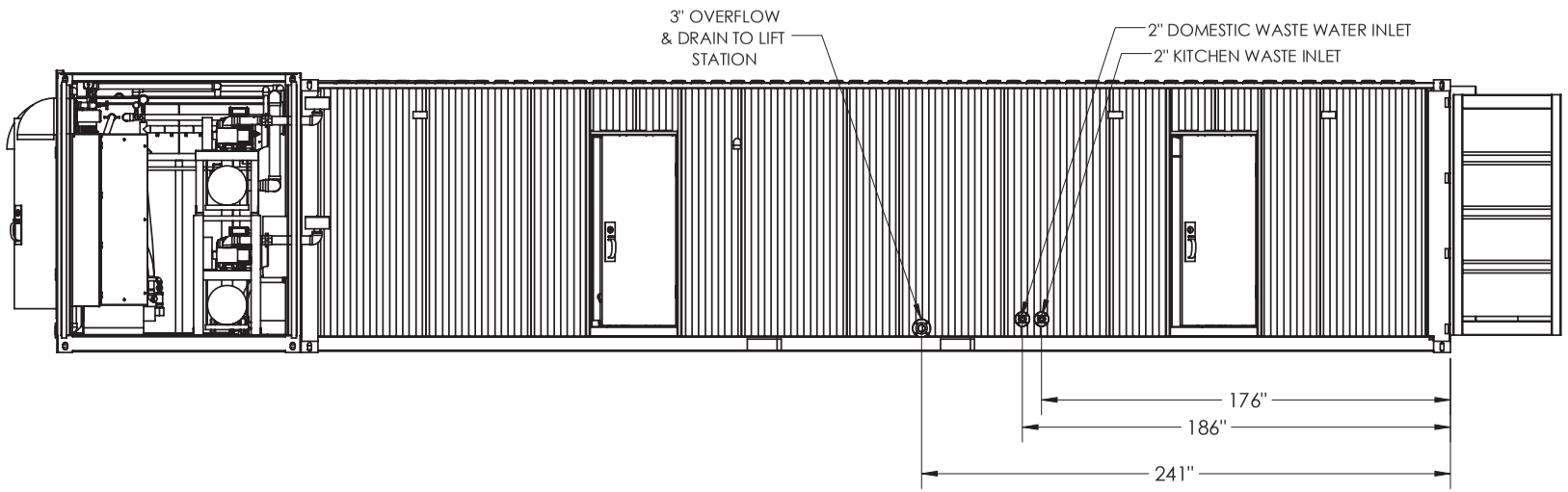

GENERAL TOLERANCES
.XX ± 1/8 "
.XXX ± 1/16 "
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

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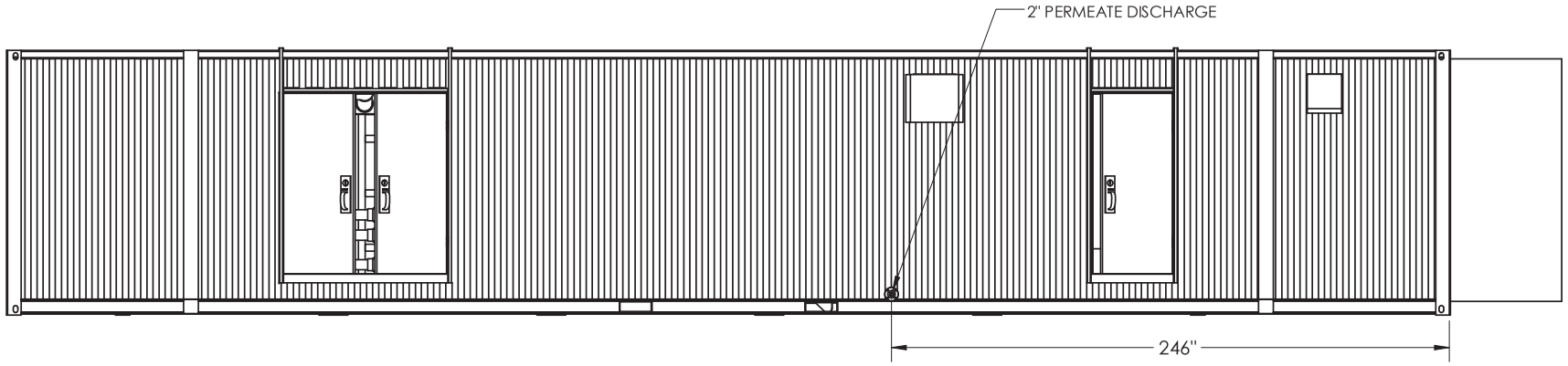
LEVEL	DATE	BY	REVISION
C1	11/08/17	AH	AS BUILT
B1	07/06/17	GH	FOR PRODUCTION
B	06/08/2017	GH	FOR PRODUCTION

DWG. NO:
PROJECT NUMBER: 1704432
TITLE: SYSTEM LAYOUT
CUSTOMER: AGNICO EAGLE
DRAWN BY: GH
DATE: 06/06/17
SHEET 3 OF 4



GENERAL TOLERANCES
.XX ± 1/8 "
.XXX ± 1/16 "
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

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B1	07/06/17	GH	FOR PRODUCTION
B	06/06/2017	GH	FOR PRODUCTION

DWG. NO:

PROJECT NUMBER: 1704432

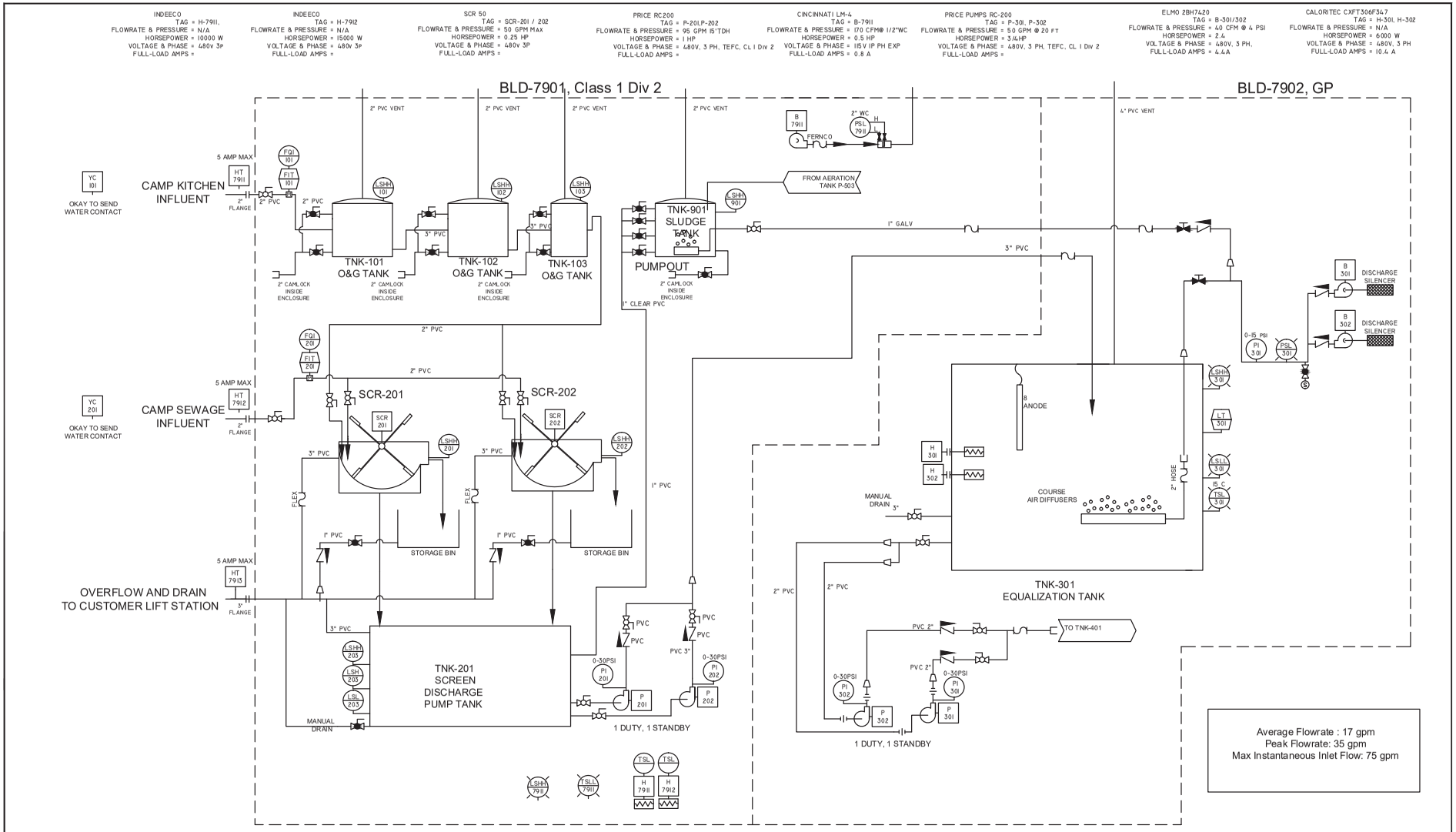
TITLE: SYSTEM LAYOUT

CUSTOMER: AGNICO EAGLE

DRAWN BY: GH

DATE: 06/06/17

SHEET 4 OF 4



NOTES

IS INPUT WIRING TO BE WIRED FOR OUTDOORS, ACCORDING CEC FOR HAZARDOUS LOCATIONS.

WIRING TO BE CLASS I DIVISION 2, AS PER THE CEC.

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LEVEL	REVISION	DATE (mm/dd/yy)	BY
C	AS-BUILT	13/08/17	JJK
B	PRODUCTION	06/06/17	JJK
A2	SUBMITTAL REVISIONS	26/05/17	JJK
A	SUBMITTAL	23/05/17	JJK

PROJECT NUMBER: 1704432

TITLE AND LOCATION: P&ID AMARUQ MINE

CUSTOMER: AGNICO EAGLE MINE

DRAWN BY: MH | DATE: | SHEET: 1 | SHEETS: 4

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PRICE PUMPS RC-200
TAG = P-401,402
FLOWRATE & PRESSURE = 300 GPM @ 60 FT
HORSEPOWER = 5HP
VOLTAGE & PHASE = 480V, 3 PH, TEFC, CL I Div 2
FULL-LOAD AMPS =

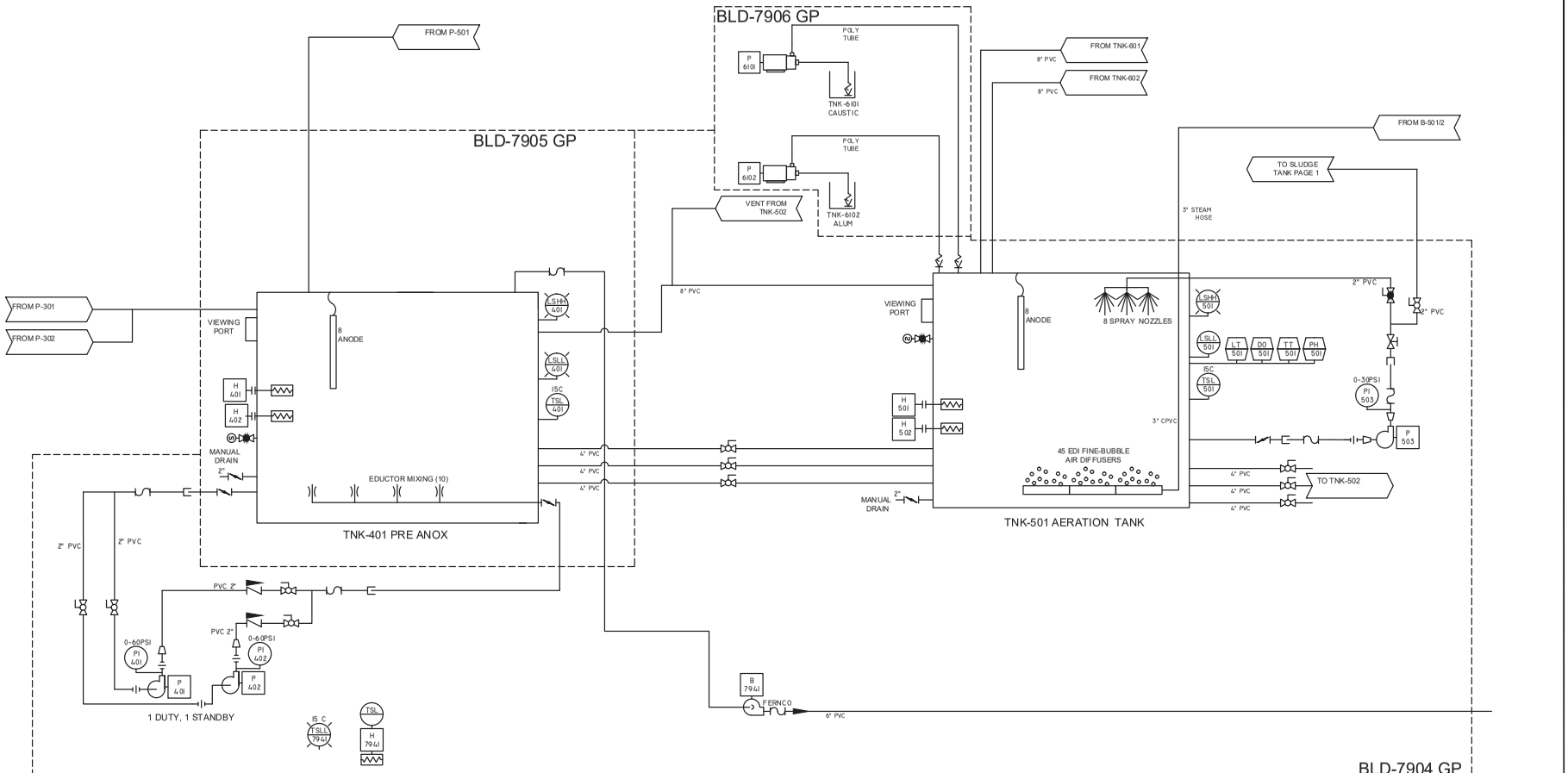
CALORITEC CXFT306F347R83
TAG = H-401,402,501,502
FLOWRATE & PRESSURE = N/A
HORSEPOWER = 6000 W
VOLTAGE & PHASE = 480V, 3 PH
FULL-LOAD AMPS = 10.4 A

CINCINNATI LM6
TAG = B-7941
FLOWRATE & PRESSURE = 700 CFM@ 2"WC
HORSEPOWER = 1.5 HP
VOLTAGE & PHASE = 480V 3P PH
FULL-LOAD AMPS =

OUELLET OAC04808BL
TAG = H-7941
FLOWRATE & PRESSURE = N/A
HORSEPOWER = 4,800 W
VOLTAGE & PHASE = 480 V, 1 PH
FULL-LOAD AMPS = 8.34

PRICE PUMPS RC-200
TAG = P-503
FLOWRATE & PRESSURE = 50 GPM @ 10 FT
HORSEPOWER = 1/4 HP
VOLTAGE & PHASE = 480V, 3 PH, TEFC, CL I Div 2
FULL-LOAD AMPS =

PROMINENT BETA 4
TAG = P-6101, 6102
FLOWRATE & PRESSURE = 3.2 GPH@58PSI
HORSEPOWER = N/A
VOLTAGE & PHASE = 120 V, 1 PH
FULL-LOAD AMPS = N/A



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PROJECT NUMBER: 1704432
TITLE AND LOCATION: P&ID AMARUQ MINE
CUSTOMER: AGNICO EAGLE MINE
DRAWN BY: MH
DATE:
SHEET: 2
SHEETS: 4

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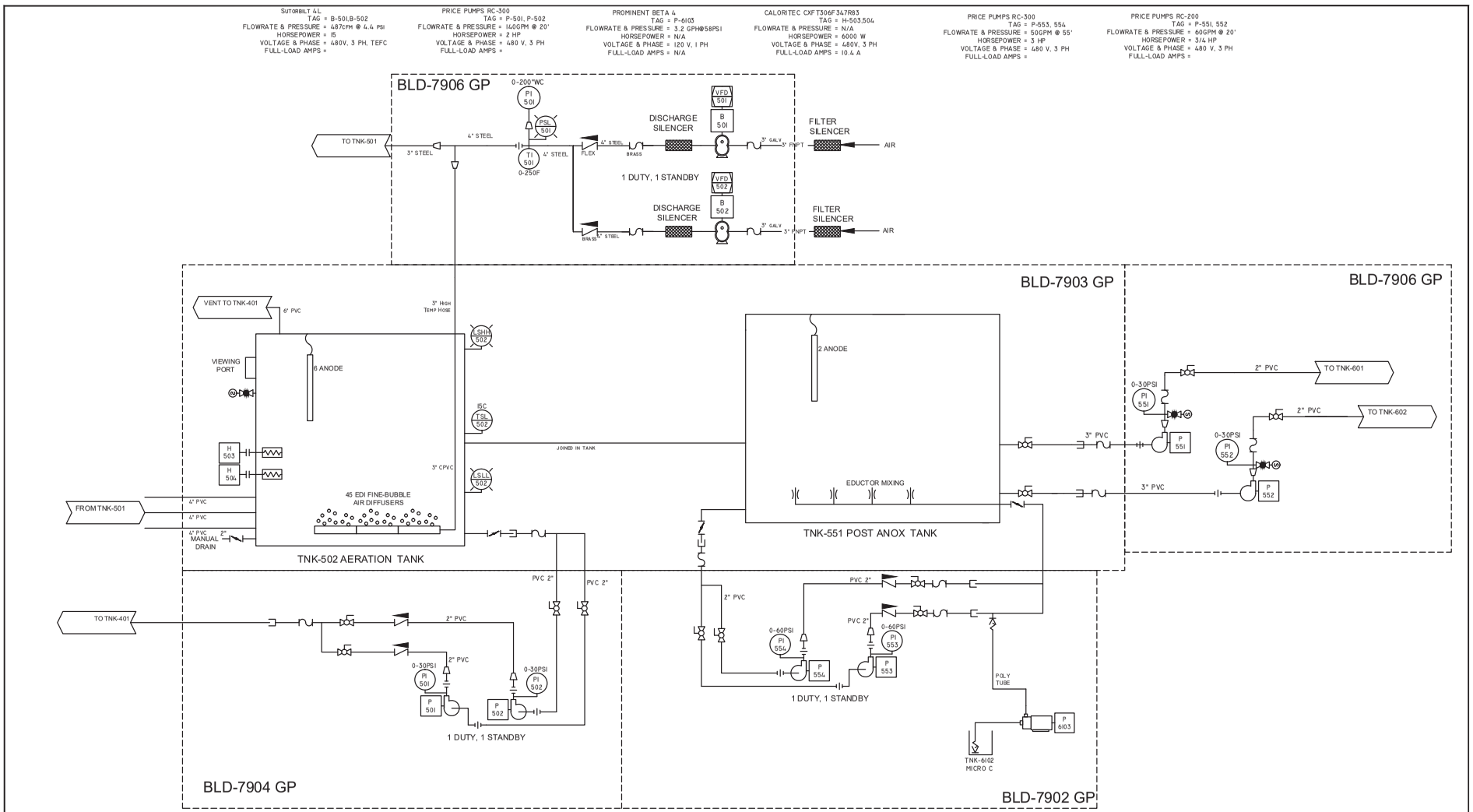

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PROJECT NUMBER: 1704432

TITLE AND LOCATION: P&ID AMARUQ MINE

CUSTOMER: AGNICO EAGLE MINE

DRAWN BY: MH | DATE: | SHEET: 3 | SHEETS: 4

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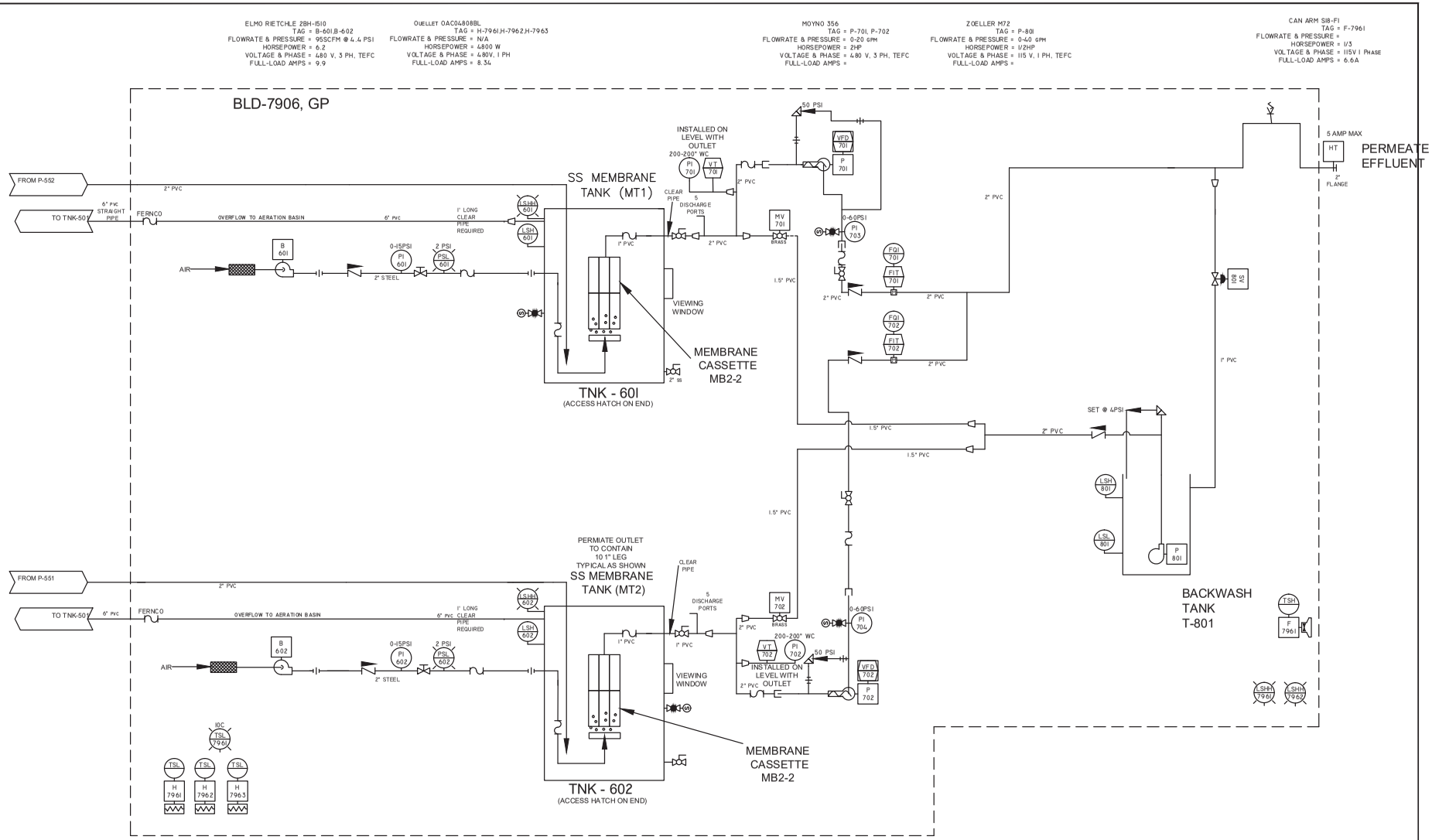

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PROJECT NUMBER: 1704432

TITLE AND LOCATION: P&ID AMARUQ MINE

CUSTOMER: AGNICO EAGLE MINE

DRAWN BY: MH | DATE: | SHEET: 4 | SHEETS: 4

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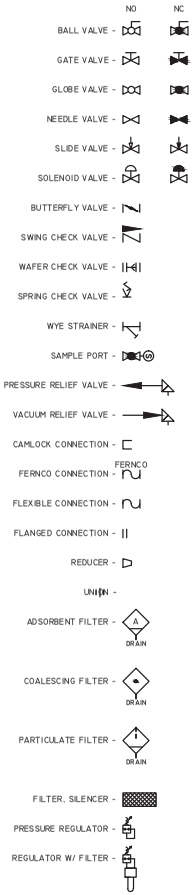
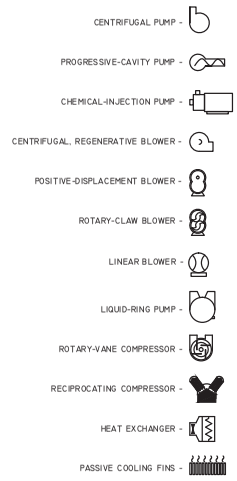
VALVES AND PIPING



EQUIPMENT

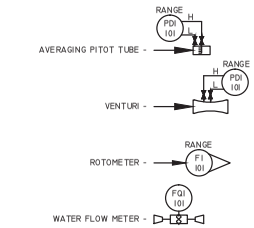
EQUIPMENT



EQUIPMENT

AV - ACTUATED VAVLE
B - BLOWER
F - FAN
H - HEATER
MBR - MEMBRANE BIOLOGICAL REACTOR
MV - MODULATED VALVE
P - PUMP
SV - SOLENOID VALVE
TNK - TANK
UV - ULTRA VIOLET LIGHT
VFD - VARIABLE FREQUENCY DRIVE

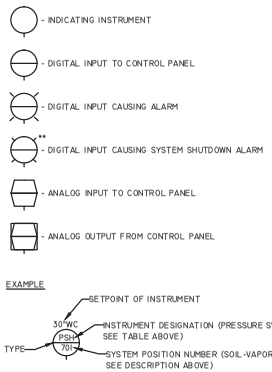
FLOW MEASUREMENT



INSTRUMENT DESIGNATION

	INPUT	1ST MODIFIER	2ND MODIFIER	3RD MODIFIER	OUTPUT	1ST MODIFIER	
A							A
B						BLOWER	B
C	CYCLE					COMPRESSOR	C
D		DIFFERENTIAL				AIR DRYER	D
E							E
F	FLOW					FAN	F
G	GAS (LEL)		GAUGE				G
H				HIGH	HAND	HEATER	H
I	CURRENT		INDICATOR				I
J							J
K							K
L	LEVEL			LOW			L
M					MOTORIZED		M
N							N
O							O
P	PRESSURE				PNEUMATIC	PUMP	P
Q		QUANTITY					Q
R							R
S	SPEED		SWITCH		SOLENOID		S
T	TEMPERATURE		TRANSMITTER				T
U							U
V						VALVE	V
W							W
X							X
Y							Y
Z	POSITION						Z

INSTRUMENT IDENTIFICATION



SYSTEM POSITION DESIGNATION

1000 - LIFT STATION
2000 - INLET SCREEN
3000 - EQUALIZATION TANK
4901 - SCREEN DISCHARGE PUMP TANK
5000 - AERATION TANK
5500 - SLUDGE HOLDING TANK
6000 - MBR TANK
6100 - CHEMICAL INJECTION
7000 - PERMEATE
7500 - UV LIGHT
7900 - BUILDING,TRAILER OR SKID
8000 - DISCHARGE TANK
8200 - CONTROL PANEL
8300 - TELEMETRY
9900 - EXTRAS

NOTES

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A	SUBMITTAL	23/05/17	JJK

PROJECT NUMBER: 1704432

TITLE AND LOCATION: P&ID AMARUQ MINE

CUSTOMER: AGNICO EAGLE MINE

DRAWN BY: MH | DATE: | SHEET: 4 | SHEETS: 4

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Project:

1704432 - AGNICO EAGLE MINE - C

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clean water. modular solutions. simple.™

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67	BLD-7904 BILL OF MATERIAL, MODULE 8904 - SHEET 1 OF 2
68	BLD-7904 BILL OF MATERIAL, MODULE 8904 - SHEET 2 OF 2
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70	BLD-7906 BILL OF MATERIAL, MODULE 8906 - SHEET 1 OF 2
71	BLD-7906 BILL OF MATERIAL, MODULE 8906 - SHEET 2 OF 2

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ELECTRICAL SPECIFICATIONS	
VOLTAGE	600V
PHASE	3Ø
FREQUENCY	60 Hz
FULL LOAD AMPS	172A
MAIN DISCONNECT SIZE	400A - FUSED @ 250A
SCCR SYMMETRICAL (kAMPS)	10
SYSTEM APPROVAL AND CLASSIFICATION	cMET - CL1Div2
PANEL APPROVAL AND CLASSIFICATION	cMETus to UL698A

WIRE LEGEND

BLACK: POWER
RED: 120VAC CONTROL
WHITE: NEUTRAL
BLUE: +24VDC & IS WIRING
BLU/WHT: 0VDC
YELLOW: INTERLOCKS

NOTES:

1325 CALIFORNIA AVE.
BROCKVILLE, ONTARIO
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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432
TITLE AND LOCATION: SYSTEM SPECIFICATIONS

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	2	71

1704432 - AGNICO EAGLE MINE - C

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FLOW SWITCH, NORMALLY CLOSED

