NOTE
DO NOT PARALLEL CIRCUITS B3 & B4 THROUGH THE 115 kV BUS

LEGEND

- 115kV
- 13.8kV
- 600/347V
- 120/208V
- EMERGENCY
- CT'S, METERS & RELAYS

B4 — 91-B4 (600A) — YELLOW — B4 CVT — "A1" BUS 115 kV — (600A) — "A2" BUS — 115 kV — "A3" BUS — BLACK 91A1-A2 — 91A2-A3 (N.O.) GREEN — B3 — 91-B3 (600A) — RED — B3 CVT

91T1-A (600A) LT. BLUE — ELECTRICAL INTERLOCK WITH T1Q — LA 108/84 kV T1-LA — 3x30A

91T2-A (600A) ORANGE — ELECTRICAL INTERLOCK WITH T2Q — LA 108/84 kV T2-LA — 3x30A

NF-91

SEL-311C-A: A21 A27 A59 A81 A59N — 51B 51C — 87 — 240:5

SEL-311C-B: B21 B27 B59 B81 B59N — 240:5

FIBRE JB

T-1 BROWN 30/40/48 MVA 115/13.8 kV, 11.8% Z — 63 26 — 4 ohm 2000A — 2000:5 — 90V AC TO TAP CHANGER — T1PT1 8000:120V, 5kVA — T1PT1-X

T-2 MAGENTA 30/40/48 MVA 115/13.8 kV, 11.8% Z — 63 26 — 4 ohm 2000A — 2000:5 — 90V AC TO TAP CHANGER — T2PT1 8000:120V, 5kVA — T2PT1-X

94 — A85 TTT / B85 TTT — TRANSFER TRIP TO BURLINGTON

A85 TTR / B85 TTR — TRANSFER TRIP FROM BURLINGTON

IESO BACKUP PT'S: ACC. CLASS 0.3WXYZ 14,400:120V (2 X 1.75kVA) — T1PT2 — M

IESO BACKUP CT'S: ACC. CLASS 0.3B2.0 2000/1000:5 (2 X CT'S)

IESO MAIN CT'S: ACC. CLASS 0.3B1.8 2000:5 (3 X CT'S)

2000:5 (3 X CT'S) — 51 51N AM

T1Q (2,000A) — 2000:5 — T2Q BF

IESO MAIN PT'S: ACC. CLASS 0.3WXYZ 8400:120V (3 X 1.75kVA) — T1PT3 — T1PT3-X — M — SS1 — SS1-X — 13,800:120-208V 30 kVA — LA 15/12.7 kV

8500 ION (1) — IESO MAIN 8600 (1) — 7600 ION (2 4) — TO T1 TAP CHANGER — TO T2 TAP CHANGER — UPS

T3Q (SPARE)

T2Q (2,000A) — 2000:5

IESO MAIN PT'S: ACC. CLASS 0.3WXYZ 8400:120V (3 X 1.75kVA) — T2PT3 — T2PT3-X — SS2 — SS2-X — 13,800:120-208V 30 kVA — LA 15/12.7 kV

CUSTOMER LOAD 15kV SWITCHGEAR IN CLARKE UTILITIES CENTRE

E. T. CLARKE

M1A — 13800:120V — PM 8244 — 1200:5 — LA 18/15.3kV

M1 T1Q1 (2,000A) — 2000:5 — SEL-751 (67N 67 51 51N)

M16A — 13800:120V — PM 8244 — 1200:5 — LA 18/15.3kV

M16 T2Q3 (2,000A) — 2000:5 — SEL-751 (51N 51 67 67N)

AIP-1 SEL-2100 — TO 52-G7

AIP-2 SEL-2100

Q1 BUS PT'S 13800:120V — Q1 BUS, 2000A, 13.8kV, 3W

M9 TIE BREAKER Q1Q2 — PM 8244 — SEL-751 — 2000:5

Q2 BUS PT'S 13800:120V — Q2 BUS, 2000A, 13.8kV, 3W

M15 TIE BREAKER Q2Q3 — PM 8244 — SEL-751 — 2000:5

Q3 BUS PT'S 13800:120V — Q3 BUS, 2000A, 13.8kV, 3W

600:5 PM 8244 SEL-751 feeders:

