incoming feeder 'Incoming_2'

Relay Type: MCGG62
Selected Characteristic: SI
Generic Formula: T = (TMS/1) × {K / [(I/Is)^alfa -1]^Gama + Beta} = (TMS/1) ×

{0.14 / [(I/Is)^0.02 -1]^1 + 0}
alfa = 0.02 ; Beta = 0 ; Gama = 1 ; K = 0.14 ; M = 1

In = 1 A ; Relay Nominal Current

C.T Ratio = I1CT / I2CT = 2000 / 1
Feeder type: Trans.
Connected to Section Nr. 2

In(Transformer 63 kV side) = 160000 / (63 × 3^0.5) = 1466.29 A

ISR(Incoming_2) = 1.2 × In(Transformer 63 kV side) = 1759.55 A

Is = [ISR(Incoming_2) / 2000] × In = 0.88 × In ; Best Norm ===> 0.9 × In

IPMax(Bus_LV_1) = 7157.31 A
TR(Bus_LV_1) = TMS(Bus_LV_1) / 1 × {0.14 / [(IPMax(Bus_LV_1) / ISR(Bus_LV_1)) ^ 0.02 - 1] + 0} = 1.151 sec ; Operating time for the Slowest Relay from lower layers
TR(Incoming_2) = TR(Bus_LV_1) + 0.4 = 1.551 sec

TMS = TR(Incoming_2) × 1 / {0.14 / [(IPMax(Bus_LV_1) / ISR(Incoming_2)) ^ 0.02 - 1] + 0} = 0.31 ; High Norm ===> 0.325

Iinst = Infinity
Tinst = 1 sec; Norm ===> 0 sec

Permissible Load according to Relay Current Setting:
I = 1800 A
S = 196 MVA

----------<< O/C Protection >>----------
Overcurrent Protective Relay R4(1) for 63 KV at L.V Side feeder 'Trans_1'

Relay Type: MCGG62
Selected Characteristic: SI
Generic Formula: T = (TMS/1) × {K / [(I/Is)^alfa -1]^Gama + Beta} = (TMS/1) × {0.14 / [(I/Is)^0.02 -1]^1 + 0}
alfa = 0.02 ; Beta = 0 ; Gama = 1 ; K = 0.14 ; M = 1

In = 1 A ; Relay Nominal Current

C.T Ratio = I1CT / I2CT = 2500 / 1
Feeder type: Trans.
Connected to Section Nr. 1

ISR(Trans_1) = 1.2 × ISR(Incoming_1) = 2160 A

Is = [ISR(Trans_1) / 2500] × In = 0.864 × In ; Best Norm ===> 0.85 × In

IPMax(Incoming_1) = 7157.31 A
TR(Incoming_1) = TMS(Incoming_1) / 1 × {0.14 / [(IPMax(Incoming_1) / ISR (Incoming_1)) ^ 0.02 - 1] + 0} = 1.625 sec ; Operating time for the Slowest Relay from lower layers
TR(Trans_1) = TR(Incoming_1) + 0.4 = 2.025 sec

TMS = TR(Trans_1) × 1 / {0.14 / [(IPMax(Incoming_1) / ISR(Trans_1)) ^ 0.02 - 1] + 0} = 0.356 ; Best Norm ===> 0.35

Iinst = Infinity
Tinst = 0 sec; Norm ===> 0 sec

Permissible Load according to Relay Current Setting:
I = 1800 A
S = 196 MVA

----------<< O/C Protection >>----------
Overcurrent Protective Relay R4(2) for 63 KV at L.V Side feeder 'Trans_2'

Relay Type: MCGG62
Selected Characteristic: SI
Generic Formula: T = (TMS/1) × {K / [(I/Is)^alfa -1]^Gama + Beta} = (TMS/1) × {0.14 / [(I/Is)^0.02 -1]^1 + 0}
alfa = 0.02 ; Beta = 0 ; Gama = 1 ; K = 0.14 ; M = 1

In = 1 A ; Relay Nominal Current

C.T Ratio = I1CT / I2CT = 2500 / 1
Feeder type: Trans.
Connected to Section Nr. 2