FLOW SWITCH, NORMALLY OPEN

FLOAT SWITCH, NORMALLY CLOSED

FLOAT SWITCH, NORMALLY OPEN

LIMIT SWITCH, NORMALLY CLOSED

LIMIT SWITCH, NORMALLY OPEN

PRESSURE SWITCH, CHANGE OVER CONTACTS

PRESSURE SWITCH, NORMALLY CLOSED OPENS ON PRESSURE INCREASE

PRESSURE SWITCH, NORMALLY OPEN CLOSES ON PRESSURE INCREASE

TEMPERATURE SWITCH, CHANGE OVER CONTACTS

TEMPERATURE SWITCH, NORMALLY CLOSED OPENS ON TEMPERATURE INCREASE

TEMPERATURE SWITCH, NORMALLY OPEN CLOSES ON TEMPERATURE INCREASE

PROXIMITY SWITCH, NORMALLY CLOSED

PROXIMITY SWITCH, NORMALLY OPEN

METAL OXIDE VARISTOR
MOV

S7296
DIODE

TANDEM TERMINAL BLOCK

PANEL TERMINAL BLOCK

JUNCTION BOX TERMINAL BLOCK

CUSTOMER TERMINAL BLOCK

FUSED TERMINAL BLOCK

TOGGLE SWITCH, NORMALLY OPEN

TOGGLE SWITCH, CHANGE OVER CONTACTS, 3 WAY

PUSH BUTTON, NORMALLY CLOSED

PUSH BUTTON, NORMALLY OPEN

PUSH BUTTON, NORMALLY CLOSED MUSHROOM HEAD

SELECTOR SWITCH, 2 POSITION
2 NORMALLY OPEN

SELECTOR SWITCH, 3 POSITION
2 NORMALLY OPEN

PILOT LIGHT, X=COLOR

COLOR CODE
A - AMBER
B - BLUE
G - GREEN
R - RED
W - WHITE

PILOT LIGHT, PUSH-TO-TEST
X=COLOR

BEACON LIGHT
X=COLOR

CONTACT, NORMALLY CLOSED

CONTACT, NORMALLY OPEN

TIME DELAY CONTACT, INSTANTANEOUS OPEN
TIMED CLOSED ON DE-ENERGIZE

TIME DELAY CONTACT, INSTANTANEOUS CLOSE
TIMED OPEN ON DE-ENERGIZE

TIME DELAY CONTACT, INSTANTANEOUS OPEN
TIMED CLOSE ON ENERGIZE

TIME DELAY CONTACT, INSTANTANEOUS CLOSE
TIMED OPEN ON ENERGIZE

COIL - RELAY, CONTACTOR
TIMER, MOTOR STARTER

ANNUNCIATOR, BELL

ANNUNCIATOR, HORN

ANNUNCIATOR, BUZZER

BATTERY

TRANSMITTER, 2 WIRE
LOOP POWERED

INTRINSICALLY SAFE BARRIERS
(NOT TO SCALE)

4CHANNEL DISCRETE

2 CHANNEL ANALOG

NETWORK SWITCH -ETHERNET
(NOT REPRESENTATIVE OF ALL TYPES)
(NOT TO SCALE)

PANEL METER
AM=AMMETER
VM=VOLT METER

ETM
ELAPSED TIME METER

CURRENT TRANSFORMER

GROUND

INSTRUMENTATION
GROUND

SOLENOID

CURRENT SWITCH

FUSED DISCONNECT
X=AMP RATING

FUSE, X=AMP RATING

CIRCUIT BREAKER
X=AMP RATING

COMBINATION STARTER
X - X AMP=CURRENT RANGE

CONTACTOR

DISTRIBUTION BLOCK

X HP
X FLA
X AWG
3 PHASE MOTOR

X kW
X AMP
X AWG
3 PHASE HEATER

RECEPTACLE, SINGLE OUTLET

RECEPTACLE, DUPLEX

TRANSFORMER
CONTROL POWER
(NOT REPRESENTATIVE OF ALL TYPES)

TRANSFORMER
DISTRIBUTION/LIGHTING
(NOT REPRESENTATIVE OF ALL TYPES)

120VAC
24VDC
72Wat
DC POWER SUPPLY
(NOT REPRESENTATIVE OF ALL TYPES)

REACTOR

COIL: *LOCATION*
4 POLE RELAY
CROSS REFERENCES

LOCATION
COMBINATION STARTER
CROSS REFERENCES

VARIABLE FREQUENCY DRIVE
(NOT REPRESENTATIVE OF ALL TYPES)
(NOT TO SCALE)

GENERAL PURPOSE WIRING
EXTERNAL TO PANEL

CL1Div2 WIRING
EXTERNAL TO PANEL

WIRING BY OTHERS
EXTERNAL TO PANEL

USA 3 PHASE
POWER WIRING COLOR CODE

480V	208/230V(HIGH LEG)
PHASE A - BROWN	PHASE A - BLACK
PHASE B - ORANGE	PHASE B - RED(ORG)
PHASE C - YELLOW	PHASE C - BLUE

CANADIAN 3 PHASE
POWER WIRING COLOR CODE

PHASE A - RED
PHASE B - BLACK
PHASE C - BLUE

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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PROJ. NO: 1704432

TITLE AND LOCATION: LEGEND ELECTRICAL

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	3	71

1704432 - AGNICO EAGLE MINE - C

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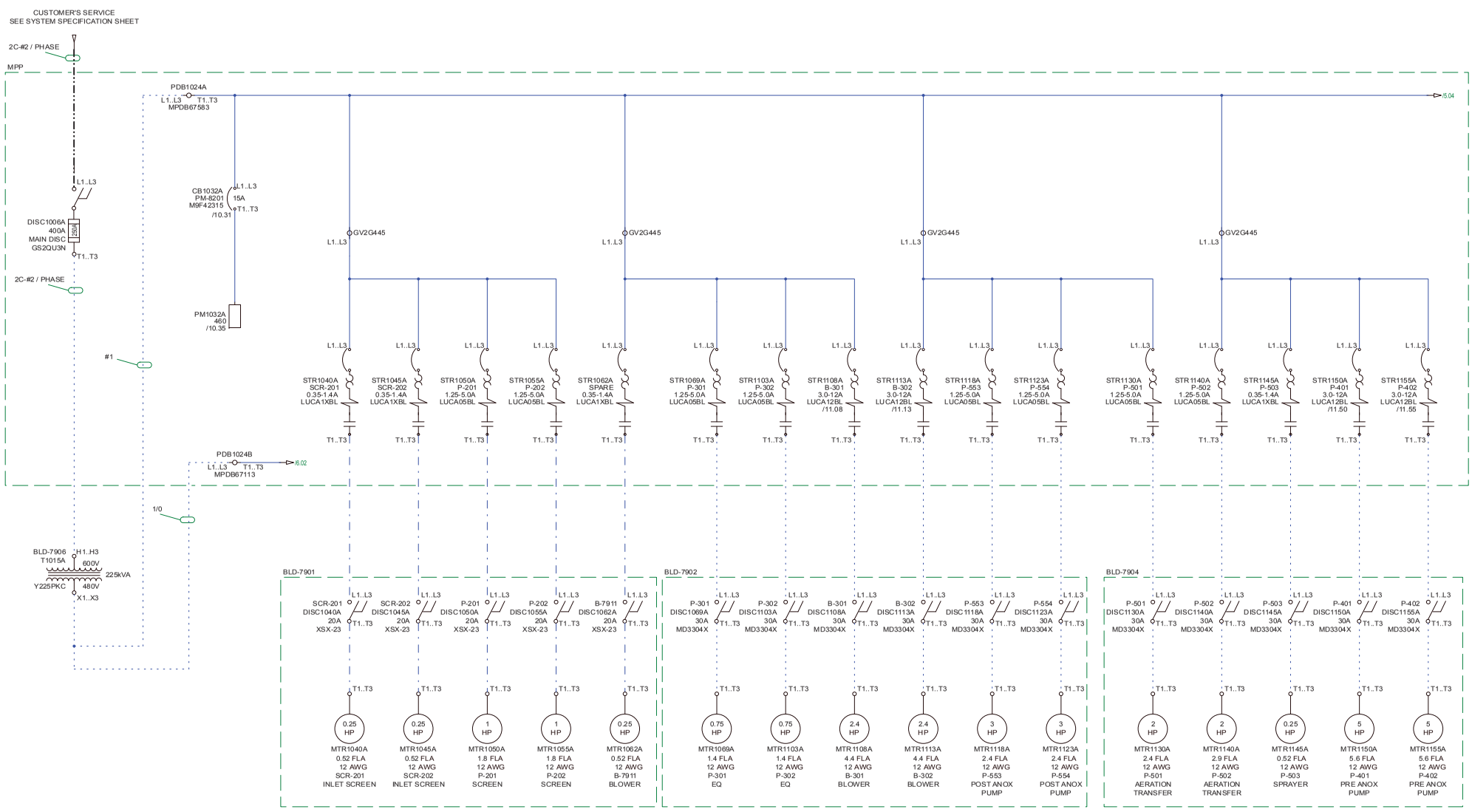

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PROJ. NO: 1704432

TITLE AND LOCATION: SINGLE LINE DIAGRAM SHEET 1 OF 3

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	4	71

1704432 - AGNICO EAGLE MINE - C

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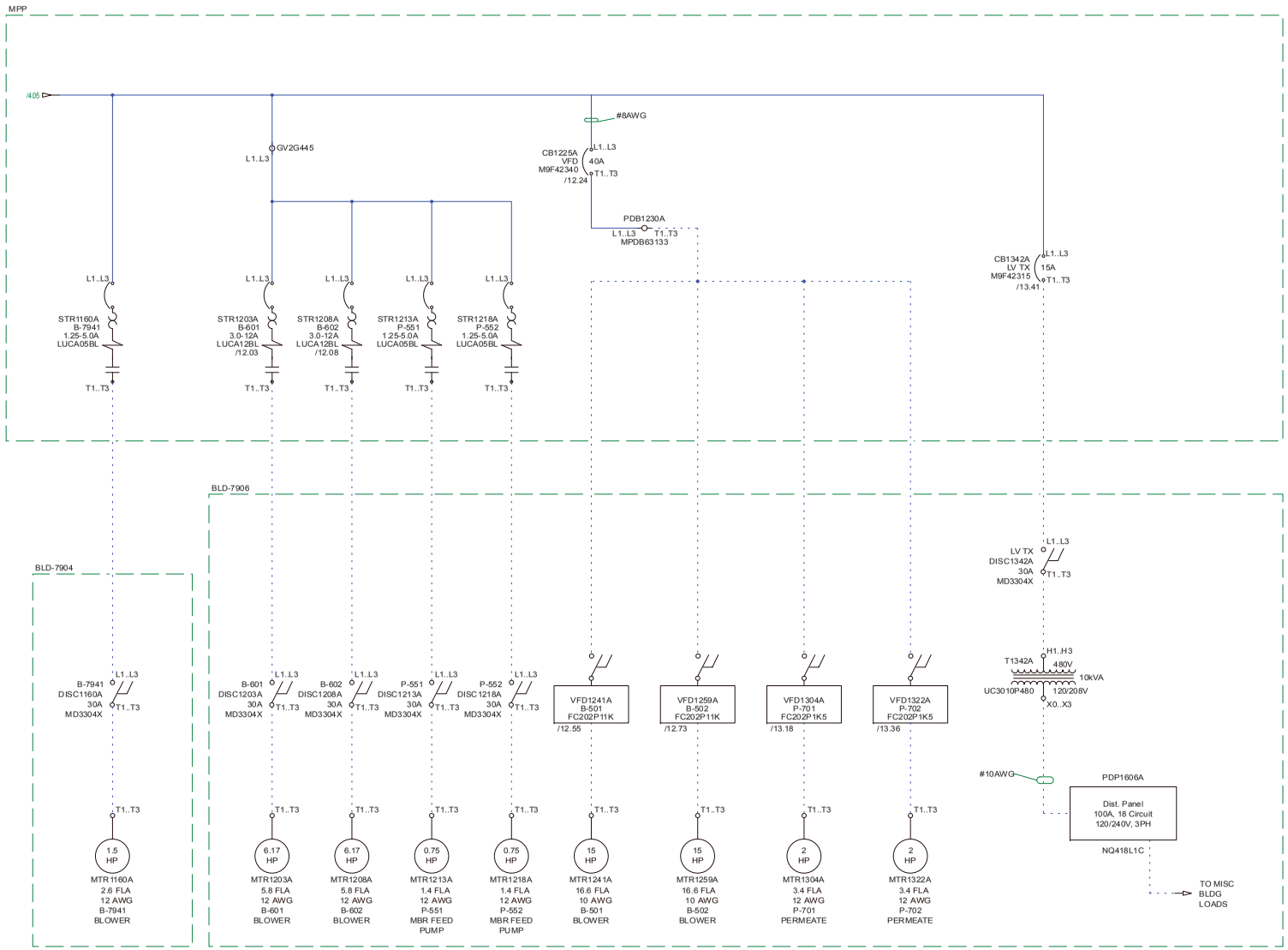

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NOTES:

1.

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PHONE: (613)498-1876
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C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: SINGLE LINE DIAGRAM SHEET 2 OF 3

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	5	71

1704432 - AGNICO EAGLE MINE - C

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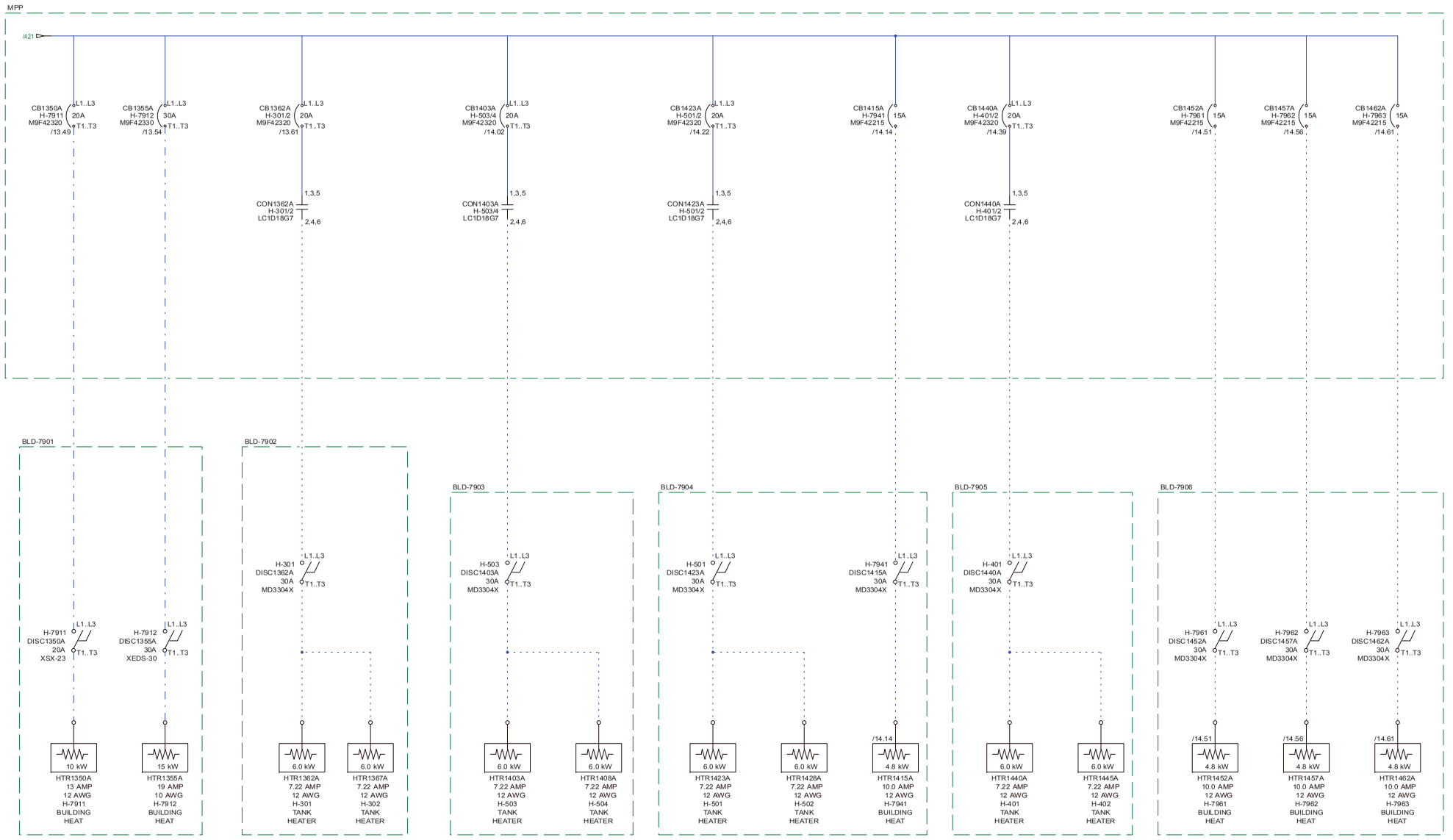

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: SINGLE LINE DIAGRAM SHEET 3 OF 3

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	10/05/17	6	71

1704432 - AGNICO EAGLE MINE - C

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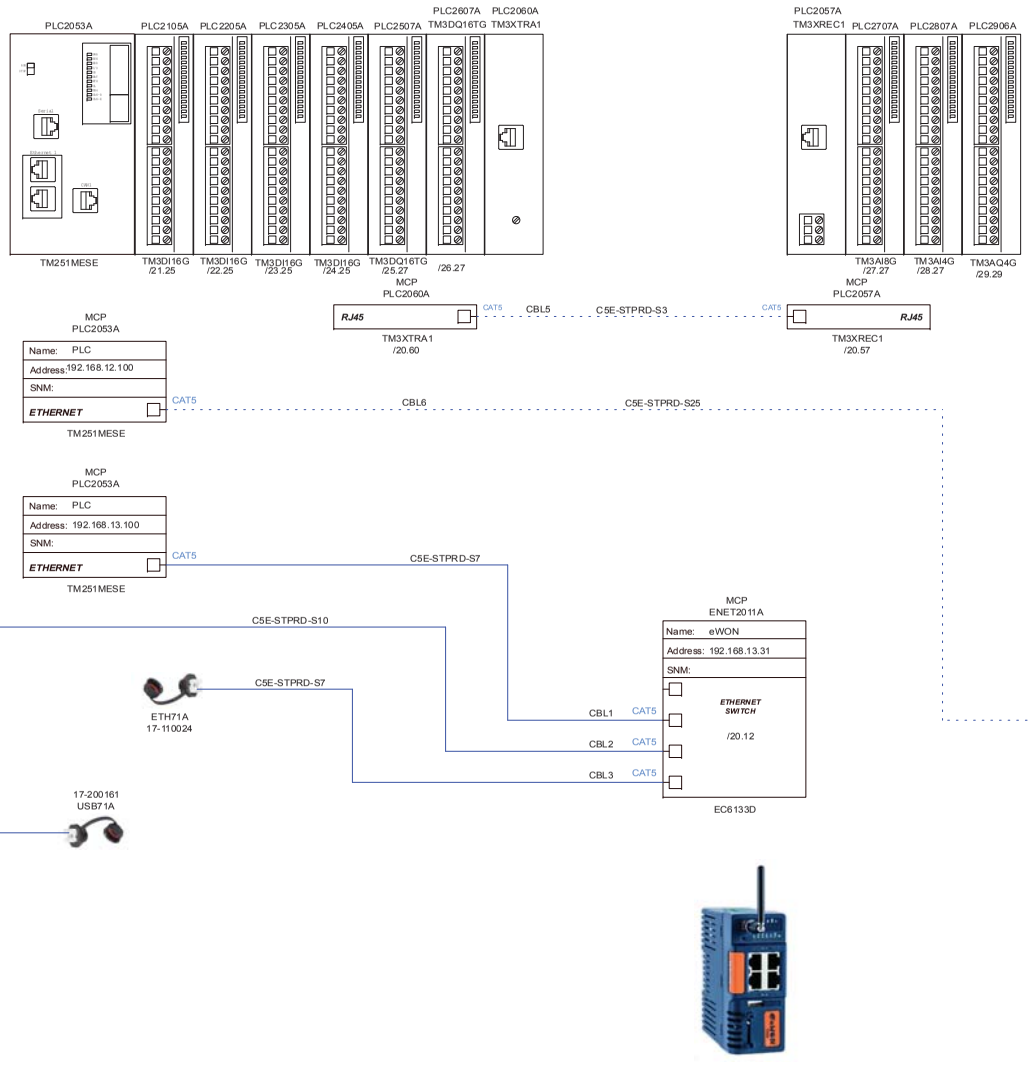

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: PLC/COMMUNICATION LAYOUT

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	7	71

1704432 - AGNICO EAGLE MINE - C

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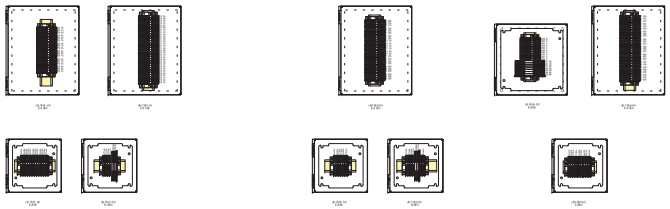
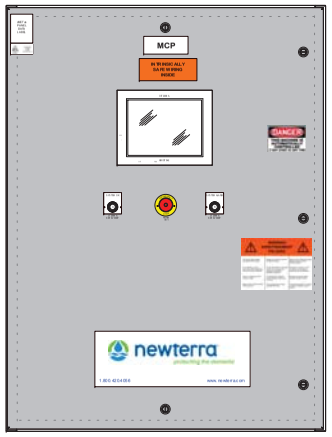
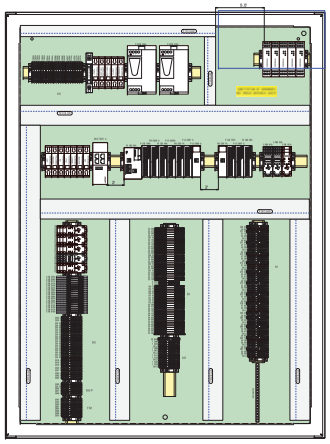


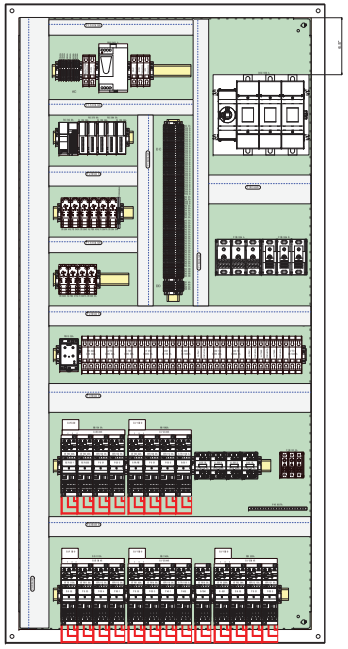


PANEL OUTER DOOR



MCP
ENABLEMENT 20Y
PANEL INTERIOR

PANEL OUTER DOOR



MPP
ENABLEMENT 20Y
PANEL INTERIOR

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: PANEL LAYOUTS

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	8	71

1704432 - AGNICO EAGLE MINE - C

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WIRE LEGEND

BLACK:	POWER
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WHITE:	NEUTRAL
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BLU/WHT:	0VDC
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NOTES:

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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: SPARE SHEET

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	9	71

1704432 - AGNICO EAGLE MINE - C

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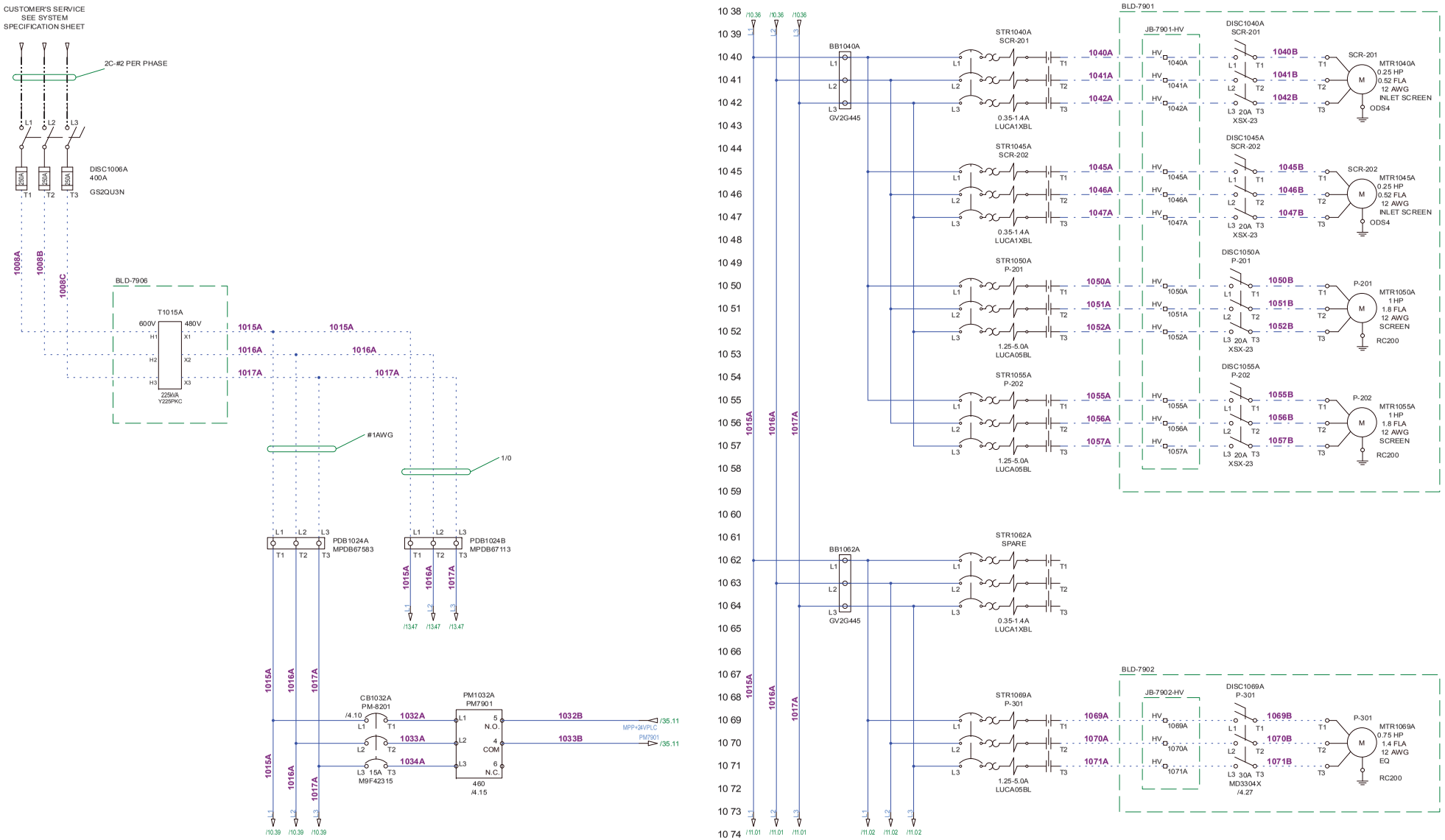

WIRE LEGEND

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RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. USE CANADIAN WIRING CODE

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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: 600V/480V POWER DISTRIBUTION MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	10	71

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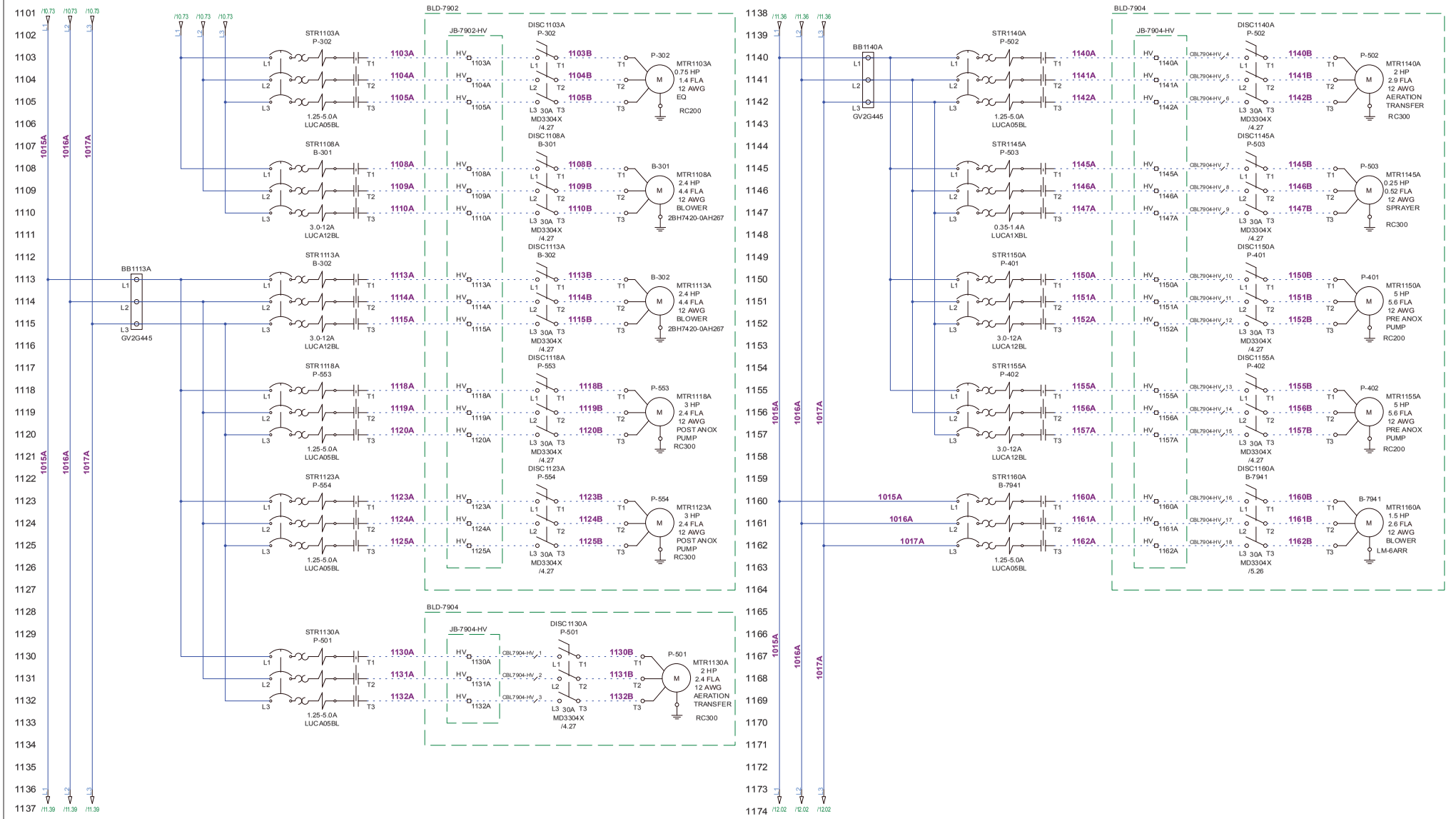