M2 COGEN-G7 — M2A SPARE — M3 (C5,S1) 12-SUB.2 — M4 (C4,S1) 26,31,33,40, 50 — M5 SPARE — M5A (C10,S1) 12-SUB.1 — M6 (C2,S1) 10,20,23, 24,28, 39,45,46, 51,53,74 — M7A (C9,S2) 25 — M9A (C5,S2) 12-SUB.2 — M10 (C2,S2) 10,20,23, 24,28, 39,45,46, 51,53,74 — M11 SPARE — M11A SPARE — B6 300:5A — M12 (C8) 12-T6 — M12A (C1,S2) 12-T10 — M13 (C3,S2) 9A,9-15,11SW, 11NW,16,16A, 32,34,48,49, 56 — M14A (C6,S1) 37 — M15A SPARE — M17 (C4,S2) 26,31,33,40, 50 — M18 SPARE — M18A (C10,S2) 12-SUB.1 — B9 300:5A — M19 (C7) 12-T5 — M19A (C1,S1) 12-T11 — M20 (C9,S1) 25 — M20A (C3,S1) 9A,9-15,11SW, 11NW,16,16A, 32,34,48,49, 56 — M21 (C6,S2) 37

E.T. CLARKE CHP

(3) — REVENUE METERING (M) — 14400:120V — 600:5 — FROM AIP-1 — 52-G7 — 14400:120V (2) — 300:5 — ION PM8244 — SEL-700G — G7 — TO SCADA — GCP — (1) 600:5 — (3) 600:5 — (3) 600:5 — (1) 50:5 — NGR 8000V 50A, 10 SEC. 160 Ω

NOTE:
COLOURS SHOWN DENOTE KEYING SYSTEM.

- (51) PHASE OVERCURRENT PROTECTION RELAY
- (51N) NEUTRAL OVERCURRENT PROTECTION RELAY
- (51G) GROUND OVERCURRENT PROTECTION RELAY
- (63) TRANSFORMER PRESSURE SWITCH
- (67) DIRECTIONAL OVERCURRENT RELAY
- (67N) NEUTRAL DIRECTIONAL OVERCURRENT RELAY
- (87) DIFFERENTIAL PROTECTION RELAY
- (90) TAP CHANGER CONTROL
- (94) REMOTE TRIP RELAY
- (AM) AMMETER
- (M) MOTOR OPERATOR

(1) ION 8600 REVENUE METERS, MAIN & ALTERNATE CAT. No. P8500F9C0H6E0A4A (BURDEN: 0.15 VA) c/w BREAKOUT CABLE.

(2) ION 7600 POWER QUALITY METER C/W DIGITAL I/O, CAT. No. P7600A0C0B6E0E0A (BURDEN:0.15VA).

(3) NOT USED.

(4) POWERED BY UPS 120V SUPPLY.

McMASTER CTS-NF91
Tripping Matrix

Normal Initiating Protection – B4 Line, Transformer T1

PROTECTION FUNCTION	B4 A21P1 A59N	B4 A27/A59 A81	B4 A85 TTR	B4 B21P1 B59N	B4 B27/B59 B81	B4 B85 TTR	T1Q BF	XFRT1 87	XFRT1 51B (HV)	XFRT1 51G (HV)	XFRT1 26 63	XFRT1 51 (LV)	XFRT1 51N (LV)	T1Q1 FDR 51 (LV)	T1Q1 FDR 51N (LV)	T1Q1 FDR 67 (LV)	T1Q1 FDR 67N (LV)	Q1 Bus 51 (LV)	Q1 Bus 51N (LV)
RELAY	SEL-311C A	SEL-311C A	NSD-570 Main	SEL-311C B	SEL-311C B	NSD-570 Alt.	SEL-311C A	West HU-1	West CO-8	West CO-9		West CO-8	West CO-9	SEL-751	SEL-751	SEL-751	SEL-751	SEL-751	SEL-751
BURLINGTON TS							TT	TT	TT	TT	TT								
91T1-A-MDS							0	0	0	0	0								
T1Q BKR	T	T	T	T	T	T	T	T	T	T	T	T	T						
T1Q1 BKR							T							T	T	T	T		
Q1Q2 BKR																		T	T
T1Q BF Init	X	X	X	X	X	X		X	X	X	X	X	X						

