

Protective Relaying Report

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TRANSMISSION LINE PROTECTION

Ames-Ankeny Transmission line

- Huxley connection
- 23 mi
- Voltage 138kV
- Protection Scheme Directional Comparison Blocking (DCB) and Directional Comparison Unblocking (DCUB)
- 2 sets of CT per-phase rated for 138kV, 1200:5 MR @800:5 on the incoming line
- 2 sets of CVTs rated 145kV max, 693/1200:1 ratio,
- Relays
 - Primary: SEL-401L (4 zone P-P & P-G distance protection) has on/off type tripping
 - Backup: SEL-421 (3 zone P-P & P-G distance with overcurrent backup)
 - For Huxley connection: SEL-421 (with DCUB frequency key shift provides external protection loss of blocking function tripping provides internal fault protection)
 - Breaker failure detection: SEL-352 (Overcurrent)
- Automatic Reclosing
- Communication Channel: Power Line Carrier for DCB use

Ames-Boone Transmission Line

- 15 mi
- Voltage 138kV
- Protection Scheme 87L and POTT
- 2 sets of CT per-phase rated for 138kV, 1200:5 MR @800:5 on the incoming line
- 2 sets of CVTs rated 145kV max, 693/1200:1 ratio
- Relays
 - Primary: SEL-411L (line differential with distance backup protection)
 - Backup: SEL-421 (3 zone P-P & P-G distance with overcurrent backup)
 - Breaker failure protection: SEL-352
- Automatic Reclosing
- Communication Channel optical ground wire

Ames-Nevada Transmission Line

- 2.5 mi
- Voltage 138kV
- Protection Scheme 87L with 87L also used for backup
- 2 sets of CT per-phase rated for 138kV, 1200:5 MR @800:5 on the incoming line
- 2 sets of CVTs rated 145kV max, 693/1200:1 ratio
- Relays
 - Primary: SEL-411L (line current differential)
 - Secondary: SEL-387 (line current differential)
 - CB Protection: SEL-352 (Overcurrent)
- Automatic Reclosing
- Communication Channel optical ground wire

Ames Solar Farm

- 0.5 mile
- 69kV
- Protection Scheme 87L and 87L backup
- 2 sets of CT per-phase rated for 138kV, 1200:5 MR @800:5 on the incoming line for 87L
- 2 sets of CVTs rated 145kV max, 693/1200:1 ratio
- Relays
 - Primary: SEL-411L (line current differential)
 - Secondary: SEL-387 (line current differential)
 - CB Protection: SEL-352 (Overcurrent)
- No Automatic Reclosing
- Communication Channel optical ground wire

TRANSFORMER & REACTOR PROTECTION

- 2 MVA 69-138kV step up autotransformer
- Primary side motor switch protection
- 1 69kV dead tank circuit breaker on the low voltage side (CB5).
- 1 CT per-phase on the incoming solar farm line rated for 69kV, 1200:5 MR @800:5.
- CTs 3 per-phase on the transformer high side rated for 138kV, 1200:5 MR @800:5.
- 1CVT max voltage 72.5kV, 346/600:1 secondary voltage
- Relays

- Primary: SEL-487E (transformer protection relay) with 125V DC. 67 and 21 elements for directional overcurrent and distance relay protection respectively.
- Secondary: SEL-387E (current differential and voltage relay) Earth fault protection-has 51G. Use 87 current differential.

BREAKER PROTECTION

- Ring Bus Configuration
- 4 138kV dead tank circuit breakers (B1, B2, B3, & B4)
- No piloting required for ring bus.
- Each breaker shall have 4 sets of CTs 1 per-phase rated for 138kV 1200:5, MR @800:5. CTs connect to the bus before the breaker for each SEL-352 current measurement.

RELAY SPECIFICATIONS

138 kV Breaker B1&B2 (Ames/Ankeny)

- ❖ Primary relay to be Schweitzer SEL-421, transmission protection system. Rated for use at 125 Vdc.
 1. Access to back of relay is required in order to have a PC connection.
 2. Test and disconnect switches are required for relay testing and isolation.