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: 480V POWER DISTRIBUTION SHEET 1 OF 4 MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
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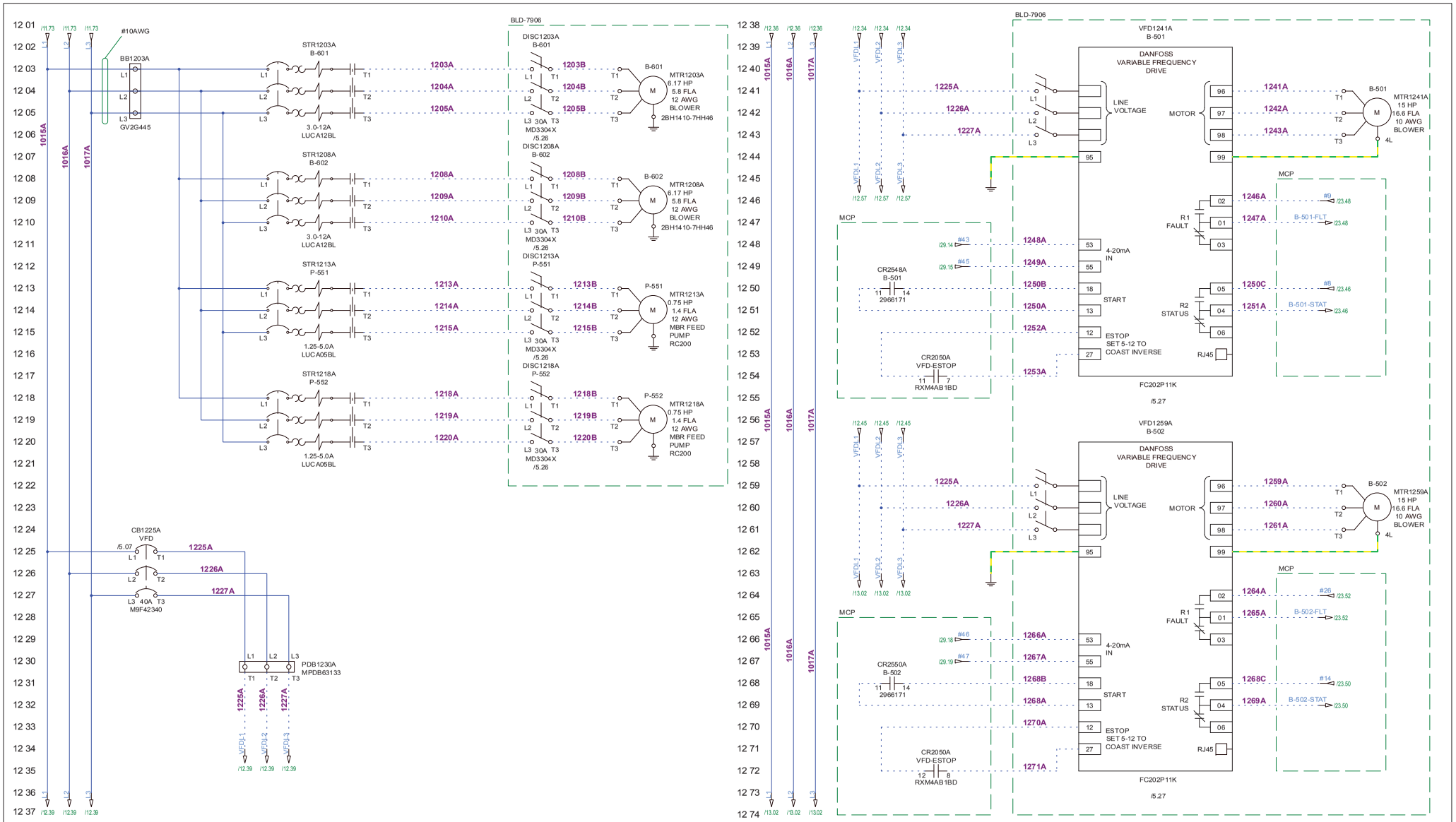

WIRE LEGEND

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RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: 480V POWER DISTRIBUTION SHEET 2 OF 4 MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	12	71

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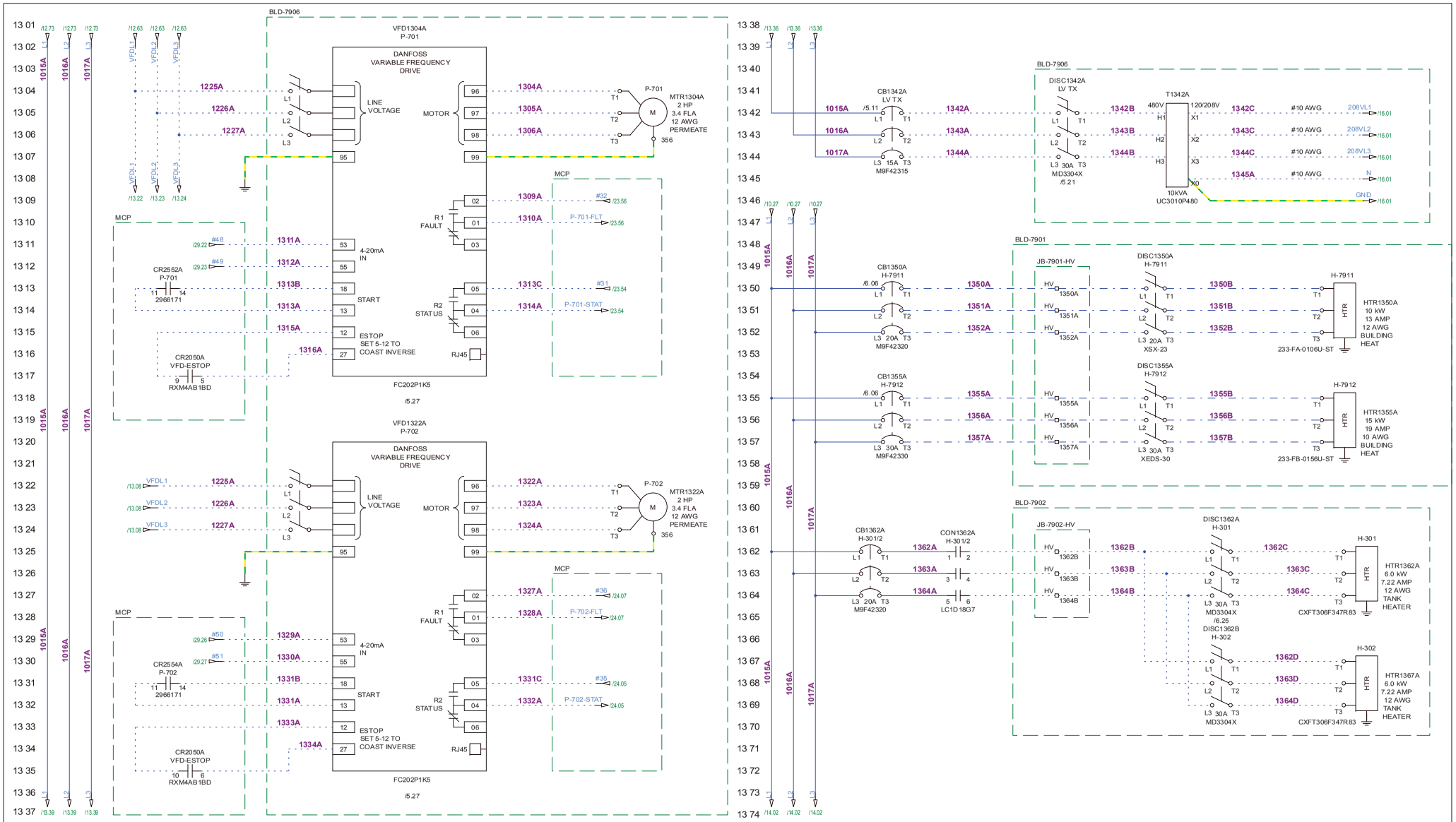

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: 480V POWER DISTRIBUTION SHEET 3 OF 4 MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	10/05/17	13	71

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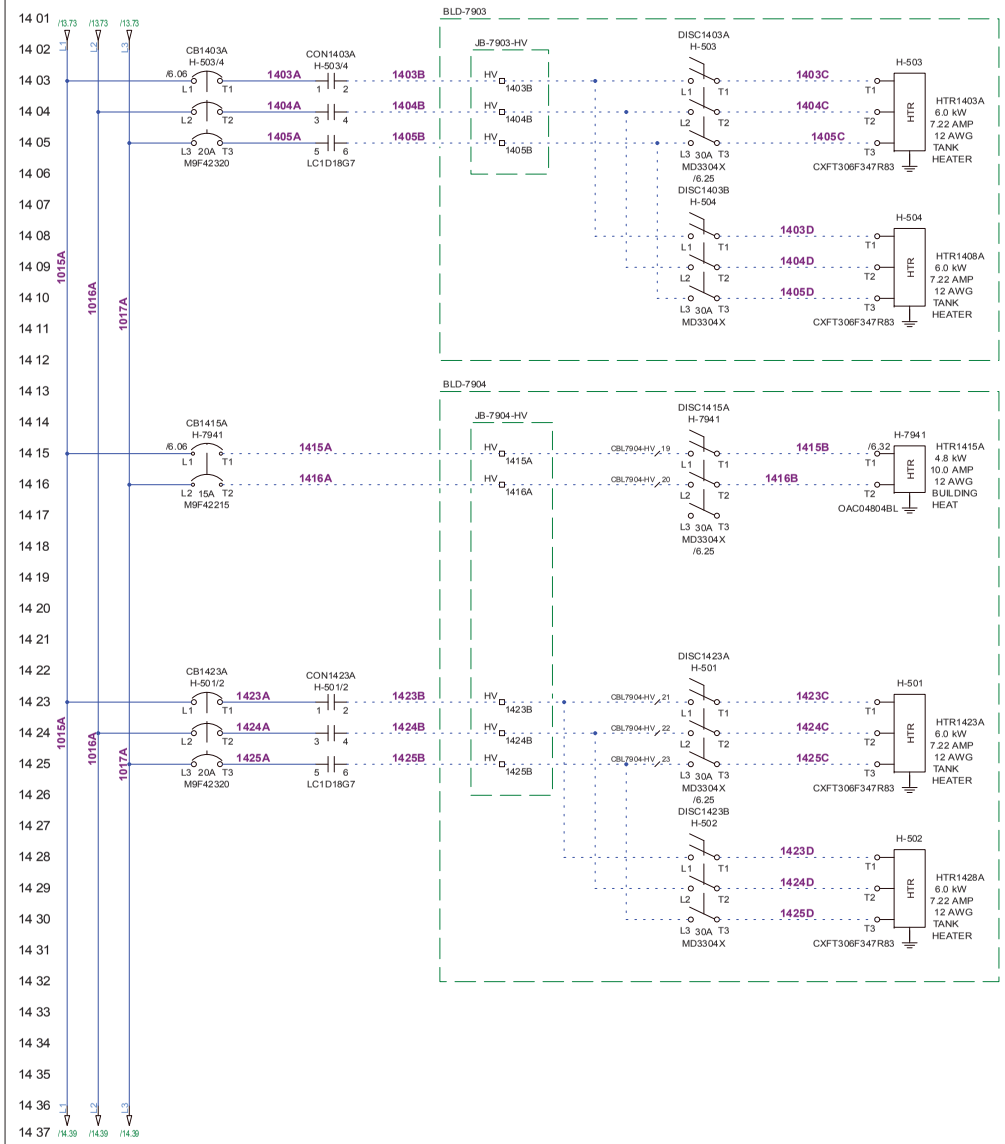

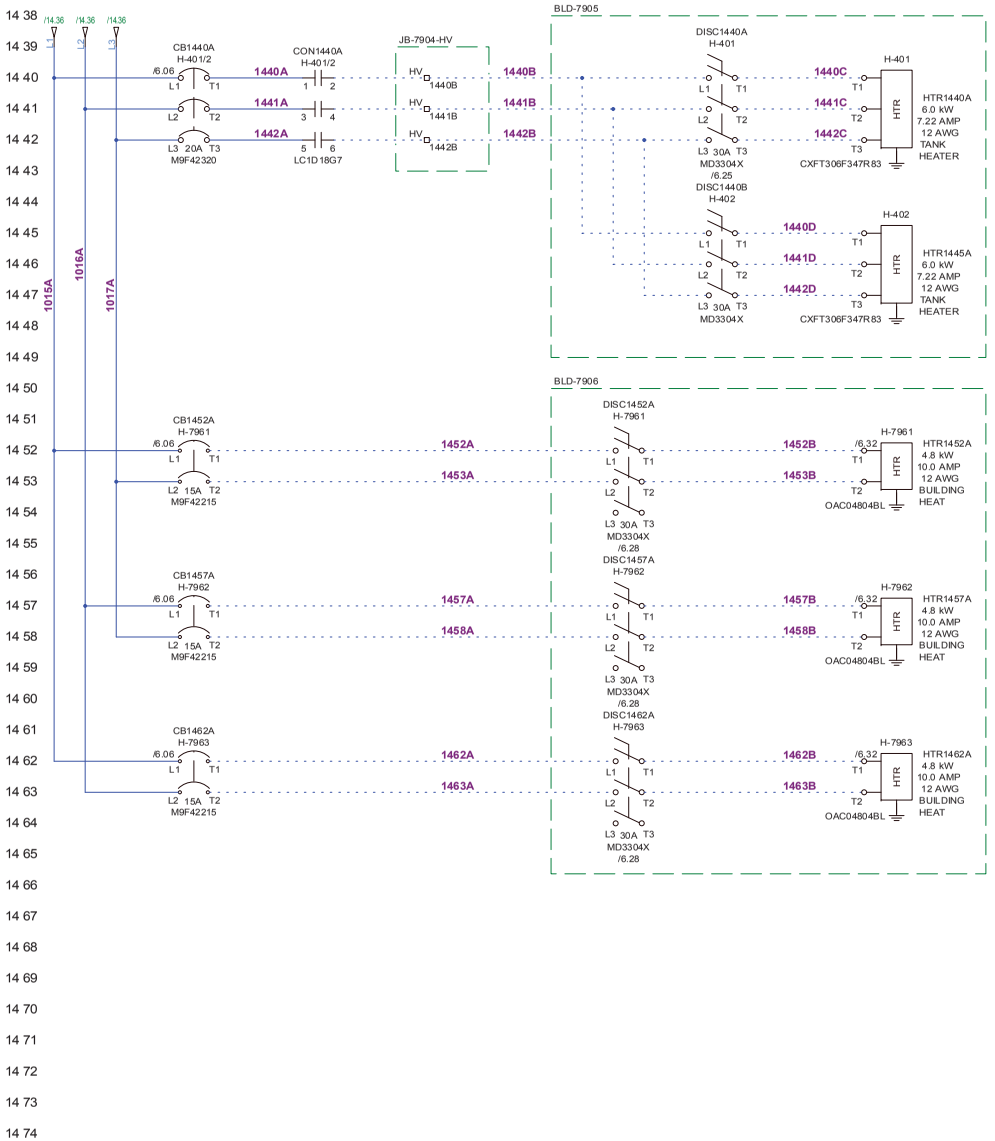

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. USE CANADIAN WIRING CODE

3. DEVICES IN BLD-7903 ARE ONLY REQUIRED FOR THE 400 MAN OPTION. IF THE 400 MAN IS NOT REQUIRED, STOP WIRING AT BASE OF P2019A CONNECTOR.
4. USE TANDEM FERRULES FOR CONNECTING WIRES TO DISTRIBUTION LUG

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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: 480V POWER DISTRIBUTION SHEET 4 OF 4 MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	14	71

1704432 - AGNICO EAGLE MINE - C

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WIRE LEGEND

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BLUE:	+24VDC & IS WIRING
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NOTES:

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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: SPARE SHEET

MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	23/05/17	15	71

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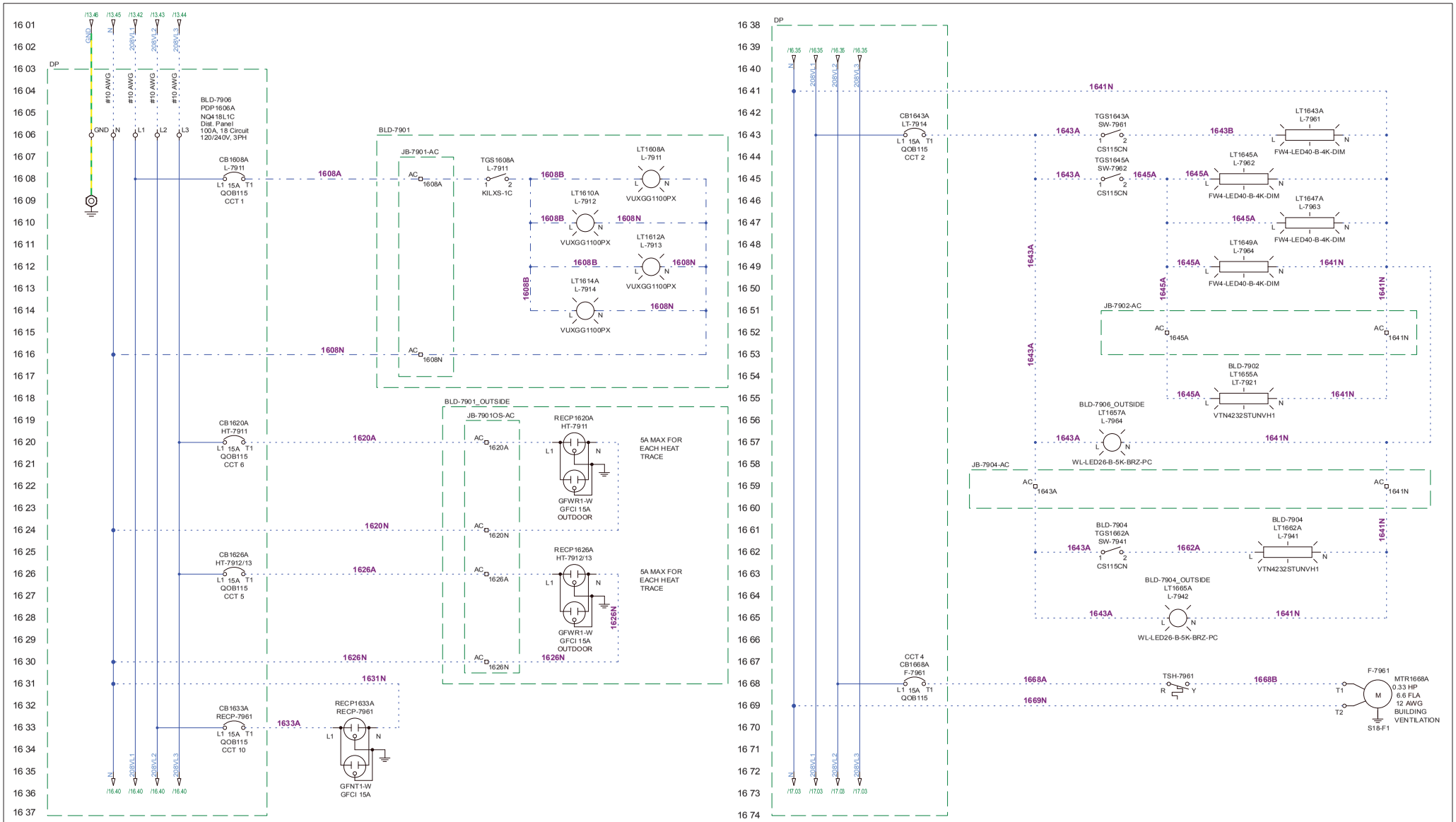

WIRE LEGEND

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WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. FOLLOW CANADIAN COLOUR CODE FOR POWER WIRING (SEE SHEET 3 - LEGEND)
2. WIRE SIZE IS #12 AWG FOR POWER UNLESS OTHERWISE SPECIFIED

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A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION:
LV DISTRIBUTION PANEL
SHEET 1 OF 2
BLD-7906

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	16	71

1704432 - AGNICO EAGLE MINE - C

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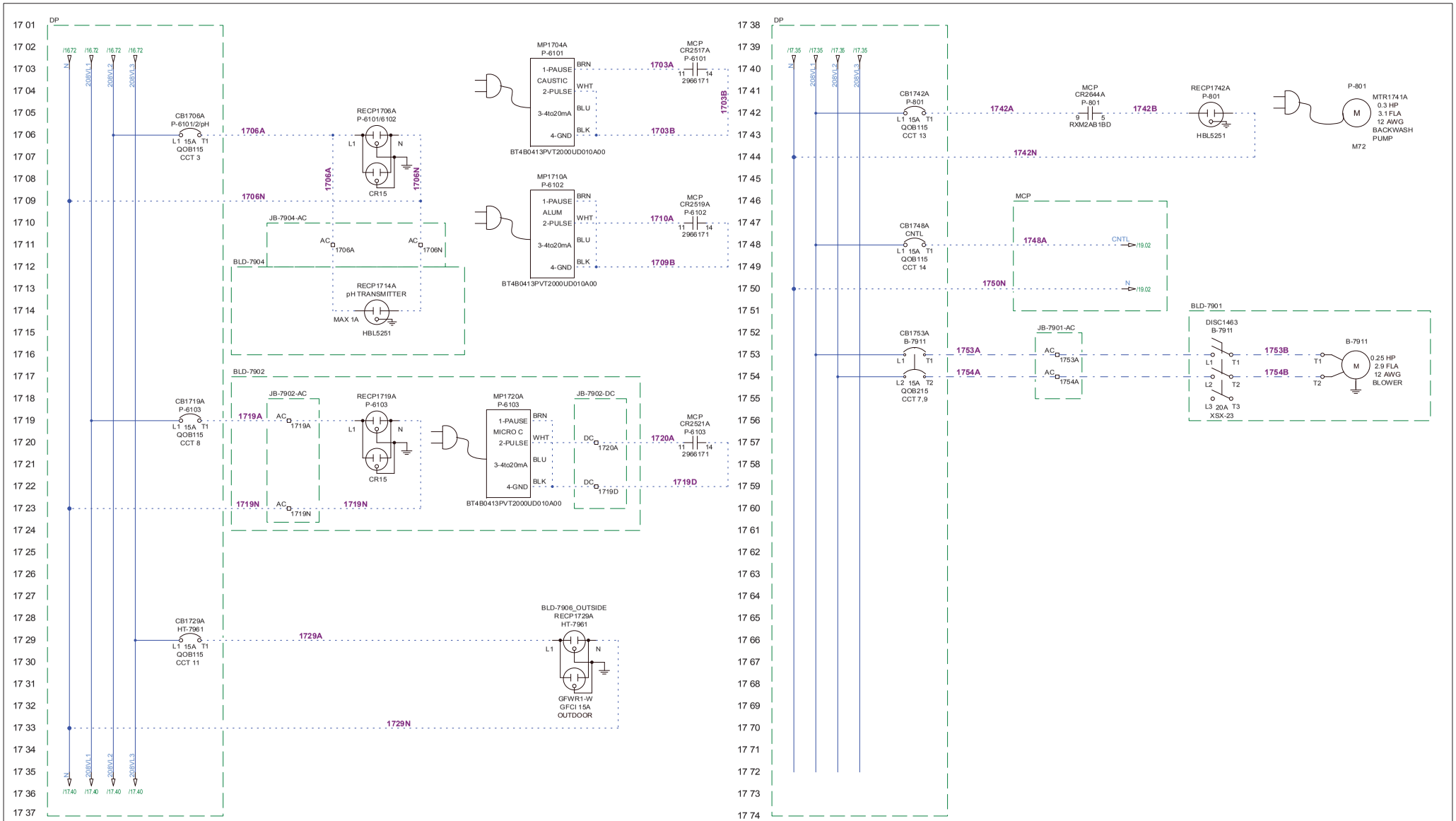

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PROJ. NO: 1704432

TITLE AND LOCATION:
LV DISTRIBUTION PANEL
SHEET 2 OF 2
BLD-7906

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	17	71

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A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: SPARE SHEET

BLD-7906

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	29/05/17	18	71

1704432 - AGNICO EAGLE MINE - C

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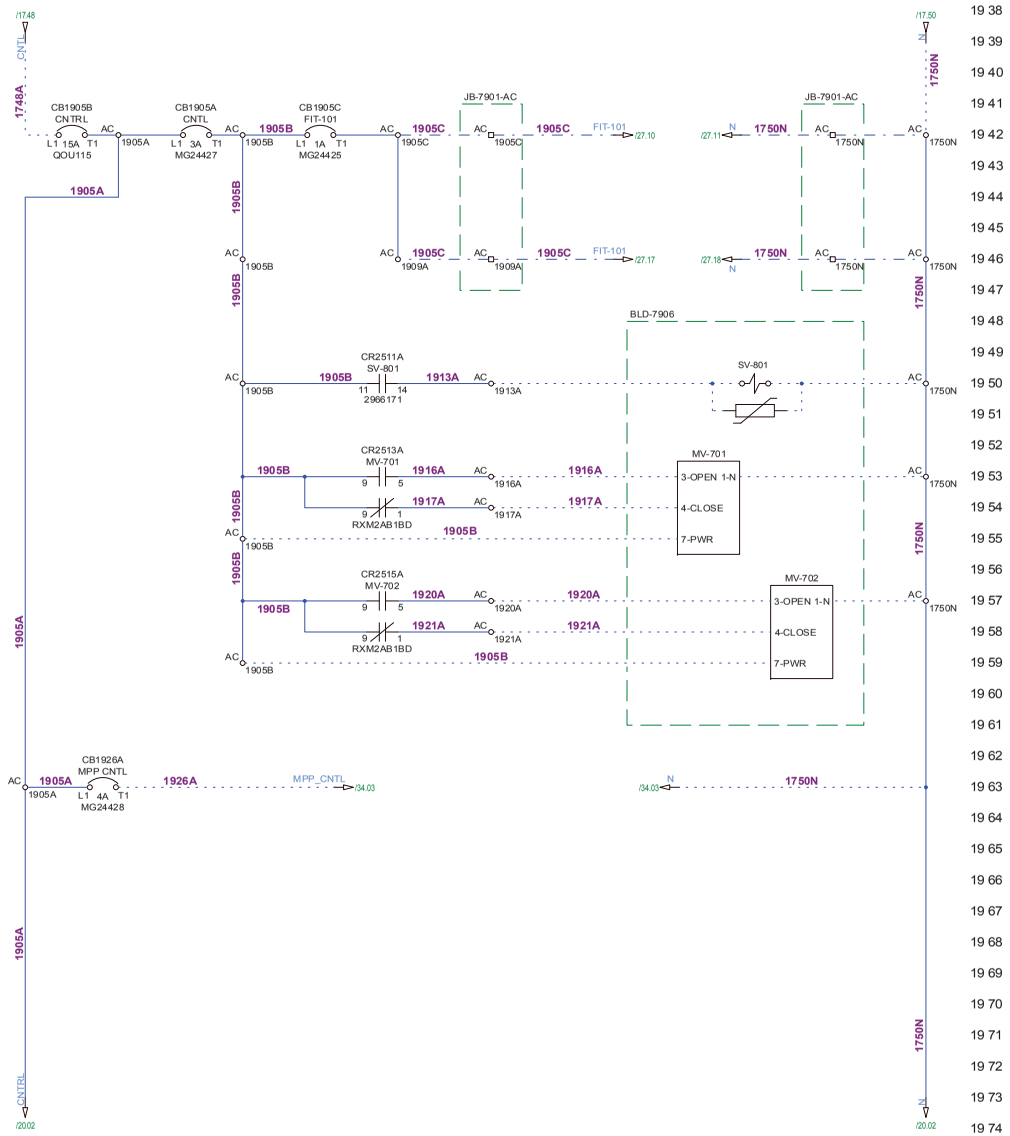

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WIRE LEGEND

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BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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2. WIRE SIZE IS #12 AWG FOR POWER UNLESS OTHERWISE SPECIFIED

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MCP - 120VAC CONTROL POWER
MCP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	19	71