Normal Initiating Protection – B3 Line, Transformer T2

PROTECTION FUNCTION	B3 A21P1 A59N	B3 A27/A59 A81	B3 A85 TTR	B3 B21P1 B59N	B3 B27/B59 B81	B3 B85 TTR	T2Q BF	XFRT2 87	XFRT2 51B (HV)	XFRT2 51G (HV)	XFRT2 26 63	XFRT2 51 (LV)	XFRT2 51N (LV)	T2Q3 FDR 51 (LV)	T2Q3 FDR 51N (LV)	T2Q3 FDR 67 (LV)	T2Q3 FDR 67N (LV)	Q3 Bus 51 (LV)	Q3 Bus 51N (LV)
RELAY	SEL-311C A	SEL-311C A	NSD-570 Main	SEL-311C B	SEL-311C B	NSD-570 Alt.	SEL-311C A	West HU-1	West CO-8	West CO-9		West CO-8	West CO-9	SEL-751	SEL-751	SEL-751	SEL-751	SEL-751	SEL-751
BURLINGTON TS							TT	TT	TT	TT	TT								
91T2-A-MDS							0	0	0	0	0								
T2Q BKR	T	T	T	T	T	T	T	T	T	T	T	T	T						
T2Q3 BKR							T							T	T	T	T		
Q2Q3 BKR																		T	T
T2Q BF Init	X	X	X	X	X	X		X	X	X	X	X	X						

LEGEND

T = Trip
O = Open (1 sec delay)
X = Initiate
TT = Send Transfer Trip
TTR = Transfer Trip Receive
BF = Breaker Failure

MUMC LOAD BREAK SWITCH (MUMC ELECT. RM) — S — K — 13.8:115V — 52-UH2 1000A — SEL-351 — FIBRE JB — 52-UH1 1000A — SEL-351 — MUMC LOAD BREAK SWITCH (MUMC ELECT. RM)

UH-T2 — UH-T1 — N.O.

52-GBM2 — NORMAL — 52-CGTIE — N.O. — 52-GBM1 — NORMAL

F12 — 52-G6 — 52-G5 — 52-G4 — G6 — G5 — G4 — EMERG.

52-G3 — 52-G2 — 52-G1 — F11 — G3 — G2 — G1 — EMERG.

M.U.M.C.

REV	DESCRIPTION	YR	MO	DA
2	AS BUILT	18	06	18
1	CORRECTED NF91 METERING, ADDED G7	18	2	2
0	RECORD DRAWING	17	03	08

SCALE NTS — DATE 2017.03.08

McMASTER UNIVERSITY

TITLE: NF-91 AND E.T. CLARKE OPERATING DIAGRAM

CAD FILE: NF91.SingleL.Apr.2018 — REV 2

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Monday, February 5, 2018 10:59:35 AM

NOTE
DO NOT PARALLEL CIRCUITS B3 & B4 THROUGH THE 115 kV BUS

LEGEND

- 115kV
- 13.8kV
- 600/347V
- 120/208V
- EMERGENCY
- CT'S, METERS & RELAYS

1. 1200/800/200–5A 10L800@1200–5A
2. 3200/2400/2000–5A 10L800@1200–5A
3. 4000/2800/800–5A 10L400@1200–5A
4. CVT, 3 x 69KV–115/69V–115/69V (600/1000:1) 0.3 WXY, 0.6Z, 0.3WXY, 0.6Z, 3PZ–3PZ THERMAL BURDEN 1000VA
5. 3 x 1Ø COMBINED CT/VT UNIT CT, 3 x 2400/1600/800–5A 0.15SB0.9 ON 2400/1600:5A 0.15B0.5 ON 800:5A, VT, 3 x 8.4KV–120V 500VA (THERMAL) 0.3Y, MC APPROVED FOR REVENUE