Input Contact Assignments:

IN101 - Breaker B1 status close - 52a

IN102 - Breaker B2 status close - 52a

IN103 - Breaker B1 status open - 52b

IN104 - Breaker B2 status open - 52b

IN105 - Spare

IN106 - Spare

IN107 - Spare

Output Contact Assignments:

OUT101 - Breaker B1 trip - 52 contact tripping coil

OUT102 - Breaker B1 close - 52 contact closing coil

OUT103 - Breaker B2 trip - 52 contact tripping coil

OUT104 - Breaker B2 close - 52 contact closing coil
OUT105 - Secondary 138kV Ames-Ankeny SEL-421 IN105 79 reclose
OUT106 - Spare
OUT107 - Spare
ALARM - Annunciator RTU

- ❖ Secondary relay to be Schweitzer SEL-421, protection and automation system. Rated for use at 125Vdc.

3. Access to back of relay is required in order to have a PC connection.
4. Test and disconnect switches are required for relay testing and isolation.

Input Contact Assignments:

IN101 - Breaker B1 status close - 52a
IN102 - Breaker B2 status close - 52a
IN103 - Breaker B1 status open - 52b
IN104 - Breaker B2 status open - 52b
IN105 - Initiate reclose

Output Contact Assignments:

OUT101 - Breaker B1 trip - 52 contact tripping coil
OUT102 - Breaker B1 close - 52 contact & 79 reclose closing coil
OUT103 - Breaker B2 trip - 52 contact tripping coil
OUT104 - Breaker B2 close - 52 contact & 79 reclose closing coil
OUT105 - Spare
OUT106 - Spare

- ❖ Breaker failure protection to be Schweitzer SEL-352, breaker failure relay. Rated for use at 125 Vdc. Will be used for breaker B1 failure protection.

Input Contact Assignments

IN101 - Breaker B1 status close - 52a contact
IN102 - Spare
IN103 - Spare
IN104 - Relay Trip
IN105 - MOD Status
IN106 - Breaker B1 status open - 52b contact
IN107 - Spare

Output Contact Assignments

OUT101 - Breaker B1 trip - 86BFT aux relay
OUT102 - Spare
OUT103 - Breaker B1 alarm - BALRM 52 Ann
OUT104 - Spare
OUT105 - Breaker B1 trip motor operated disconnect - MDT TC
OUT106 - Breaker B1 reset output - 86RS
OUT107 - Breaker B1 retrip- 52 TC1

138 kV Breaker B1&B4 (Ames-Boone)

- ❖ Primary relay to be Schweitzer SEL-411L, advances line differential protection, automation, and control system. Rated for use at 125 Vdc.

Input Contact Assignments

IN101 - Breaker B1 status trip - 52a contact
IN102 - Breaker B4 status close - 52b contact
IN103 - Breaker status B4 trip - 52a contact
IN104 - Breaker status B4 close - 52b contact
IN105 - Spare
IN106 - Spare

Output Contact Assignments

OUT101 - Breaker B1 trip - 52 contact tripping coil
OUT102 - Breaker B1 close - 52 contact closing coil
OUT103 - Breaker B4 trip - 52 contact tripping coil
OUT104 - Breaker B4 close - 52 contact closing coil
OUT105 - Secondary 138kV Ames-Boon SEL-421 IN105 79 reclose
OUT106 - Spare
OUT107 - SCADA Relay Failure Breaker B4

- ❖ Secondary relay to be Schweitzer SEL-421, protection and automation system. Rated for use at 125 Vdc.

Input Contact Assignments:

IN101 - Breaker B1 status close - 52a
IN102 - Breaker B4 status close - 52a
IN103 - Breaker B1 status open - 52b
IN104 - Breaker B4 status open - 52b
IN105 - Initiate reclose

Output Contact Assignments:

OUT101 - Breaker B1 trip - 52 contact tripping coil
OUT102 - Breaker B1 close - 52 contact & 79 reclose closing coil
OUT103 - Breaker B4 trip - 52 contact tripping coil
OUT104 - Breaker B4 close - 52 contact & 79 reclose closing coil
OUT105 - Spare
OUT106 - Spare

- ❖ Breaker protection to be Schweitzer SEL-352, breaker failure relay. Rated for use at 125 Vdc. Will be used for breaker B4 failure protection.