1704432 - AGNICO EAGLE MINE - C

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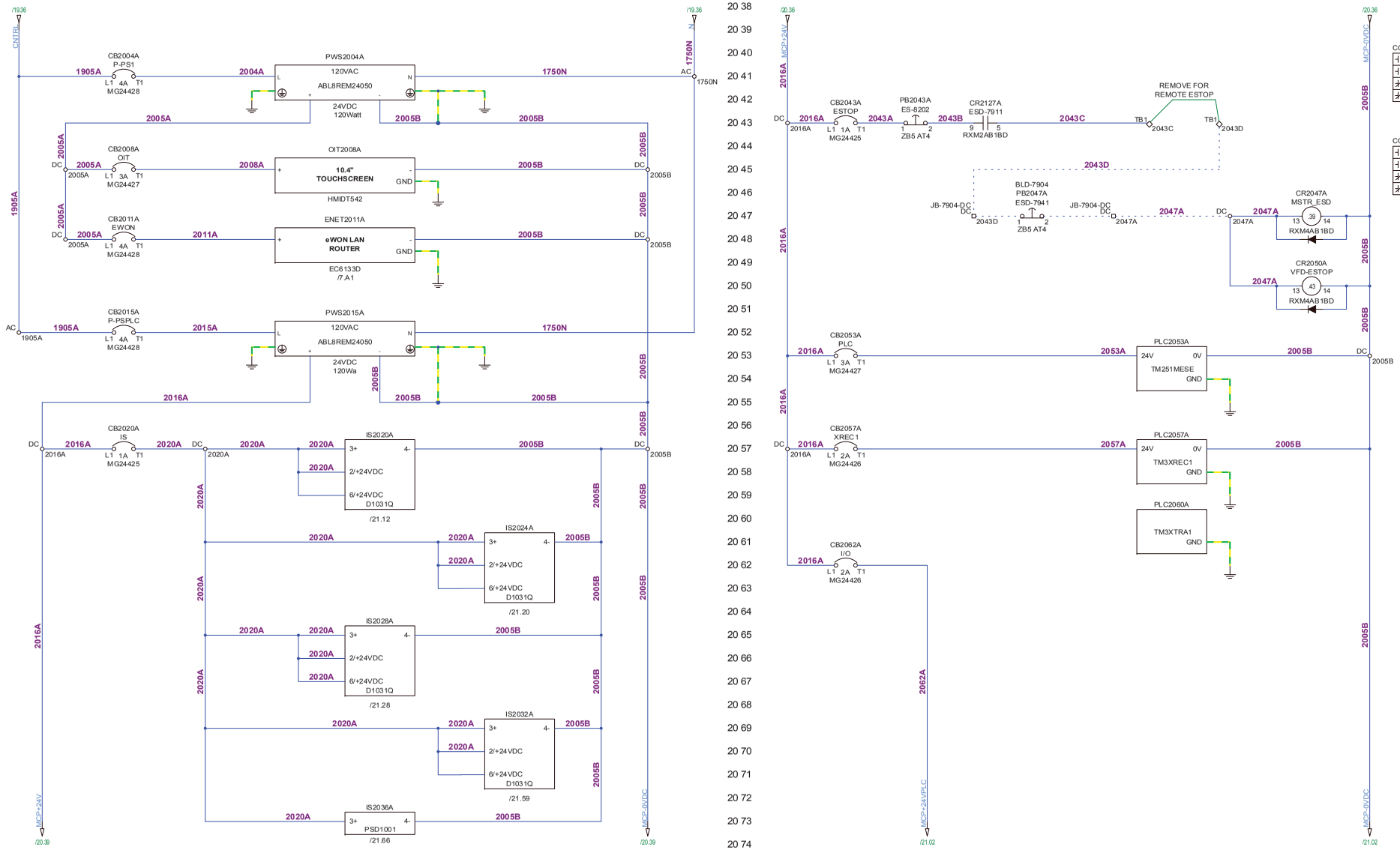

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. FOLLOW CANADIAN COLOUR CODE FOR POWER WIRING (SEE SHEET 3 - LEGEND)
2. WIRE SIZE IS #12 AWG FOR POWER UNLESS OTHERWISE SPECIFIED

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C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MCP - 24VDC CONTROL POWER MCP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	20	71

1704432 - AGNICO EAGLE MINE - C

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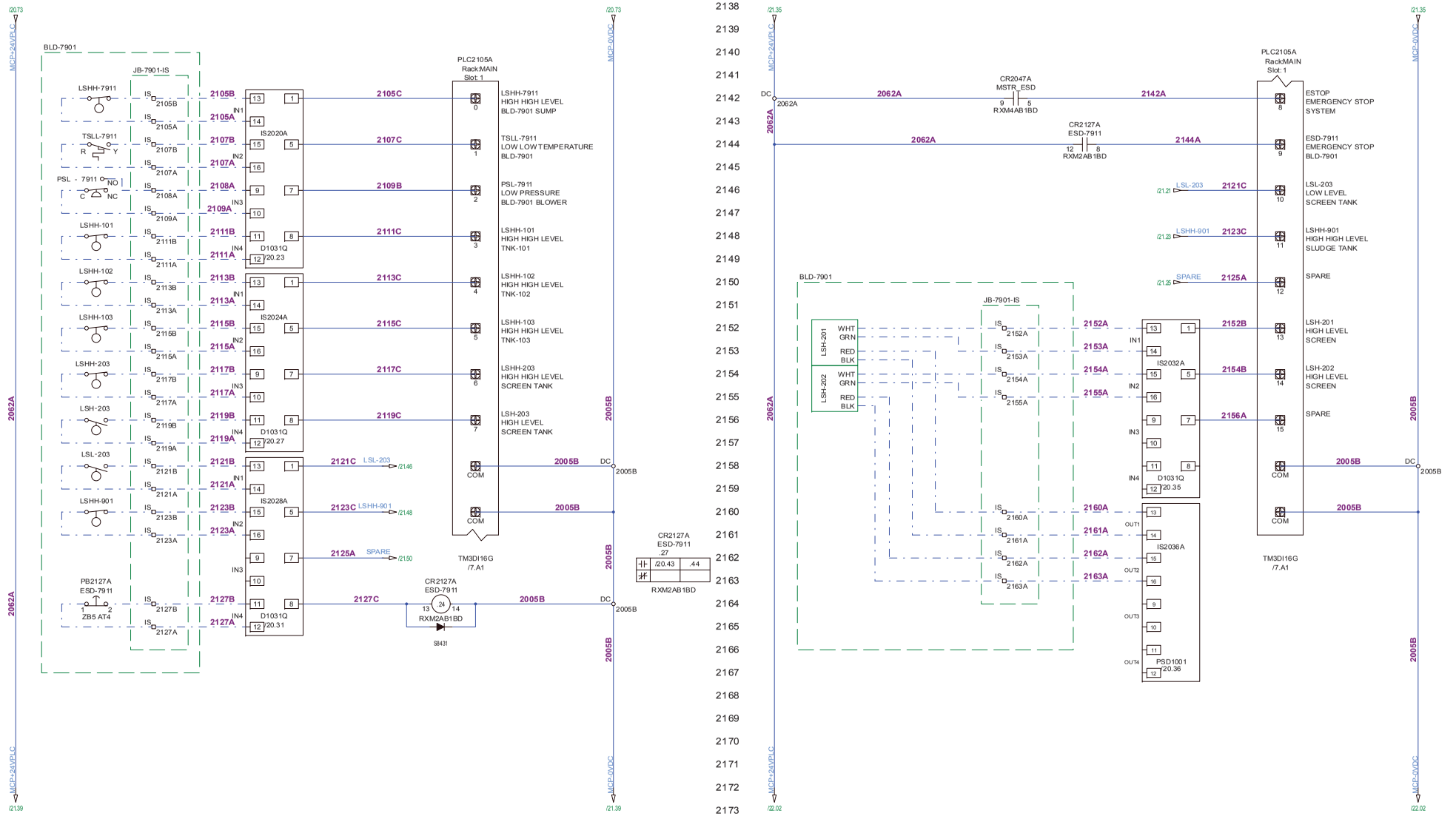

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MCP DISCRETE INPUTS SHEET 1 OF 4 MCP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	21	71

1704432 - AGNICO EAGLE MINE - C

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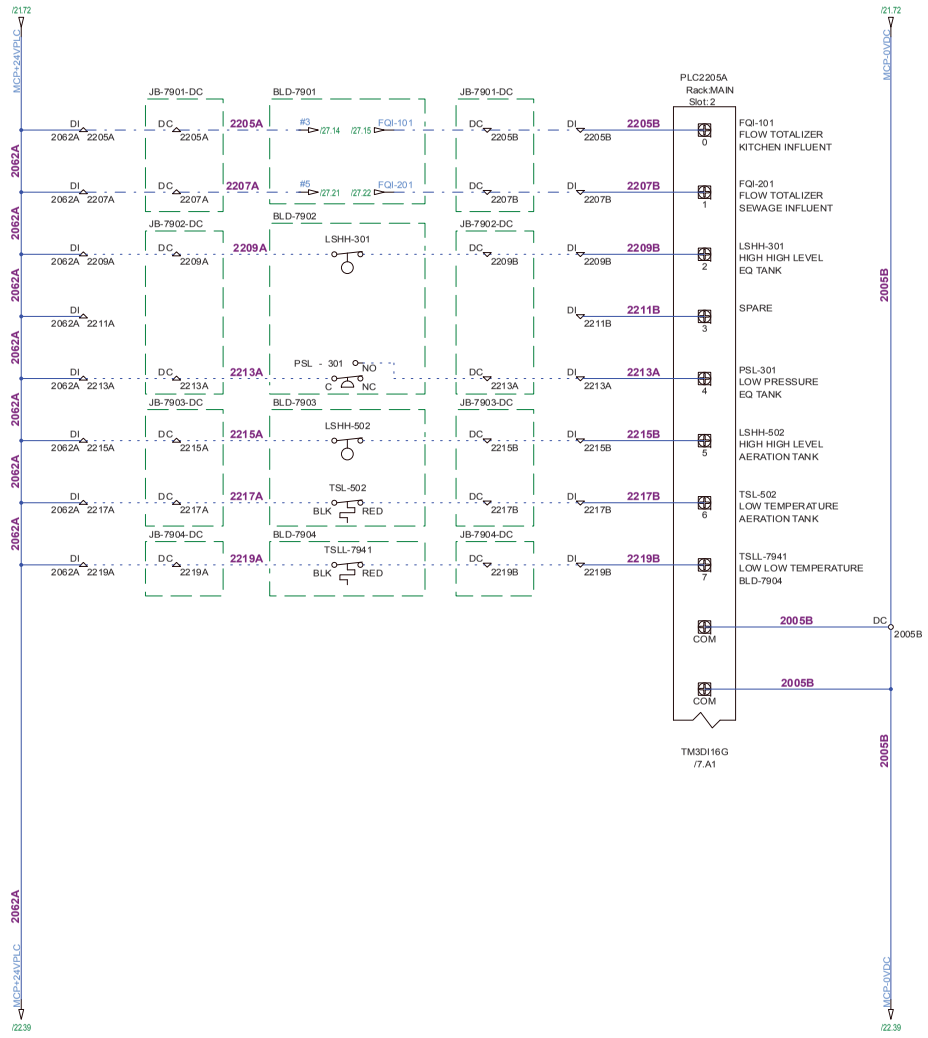

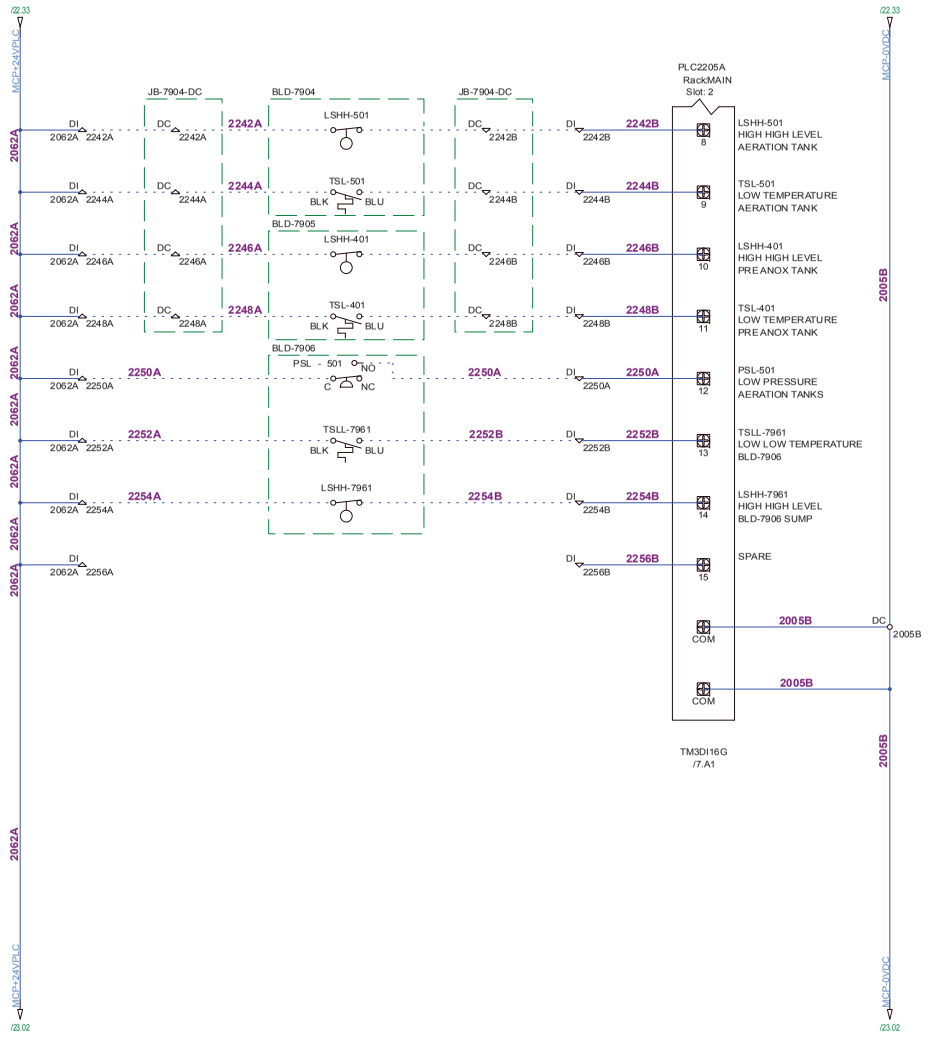

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. FOLLOW CANADIAN COLOUR CODE FOR POWER WIRING (SEE SHEET 3 - LEGEND)
2. WIRE SIZE IS #12 AWG FOR POWER UNLESS OTHERWISE SPECIFIED

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION:
MCP DISCRETE INPUTS
SHEET 2 OF 4
MCP

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	22	71

1704432 - AGNICO EAGLE MINE - C

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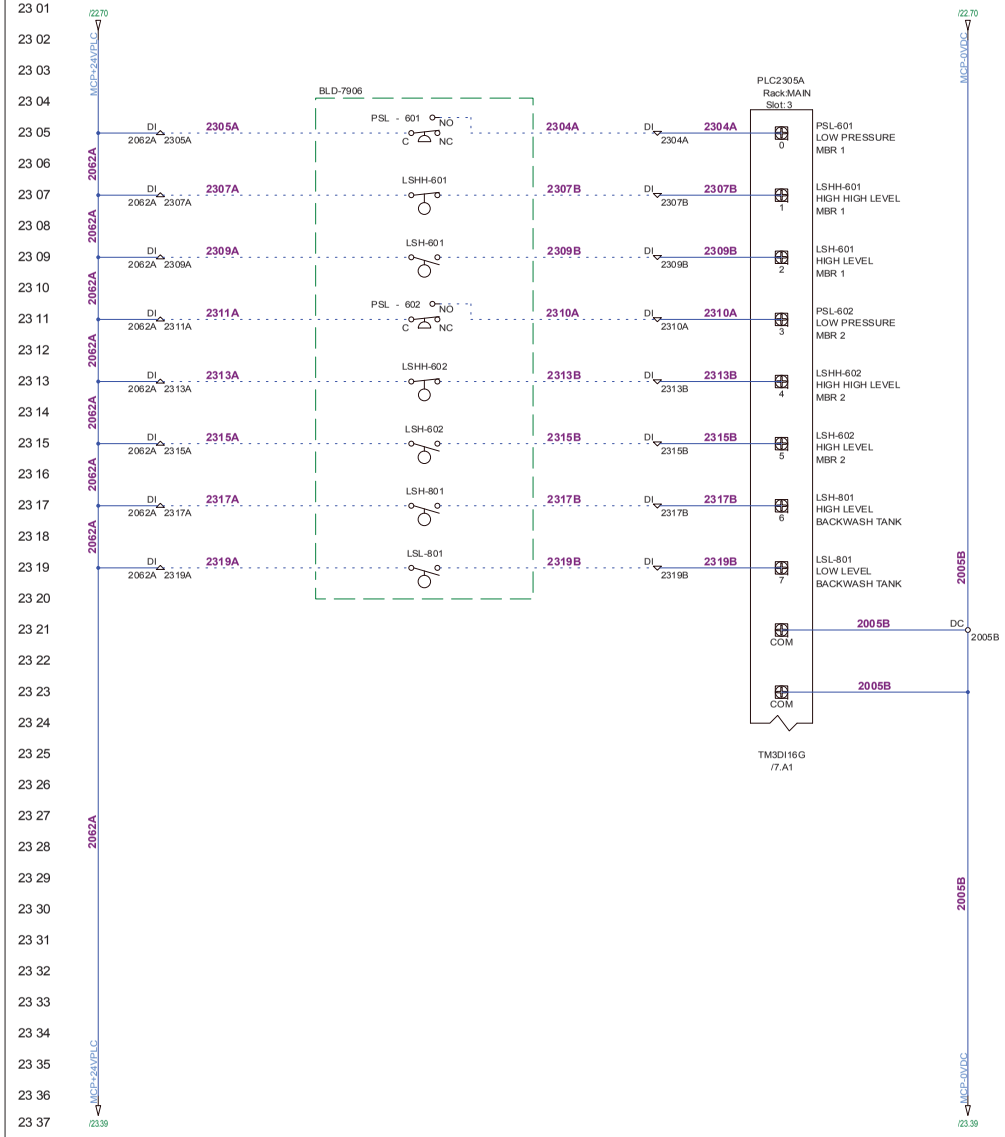

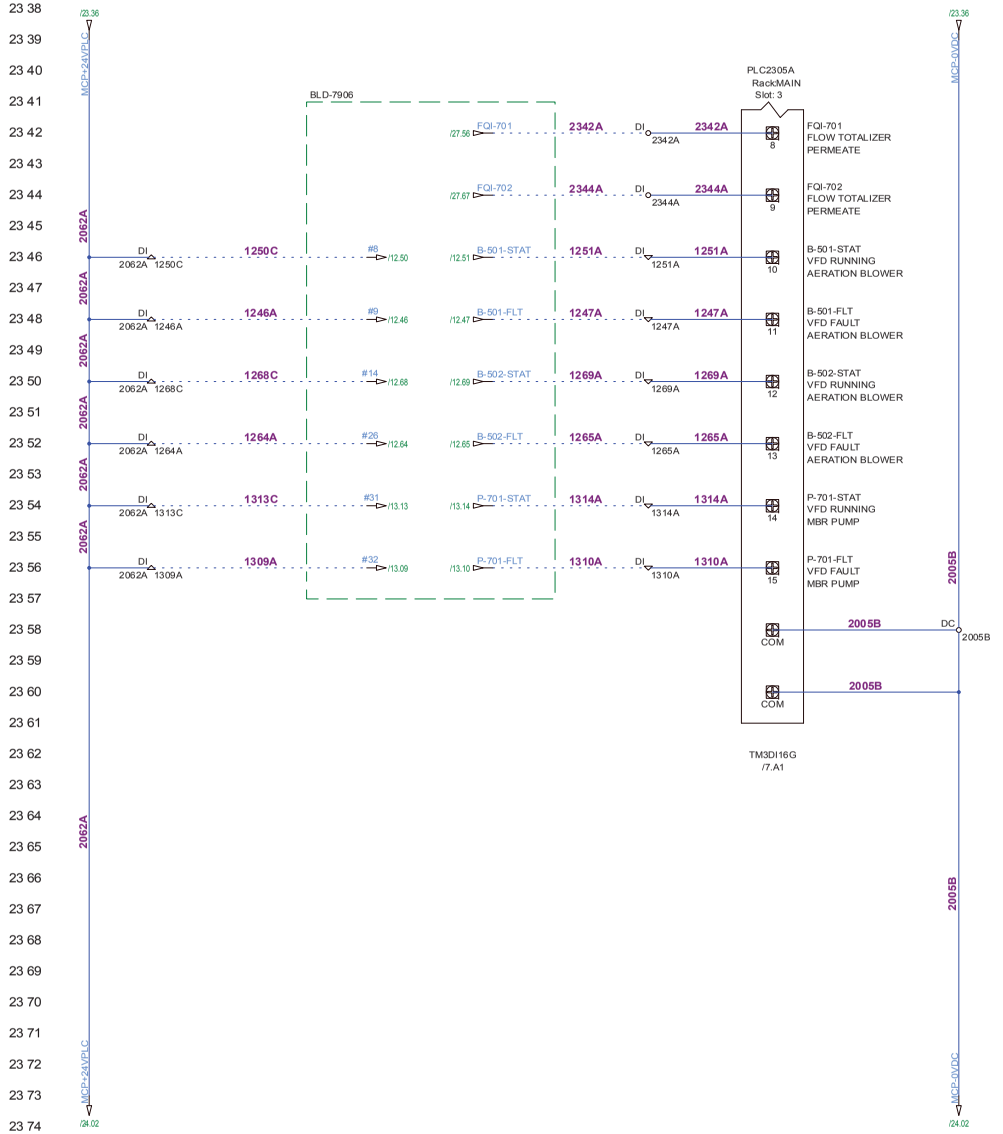

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MCP DISCRETE INPUTS SHEET 3 OF 4 MCP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	23	71

1704432 - AGNICO EAGLE MINE - C

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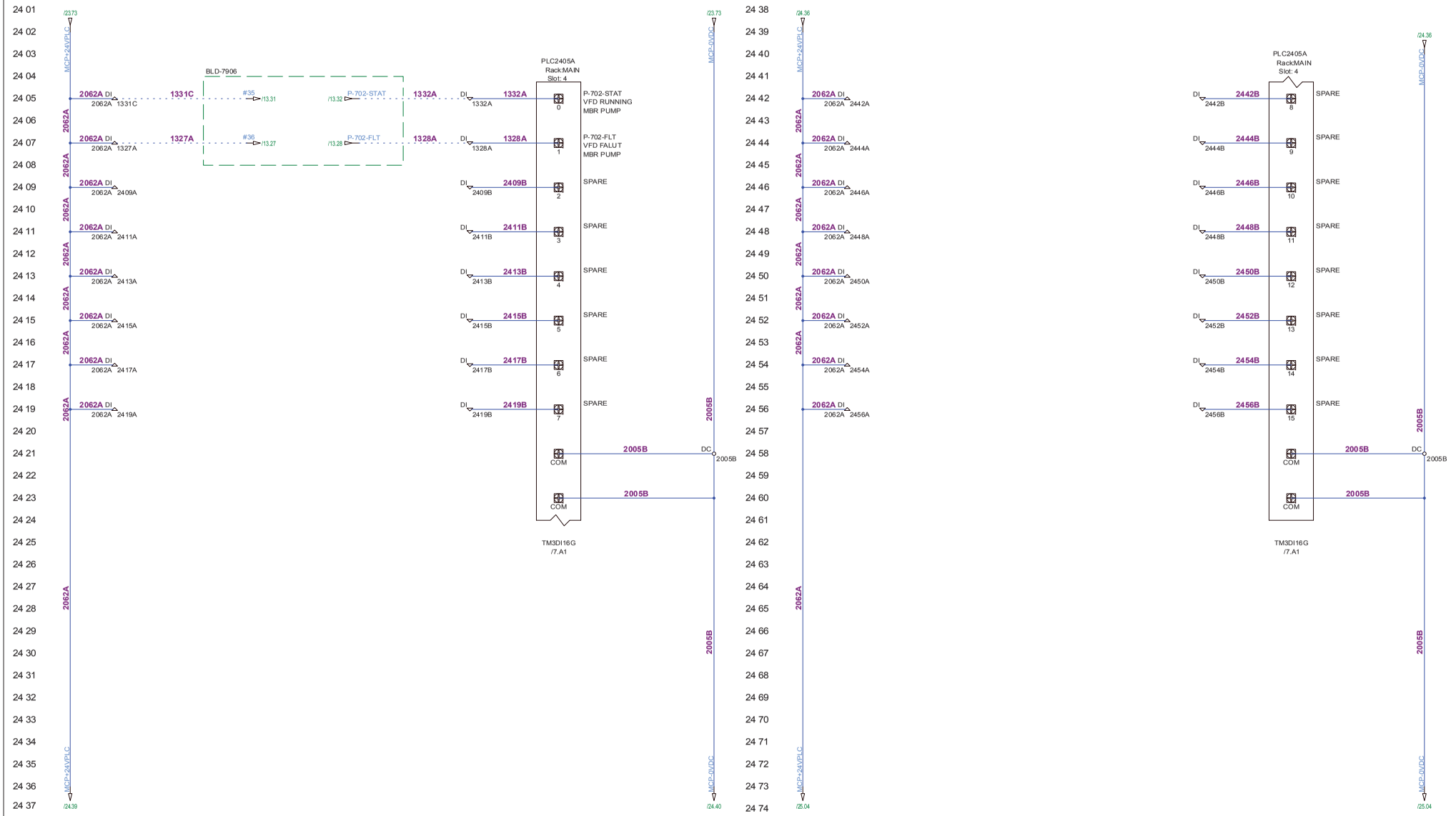

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION:
MCP DISCRETE INPUTS
SHEET 4 OF 4
MCP

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	25/05/17	24	71

1704432 - AGNICO EAGLE MINE - C

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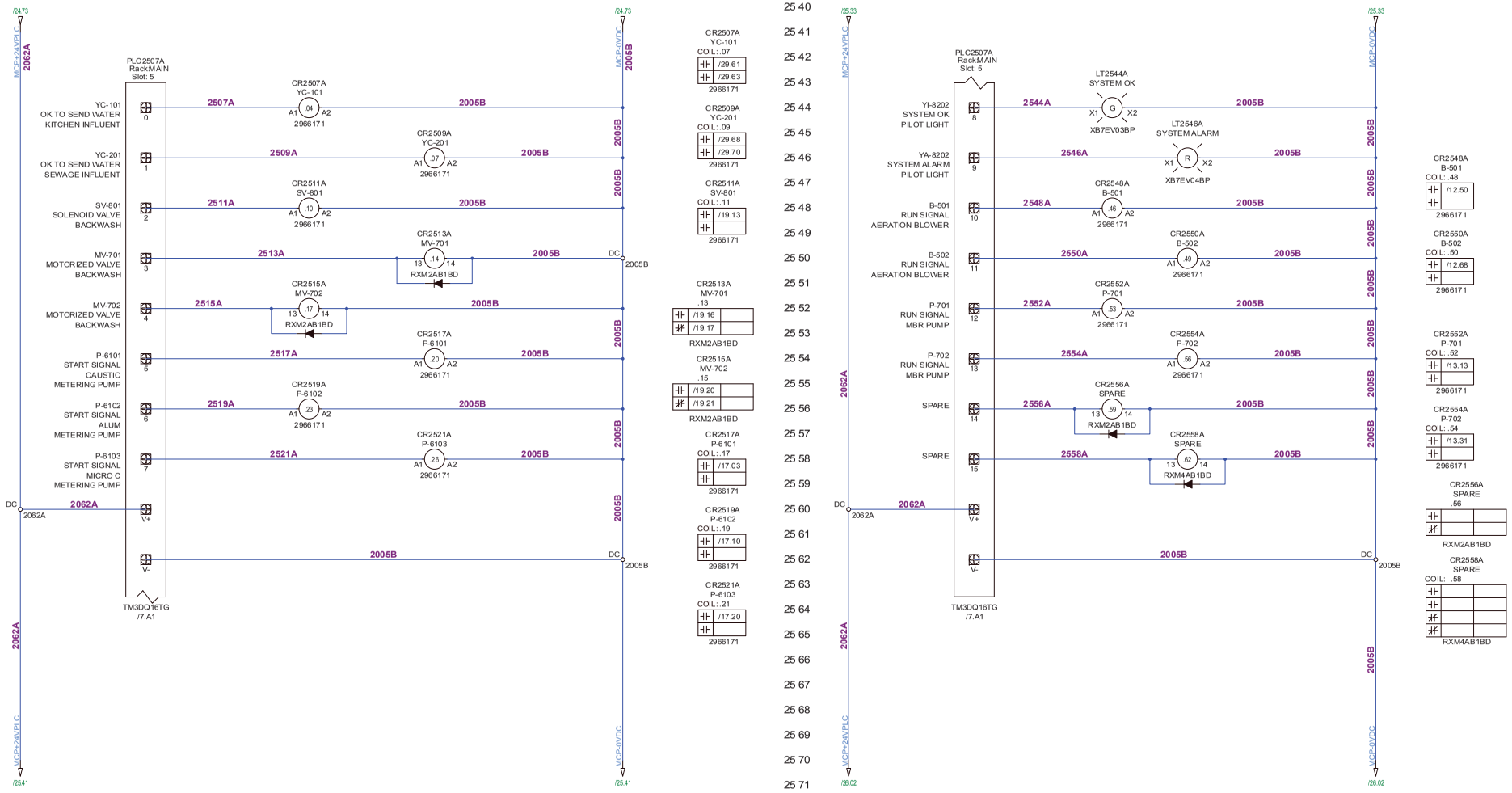

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. FOLLOW CANADIAN COLOUR CODE FOR POWER WIRING (SEE SHEET 3 - LEGEND)
2. WIRE SIZE IS #12 AWG FOR POWER UNLESS OTHERWISE SPECIFIED

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C	AS BUILT	14/08/17	DMB
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A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION:
MCP DISCRETE OUTPUTS
SHEET 1 OF 2
MCP