04

B4 91–B4 (600A) YELLOW — "A1" BUS 115 kV — LINK — "A2" BUS 115 kV — 91A2–A3 (N.O.) GREEN — "A3" BUS 115 kV — B3 91–B3 (600A) RED

91T1–A (600A) LT. BLUE — T1–SA 108/84 kV — ELECTRICAL INTERLOCK WITH T1Q — 69V ø–N 3x30A

TRANSFER TRIP TO/FROM BURLINGTON
MAIN NSD 570 (MB TR/R) T–1 T–2 — MAIN TTS/TTR T2
TRANSFER TRIP TO/FROM BURLINGTON
ALT NSD 570 (MB TR/R) T–1 T–2 — ALT. TTS/TTR T2
MAIN TTS/TTR T1
ALT. TTS/TTR T1

FIBER PATCH PANEL MOD A — FIBRE JB

T1 POM PM 8244 — 400:5 — GE–T60 ZATM"A"–T1 — A27 A50 A51 A59N A67 A81 A87 A87N — SEL–387E ZATM"B"–T1 — B27 B50 B51 B59N B67 B81 B87 B87N

T1 BROWN — ONAN/ONAF/ONAF 30/40/50MVA 115kV 13.8kV 3ø 60Hz Dyn1 — 90V — AC TO TAP CHANGER — T1PT1 — TAP CONTROLLER T1PT1–X — T1RM CTVT — 63 26 — 200:5 — X0 4 ohm 2000A

CT/PT COMBO METERING — T1 REV METG T1 CT/VT JCT BOX — 3x1000VA 8.4KV 10 60Hz 120V — 3x1600–5A — T1–SA2 — H1 13.8/11KV — H2

TSS1 100kVA Dyn11 — 13.8kV–208/120V 3ø 60HZ ±5% OFF LOAD TAP — 4A

2000:5 — SEL–311L — 50 50N 67L T2Q BF — T1Q (2,000A) — 2000:5

STATUS — D.SW(91–B4) — D.SW(A2–A3) — D.SW(91T1–A) — C.B(T1Q) — CTM 2506 T1

B/F TTS

T2 POM PM 8244 — 400:5 — GE–T60 ZATM"A"–T2 — A27 A50 A51 A59N A67 A81 A87 A87N — SEL–387E ZATM"B"–T2 — B27 B50 B51 B59N B67 B81 B87 B87N

T2 BROWN — ONAN/ONAF/ONAF 30/40/50MVA 115kV 13.8kV 3ø 60Hz Dyn1 — 90V — AC TO TAP CHANGER — T2PT2 — TAP CONTROLLER T2PT2–X — T2RM CTVT — 63 26 — 200:5 — X0 4 ohm 2000A

CT/PT COMBO METERING — T2 REV METG T2 CT/VT JCT BOX — 3x1000VA 8.4KV 10 60Hz 120V — 3x1600–5A — T2–SA2 — H1 13.8/11KV — H2

TSS2 100kVA Dyn11 — 13.8kV–208/120V 3ø 60HZ ±5% OFF LOAD TAP — 4A

2000:5 — SEL–311L — 50 50N 67L T2Q BF — T2C (2,000A) — 2000:5

2000A SPARE

91T2–A (600A) ORANGE — T2–SA 108/84 kV — ELECTRICAL INTERLOCK WITH T2Q — 69V ø–N 3x30A

MAIN TTS/TTR T2
ALT. TTS/TTR T2

FIBER PATCH PANEL MOD B

STATUS — D.SW(91–B3) — D.SW(91T2–A) — C.B(T2Q) — CTM 2506 T2

B/F TTS

NOTE:
COLOURS SHOWN DENOTE KEYING SYSTEM.