Input Contact Assignments

IN101 - Breaker B4 trip - 52a contact
IN102 - Spare
IN103 - Spare
IN104 - Relay Trip
IN105 - MOD Status
IN106 - Breaker B2 close - 52b contact
IN107 - Spare

Output Contact Assignments

OUT101 - Breaker B4 trip - 86BFT aux relay
OUT102 - Spare
OUT103- Breaker B4 alarm - BALRM 52 Ann
OUT104 - Spare
OUT105 - Breaker B4 trip motor operated disconnect - MDT TC
OUT106 - Breaker B4 reset output - 86RS
OUT107 - Breaker B4 retrip- 52 TC1

138 kV Breaker B3&B2 (Ames-Nevada)

- ❖ Primary relay to be Schweitzer SEL-411L, line current differential protection and automation system. Rated for use at 125 Vdc.

Input Contact Assignments:

IN101 - Breaker B3 status close - 52a
IN102 - Breaker B2 status close - 52a
IN103 - Breaker B3 status open - 52b
IN104 - Breaker B2 status open - 52b
IN105 - Spare

Output Contact Assignments:

OUT101 - Breaker B3 trip - 52 contact tripping coil
OUT102 - Breaker B3 close - 52 contact closing coil
OUT103 - Breaker B2 trip - 52 contact tripping coil
OUT104 - Breaker B2 close - 52 contact closing coil
OUT105 - Secondary 138kV Ames Nevada SEL-411L IN105 79 reclose
OUT106 - Spare
OUT107 - Spare
ALARM - Annunciator RTU

- ❖ Secondary relay to be Schweitzer SEL-411L, line current differential protection and automation system. Rated for use at 125 Vdc.

Input Contact Assignments:

IN101 - Breaker B3 status close - 52a
IN102 - Breaker B2 status close - 52a
IN103 - Breaker B3 status open - 52b
IN104 - Breaker B2 status open - 52b
IN105 - Initiate reclose

Output Contact Assignments:

OUT101 - Breaker B3 trip - 52 contact tripping coil
OUT102 - Breaker B3 close - 52 contact & 79 reclose closing coil
OUT103 - Breaker B2 trip - 52 contact tripping coil
OUT104 - Breaker B2 close - 52 contact & 79 reclose closing coil
OUT105 - Spare
OUT106 - Spare
OUT107 - Breaker B2 SCADA Relay Failure alarm
ALARM - Breaker B3 SCADA Relay Failure

- ❖ Breaker protection to be Schweitzer SEL-352, breaker failure relay. Rated for use at 125 Vdc. Will be used for 138 kV Breaker B2 failure-to-trip protection.

Input Contact Assignments

IN101 - Breaker B2 status close - 52a
IN102 - Spare
IN103 - Spare
IN104 - Relay trip
IN105 - MOD Status
IN106 - Breaker B2 status open - 52b contact
IN107 - Spare

Output Contact Assignments

OUT101 - Breaker B2 trip - 86BFT aux relay
OUT102 - Spare
OUT103 - Breaker B2 alarm - BALRM 52 Ann
OUT104 - Spare
OUT105 - Breaker B2 trip motor operated disconnect - MDT TC
OUT106 - Breaker B2 reset output - 86RS
OUT107 - Breaker B2 retrip- 52 TC1

138 kV Breaker B4&B3 (Ames Solar Farm)

- ❖ Primary relay to be Schweitzer SEL-411L, advances line differential protection, automation, and control system. Rated for use at 125 Vdc.

Input Contact Assignments:

IN101 - Breaker B3 status close - 52a
IN102 - Breaker B4 status close - 52a
IN103 - Breaker B3 status open - 52b
IN104 - Breaker B4 status open - 52b
IN105 - Spare
IN106 - Spare

Output Contact Assignments:

OUT101 - Breaker B3 trip - 52 contact tripping coil
OUT102 - Breaker B4 close - 52 contact closing coil
OUT103 - Breaker B3 trip - 52 contact tripping coil
OUT104 - Breaker B4 close - 52 contact closing coil
OUT105 - Secondary 138kV Ames-Solar Farm SEL-411L IN105 79 reclose
OUT106 - Spare
OUT107 - SCADA Relay Failure Breaker B4

ALARM - SCADA Relay Failure Breaker B1

- ❖ Secondary relay to be Schweitzer SEL-411L, line current differential protection and automation system. Rated for use at 125 Vdc.