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	25	71

1704432 - AGNICO EAGLE MINE - C

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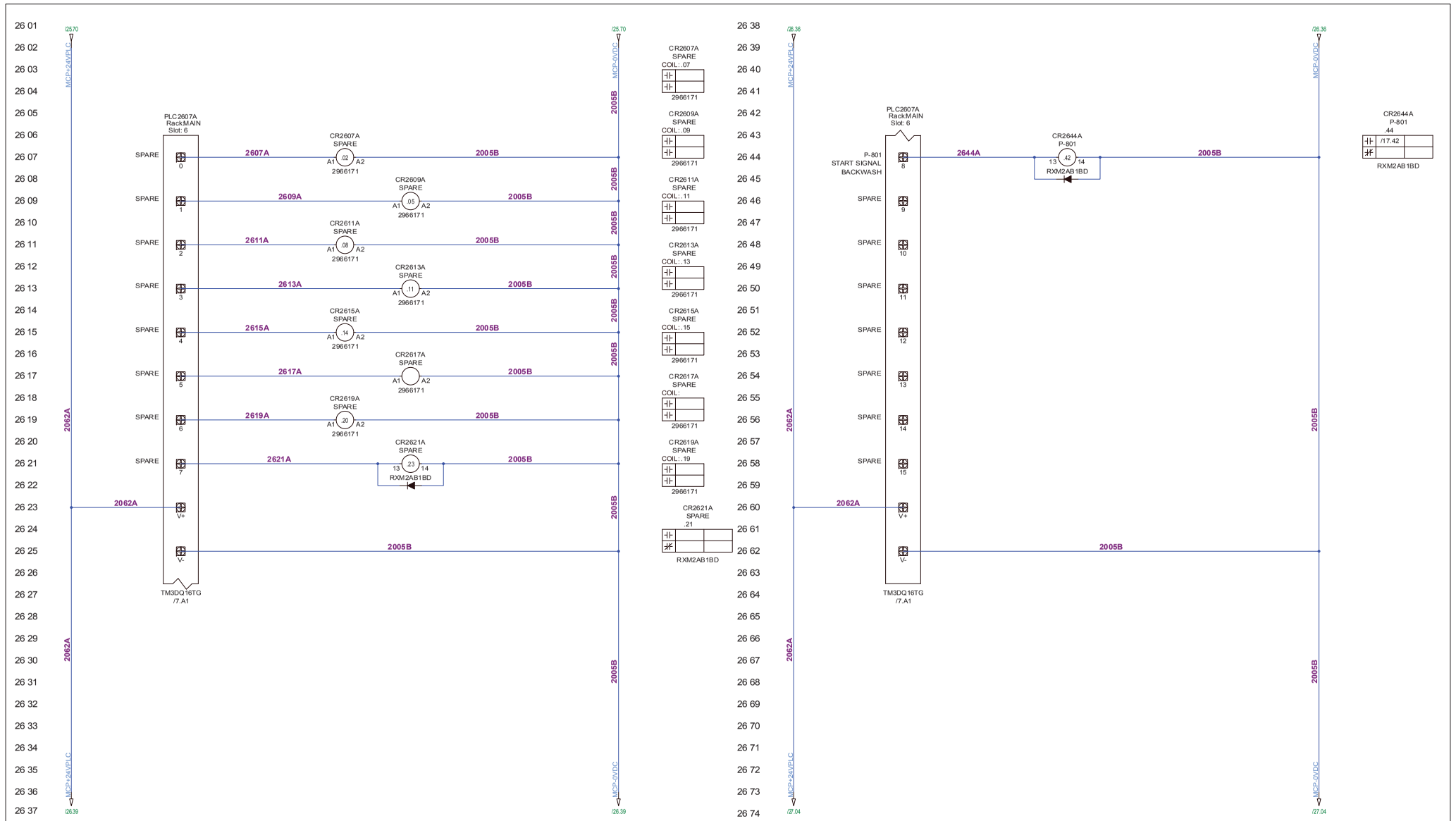

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MCP DISCRETE OUTPUTS SHEET 2 OF 2 MCP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	25/05/17	26	71

1704432 - AGNICO EAGLE MINE - C

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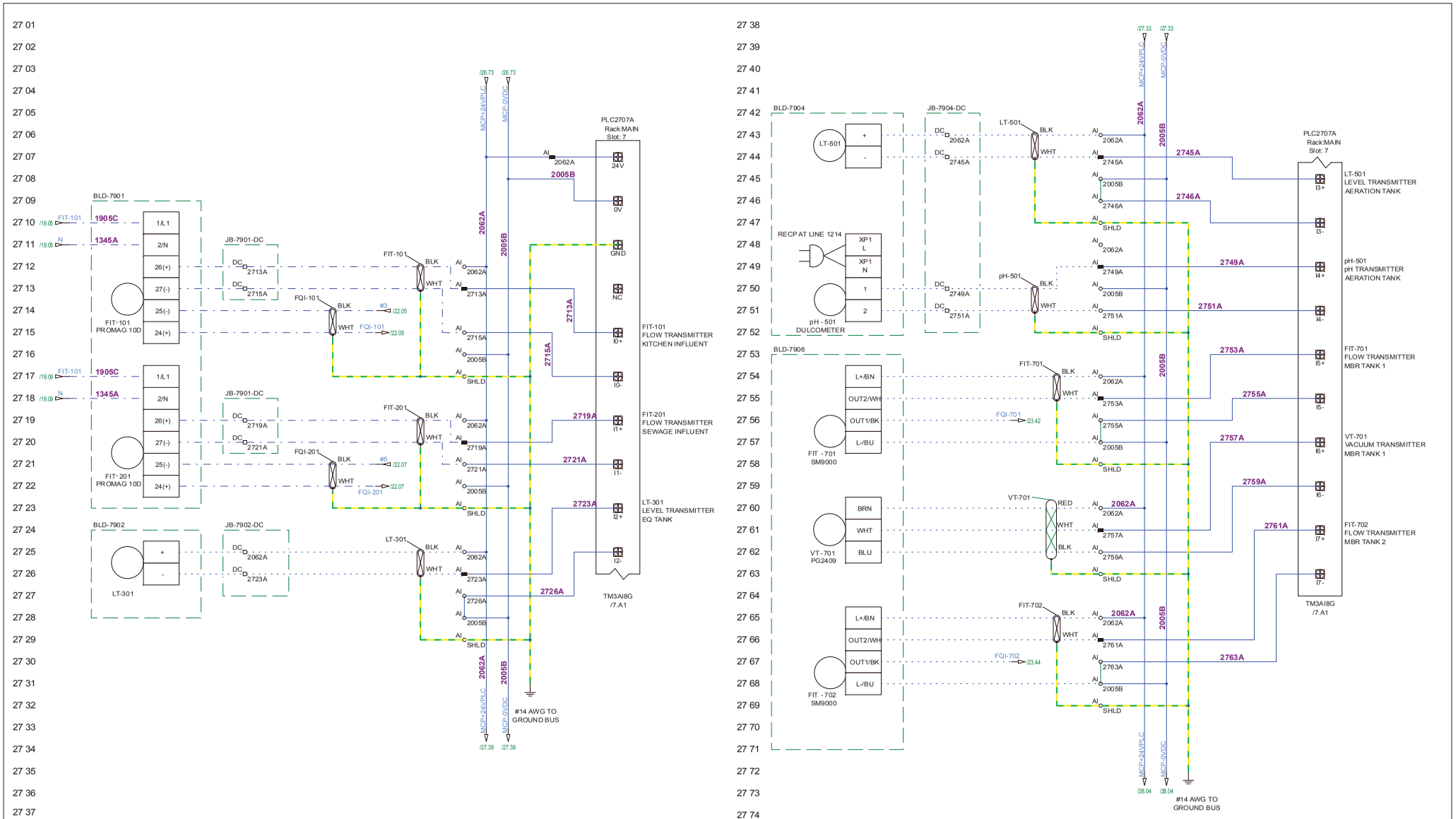

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. FOLLOW CANADIAN COLOUR CODE FOR POWER WIRING (SEE SHEET 3 - LEGEND)
2. WIRE SIZE IS #12 AWG FOR POWER UNLESS OTHERWISE SPECIFIED

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MCP ANALOG INPUTS SHEET 1 OF 2 MCP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	27	71

1704432 - AGNICO EAGLE MINE - C

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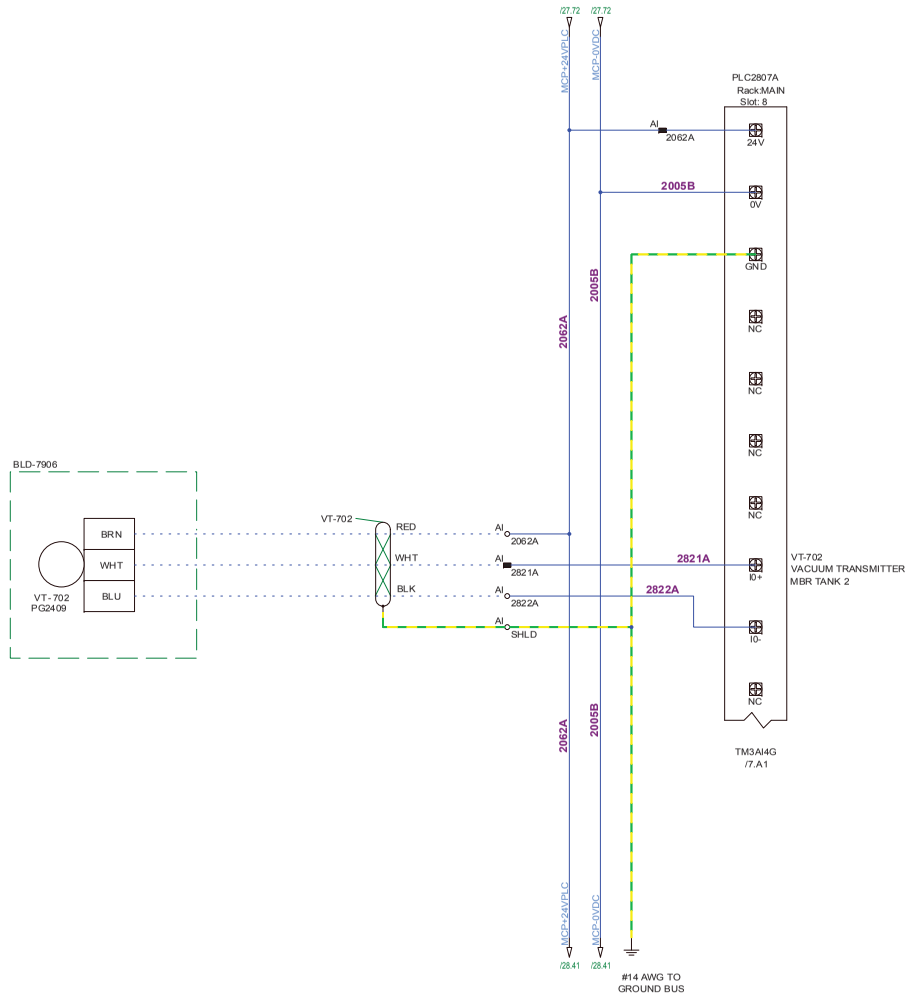

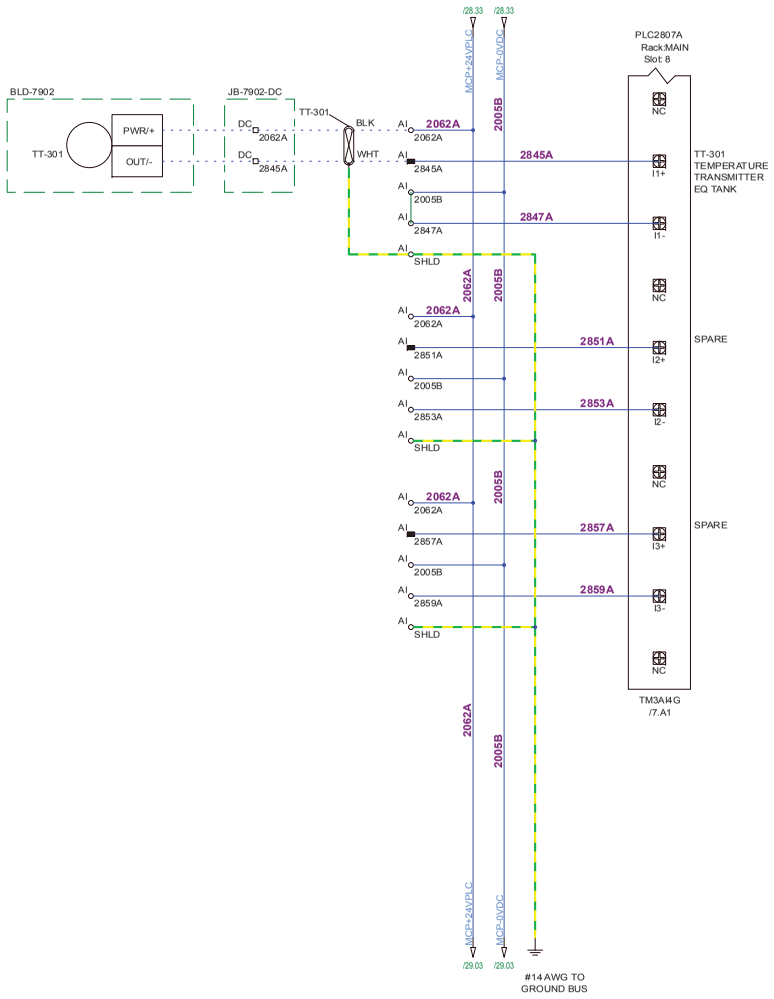

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION:
MCP ANALOG INPUTS
SHEET 2 OF 2
MCP

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	29/05/17	28	71

1704432 - AGNICO EAGLE MINE - C

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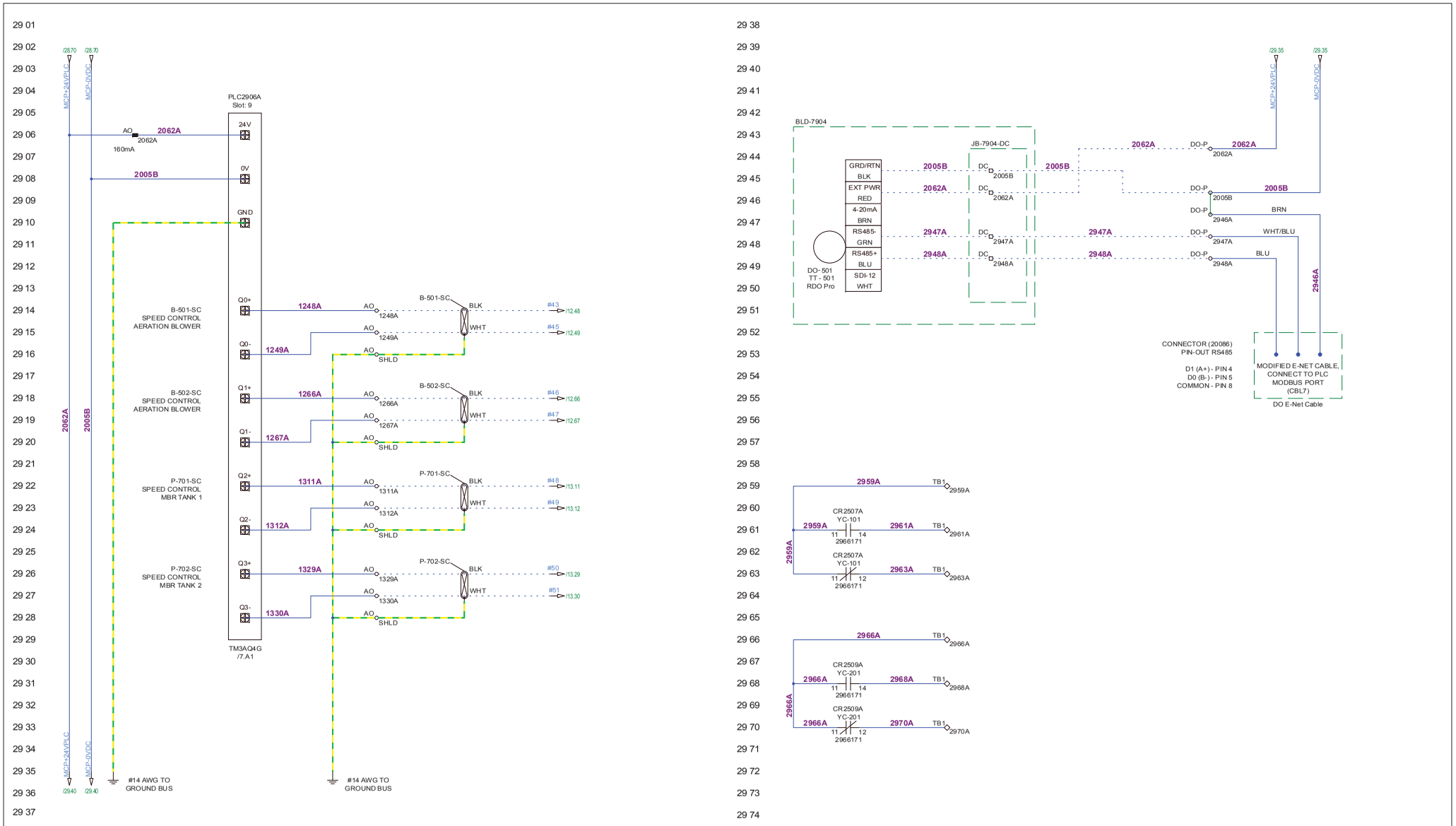

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION:
MCP ANALOG OUTPUTS, DO/TT
PROBE & CUSTOMER CONNECTIONS
MCP

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	29/05/17	29	71

1704432 - AGNICO EAGLE MINE - C

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INTENTIONALLY BLANK

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INTENTIONALLY BLANK

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: SPARE SHEET

MCP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	29/05/17	30	71

1704432 - AGNICO EAGLE MINE - C

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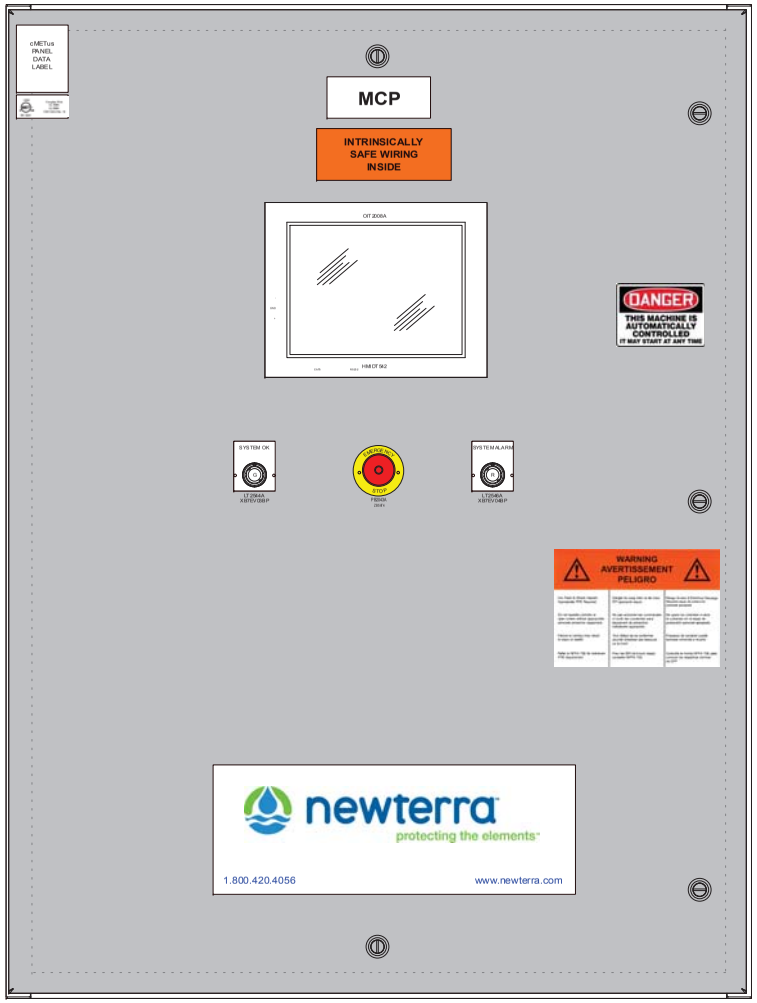
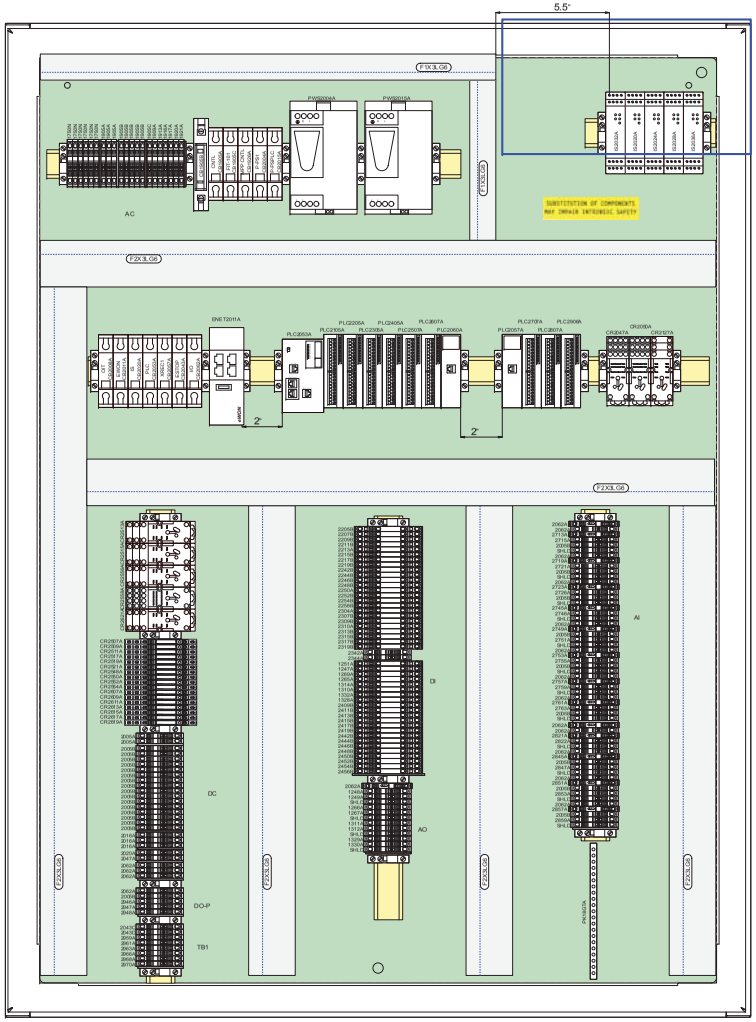


PANEL OUTER DOOR



MCP
EN4SD483612GY
PANEL INTERIOR

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MCP PANEL LAYOUT

MCP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	31	71

1704432 - AGNICO EAGLE MINE - C

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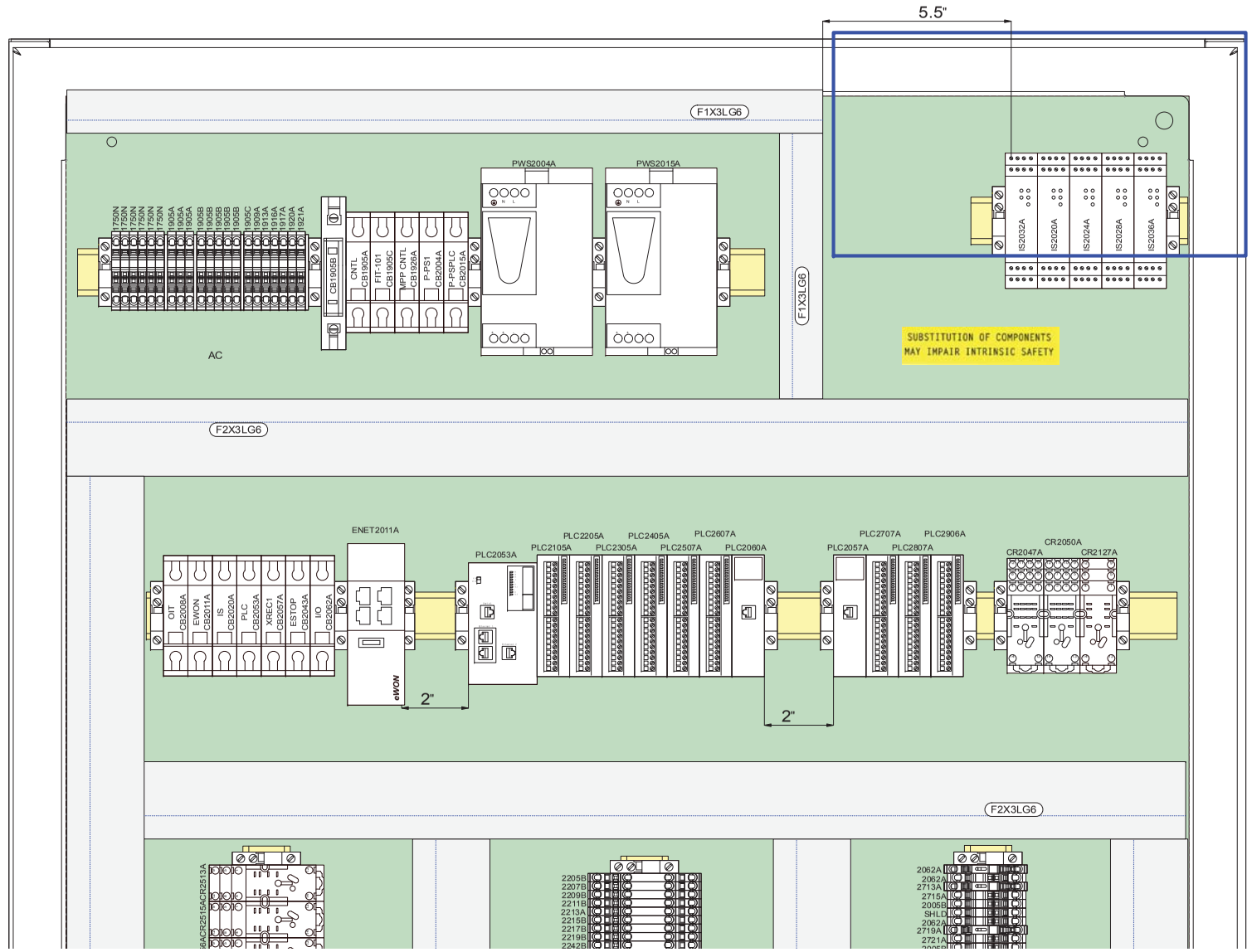

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MCP PANEL LAYOUT TOP MCP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	32	71

1704432 - AGNICO EAGLE MINE - C

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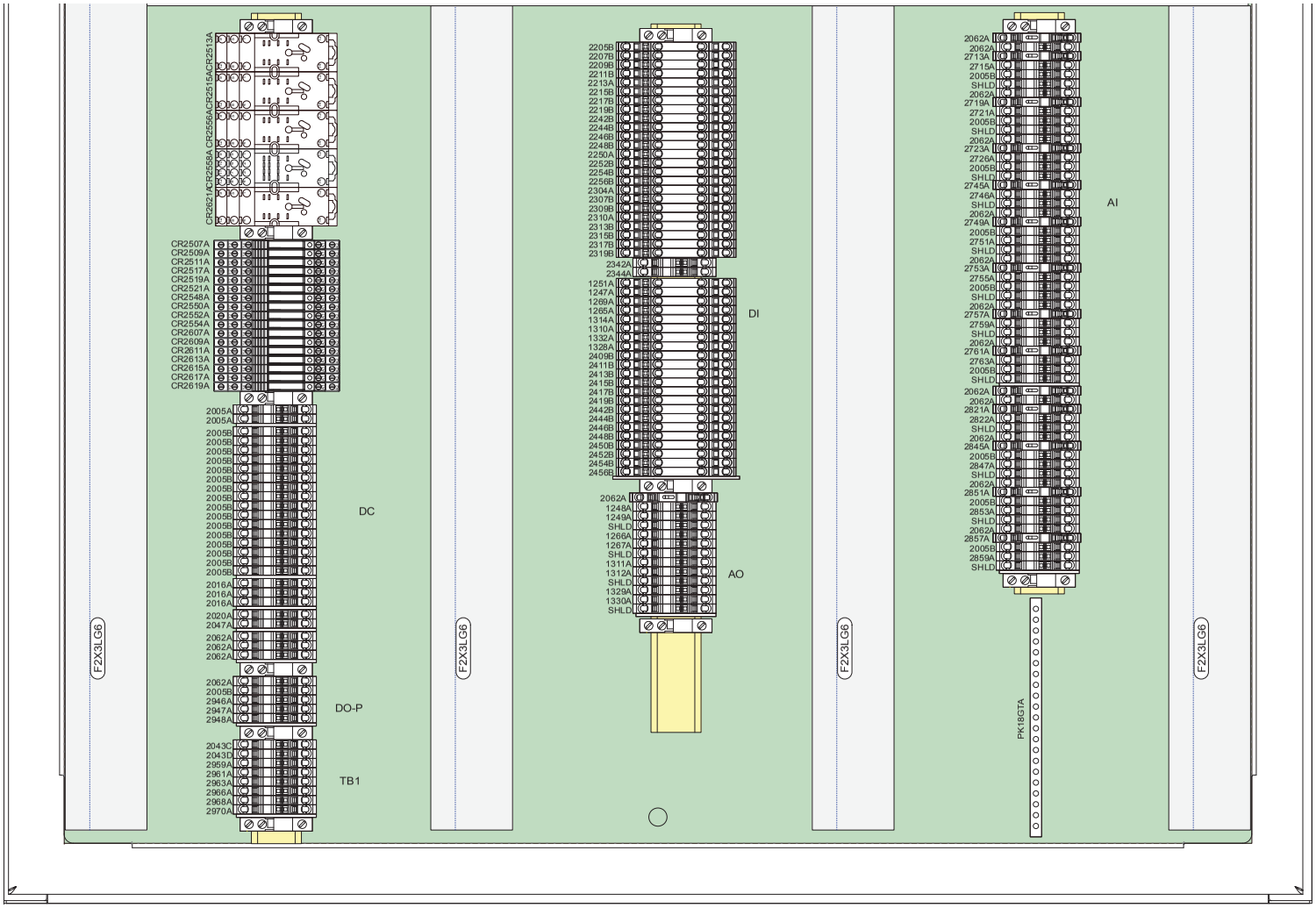

MCP

EN4SD483612GY

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MCP PANEL LAYOUT BOTTOM MCP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	33	71