ISR(Trans_2) = 1.2 × ISR(Incoming_2) = 2160 A

Is = [ISR(Trans_2) / 2500] × In = 0.864 × In ; Best Norm ===> 0.85 × In

IPMax(Incoming_2) = 7157.31 A
TR(Incoming_2) = TMS(Incoming_2) / 1 × {0.14 / [(IPMax(Incoming_2) / ISR (Incoming_2)) ^ 0.02 - 1] + 0} = 1.625 sec ; Operating time for the Slowest Relay from lower layers
TR(Trans_2) = TR(Incoming_2) + 0.4 = 2.025 sec

TMS = TR(Trans_2) × 1 / {0.14 / [(IPMax(Incoming_2) / ISR(Trans_2)) ^ 0.02 - 1] + 0} = 0.356 ; Best Norm ===> 0.35

Iinst = Infinity
Tinst = 0 sec; Norm ===> 0 sec

Permissible Load according to Relay Current Setting:
I = 1800 A
S = 196 MVA

----------<< O/C Protection >>----------
Overcurrent Protective Relay R5(1) for 230 KV at Trans. Primary Side feeder 'HV_1'

Relay Type: MCGG62
Selected Characteristic: SI
Generic Formula: T = (TMS/1) × {K / [(I/Is)^alfa -1]^Gama + Beta} = (TMS/1) × {0.14 / [(I/Is)^0.02 -1]^1 + 0}
alfa = 0.02 ; Beta = 0 ; Gama = 1 ; K = 0.14 ; M = 1

In = 1 A ; Relay Nominal Current

C.T Ratio = I1CT / I2CT = 600 / 1
Feeder type: Trans.
Connected to Section Nr. 1

In(Transformer 230 kV side) = 160000 / (230 × 3^0.5) = 401.63 A

ISR(HV_1) = 1.25 × In (Transformer 230 kV side) = 502.04 A

Is = [ISR(HV_1) / 600] × In = 0.837 × In ; Best Norm ===> 0.85 × In
ISR(HV_1) = 0.85 × 600 = 510 A

IPMax(Trans_1) = 7157.31 A
I'PMax(Trans_1) = IPMax(Trans_1) × 0.274 = 1961.1 A

IPMin(Trans_1) = 2758.45 A
I'PMin(Trans_1) = IpMin(Trans_1) × 0.866 = 2388.82 A

Checking: I'PMin(Trans_1) / ISR(HV_1) = 4.68

TR(Trans_1) = TMS(Trans_1) / 1 × {0.14 / [(IPMax(Trans_1) / ISR(Trans_1)) ^ 0.02 - 1] + 0} = 1.993 sec ; Operating time for the Slowest Relay from lower layers
TR(HV_1) = TR(Trans_1) + 0.3 = 2.293 sec

TMS = TR(HV_1) × 1 / {0.14 / [(I'PMax(Trans_1) / ISR(HV_1)) ^ 0.02 - 1] + 0} = 0.447 ; Best Norm ===> 0.45

Iinst = 0.9 × [In (Transformer 230 kV side) / ISR(HV_1)] × Is = 0.71 × Is ; Norm ===> 2 × Is
Tinst = 0 sec; Norm ===> 0 sec

Permissible Load according to Relay Current Setting:
I = 493 A
S = 196 MVA

----------<< O/C Protection >>----------
Overcurrent Protective Relay R5(2) for 230 KV at Trans. Primary Side feeder 'HV_2'

Relay Type: MCGG62

Selected Characteristic: SI
Generic Formula: T = (TMS/1) × {K / [(I/Is)^alfa -1]^Gama + Beta} = (TMS/1) × {0.14 / [(I/Is)^0.02 -1]^1 + 0}
alfa = 0.02 ; Beta = 0 ; Gama = 1 ; K = 0.14 ; M = 1

In = 1 A ; Relay Nominal Current

C.T Ratio = I1CT / I2CT = 600 / 1
Feeder type: Trans.
Connected to Section Nr. 1

In(Transformer 230 kV side) = 160000 / (230 × 3^0.5) = 401.63 A

ISR(HV_2) = 1.25 × In (Transformer 230 kV side) = 502.04 A

Is = [ISR(HV_2) / 600] × In = 0.837 × In ; Best Norm ===> 0.85 × In
ISR(HV_2) = 0.85 × 600 = 510 A