27 UNERVOLTAGE PROT. ELEMENT
51 PHASE OVERCURRENT PROTECTION ELEMENT
51N NEUTRAL OVERCURRENT PROTECTION ELEMENT
51G GROUND OVERCURRENT PROTECTION RELAY
59N NEUTRAL OVERVOLTAGE PROT. ELEMENT
63 TRANSFORMER PRESSURE SWITCH
67 DIRECTIONAL OVERCURRENT ELEMENT
67N NEUTRAL DIRECTIONAL OVERCURRENT ELEMENT
87 DIFFERENTIAL PROTECTION ELEMENT
90 TAP CHANGER CONTROL
87L CURRENT DIFFERENTIAL
M MOTOR OPERATOR

CUSTOMER LOAD 15kV SWITCHGEAR IN CLARKE UTILITIES CENTRE

E. T. CLARKE

LA 15/12.7 kV — M1A 13800:120V — PM 8244 1200:5 — LA 18/15.3kV — M1 T1Q1 (2,000A) — 2000:5 — 25 79 51N 51 67 67N — SEL–751 — 87L 50 51N — SEL–311L

FIBER PATCH PANEL — D — AP–1 SEL–2100 — TO 52–G7 — AP–2 SEL–2100

SA 15/12.7 kV — 13800:120V — LA 18/15.3kV — PM 8244 1200:5 — M16A — M16 T2Q3 (2,000A) — 2000:5 — 25 79 51N 51 67 67N — SEL–751 — 87L 50 51N — SEL–311L

Q1 BUS PT'S 13800:120V — Q1 BUS, 2000A, 13.8kV, 3W — 600:5 — PM 8244

M2 COGEN–G7 — M2A SPARE — M3 (C5,S1) 12–SUB.2 — M4 (C4,S1) 26,31,33,40, 50 — M5 SPARE — M5A (C10,S1) 12–SUB.1 — M6 (C2,S1) 10,20,23, 24,28, 39,45,46, 51,53,74 — M7A (C9,S2) 25 — M9A (C5,S2) 12–SUB.2 — M10 (C2,S2) 10,20,23, 24,28, 39,45,46, 51,53,74 — M11 SPARE — M11A SPARE

M9 TIE BREAKER Q1Q2 — SEL–751 — 2000:5

Q2 BUS PT'S 13800:120V — Q2 BUS, 2000A, 13.8kV, 3W — M15 TIE BREAKER Q2Q3 — 1000:5

B8 300:5A — M12 (C8) 12–T6 — M12A (C1,S2) 12–T10 — M13 (C3,S2) 9A,9–15,115W, 11NW,16,16A, 32,34,48,49, 56 — M14A (C6,S1) 37 — M15A SPARE — M17 (C4,S2) 26,31,33,40, 50 — M18 SPARE — M18A (C10,S2) 12–SUB.1 — B9 300:5A — M19 (C7) 12–T5 — M19A (C1,S1) 12–T11 — M20 (C9,S1) 25 — M20A (C3,S1) 9A,9–15,115W, 11NW,16,16A 32,34,48,49, 56 — M21 (C6,S2) 37

Q3 BUS PT'S 13800:120V — Q3 BUS, 2000A, 13.8kV, 3W

E.T. CLARKE CHP

(3) REVENUE METERING (M) — 14400:120V — 600:5 — FROM AIP–1 — 52–G7 — 14400:120V (2) — 300:5 — ION PM8244 — SEL–700G — G7 — TO SCADA — GCP

(1) 600:5 — (3) 600:5 — (3) 600:5 — (1) 50:5 — NGR 8000V 50A, 10 SEC. 160 Ω

LEGEND
T = Trip
O = Open (1 sec delay)
X = Initiate
TT = Send Transfer Trip
TTR = Transfer Trip Receive
BF = Breaker Failure