1704432 - AGNICO EAGLE MINE - C

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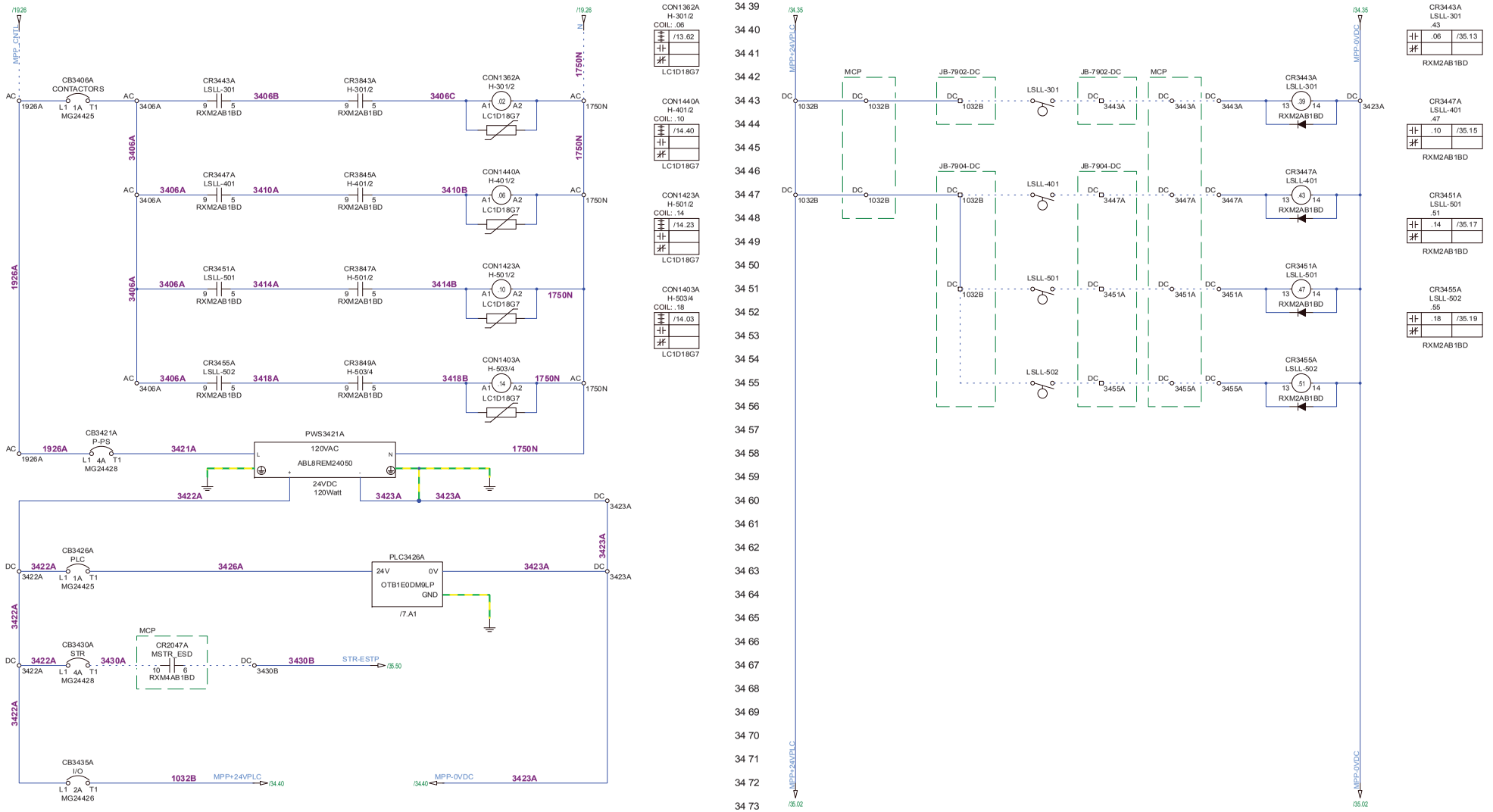

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. FOLLOW CANADIAN COLOUR CODE FOR POWER WIRING (SEE SHEET 3 - LEGEND)
2. WIRE SIZE IS #12 AWG FOR POWER UNLESS OTHERWISE SPECIFIED

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PHONE: (613)498-1876
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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MPP 120VAC & 24VDC CONTROL POWER MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	34	71

1704432 - AGNICO EAGLE MINE - C

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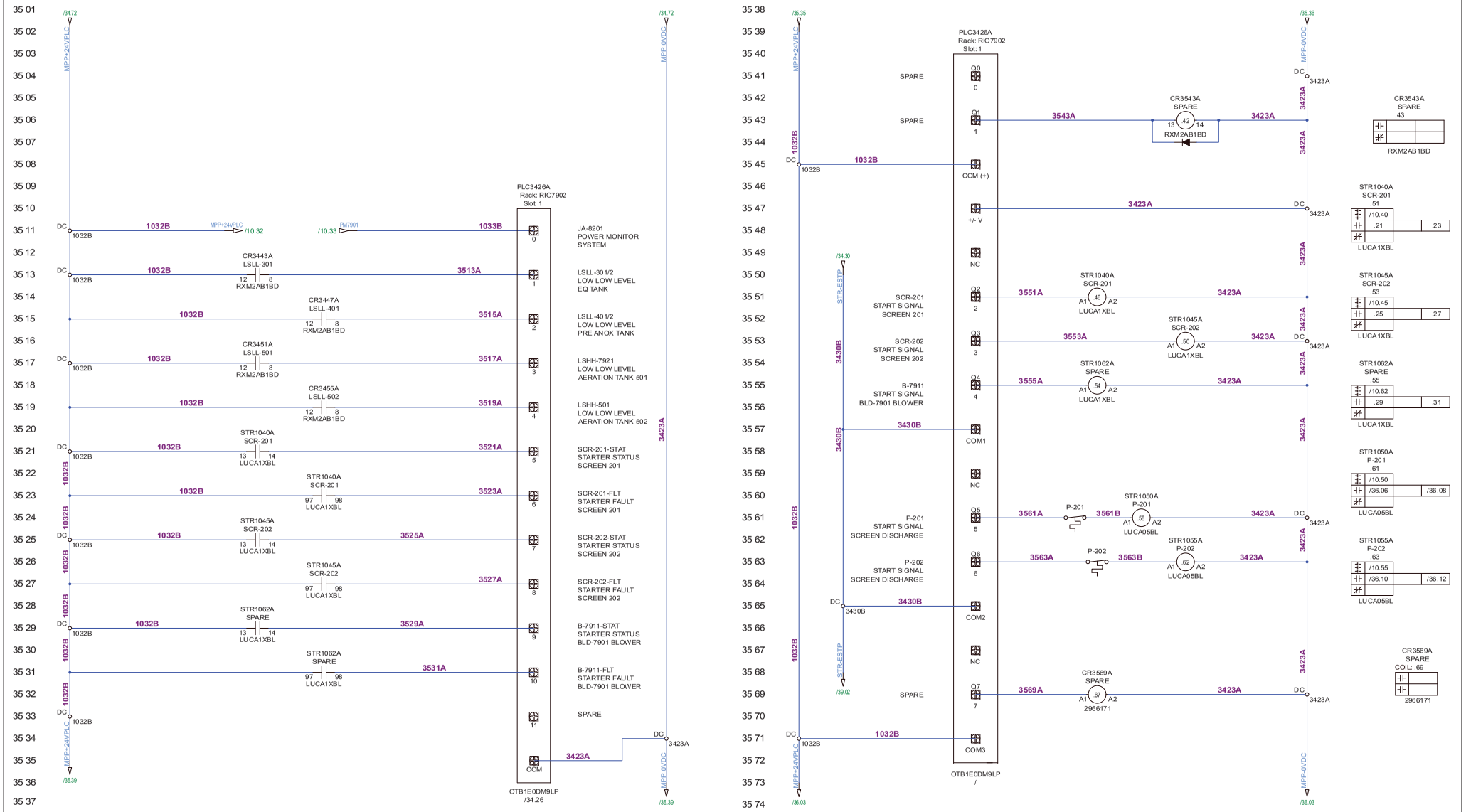

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. FOLLOW CANADIAN COLOUR CODE FOR POWER WIRING (SEE SHEET 3 - LEGEND)
2. WIRE SIZE IS #12 AWG FOR POWER UNLESS OTHERWISE SPECIFIED

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C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION:
MPP OTB I/O
DISCRETE INPUTS/OUTPUTS
MPP

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	35	71

1704432 - AGNICO EAGLE MINE - C

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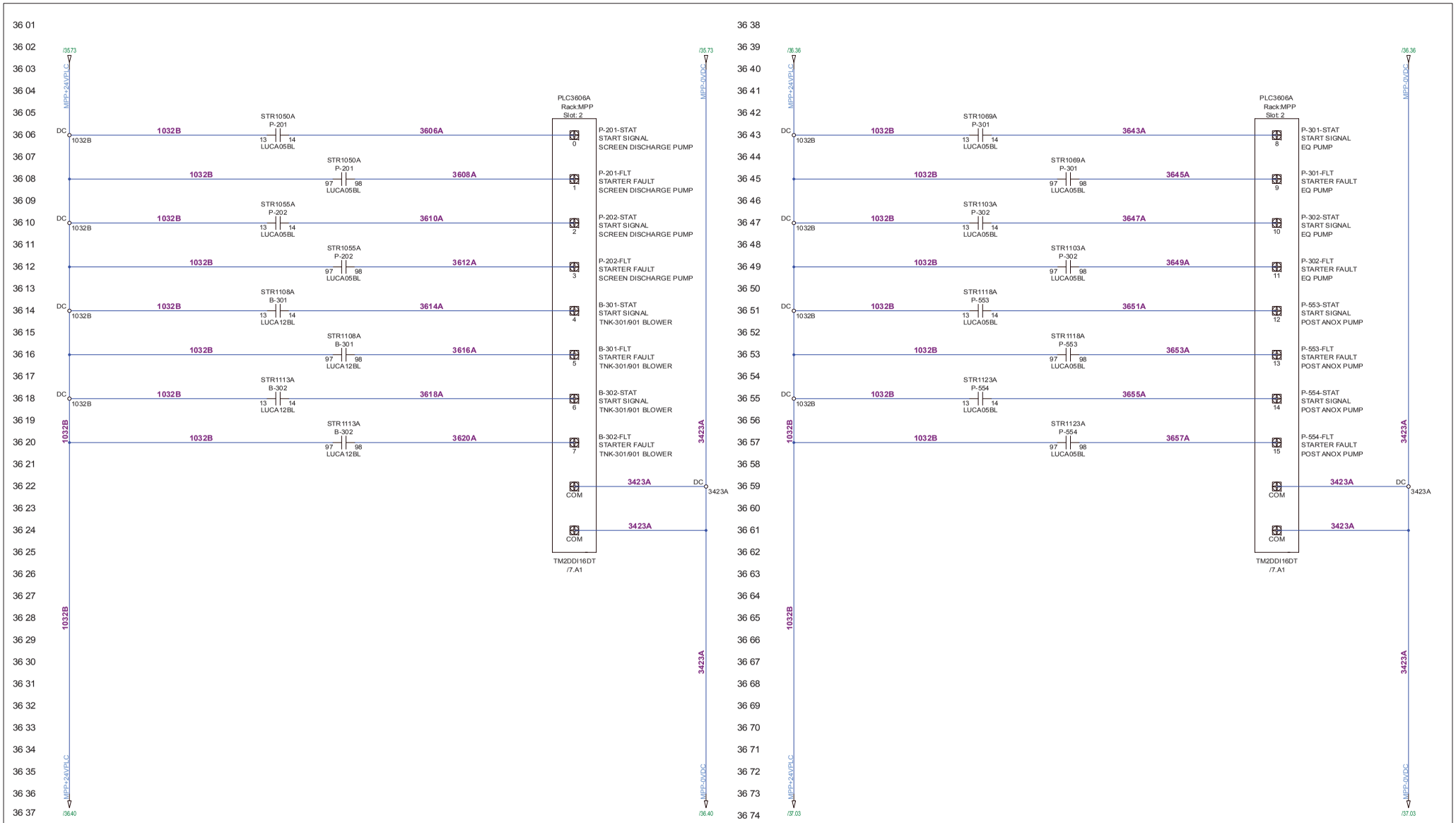
/3573
MPP+24VPLC
DC
1032B
STR1050A
P-201
13 14
LUCA05BL
3606A
PLC3606A
Rack:MPP
Slot: 2
0
P-201-STAT
START SIGNAL
SCREEN DISCHARGE PUMP
97 98
3608A
1
P-201-FLT
STARTER FAULT
SCREEN DISCHARGE PUMP
STR1055A
P-202
3610A
2
P-202-STAT
START SIGNAL
SCREEN DISCHARGE PUMP
3612A
3
P-202-FLT
STARTER FAULT
SCREEN DISCHARGE PUMP
STR1108A
B-301
LUCA12BL
3614A
4
B-301-STAT
START SIGNAL
TNK-301/901 BLOWER
3616A
5
B-301-FLT
STARTER FAULT
TNK-301/901 BLOWER
STR1113A
B-302
3618A
6
B-302-STAT
START SIGNAL
TNK-301/901 BLOWER
3620A
7
B-302-FLT
STARTER FAULT
TNK-301/901 BLOWER
3423A
COM
TM2DDI16DT
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MPP-0VDC
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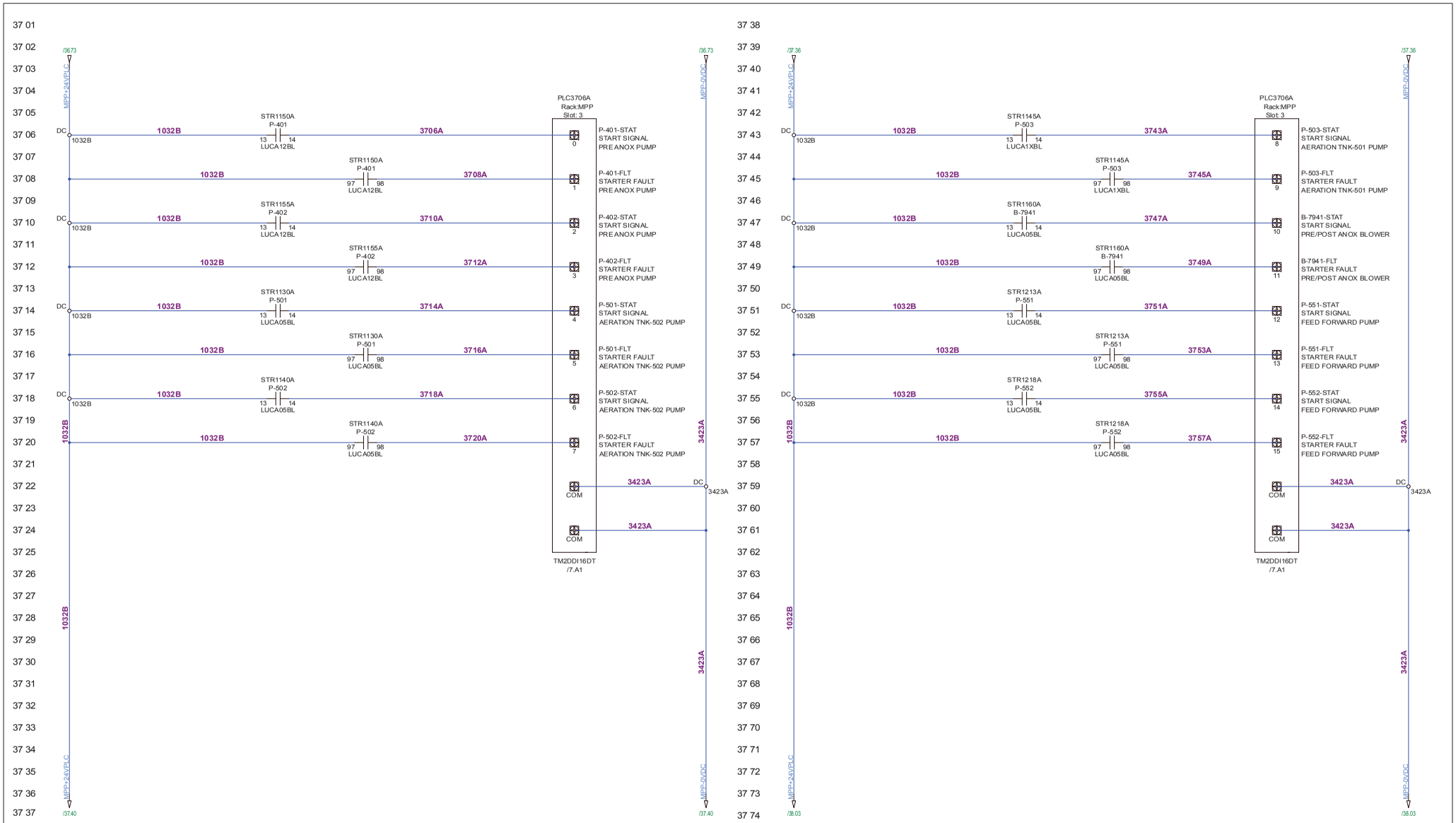

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION:
MPP DISCRETE INPUTS
SHEET 2 OF 2
MPP

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	29/05/17	37	71

1704432 - AGNICO EAGLE MINE - C

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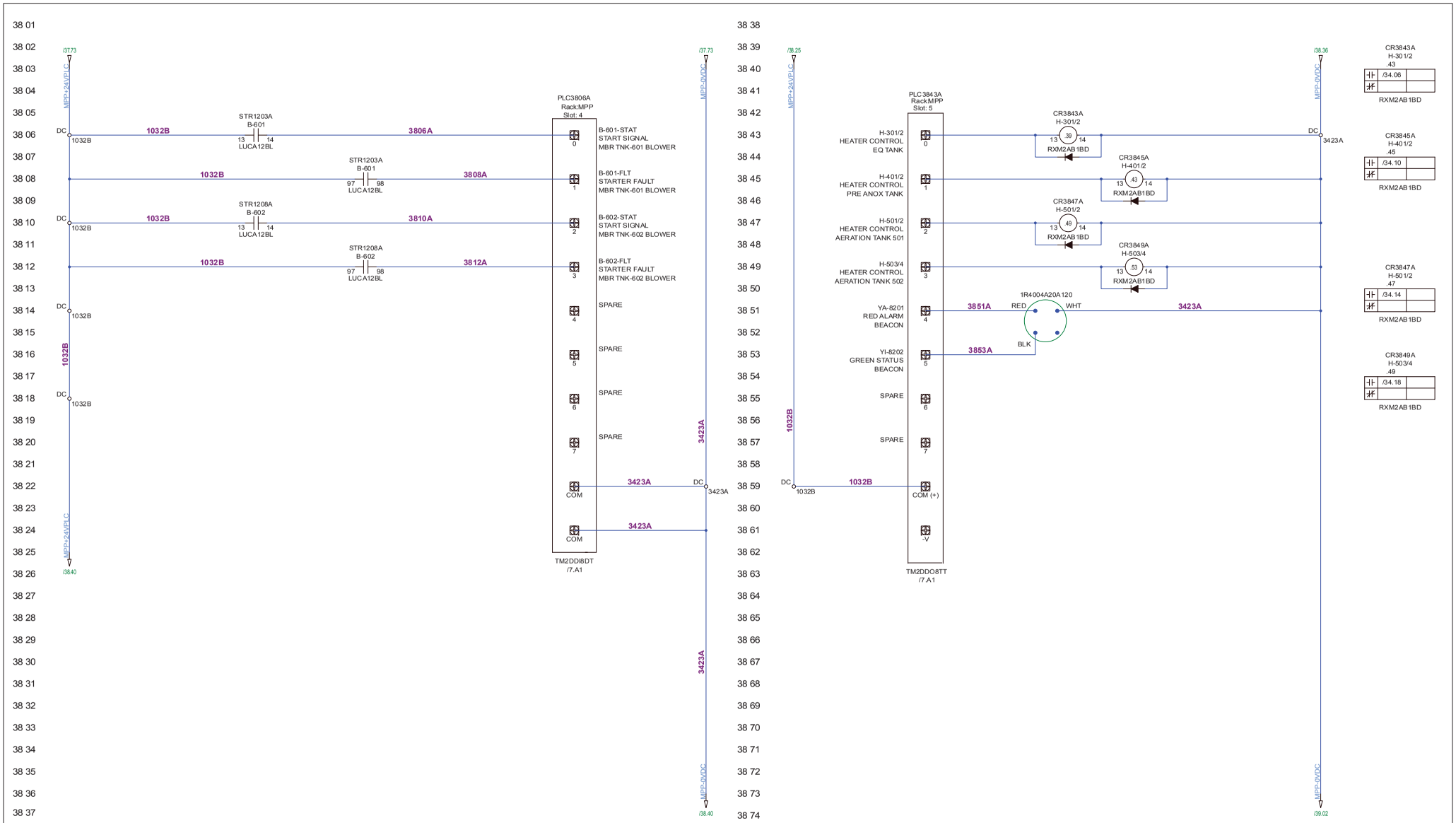

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MPP DISCRETE INPUTS & OUTPUTS MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	29/05/17	38	71

1704432 - AGNICO EAGLE MINE - C

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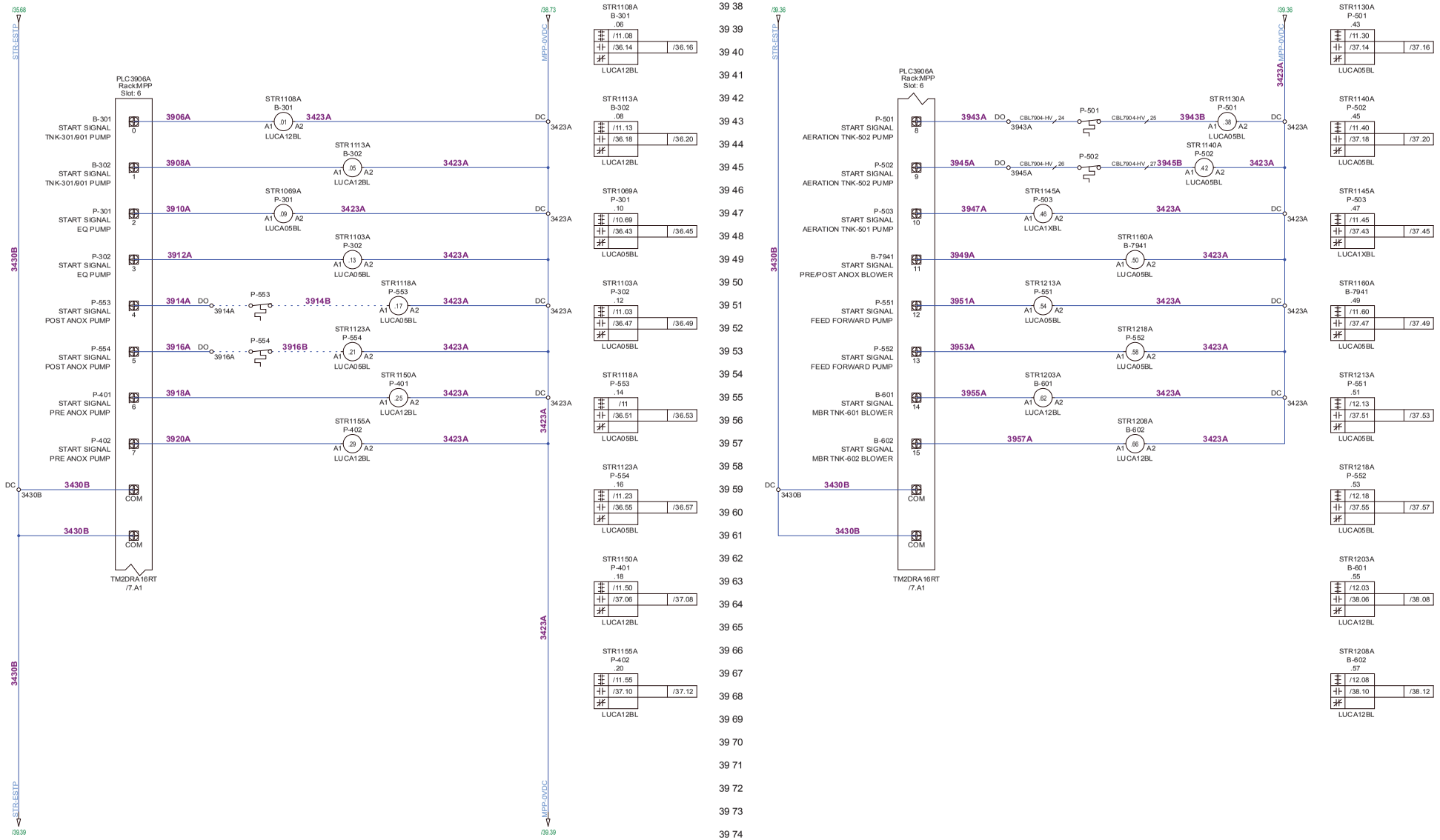

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MPP RELAY OUTPUTS

MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	39	71

1704432 - AGNICO EAGLE MINE - C

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INTENTIONALLY BLANK

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1. FOLLOW CANADIAN COLOUR CODE FOR POWER WIRING (SEE SHEET 3 - LEGEND)
2. WIRE SIZE IS #12 AWG FOR POWER UNLESS OTHERWISE SPECIFIED

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MPP SPARE SHEET

MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	40	71

1704432 - AGNICO EAGLE MINE - C

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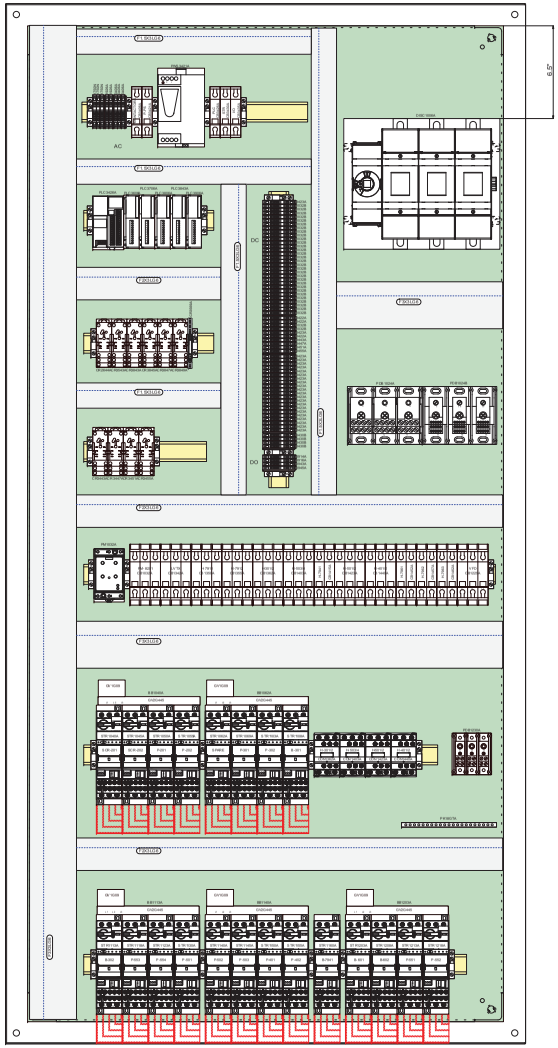
PANEL OUTER DOOR



MPP
EN4SD723612GY
PANEL INTERIOR

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MPP PANEL LAYOUT

MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	41	71

1704432 - AGNICO EAGLE MINE - C

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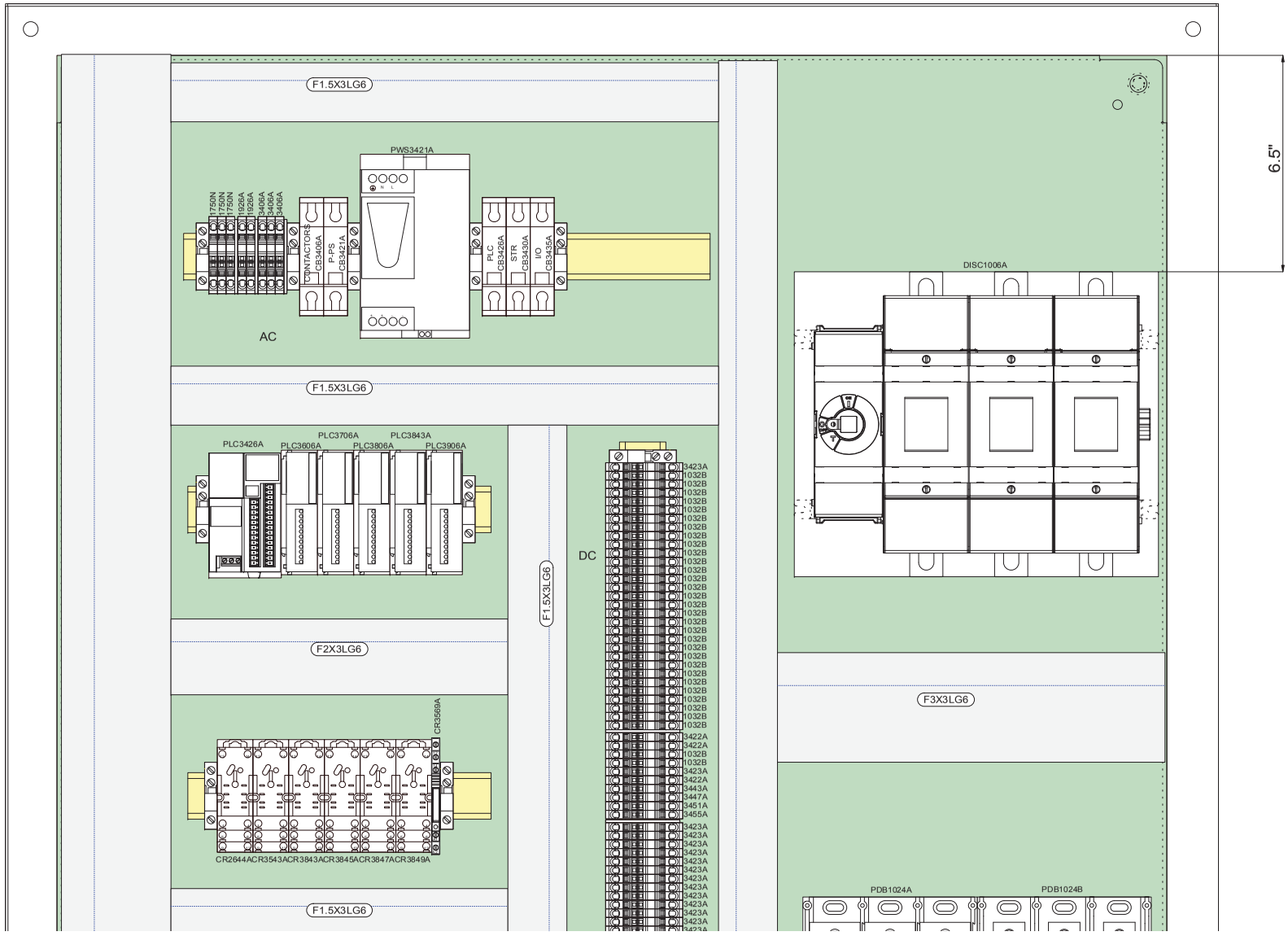