IPMax(Trans_2) = 7157.31 A
I'PMax(Trans_2) = IPMax(Trans_2) × 0.274 = 1961.1 A

IPMin(Trans_2) = 2758.45 A
I'PMin(Trans_2) = IpMin(Trans_2) × 0.866 = 2388.82 A

Checking: I'PMin(Trans_2) / ISR(HV_2) = 4.68

TR(Trans_2) = TMS(Trans_2) / 1 × {0.14 / [(IPMax(Trans_2) / ISR(Trans_2)) ^ 0.02 - 1] + 0} = 1.993 sec ; Operating time for the Slowest Relay from lower layers
TR(HV_2) = TR(Trans_2) + 0.3 = 2.293 sec

TMS = TR(HV_2) × 1 / {0.14 / [(I'PMax(Trans_2) / ISR(HV_2)) ^ 0.02 - 1] + 0} = 0.447 ; Best Norm ===> 0.45

Iinst = 0.9 × [In (Transformer 230 kV side) / ISR(HV_2)] × Is = 0.71 × Is ; Norm ===> 2 × Is
Tinst = 0 sec; Norm ===> 0 sec

Permissible Load according to Relay Current Setting:
I = 493 A
S = 196 MVA

----------<< O/C Protection >>----------
Overcurrent Protective Relay R7(1) for 230 kV side Line Bay 'Abhar'

Relay Type: MCGG62
Selected Characteristic: SI
Generic Formula: T = (TMS/1) × {K / [(I/Is)^alfa -1]^Gama + Beta} = (TMS/1) × {0.14 / [(I/Is)^0.02 -1]^1 + 0}
alfa = 0.02 ; Beta = 0 ; Gama = 1 ; K = 0.14 ; M = 1

In = 1 A ; Relay Nominal Current

C.T Ratio = I1CT / I2CT = 1200 / 1
Feeder type: Line
Connected to Section Nr. 1

Line Thermal Rating = 560 A
Direction: Line side

Ibase = 251.02 A ; Base Current
If1(Abhar) = 10.925 pu = 2742.41 A ; Maximum 3-ph short circuit at forward Line beginning, seen by this Relay
If2(Abhar) = 8.52 pu = 2138.71 A ; Maximum 3-ph short circuit at forward Line end, seen by this Relay
If5(Abhar) = 5 pu = 1255.11 A ; Minimum 2-ph short circuit, seen by this Relay

ISR(Abhar) = Min [LTR , 1.2 × CT.Rating] = 560 A

Is = [ISR(Abhar) / 1200] × In = 0.467 × In ; Best Norm ===> 0.45 × In
ISR(Abhar) = 0.45 × 1200 = 540 A

Checking: If5(Abhar) / ISR(Abhar) = 2.32

TMS(Final) = Max [User defined TMS or Calculated TMS] = 0 ; Best Norm ===> 0.05

Iinst = 0.9 × [If1(Abhar) / ISR(Abhar)] × Is = 4.57 × Is ; Norm ===> 5 × Is
Tinst = 0 sec; Norm ===> 0 sec
Checking: [(If1 - If2) / If1] × 100 = 22 %

----------<< O/C Protection >>----------
Overcurrent Protective Relay R7(2) for 230 kV side Line Bay 'Eshragh'

Relay Type: MCGG62
Selected Characteristic: SI
Generic Formula: T = (TMS/1) × {K / [(I/Is)^alfa -1]^Gama + Beta} = (TMS/1) × {0.14 / [(I/Is)^0.02 -1]^1 + 0}
alfa = 0.02 ; Beta = 0 ; Gama = 1 ; K = 0.14 ; M = 1

In = 1 A ; Relay Nominal Current

C.T Ratio = I1CT / I2CT = 1200 / 1
Feeder type: Reactor
Connected to Section Nr. 1

Line Thermal Rating = 560 A
Direction: Busbar side

Ibase = 251.02 A ; Base Current
If3(Eshragh) = 7 pu = 1757.15 A ; Maximum 3-ph short circuit at reverse Line

beginning (if any), seen by this Relay
If4(Eshragh) = 6 pu = 1506.13 A ; Maximum 3-ph short circuit at reverse Line end (if any), seen by this Relay
If5(Eshragh) = 5 pu = 1255.11 A ; Minimum 2-ph short circuit, seen by this Relay
If6(Eshragh) = 8 pu = 2008.17 A ; Maximum common 3_ph short circuit with Remote Substation