Input Contact Assignments:

IN101 - Breaker B3 status close - 52a
IN102 - Breaker B4 status close - 52a
IN103 - Breaker B3 status open - 52b
IN104 - Breaker B4 status open - 52b
IN105 - Initiate reclose

Output Contact Assignments:

OUT101 - Breaker B3 trip - 52 contact tripping coil
OUT102 - Breaker B3 close - 52 contact & 79 reclose closing coil
OUT103 - Breaker B4 trip - 52 contact tripping coil
OUT104 - Breaker B4 close - 52 contact & 79 reclose closing coil
OUT105 - Spare
OUT106 - Spare
OUT107 - Breaker B3 SCADA Relay Failure alarm
ALARM - Breaker B4 SCADA Relay Failure

- ❖ Breaker failure protection to be Schweitzer SEL-352, breaker failure relay. Rated for use at 125 Vdc. Will be used for breaker B3 failure protection.

Input Contact Assignments

IN101 - Breaker B3 status close - 52a
IN102 - Spare
IN103 - Spare
IN104 - Relay trip
IN105 - MOD status
IN106 - Breaker B3 status close - 52b
IN107 - Spare

Output Contact Assignments

OUT101 - Breaker B3 trip - 86BFT aux relay
OUT102 - Spare
OUT103- Breaker B3 alarm - BALRM 52 Ann
OUT104- Spare
OUT105- Breaker B3 trip motor operated disconnect - MDT TC

OUT106- Breaker B3 reset output - 86RS
OUT107- Breaker B3 retrip- 52 TC1

69kV Transformer Breaker B5

- ❖ Primary - transformer protection to be Schweitzer SEL-487E, transformer protection relay. Rated for use at 125 Vdc.

Input Contact Assignments

IN101 - Breaker B5 status close - 52a
IN102 - Breaker B5 status open - 52b
IN103 - Breaker B3 status close - 52a
IN104 - Breaker B3 status open - 52b
IN105 - Breaker B4 status close - 52a
IN106 - Breaker B4 status open - 52b
IN107 - Spare
IN108 - Spare

Output Contact Assignments

OUT101 - Breaker B5 trip - 52 contact tripping coil
OUT102 - Breaker B5 close - 52 contact closing coil
OUT103 - Spare
OUT104 - Spare
OUT105 - Breaker B4 trip - 52 contact tripping coil
OUT106 - Breaker B4 close - 52 contact closing coil
OUT107 - Breaker B3 trip - 52 contact tripping coil
OUT108 - Breaker B3 close - 52 contact closing coil

- ❖ Backup - transformer protection to be Schweitzer SEL-387E i3981, transformer protection relay. Rated for use at 125 Vdc.

Input Contact Assignments

IN101 - Breaker B5 status close - 52a
IN102 - Breaker B5 status open - 52b
IN103 - Breaker B3 status close - 52a
IN104 - Breaker B3 status open - 52b
IN105 - Breaker B4 status close - 52a

IN106 - Breaker B4 status open - 52b
IN107 - Spare
IN108 - Spare

Output Contact Assignments

OUT101 - Breaker B5 trip - 52 contact tripping coil
OUT102 - Breaker B5 close - 52 contact closing coil
OUT103 - Spare
OUT104 - Spare
OUT105 - Breaker B4 trip - 52 contact tripping coil
OUT106 - Breaker B4 close - 52 contact closing coil
OUT107 - Breaker B3 trip - 52 contact tripping coil
OUT108 - Breaker B3 close - 52 contact closing coil

- ❖ Breaker failure protection to be Schweitzer SEL-352, breaker failure relay. Rated for use at 125 Vdc. Will be used for breaker B5 failure protection.

Input Contact Assignments

IN101 - Breaker B5 status close - 52a contact
IN102 - Spare
IN103 - Spare
IN104 - Relay trip
IN105 - MOD status
IN106 - Breaker B5 status open - 52b contact
IN107 - Spare

Output Contact Assignments

OUT101 - Breaker B5 trip - 86BFT aux relay
OUT102 - Spare
OUT103- Breaker B5 alarm - BALRM 52 Ann
OUT104- Spare
OUT105- Breaker B5 trip motor operated disconnect - MDT TC
OUT106- Breaker B5 reset output - 86RS
OUT107- Breaker B5 retrip- 52 TC1