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION:
MPP PANEL LAYOUT
TOP
MPP

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	42	71

1704432 - AGNICO EAGLE MINE - C

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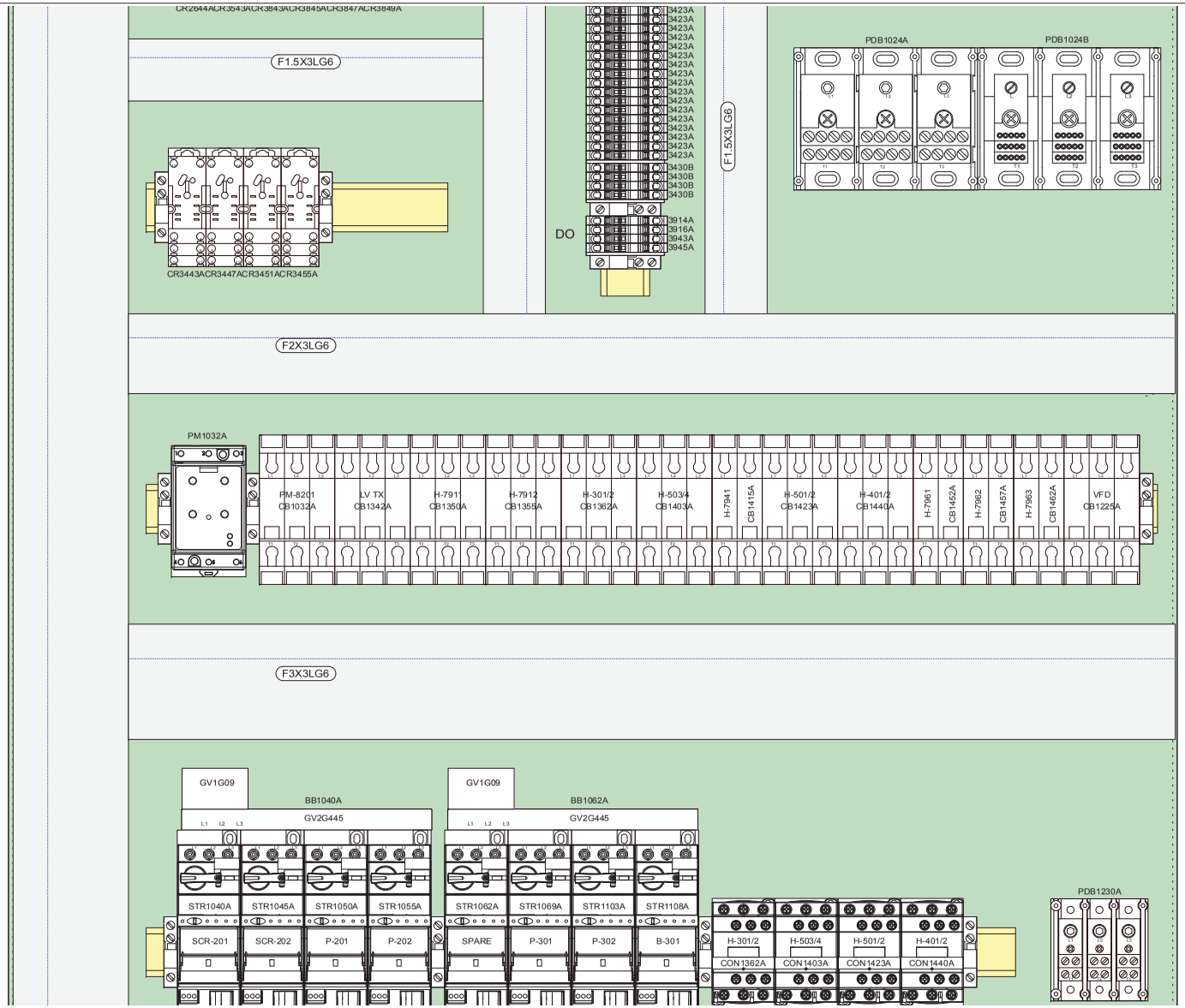

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MPP PANEL LAYOUT MIDDLE MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	43	71

1704432 - AGNICO EAGLE MINE - C

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MPP
EN4SD723612GY
PANEL INTERIOR

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MPP PANEL LAYOUT BOTTOM MPP

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	08/05/17	44	71

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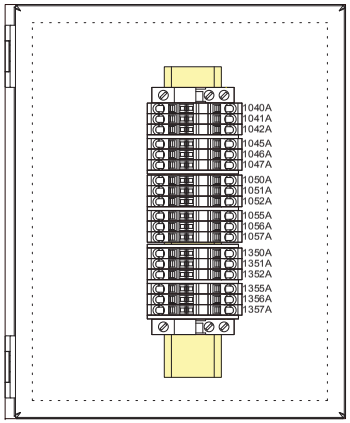
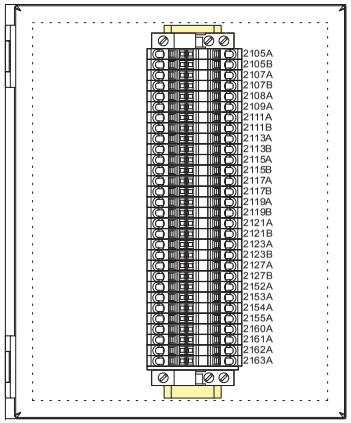


JB-7901-HV
EJ1084



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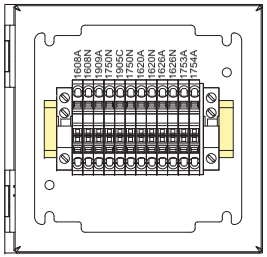

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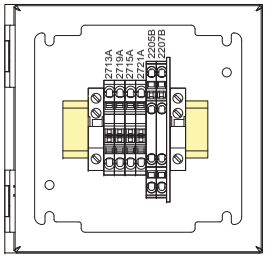

JB-7901-DC
EJ664

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: JUNCTION BOX LAYOUTS JB-7901'S

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	30/05/17	45	71

1704432 - AGNICO EAGLE MINE - C

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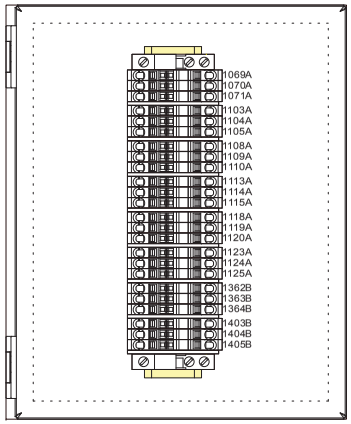
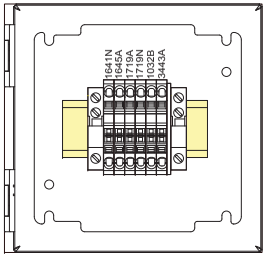
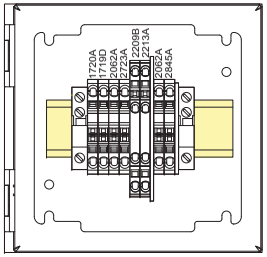


JB-7902-HV
EJ1084



JB-7902-AC
EJ664



JB-7902-DC
EJ664

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: JUNCTION BOX LAYOUTS JB-7902'S

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	30/05/17	46	71

1704432 - AGNICO EAGLE MINE - C

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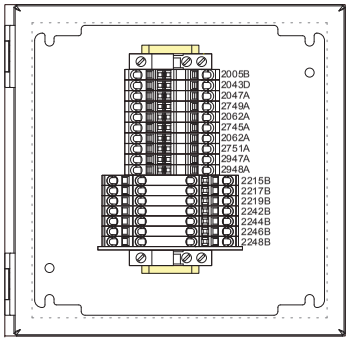
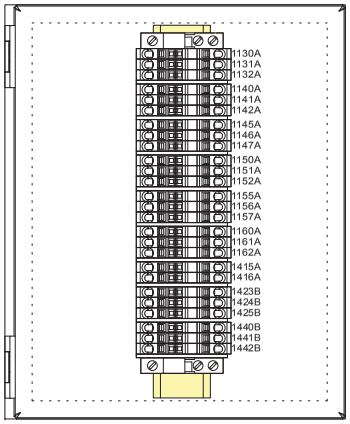
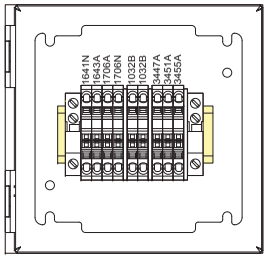


JB-7904-DC
EJ884



JB-7904-HV
EJ1084



JB-7904-AC
EJ664

WIRE LEGEND

BLACK:	POWER
RED:	120VAC CONTROL
WHITE:	NEUTRAL
BLUE:	+24VDC & IS WIRING
BLU/WHT:	0VDC
YELLOW:	INTERLOCKS

NOTES:

1.

1325 CALIFORNIA AVE.
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CANADA K6V 5Y6
PHONE: (613)498-1876
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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: JUNCTION BOX LAYOUTS JB-7904'S

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	30/05/17	47	71

1704432 - AGNICO EAGLE MINE - C

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MPP - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
1	37557	2QPL	Pad Lockable Qurater Turn Latch	Hammond	MPP
1	18396	460	190-480V, 3PH Power/Phase Monitor	Symcom	PM1032A
25	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB1, TB5, TB13, TB14, TB15, TB17, TB19, TB20, TB21, TB22, TB23, TB24,
					TB25, TB26, TB27, TB28, TB31, TB34, TB38, TB39, TB40, TB41, TB42, TB43,
					TB44
8	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS1, TS5, TS6, TS7, TS8, TS9, TS10, TS11
1	23751	2966171	Relay, SPDT, 24VDC Coil	Phoenix Contact	CR3569A
7	23742	3030420	End Plate - 30A Feed Thru	Phoenix Contact	TB16, TB30, TB32, TB33, TB35, TB36, TB37
69	23738	3031377	Terminal, Blue, 28-12AWG, 30A, 600V	Phoenix Contact	AC(3), DC(66)
5	23740	3037151	Terminal, Red, 28-12AWG, 30A, 600V	Phoenix Contact	AC(5)
1	35707	ABL8REM24050	24VDC Power Supply, 120W, 5A	Schneider Electric	PWS3421A
3	12404	AJT250	Fuse,GLD AJT250250A 600V Time Delay, Class J	Ferraz Shawmut	DISC1006A(3)
1	24694	Arc Flash	Panel Label - Arc Flash Tri-lingual	Panel	8.11D
5	27397	C1.5LG6	Wire Duct Cover, 1.5", Grey	Panduit	WD8, WD9, WD10, WD12, WD16
3	27399	C2LG6	Wire Duct Cover, 2", Grey	Panduit	WD7, WD13, WD15
3	27405	C3LG6	Wire Duct Cover, 3", Grey	Panduit	WD1, WD4, WD11
1	38090	EN4SD723612GY	72" x 36" x 12" NEMA4 Steel Enclosure	Hammond	MPP
1	38041	EP7236	72" x 36" Backplate	Hammond	MPP
1	37558	EZPMFHD	Mounting Feet, Zinc, Set of 4	Hammond	MPP
5	27396	F1.5X3LG6	Wire Duct, 1.5"x3", Grey, Narrow Finger	Panduit	WD8, WD9, WD10, WD12, WD16
3	27398	F2X3LG6	Wire Duct, 2"x3", Grey, Narrow Finger	Panduit	WD7, WD13, WD15
3	27404	F3X3LG6	Wire Duct, 3"x3", Grey, Narrow Finger	Panduit	WD1, WD4, WD11
1	27929	GS1AW503	Terminal Lug, 2@#2AWG-600MCM, for use in 400A,600A,800A	Schneider Electric	DISC1006A
1	27712	GS2AE2	Shaft for Rotary Thru Door Handle	Schneider Electric	DISC1905
1	27713	GS2AH140	Through Door Rotary Handle	Schneider Electric	DISC1905
1	27928	GS2AP53	Terminal Shroud Kit 400A	Schneider Electric	DISC1006A
1	27927	GS2QU3N	Internal Fusible switch, 400A, Class J	Schneider Electric	DISC1006A
6	17158	GV1G09	Combination Starter, Busbar Top Mount	Schneider Electric	BB1040A, BB1062A, BB1113A, BB1140A, BB1203A, STR1160A
5	22546	GV2G445	Busbar 4 TeSysU Starters, #6AWG 63A MAX	Schneider Electric	BB1040A, BB1062A, BB1113A, BB1140A, BB1203A
4	10254	LC1D18G7	Contactor (TeSys D) Non-Reversing, 18A(AC3) 125A(AC1), 3-Pole (3 NO)	Schneider Electric	CON1362A, CON1403A, CON1423A, CON1440A
15	37367	LU9BN11C	TeSysU Prewired Coil Connection, Front Connection	Schneider Electric	STR1040A, STR1045A, STR1050A, STR1055A, STR1069A, STR1103A, STR1108A,
					STR1113A, STR1118A, STR1123A, STR1130A, STR1140A, STR1145A, STR1203A,
					STR1208A

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PROJ. NO: 1704432

TITLE AND LOCATION:
MPP BILL OF MATERIAL
MODULE 8201 - SHEET 1 OF 2

CUSTOMER:
AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	31/05/17	48	71

1704432 - AGNICO EAGLE MINE - C

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MPP - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
21	19269	LUA1C20	Combination Starter, 1NO Ready, 1NO Fault Aux. Contact Module	Schneider Electric	STR1040A, STR1045A, STR1050A, STR1055A, STR1062A, STR1069A, STR1103A,
					STR1108A, STR1113A, STR1118A, STR1123A, STR1130A, STR1140A, STR1145A,
					STR1150A, STR1155A, STR1160A, STR1203A, STR1208A, STR1213A, STR1218A
21	19264	LUB12	Combination Starter, 12A Power Base, 3/7.5/10HP	Schneider Electric	STR1040A, STR1045A, STR1050A, STR1055A, STR1062A, STR1069A, STR1103A,
					STR1108A, STR1113A, STR1118A, STR1123A, STR1130A, STR1140A, STR1145A,
					STR1150A, STR1155A, STR1160A, STR1203A, STR1208A, STR1213A, STR1218A
4	19503	LUCA1XBL	Combination Starter, TeSysU Standard Control Unit 0.35-1.4A, 24VDC coil	Schneider Electric	STR1040A, STR1045A, STR1062A, STR1145A
11	21191	LUCA05BL	Combination Starter, TeSysU Standard Control Unit 1.25-5.0A, 24V/60mA DC coil	Schneider Electric	STR1050A, STR1055A, STR1069A, STR1103A, STR1108A, STR1113A, STR1130A,
					STR1140A, STR1160A, STR1213A, STR1218A
6	22706	LUCA12BL	Combination Starter, TeSysU Standard Control Unit 3-12A, 24V/60mA DC coil	Schneider Electric	STR1118A, STR1123A, STR1150A, STR1155A, STR1203A, STR1208A
4	38092	M9F42215	Breaker, Multi9, 480/277V 15 AMP 2P C Trip Curve, 10k SCCR	Schneider Electric	CB1415A, CB1452A, CB1457A, CB1462A
2	38069	M9F42315	Breaker, Multi9 480/277V 15 AMP 3P C Trip Curve, 10k SCCR	Schneider Electric	CB1032A, CB1342A
5	38070	M9F42320	Breaker, Multi9 480/277V 20 AMP 3P C Trip Curve, 10k SCCR	Schneider Electric	CB1350A, CB1362A, CB1403A, CB1423A, CB1440A
1	38071	M9F42330	Breaker, Multi9 480/277V 30 AMP 3P C Trip Curve, 10k SCCR	Schneider Electric	CB1355A
2	38136	MG24425	Breaker, 240V 1 AMP 1P C	Schneider Electric	CB3406A, CB3426A
1	38137	MG24426	Breaker, 240V 2 AMP 1P C	Schneider Electric	CB3435A
1	38138	MG24427	Breaker, 240V 3 AMP 1P C	Schneider Electric	CB3421A
1	38139	MG24428	Breaker, 240V 4 AMP 1P C	Schneider Electric	CB3430A
2	26722	MPDB67113	Power Block, 175A 1Pri 12Sec Aluminum, 2/0-#14Pri #10-14Sec	MERSEN	PDB1024A, PDB1024B
6	26741	MPDBC6667	Power Block, MPDBC6667 safety cover,	MERSEN	PDB1024A(3), PDB1024B(3)
1	36638	NT-CV-12	Panel Label - newterra Decal	Panel	8.11E
1	36639	NT-PS	Panel Label - newterra Sticker	Panel	8.11F
1	36316	OTB1E0DM9LP	OTB RIO Adapter, Ethernet	Schneider Electric	PLC3426A
1	10586	PK18GTA	NQ Panelboard Ground Bus	Schneider Electric	GB1
10	22324	RXM2AB1BD	Relay, SQT RXM2AB1BD, Miniature Relay 2PDT 24 VDC	Schneider Electric	CR3443A, CR3447A, CR3451A, CR3455A, CR3541A, CR3543A, CR3843A, CR3845A,
					CR3847A, CR3849A
10	22326	RXZE2S108M	Relay, SQT RXZE2S108M, Base/Socket for RXM2 2P Relays	Schneider Electric	CR3443A, CR3447A, CR3451A, CR3455A, CR3541A, CR3543A, CR3843A, CR3845A,
					CR3847A, CR3849A
1	36317	TM2DDI8DT	TM2 8 point DI Expansion Module	Schneider Electric	PLC3806A
2	37596	TM2DDI16DT	TM2 16 point DI Expansion Module	Schneider Electric	PLC3606A, PLC3706A
1	38119	TM2DDO8TT	TM2 8 point DO Expansion Module, Removable Terminal Blocks	Schneider Electric	PLC3843A
1	38209	TM2DRA16RT	TM2 16RO Expansion Module	Schneider Electric	PLC3906A

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A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MPP BILL OF MATERIAL MODULE 8201 - SHEET 2 OF 2

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	31/05/17	49	71

1704432 - AGNICO EAGLE MINE - C

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MCP - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
1	37557	2QPL	Pad Lockable Qurater Turn Latch	Hammond	MCP
1	26829	8GB_Micro	8GB Micro USB Key	Generic	OIT2008A
1	26511	17-200161	USB TypeA F-F Bulkhead Connector	Conec	USB71A
1	20698	20698	Mounting Bracket, Antenna & Surge Protector		ENET2011A
27	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB2, TB3, TB4, TB5, TB6, TB10, TB11, TB12, TB13, TB14, TB15, TB16, TB37,
					TB38, TB39, TB42, TB43, TB44, TB45, TB46, TB47, TB52, TB54, TB57, TB58,
					TB59, TB65
6	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS1, TS2, TS3, TS8, TS9, TS10
17	23751	2966171	Relay, SPDT, 24VDC Coil	Phoenix Contact	CR2507A, CR2509A, CR2511A, CR2517A, CR2519A, CR2521A, CR2548A, CR2550A,
					CR2552A, CR2554A, CR2607A, CR2609A, CR2611A, CR2613A, CR2615A, CR2617A,
					CR2619A
14	23742	3030420	End Plate - 30A Feed Thru	Phoenix Contact	TB29, TB31, TB33, TB34, TB49, TB50, TB55, TB56, TB60, TB61, TB62, TB63,
					TB64, TB66
1	23748	3030747	End Plate - Double Feed Thru	Phoenix Contact	TB48
10	23737	3031364	Terminal, Grey, 28-12AWG, 30A, 600V	Phoenix Contact	AC(6), AO(4)
83	23738	3031377	Terminal, Blue, 28-12AWG, 30A, 600V	Phoenix Contact	AI(44), AO(8), DC(26), DO-P(5)
48	35073	3031432	Terminal, Double, 28-10AWG, 30A, 600V, Blue	Phoenix Contact	DI(48)
15	29545	3036369	Fused Terminal, 28-10AWG, 6.3A, 500V	Phoenix Contact	AI(14), AO
8	23741	3037148	Terminal, Yellow, 28-12AWG, 30A, 600V	Phoenix Contact	TB1(8)
15	23740	3037151	Terminal, Red, 28-12AWG, 30A, 600V	Phoenix Contact	AC(15)
2	35707	ABL8REM24050	24VDC Power Supply, 120W, 5A	Schneider Electric	PWS2004A, PWS2015A
1	24694	Arc Flash	Panel Label - Arc Flash Tri-lingual	Panel	8.11C
2	27402	C1LG6	Wire Duct Cover, 1", Grey	Panduit	WD2, WD11
6	27399	C2LG6	Wire Duct Cover, 2", Grey	Panduit	WD1, WD3, WD8, WD9, WD10, WD12
1	27949	C5E-STPRD-S3	Red Industrial Ethernet Cable, RJ45, 3ft, STP	Canada Computer	CBL5
2	27950	C5E-STPRD-S7	Industrial Ethernet Cable, RJ45, 7ft, STP	Canada Computer	CBL1, CBL3
1	27951	C5E-STPRD-S10	Industrial Ethernet Cable, RJ45, 10ft, STP	Canada Computer	CBL2
1	27953	C5E-STPRD-S25	Industrial Ethernet Cable, RJ45, 25ft, STP	Canada Computer	CBL6
4	12475	D1031Q	4Ch Discrete, Transistor Output, Intrinsically Safe Barrier	GM International	IS2020A, IS2024A, IS2028A, IS2032A
1	24602	E100502	Industrial RJ45 Jack	Belden	ETH71A
1	29140	EC6133D	eWON Cosy 131 LAN/Cell Router, 24VDC Power	eWON	ENET2011A
1	37906	EN4SD483612GY	48" x 36" x 12" NEMA4 Steel Enclosure	Hammond	MCP
1	37907	EP4836	48" x 36" Backplate	Hammond	MCP

NOTES:

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B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: MCP BILL OF MATERIAL
MODULE 8202 - SHEET 1 OF 3

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	30/05/17	50	71

1704432 - AGNICO EAGLE MINE - C

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MCP - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
1	37558	EZPMFHD	Mounting Feet, Zinc, Set of 4	Hammond	MCP
2	27400	F1X3LG6	Wire Duct, 1"x3", Grey, Narrow Finger	Panduit	WD2, WD11
6	27398	F2X3LG6	Wire Duct, 2"x3", Grey, Narrow Finger	Panduit	WD1, WD3, WD8, WD9, WD10, WD12
14	20369	GSB1/10	Fuse,GLD GSB1/10100mA 250V Fast Acting, Miniature 5x20mm	Ferraz Shawmut	AI(14)
1	36555	GSB16/100	Fuse, 160mA 250V Fast Acting, Miniature 5x20mm	Ferraz Shawmut	AO
1	20569	GW195-180-SM-NM	Cellular Modem Antenna Cable - 15Ft. N-Male to SMA-Male	Airlink_Communications	ENET2011A
1	36126	HMIDT542	Touchscreen, 10.4" TOUCH SMART DISPLAY	Schneider Electric	OIT2008A
1	36124	HMIG3U	HMI Linux Processor, for use with HMIDT smart displays	Schneider Electric	OIT2008A
1	26892	IS Wiring Inside	Panel Label - IS Wiring Inside	Panel	8.11A
4	38136	MG24425	Breaker, 240V 1 AMP 1P C	Schneider Electric	CB1905C, CB1909A, CB2020A, CB2043A
2	38137	MG24426	Breaker, 240V 2 AMP 1P C	Schneider Electric	CB2057A, CB2062A
5	38138	MG24427	Breaker, 240V 3 AMP 1P C	Schneider Electric	CB1905A, CB2004A, CB2008A, CB2015A, CB2053A
2	38139	MG24428	Breaker, 240V 4 AMP 1P C	Schneider Electric	CB1926A, CB2011A
1	36639	NT-PS	Panel Label - newterra Sticker	Panel	8.11D
1	10586	PK18GTA	NQ Panelboard Ground Bus	Schneider Electric	GB1
1	23504	PSD1001	4Ch Power Supply, 15V - 20mA	GM International	IS2036A
1	11482	QOU1PA	Breaker Lock for 1 pole QOU breakers	Schneider Electric	CB1905B
1	10270	QOU115	Breaker, SQD QOU115 1240V 15A 1P DIN Mount, 10k SCCR	Schneider Electric	CB1905B
5	22324	RXM2AB1BD	Relay, SQT RXM2AB1BD, Miniature Relay 2PDT 24 VDC	Schneider Electric	CR2127A, CR2513A, CR2515A, CR2556A, CR2621A
2	21888	RXM4AB1BD	Relay, SQT RXM4AB1BD, Miniature Relay, 4PDT, 24 VDC, 6A contacts	Schneider Electric	CR2050A, CR2558A
1	21887	RXM4AB1F7	Relay, SQT RXM4AB1F7, Miniature Relay, 4PDT, 120VAC, 6A contacts	Schneider Electric	CR2047A
5	22326	RXZE2S108M	Relay, SQT RXZE2S108M, Base/Socket for RXM2 2P Relays	Schneider Electric	CR2127A, CR2513A, CR2515A, CR2556A, CR2621A
3	21889	RXZE2S114M	Relay, SQT RXZE2S114M, Base/Socket for RXM4 4P Relays	Schneider Electric	CR2047A, CR2050A, CR2558A
1	26891	Substitution of IS	Panel Label - Substitution of IS Components	Panel	8.11B
1	36089	TM3AI4G	TM3 4-channel AI Expansion Module	Schneider Electric	PLC2807A
1	36090	TM3AI8G	TM3 8-channel AI Expansion Module	Schneider Electric	PLC2707A
1	36543	TM3AQ4G	TM3 4-channel AO Expansion Module	Schneider Electric	PLC2906A
4	36087	TM3DI16G	TM3 16DI Expansion Module	Schneider Electric	PLC2105A, PLC2205A, PLC2305A, PLC2405A
2	36088	TM3DQ16TG	TM3 16DO Expansion Module	Schneider Electric	PLC2507A, PLC2607A
1	36558	TM3XREC1	TME Bus Receiver Module	Schneider Electric	PLC2057A
1	36557	TM3XTRA1	TME Bus Transmitter Module	Schneider Electric	PLC2060A
1	28484	TM251MESE	M251 Controller, Dual Ethernet	Schneider Electric	PLC2053A
1	24550	USB_A-A	6ft, USB MaleA/MaleA	Generic	CBL4

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PROJ. NO: 1704432

TITLE AND LOCATION: MCP BILL OF MATERIAL
MODULE 8202 - SHEET 2 OF 3

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	30/05/17	51	71

1704432 - AGNICO EAGLE MINE - C

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MCP - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
1	25880	WMLPVDB800	Cellular Modem Antenna, N-Female, White	Airlink_Communications	ENET2011A
1	21650	XB7EV03BP	Button, XB7EV03GP, GREEN LED PILOT LIGHT 24VDC	Schneider Electric	LT2544A
1	21649	XB7EV04BP	Button, XB7EV03GP, RED LED PILOT LIGHT 24VDC	Schneider Electric	LT2546A
1	14607	ZB5 AT4	Button, ZB5 AT4, E-Stop Button	Schneider Electric	PB2043A
1	14611	ZB5 AZ102	Button, ZB5 AZ102, Collar with 1 NC Contact Block	Schneider Electric	PB2043A
1	23054	ZBY9330	ESTOP Label	Schneider Electric	PB2043A

NOTES:

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PROJ. NO: 1704432

TITLE AND LOCATION: MCP BILL OF MATERIAL
MODULE 8202 - SHEET 3 OF 3

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	30/05/17	52	71

1704432 - AGNICO EAGLE MINE - C

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JB-7901-AC - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB1, TB3
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS1
1	23742	3030420	End Plate - 30A Feed Thru	Phoenix Contact	TB2
3	23737	3031364	Terminal, Grey, 28-12AWG, 30A, 600V	Phoenix Contact	AC(3)
3	23740	3037151	Terminal, Red, 28-12AWG, 30A, 600V	Phoenix Contact	AC(3)
1	37975	EJ664	6" x 6" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7901-AC

NOTES:

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A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: JB-7901-AC BILL OF MATERIAL MODULE 8203 - SHEET 1 OF 11

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	30/05/17	53	71

1704432 - AGNICO EAGLE MINE - C

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JB-7901-DC - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB4, TB5
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS2
1	23748	3030747	End Plate - Double Feed Thru	Phoenix Contact	TB1
4	23738	3031377	Terminal, Blue, 28-12AWG, 30A, 600V	Phoenix Contact	DC(4)
2	35073	3031432	Terminal, Double, 28-10AWG, 30A, 600V, Blue	Phoenix Contact	DC(2)
1	37975	EJ664	6" x 6" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7901-DC

NOTES:

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A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: JB-7901-DC BILL OF MATERIAL MODULE 8203 - SHEET 2 OF 11

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

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DMB	30/05/17	54	71

1704432 - AGNICO EAGLE MINE - C

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JB-7901-HV - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB4, TB11
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS2
7	23742	3030420	End Plate - 30A Feed Thru	Phoenix Contact	TB1, TB5, TB6, TB7, TB8, TB9, TB10
21	23740	3037151	Terminal, Red, 28-12AWG, 30A, 600V	Phoenix Contact	HV(21)
1	38220	EJ1084	10" x 8" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7901-HV