ISR(Eshragh) = Max { 1.1 × Max[Is(all of O/C Relays that are Line side or NonDirectional)] and Min [LTR , 1.2 × CT.Rating] } Not greater than LTR = 560 A

Is = [ISR(Eshragh) / 1200] × In = 0.467 × In ; Low Norm ===> 0.45 × In
ISR(Eshragh) = 0.45 × 1200 = 540 A

Checking: If5(Boein Zahra) / ISR(Eshragh) = 2.32

Coordination with H.V side or Relays in Lower layers:
TR(HV_2)= 0.45 / 1 × {0.14 / [(If3 (Eshragh) / ISR(HV_2)) ^ 0.02 - 1] + 0} = 2.515 sec
TMS5 =(TR(HV_2) + 0.3) × 1 / {0.14 / [(If3 (Eshragh) / ISR(Eshragh)) ^ 0.02 - 1] + 0} = 0.48

TMS according to required Relay Operating time for Faults in the Reverse Line beginning (Zone 1):
TMS3 = 0.4 × 1 / {0.14 / [(If3(Eshragh) / ISR(Eshragh)) ^ 0.02 - 1] + 0} = 0.068
TMS according to required Relay Operating time for Faults in the Reverse Line End (Zone 2):
TMS4 = 0.8 × 1 / {0.14 / [(If4(Eshragh) / ISR(Eshragh)) ^ 0.02 - 1] + 0} = 0.118

Coordination with Remote substation's Relay or Fuse (You may deactivate this option):
Time of Extra Relay or Fuse = 0.222 sec ; Operating time for If6
TR6(Eshragh) = 0.4 + 0.222 = 0.62 sec
TMS6 = 0.62 × 1 / {0.14 / [(If6(Eshragh) / ISR(Eshragh)) ^ 0.02 - 1] + 0} = 0.118

Coordination with Line O/C Relays:
T(Abhar) = 0.05 / 1 × {0.14 / [(If3(Eshragh) / ISR(Abhar)) ^ 0.02 - 1] + 0} = 0.212 sec
T(Eshragh) = T(Abhar) + 0.4 = 0.612 sec
TMS (Eshragh) = 0.612 × 1 / {0.14 / [(If3(Eshragh) / ISR(Eshragh)) ^ 0.02 - 1] + 0} = 0.144

TMS(Final) = Max [User defined TMS or Calculated TMS] = 0.48 ; Best Norm ===> 0.475

Iinst = 0.9 × [If3(Eshragh) / ISR(Eshragh)] × Is = 2.93 × Is ; Norm ===> 3 × Is
Tinst = 0 sec; Norm ===> 0 sec

----------<< O/C Protection >>----------
Overcurrent Protective Relay R7(3) for 230 kV side Line Bay 'Boein Zahra'

Relay Type: MCGG62

Selected Characteristic: SI
Generic Formula: T = (TMS/1) × {K / [(I/Is)^alfa -1]^Gama + Beta} = (TMS/1) × {0.14 / [(I/Is)^0.02 -1]^1 + 0}
alfa = 0.02 ; Beta = 0 ; Gama = 1 ; K = 0.14 ; M = 1

In = 1 A ; Relay Nominal Current

C.T Ratio = I1CT / I2CT = 1200 / 1
Feeder type: Reactor
Connected to Section Nr. 2

Line Thermal Rating = 560 A
Direction: NonDirectional

Ibase = 251.02 A ; Base Current
If1(Boein Zahra) = 21.95 pu = 5509.93 A ; Maximum 3-ph short circuit at forward Line beginning, seen by this Relay
If2(Boein Zahra) = 8 pu = 2008.17 A ; Maximum 3-ph short circuit at forward Line end, seen by this Relay
If3(Boein Zahra) = 7 pu = 1757.15 A ; Maximum 3-ph short circuit at reverse Line beginning (if any), seen by this Relay
If4(Boein Zahra) = 6 pu = 1506.13 A ; Maximum 3-ph short circuit at reverse Line end (if any), seen by this Relay
If5(Boein Zahra) = 5 pu = 1255.11 A ; Minimum 2-ph short circuit, seen by this Relay
If6(Boein Zahra) = 8 pu = 2008.17 A ; Maximum common 3_ph short circuit with Remote Substation, seen by this Relay