McMASTER CTS–NF91
Tripping Matrix

Normal Initiating Protection – B4 Line, Transformer T1

PROTECTION FUNCTION	B4 A67 A59N	B4 A27/A59	B4 A85 TTR	B4 B67 B59N	B4 B27/B59	B4 B85 TTR	T1Q BF	XFRT1 87A	XFRT1 87B	XFRT1 51B (HV)	XFRT1 51G (HV)	XFRT1 26 63	XFRT1 51 (LV)	XFRT1 51N (LV)	T1Q1 FDR 51 (LV)	T1Q1 FDR 51N (LV)	T1Q1 FDR 67 (LV)	T1Q1 FDR 67N (LV)	Q1 Bus 51 (LV)	Q1 Bus 51N (LV)
RELAY	GE–T60 A	GE–T60 A	NSD–570 Main	SEL–387E B	SEL–387E B	NSD–570 Alt.	SEL–311L A	T60	SEL–387E	T60	T60		SEL–311L	SEL–311L	SEL–751	SEL–751	SEL–751	SEL–751	SEL–751	SEL–751
BURLINGTON TS							TT	TT	TT	TT	TT	TT								
91T1–A–MDS							0	0	0	0	0	0								
T1Q BKR	T	T	T	T	T	T	T	T	T	T	T	T	T	T						
T1Q1 BKR							T								T	T	T	T		
Q1Q2 BKR																			T	T
T1Q BF Init	X	X	X	X	X	X		X	X	X	X	X	X	X						

Normal Initiating Protection – B3 Line, Transformer T2

PROTECTION FUNCTION	B3 A67 A59N	B3 A27/A59	B3 A85 TTR	B3 B67 B59N	B3 B27/B59	B3 B85 TTR	T2Q BF	XFRT2 87	XFRT2 87B	XFRT2 51B (HV)	XFRT2 51G (HV)	XFRT2 26 63	XFRT2 51 (LV)	XFRT2 51N (LV)	T2Q3 FDR 51 (LV)	T2Q3 FDR 51N (LV)	T2Q3 FDR 67 (LV)	T2Q3 FDR 67N (LV)	Q3 Bus 51 (LV)	Q3 Bus 51N (LV)
RELAY	GE–T60 A	GE–T60 A	NSD–570 Main	SEL–387E B	SEL–387E B	NSD–570 Alt.	SEL–311L A	T60	SEL–387E	GE–T60	T60		SEL–311L	SEL–311L	SEL–751	SEL–751	SEL–751	SEL–751	SEL–751	SEL–751
BURLINGTON TS							TT	TT	TT	TT	TT	TT								
91T2–A–MDS							0	0	0	0	0	0								
T2Q BKR	T	T	T	T	T	T	T	T	T	T	T	T	T	T						
T2Q3 BKR							T								T	T	T	T		
Q2Q3 BKR																			T	T
T2Q BF Init	X	X	X	X	X	X		X	X	X	X	X	X	X						

MUMC LOAD BREAK SWITCH (MUMC ELECT. RM) — 13.8:115V — 52–UH2 1000A — SEL–351 — UH–T2 — N.O. — 52–GBM2 — NORMAL — F12 — 52–G6 — 52–G5 — 52–G4 — G6 — G5 — G4 — 3X1.75MW GAS RECIPOCATING UNITS — EMERG.

MUMC LOAD BREAK SWITCH (MUMC ELECT. RM) — 13.8:115V — 52–UH1 1000A — SEL–351 — UH–T1 — N.O. — 52–GBM1 — NORMAL — 52–CGTIE — N.O. — 52–G3 — 52–G2 — 52–G1 — F11 — G3 — G2 — G1 — 3X1.75MW GAS RECIPOCATING UNITS — EMERG.

M.U.M.C.

FOR REV 04 ONLY

LICENSED PROFESSIONAL ENGINEER — M.R.Parooqi — 100062640 — 27/9/2018 — PROVINCE OF ONTARIO

RELEASED FOR CONSTRUCTION

REV	DESCRIPTION	YR	MO	DA
4	REPLACED TRANS. T1/T2, T1Q & T2Q CB, REPLACED ALL PCT RELAYS	18	09	21
3	REPLACED T1 TRANSFORMER PROTECTION STATION SERVICE	18	07	06
2	AS BUILT	18	06	18
1	CORRECTED NF91 METERING, ADDED G7	18	2	2
0	RECORD DRAWING	17	03	08

SCALE NTS — DATE 2017.03.08

McMASTER UNIVERSITY

TITLE: NF-91 AND E.T. CLARKE OPERATING DIAGRAM

CAD FILE: NF91.SingleL.Jul.2018 — REV 4

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Monday, February 5, 2018 10:59:35 AM