ISR(Boein Zahra) = MAx { 1.1 × Max[Is(all of O/C Relays that are Line side or NonDirectional)] and Min [LTR , 0.9 × CT.Rating] } Not greater than LTR = 560 A

Is = [ISR(Boein Zahra) / 1200] × In = 0.467 × In ; Low Norm ===> 0.45 × In
ISR(Boein Zahra) = 0.45 × 1200 = 540 A

Checking: If5(Boein Zahra) / ISR(Boein Zahra) = 2.32

Coordination with H.V side or Relays in Lower layers:
TR(HV_2)= 0.45 / 1 × {0.14 / [(If3 (Boein Zahra) / ISR(HV_2)) ^ 0.02 - 1] + 0} = 2.515 sec
TMS5 =(TR(HV_2) + 0.3) × 1 / {0.14 / [(If3 (Boein Zahra) / ISR(Boein Zahra)) ^ 0.02 - 1] + 0} = 0.48

Coordination with Remote substation's Relay or Fuse (You may deactivate this option):
Time of Extra Relay or Fuse = 0.222 sec ; Operating time for If6
TR6(Boein Zahra) = 0.4 + 0.222 = 0.62 sec
TMS6 = 0.62 × 1 / {0.14 / [(If6(Boein Zahra) / ISR(Boein Zahra)) ^ 0.02 - 1] + 0} = 0.118

Coordination with Line O/C Relays:

T(Abhar) = 0.05 / 1 × {0.14 / [(If3(Boein Zahra) / ISR(Abhar)) ^ 0.02 - 1] + 0} = 0.293 sec
T(Boein Zahra) = T(Abhar) + 0.4 = 0.693 sec
TMS (Boein Zahra) = 0.693 × 1 / {0.14 / [(If3(Boein Zahra) / ISR(Boein Zahra)) ^ 0.02 - 1] + 0} = 0.118

TMS(Final) = Max [User defined TMS or Calculated TMS] = 0.48 ; Best Norm ===> 0.475

Iinst = 1.3 × [If1(Boein Zahra) / ISR(Boein Zahra)] × Is = 13.26 × Is ; Norm ===> 13 × Is
Tinst = 0 sec; Norm ===> 0 sec
Checking: [(If1 - If2) / If1] × 100 = 63.6 %

----------<< O/C Protection >>----------
Overcurrent Protective Relay R8(1) for 230 kV sideSide Buscoupler feeder 'Bus_HV'

Relay Type: MCGG82
Selected Characteristic: SI
Generic Formula: T = (TMS/1) × {K / [(I/Is)^alfa -1]^Gama + Beta} = (TMS/1) × {0.14 / [(I/Is)^0.02 -1]^1 + 0}
alfa = 0.02 ; Beta = 0 ; Gama = 1 ; K = 0.14 ; M = 1

In = 1 A ; Relay Nominal Current

C.T Ratio = I1CT / I2CT = 2000 / 1
Feeder type: Bus-Coupler_HV
Connected to Section Nr. 1

Ibase = 251.02 A ; Base Current
Ip1Max(Bus_HV) =31.86 Pu = 29197.43 A ; Maximum 3-ph short circuit at Line beginning, seen by this Relay
Ip2Max(Bus_HV) =15 Pu = 13746.44 A ; Maximum 3-ph short circuit at smallest Line end, seen by this Relay
Ip3Min(Bus_HV) =2 Pu = 1832.86 A ; Minimum 2-ph short circuit, seen by this Relay

ISR(Bus_HV) >= 0.5 × I1ct(H.V)= 1000 A
ISR(Bus_HV) >= 540 A ; For (Abhar) coordination
ISR(Bus_HV) >= 540 A ; For (Boein Zahra) coordination
ISR(Bus_HV) = Maximum all of ISRs = 1000 A

Is = [ISR(Bus_HV) / 2000] × In = 0.5 × In ; Best Norm ===> 0.5 × In

Checking: IP3Min(Bus_HV) / ISR(Bus_HV) = 1.83

TMS(Final) = Max [User defined TMS or Calculated TMS] = 1 ; High Norm ===> 1

Iinst = Infinity
Tinst = 0 sec; Norm ===> 0 sec