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PROJ. NO: 1704432

TITLE AND LOCATION: JB-7901-HV BILL OF MATERIAL MODULE 8203 - SHEET 3 OF 11

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

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DMB	30/05/17	55	71

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JB-7901-IS - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB12, TB14
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS3
1	23742	3030420	End Plate - 30A Feed Thru	Phoenix Contact	TB13
30	23738	3031377	Terminal, Blue, 28-12AWG, 30A, 600V	Phoenix Contact	IS(30)
1	38220	EJ1084	10" x 8" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7901-IS

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PROJ. NO: 1704432

TITLE AND LOCATION: JB-7901-IS BILL OF MATERIAL
MODULE 8203 - SHEET 4 OF 11

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

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JB-7901OS-AC - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB5, TB8
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS3
1	23742	3030420	End Plate - 30A Feed Thru	Phoenix Contact	TB7
2	23737	3031364	Terminal, Grey, 28-12AWG, 30A, 600V	Phoenix Contact	AC(2)
2	23740	3037151	Terminal, Red, 28-12AWG, 30A, 600V	Phoenix Contact	AC(2)
1	37975	EJ664	6" x 6" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7901OS-AC

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PROJ. NO: 1704432

TITLE AND LOCATION: JB-7901OS-AC BILL OF MATERIAL
MODULE 8203 - SHEET 5 OF 11

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

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JB-7902-AC - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB6, TB10
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS4
1	23742	3030420	End Plate - 30A Feed Thru	Phoenix Contact	TB9
4	23737	3031364	Terminal, Grey, 28-12AWG, 30A, 600V	Phoenix Contact	AC(4)
2	23740	3037151	Terminal, Red, 28-12AWG, 30A, 600V	Phoenix Contact	AC(2)
1	37975	EJ664	6" x 6" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7902-AC

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PROJ. NO: 1704432

TITLE AND LOCATION: JB-7902-AC BILL OF MATERIAL
MODULE 8203 - SHEET 6 OF 11

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

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JB-7902-DC - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB11, TB13
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS5
1	23748	3030747	End Plate - Double Feed Thru	Phoenix Contact	TB12
4	23738	3031377	Terminal, Blue, 28-12AWG, 30A, 600V	Phoenix Contact	DC(4)
3	35073	3031432	Terminal, Double, 28-10AWG, 30A, 600V, Blue	Phoenix Contact	DC(3)
1	37975	EJ664	6" x 6" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7902-DC

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PROJ. NO: 1704432

TITLE AND LOCATION: JB-7902-DC BILL OF MATERIAL
MODULE 8203 - SHEET 7 OF 11

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

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JB-7902-HV - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB15, TB17
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS4
8	23742	3030420	End Plate - 30A Feed Thru	Phoenix Contact	TB16, TB18, TB19, TB20, TB21, TB22, TB23, TB24
24	23740	3037151	Terminal, Red, 28-12AWG, 30A, 600V	Phoenix Contact	HV(24)
1	38220	EJ1084	10" x 8" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7902-HV

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PROJ. NO: 1704432

TITLE AND LOCATION: JB-7902-HV BILL OF MATERIAL MODULE 8203 - SHEET 8 OF 11

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

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JB-7904-AC - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB14, TB15
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS6
3	23742	3030420	End Plate - 30A Feed Thru	Phoenix Contact	TB11, TB16, TB17
2	23737	3031364	Terminal, Grey, 28-12AWG, 30A, 600V	Phoenix Contact	AC(2)
7	23740	3037151	Terminal, Red, 28-12AWG, 30A, 600V	Phoenix Contact	AC(7)
1	37975	EJ664	6" x 6" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7904-AC

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TITLE AND LOCATION: JB-7904-AC BILL OF MATERIAL MODULE 8203 - SHEET 9 OF 11

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

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JB-7904-DC - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB18, TB20
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS5
1	23748	3030747	End Plate - Double Feed Thru	Phoenix Contact	TB19
14	23738	3031377	Terminal, Blue, 28-12AWG, 30A, 600V	Phoenix Contact	DC(14)
7	35073	3031432	Terminal, Double, 28-10AWG, 30A, 600V, Blue	Phoenix Contact	DC(7)
1	38221	EJ884	8" x 8" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7904-DC

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A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: JB-7904-DC BILL OF MATERIAL
MODULE 8203 - SHEET 10 OF 11

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

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JB-7904-HV - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	23745	800886	End Bracket - DIN Rail	Phoenix Contact	TB21, TB23
1	19168	0801733	Steel mounting rail; 35x7,5 mm, 1 mm thick; perforated	Phoenix Contact	TS6
9	23742	3030420	End Plate - 30A Feed Thru	Phoenix Contact	TB22, TB24, TB25, TB26, TB27, TB28, TB29, TB30, TB31
26	23740	3037151	Terminal, Red, 28-12AWG, 30A, 600V	Phoenix Contact	HV(26)
1	38220	EJ1084	10" x 8" x 4" NEMA4 Steel Enclosure, Hinged Cover	Hammond	JB-7904-HV

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PROJ. NO: 1704432

TITLE AND LOCATION: JB-7904-HV BILL OF MATERIAL MODULE 8203 - SHEET 11 OF 11

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
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BLD-7901 - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
1	19534	KIL SWB1	1/2" Dead End Box	Killark	TGS1608A
1	19533	KILXS-1C	NEMA7, 1P, 20A Switch	Killark	TGS1608A
4	18642	VUXGG1100PX	100W Incandescent, Medium Base, CL1Div2	Killark	LT1608A, LT1610A, LT1612A, LT1614A
1	22112	XEDS-30	Unfused Disconnect, CL1Div1&2, 30A, 20HP@480V	Killark	DISC1355A
6	26831	XSX-23	Unfused Disconnect, CL1Div1&2, 20A, 10HP@600V	Killark	DISC1040A, DISC1045A, DISC1050A, DISC1055A, DISC1062A, DISC1350A
1	14607	ZB5 AT4	Button, ZB5 AT4, E-Stop Button	Schneider Electric	PB2127A
1	14611	ZB5 AZ102	Button, ZB5 AZ102, Collar with 1 NC Contact Block	Schneider Electric	PB2127A
1	23054	ZBY9330	ESTOP Label	Schneider Electric	PB2127A

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PROJ. NO: 1704432

TITLE AND LOCATION: BLD-7901 BILL OF MATERIAL
MODULE 8901 - SHEET 1 OF 2

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

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BLD-7901_OUTSIDE - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
2	36085	GFWR1-W	GFCI 15A, 125V Duplex Receptacle, Weather Resistant, White	Leviton	RECP1620A, RECP1626A

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PROJ. NO: 1704432

TITLE AND LOCATION: BLD-7901 BILL OF MATERIAL
MODULE 8901 - SHEET 2 OF 2

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

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BLD-7902 - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
8	26830	MD3304X	Unfused Disconnect, 30A, 25HP@600V	Schneider Electric	DISC1069A, DISC1103A, DISC1108A, DISC1113A, DISC1118A, DISC1123A,
					DISC1362A, DISC1403A

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PROJ. NO: 1704432

TITLE AND LOCATION: BLD-7902 BILL OF MATERIAL MODULE 8902

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

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BLD-7904 - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
1	23293	20RC15/10	Receptacle Cover, PVC Single Cover		RECP1714A
1	23789	CR15	15A, 125V Duplex Receptacle, Commercial Grade	Hubbell	RECP1706A
1	12567	CS115CN	1P Switch, 15A, 120V, Commercial	Leviton	TGS1662A
1	22672	FSC10	PVC FSC Box, 1 Gang	Royal Pipe Systems	TGS1662A
1	23791	HBL5251	15A, 125V, Single Receptacle, Heavy Duty	Hubbell	RECP1714A
8	26830	MD3304X	Unfused Disconnect, 30A, 25HP@600V	Schneider Electric	DISC1130A, DISC1140A, DISC1145A, DISC1150A, DISC1155A, DISC1160A,
					DISC1415A, DISC1423A
1	26171	RTSC15/10	PVC Switch Cover, 1 Gang	Royal Pipe Systems	TGS1662A
1	14607	ZB5 AT4	Button, ZB5 AT4, E-Stop Button	Schneider Electric	PB2047A
1	14611	ZB5 AZ102	Button, ZB5 AZ102, Collar with 1 NC Contact Block	Schneider Electric	PB2047A
1	23054	ZBY9330	ESTOP Label	Schneider Electric	PB2047A

NOTES:

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PROJ. NO: 1704432

TITLE AND LOCATION: BLD-7904 BILL OF MATERIAL MODULE 8904 - SHEET 1 OF 2

CUSTOMER: AGNICO EAGLE 600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
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BLD-7904_OUTSIDE - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
1	38204	WL-LED26-B-5K-BRZ-PC	Wall Pack, 24W LED c/w PhotoEye	RAB Design	LT1665A

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PROJ. NO: 1704432

TITLE AND LOCATION: BLD-7904 BILL OF MATERIAL
MODULE 8904 - SHEET 2 OF 2

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

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BLD-7905 - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
1	26830	MD3304X	Unfused Disconnect, 30A, 25HP@600V	Schneider Electric	DISC1440A

BLD-7906 - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
1	23293	20RC15/10	Receptacle Cover, PVC Single Cover		RECP1742A
2	12567	CS115CN	1P Switch, 15A, 120V, Commercial	Leviton	TGS1643A, TGS1649A
2	38093	FC202P1K5	Variable Frequency Drive, Danfoss FC202 P1K5, VFD 480V 2HP, 3.4A 3PH, IP55, w/ L	Danfoss	VFD1304A, VFD1322A
2	38094	FC202P11K	Variable Frequency Drive, Danfoss FC202 P11K, VFD 480V 15HP, 21A 3PH, IP55, w/ L	Danfoss	VFD1241A, VFD1259A
2	22672	FSC10	PVC FSC Box, 1 Gang	Royal Pipe Systems	TGS1643A, TGS1649A
4	38205	FW4-LED40-B-4K-DIM	Flourescent Light, Vaportight 4Ft, LED 40W, 120-277V	RAB Design	LT1643A, LT1645A, LT1647A, LT1649A
1	10185	GFNT1-W	GFCI 15A, 125V Duplex Receptacle, White	Leviton	RECP1633A
1	23791	HBL5251	15A, 125V, Single Receptacle, Heavy Duty	Hubbell	RECP1742A
8	26830	MD3304X	Unfused Disconnect, 30A, 25HP@600V	Schneider Electric	DISC1203A, DISC1208A, DISC1213A, DISC1218A, DISC1342A, DISC1452A,
					DISC1457A, DISC1462A
1	20775	MH32	18 Circuit NQ Tub, NEMA1	Schneider Electric	PDP1606A
1	20814	NC26S	18 Circuit NQ/NF Trim	Schneider Electric	PDP1606A
1	20896	NQ418L1C	Distribution Panel, 120/240V, 3Ph, 100A Cu Bus, 18 Circuit	Schneider Electric	PDP1606A
11	19029	QOB115	Breaker, SQD QOB115 120V 15A Bolt On, 10k SCCR	Schneider Electric	CB1608A, CB1620A, CB1626A, CB1633A, CB1643A, CB1668A, CB1706A, CB1719A,
					CB1729A, CB1742A, CB1748A
1	19340	PK12GTA	NQ Panelboard Ground Bus	Schneider Electric	PDP1606A
2	26171	RTSC15/10	PVC Switch Cover, 1 Gang	Royal Pipe Systems	TGS1643A, TGS1645A
1	25526	UC3010P480	Dist. Transformer, 10kVA, 480V:120/208V	BeMag	T1342A
1	38182	Y225PKC	Autotransformer, 225kVA, 600V:480, 480:380V, 50/60Hz	Hammond	T1015A

NOTES:

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LEVEL	REVISION	DATE (dd/mm/yy)	BY
C	AS BUILT	14/08/17	DMB
B	FOR PRODUCTION	31/05/17	DMB
A1	FOR REVIEW	23/05/17	DMB
A	FOR SUBMITTAL	12/05/17	DMB

PROJ. NO: 1704432

TITLE AND LOCATION: BLD-7906 BILL OF MATERIAL
MODULE 8906 - SHEET 1 OF 2

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	30/05/17	70	71

1704432 - AGNICO EAGLE MINE - C

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BLD-7906_OUTSIDE - Bill of Materials

Qty	APES#	Part Number	Description	Manufacturer	Device Designation(s)
1	36085	GFWR1-W	GFCI 15A, 125V Duplex Receptacle, Weather Resistant, White	Leviton	RECP1729A
1	38204	WL-LED26-B-5K-BRZ-PC	Wall Pack, 24W LED c/w PhotoEye	RAB Design	LT1657A

NOTES:

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PROJ. NO: 1704432

TITLE AND LOCATION: BLD-7906 BILL OF MATERIAL
MODULE 8906 - SHEET 2 OF 2

CUSTOMER: AGNICO EAGLE
600 MAN AMARUQ MINE

DRAWN BY:	DATE:	SHEET:	SHEETS:
DMB	30/05/17	71	71

1704432 - AGNICO EAGLE MINE - C

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APPENDIX B

Packing Slip

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Project Packing List

PMProjNum **1704432**

Agnico Eagle - Amaruq Mine WWTP

Shipping Notes:

Tag	Part Number	Part Description	Req Rec PO #	EngMemo Line
0	24612	Container, 40' x 8' x 9'6", Once Use, High Cu	1	---
7901	ea	30,480kg rated, Forklift Pockets, CSC Plate,	1	
	Type: I	ABS/BV/LR Certs. Steel Checkerplate ---	1704432-0001	1
10	10959	Junction Box, PVC, 6" x 6" x 4"	5	Added by production team
	ea		5	
	Type: I	Junction Box, PVC, 6" x 6" x 4"	1704432-9999	###
10	37975	Junction Box, 6" x 6" x 4", Hammond EJ664	1	Added by production team
	ea	with Back Panel and Hinged Lid, NEMA 4	1	
	Type: I	Junction Box, 6" x 6" x 4", Hammond EJ664	1704432-9999	###
10	P1128	Elbow, 45deg, PVC 40, 4", SxS, 417-040G	1	Added by production team
	ea		1	
	Type: I	Elbow, 45deg, PVC 40, 4", SxS, 417-040G	1704432-9999	####
10	37795	Sealant, MetalSafe, Liquid Rubber, Black 3.7	6	---
-	ea		6	
	Type: P	---	1704432-0134	1
10	37796	Sealant, Polyurethane, Self Leveling, Grey 8	8	---
-	ea		8	
	Type: P	---	1704432-0131	1
10	29551	Insulation, Backer Rod, 7/8" x 15'	10	---
-	ea		10	
	Type: P	---	1704432-0131	2
10	37794	Insulation, Backer Rod, 3/8" x 30'	10	---
-	ea		10	
	Type: P	---	1704432-0131	3
10	22772	Foam, Spray, Tiger Foam, 200BF, Fast Rise	2	---
-	ea		2	
	Type: P	---	1704432-0131	4
10	21768	Chemical, Bacteria, Dry for Start Up, 25lbs p	5	---
-	pail	25 lb per pail (Buy in Pail Quantities)	5	
	Type: I	BI-CHEM CWT Blend CAN product BioRem ---	1704432-0143	1
10	37797	Tape, Seam, 4" x 50', Paintable	1	---
4	ea		1	
	Type: P	---	1704432-0134	2

Tag	Part Number	Part Description	Req Rec PO #	EngMemo Line
15	27536	Weather Barrier, Blueskin, 9" x 50' Roll	4	---
-	ea		0	
	Type: P	---		0
15	38671	3/4" copper pipe insulation foam 6' long	20	---
-	ea		0	
	Type: P	---		0
15	38672	Insulation, rigid foam sheet, 3", R10, codebo	10	---
-	ea	Blue Styrefoam	0	
	Type: P	---		0
15	10088	Elbow, 90deg, PVC 40, 6", SxS, 406-060G	2	---
-	ea		0	
	Type: I	---	1704432-0170	1
15	16240	Pipe, PVC 40 (Clear), 6"	4	---
-	ft	10ft Length, 40-060CL	0	
	Type: X	---		0
15	P1188	Flexible Coupling, 6" x 6"	4	---
-	ea		0	
	Type: I	---	1704432-0170	2
15	9998	Misc Part, Parts not included in purchasing	6	---
-	ea		0	
	Type: P	Aeration connection pipes 3 - Pre to Air 3 - Air to air		0
15	9998	Misc Part, Parts not included in purchasing	4	---
-	ea		0	
	Type: P	vent stack		0
15	9998	Misc Part, Parts not included in purchasing	2	---
-	ea		0	
	Type: P	MBR Overflow Pipes		0
15	9998	Misc Part, Parts not included in purchasing	1	---
7902	ea		0	
	Type: P	container 7902		0
15	9998	Misc Part, Parts not included in purchasing	1	---
7903	ea		0	
	Type: P	Container 7903		0
15	9998	Misc Part, Parts not included in purchasing	1	---
7904	ea		0	
	Type: P	Container 7904		0

Tag	Part Number	Part Description	Req Rec PO #	EngMemo Line
15	9998	Misc Part, Parts not included in purchasing	1	---
7905	ea		0	
	Type: P	Container 7905		0
100	P1128	Elbow, 45deg, PVC 40, 4", SxS, 417-040G	1	Added by production team
	ea		1	
	Type: I	Elbow, 45deg, PVC 40, 4", SxS, 417-040G	1704432-9999	###
500	10951	Elbow, 45deg, PVC 40, 6", SxS, 417-060G	1	---
-	ea		1	
	Type: I	---	1704432-0089	22
500	M1489	Filter, Silencer, Solberg, FS-230P-300	2	---
B501/2	ea	3"	2	
	Type: P	---	1704432-0091	1
500	36870	Transmitter, pH, Prominent pH Sensor PHER	1	MBR
PH-501	ea	requires probe holder p/n 36871	1	
	Type: P	-	1704432-0071	4
6100	15871	Spill Containment, Single Drum, Eagle 1633	3	---
-	ea		3	
	Type: P	---	1704432-0161	1
6100	19891	Pump, Metering, Misc	1	---
P-610X	ea	See Description for part details	1	
	Type: P	- BT4B0708PVT2000UD010A01 Flow: 1.88GPH / 7.10L/H Pressure: 102PSI / 07BAR Options Included: - dosing head material PV PVDF - sealmaterial T st.diaphragm w. PTFE seal - execution of dosing head 2 w. Bleed.v. , w/o. valvespr. - hydraulic-connection 0 standard-connection - execution 0 Hous.RAL5003/hoodRAL2003 - Logo 0 w. PM-Logo - type of voltage U universal 100-240 V - cable and plug D 2m USA 115 V - relay function 0 without relay - supplies 1 STDR. FV,IV,TB for PP, PV, NP - control system type 0 without lock - control version A external analog 0-20mA/4-20mA - Remote stop 0 Pause break con., Niv. break - auxiliar frequency 1 external callable frequency	1704432-0162	1
6100	25823	Pump, Metering, Parts, Multi-function Valve	3	---
p-610x	ea	PVDF, 87PSIG Size 2	3	
	Type: P	740427 ---	1704432-0162	2

Tag	Part Number	Part Description	Req Rec PO #	EngMemo Line
7906	20890	Container, Misc	1	---
7906	ea	See description	1	
	Type: P	53 foot Hi Cube Strong Industrial Steel Used Shipping Container As-is Where-is	1704432-0027	1
7906	24305	Hood, Louver, 21"	1	---
7906	ea	Fits 18" Louver	1	
	Type: I	---	1704432-0049	84
7906	24547	Hood, Fan, 15"	1	---
f7961	ea	Fits 12" Fan	1	
	Type: I	---	1704432-0049	83

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APPENDIX C

Testing Checklists/Pre-Commissioning Test Checklist

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Pre-Commissioning Checklist – 1704432

Please note that **newterra** has a limited number of Technicians. In order to successfully support your startup, **newterra** requires that the Pre-Commissioning Checklist be returned at least 10 business days prior to mobilizing a Technician to site (subject to Technician availability). **newterra** will not mobilize to site until the Pre-Commissioning Checklist has been executed and returned to service@newterra.com. Or by Fax to: 289.203.1319.

If newterra startup activities are delayed due to lack of site readiness then there may be additional charges associated with overtime and/ or additional days on site.

newterra highly recommends that the system is started by a factory trained startup technician to ensure the long term success of your project. We understand that this may not always be feasible in which case we would require a highly skilled technician capable of troubleshooting both mechanical and electrical aspects of a process treatment system and be familiar with our manual, equipment and capable of training the operator on operating and maintenance requirements of the treatment system.

The purpose of this report is to ensure that the customer is prepared for startup.

Checklist	Customer Initial	newterra Initial
Complete a visual inspection of all units when placed on the pad. **Record any damage to the systems that may have occurred during shipping and provide photos to newterra.		
Verify that system has been installed on a solid, level area		
Verify that system has been installed in accordance with the system layout drawing.		
Verify that the required approvals are in place to allow the system to discharge air and water.		
Verify site power is installed to the control panel and necessary electrical approvals have been completed.		
Verify that all high voltage wiring is completed and wired according to the Field Aid/ project O&M manual.		
Verify that all low voltage wiring is completed and wired according to the Field Aid/ project O&M manual.		
Verify that all process piping has been installed and terminated.		
Verify that all field piping is completed and wells are connected to the operating system.		
Verify that a phone line is installed and activated for alarm autodialer, if required.		
Please read through the packing list (located in the manual) and ensure the correct equipment was delivered.		
There are some items that have shipped loose with your system that will need to be installed prior to start up, these may include exterior components such as stacks, filters and hoods. Sufficient hardware should have been supplied to facilitate installation.		
Some unions in the system may have been loosened for shipment. This is done to prevent damaging susceptible equipment, especially flow meters. All unions in the systems should be checked and tightened.		

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Any external equipment such as tanks, well pumps, oxidizers, etc. need to be installed, plumbed and wired prior to start up.		
Some items may have been secured with brackets or tie downs for shipment – ensured these have been removed (eg. reciprocating compressors/ stacked blowers).		
In colder climates, if you do not plan on starting up the system before the winter months, please refer to your O&M manual for instructions on extended shutdowns. It is imperative that the correct measures be taken to prevent freezing water from damaging your system.		
If the system has been winterized, ensure all anti-freeze has been drained and disposed of in accordance with local regulations.		
Email pictures of power connection, site piping connections and installed equipment to service@newterra.com.		

MBR Specific Checks	**Customer Initial**	**newterra Initial**
Verify that Ethernet network is installed and activated if required.		
If Ethernet is to be used on site please provide 2 Static IP Addresses ____.____.____.____ ____.____.____.____		
Verify fresh water is available for Wet Test.		
Is waste activated sludge from an operating WWTP available for start-up (Seed Sludge)		
Verify Sufficient amount of sewage is available to start system (Check with newterra to determine actual amounts required).		

RO Specific Checks	**Customer Initial**	**newterra Initial**
Ensure all tanks are clean and free of dirt and debris		
Verify that a Fresh Water supply is installed to system.		
Ensure that the necessary chemicals for system operation and cleaning are available for use for starting the installation and commissioning phase.		
Verify the feed water quality		
Verify building process flow and instrumentation matches P&ID drawing. Check off drawing components against actual		
DO NOT LOAD THE MEMBRANES UNTIL DIRECTED as all system inlet piping must be flushed thoroughly before it is connected to the RO system.		

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DA Specific Checks	Customer Initial	newterra Initial
GENERAL INSTALLATION		
Stainless Steel nameplate present, visible and contains make and model information in agreement with vendor drawings		
Vessel Saddles Bolted To Structural Steel		
Vessel Properly Insulated for Personnel Protection at a minimum		
Access Platform Properly installed for full access to heater section		
Vessel Manway Gaskets appear to be undamaged		
VESSEL INTERNALS		
Heater Section Tray Assemblies Properly fastened and have been installed per the O & M manual.		
Equalizer connection to storage tank is unobstructed by any shipping materials		
Spray Nozzles appear unobstructed and undamaged by shipping		
PIPING		
Pipes properly insulated for Personnel protection at a minimum		
Relief valve installed and discharge piping run to roof		
Piping systems properly flushed		
Vent Valve is installed and fully open for initial vessel fill		
Steam Control Valve and Muffling plate installed as per drawings		
Low pressure steam trap isolated and discharge piped to flash separator		
Low pressure flash steam lines installed and isolated for initial testing		
Vacuum breaker installed per manufacturer's instructions		
Overflow trap installed with discharge piped to Blowdown Tank		
Condensate control valve installed and isolated for initial testing		
Strainer within condensate control valve station installed and cleaned		
Makeup control valve installed and isolated for initial testing		
Strainer within makeup control valve station installed and cleaned		
Level bridle and gauge glass column installed as per manufacturer's drawings. Vessel isolation valves closed for initial fill.		
Sight glass sections installed with proper washers and do not have any apparent cracks or defects.		
Level switches installed at proper heights relative to the vessel according to the manufacturer's drawings		
Level transmitter properly installed as per instrument installation detail IS-8308		
Pressure transmitter is properly installed as per instrument installation detail IS-8127		
Pressure and temperature Gauges installed with isolation valves as needed.		
Deaerator Steam flow transmitter properly installed as per instrumentation installation detail IS-8308		
Vessel Drain valve installed and fully closed for initial fill		

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Chemical feed connection valved and capped. Proper chemical feed is not required at this stage of commissioning		
All remaining spare connections on the storage tank and heater section should be tightly secured with a blind flange.		
CONTROL AND POWER WIRING		
120 volt power is run to Deaerator control panel		
Three Level switches are wired back to Deaerator Control Panel		
Pressure Transmitter is wired back to Deaerator Control Panel		
Level Transmitter is wired back to Deaerator Control Panel		
Steam Pressure Control Valve is wired back to Deaerator Control Panel		
Makeup Water Control Valve is wired back to Deaerator Control Panel		
Deaerator Steam flow transmitter is wired back to existing panel.		

Comments:
Note any deficiencies or damage to the system on arrival.

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In the event additional parts are required to be sent for commissioning, please provide a shipping address, contact name and cell number

_____

_____

_____

Provide a list of PPE required or any additional Health and Safety or training requirements that will be required for site access.

_____

_____

_____

_____

Site Address: _____

Onsite Contact Name & Cell Number: _____

Customer Sign-off: _____Date: _____

newterra clean water. modular solutions. simple.	Installation Checklist		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Misc			
Confirm that all items have been received in accordance witht the packing list			
All items are undamaged. Any damages are to be reported to newterra as soon as possible.			
Inspect all exterior of containers and note any damages, Take pictures of any damages and report to the newterra project manager as sooon as possible.			
Inspect WWTP placement location and confirm that it is firm and level. It not report to the newterra project manager as soon as possible. WWTP needs to be firm and level otherwise the operation of the WWTP can be compromised.			
Containers may be placed in a on-site storage location until ready for placement. Containers should be placed and installed before freezing temperatures			
Civil			
Placement of container on site. 6 containers. After container placement, inspct for any damages and take pictures. Report damages to newterra project manager.		Lifting - crane equiv required to move container. Fine placement via forklifts or equiv. Firm/Level base for containers See Appendix A of this manual for container layout	
Install Liquid Rubber Container Seal as per attached drawing.			
Electrical			

newterra clean water. modular solutions. simple.	Installation Checklist		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Site power has been connected and verified as per system design criteria			
All internal electrical connections have been terminated			
Confirm Phase Monitor is not in alarm			
Site voltage measured:		L1/L2:	
		L2/L3:	
		L3/L1:	
		L1/GRD:	
		L2/GRD:	
		L3/GRD:	
Check field wiring and piping as per drawings at Appendix A of the O&M Manual			
Check panel for loose wiring, Correct as required			
Check voltage on AC transformer			
Check voltage on DC transformer			
Check I.S. barrier is grounded as per input drawing			
All customer wiring has been completed in accordance with the electrical drawing in Appendix A.			
Mechanical			
Connect all internal piping and hose connections between the containers and external piping hook ups as per P&ID at Appendix A.			

newterra clean water. modular solutions. simple.	Installation Checklist		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Inspect the EQ, Pre-Anox, Aeration and Post-Anox Tanks and install anodes. Confirm that the tanks are clean and diffusers & hose connecting are secure.			
Inspect MBR tanks and removing transportation securing straps. Ensuring all hoses and fittings are tight and connected.			
MBR tank - Ensure that the membranes have not moved or shifted in the cassette. Re-secure as necessary. Ensure that the diffusers have not shitfted and are secure. Re-secure as necessary.			
Inspect the screens (SCR-201/202) and ensure that the rotating brushes are still aligned. Adjust as necessary.			
Inspect TNK-101/102/103, TNK-201 & TNK-6101/6102 and ensure that they are clean and free of any debris.			
Ensure all unions and fittings are tight, as some are loosened to prevent stress in shipping			
Check alignment of motors, Correct as required			
Check all motor belt tensions, Correct as required			
Check alignment of pulleys for all belt driven blowers			
Install the permeate header to the membrane tank and connect all piping/hoses.			

newterra clean water. modular solutions. simple.	Installation Checklist		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Ensure that the backwash tank (TNK-801) and sludge tank (TNK-901) are clean and free of debris. Clean as necessary.			

Installation Acceptance Sign-Off Form

1704432 - Amaruq Mine WWTP

newterra is pleased to announce that the Installation phase of 1704432, has successfully been completed. In order to move to the Commissioning phase, a visual inspection and walkthrough of the plant will be required, followed by signoff of this document. Installation signoff will be conditional on the completion of items listed in a Punchlist created during this walkthrough.

	Installation Signoff		Customer Acceptance
Name:	_____	**Name:**	_____
Company:	_____	**Company:**	_____
Date:	_____	**Date:**	_____
Signature:	_____	**Signature:**	_____

newterra clean water. modular solutions. simple.	Commissioning Checklist		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Ensure availability of on-site emergency eyewash station and personal protection equipment.			
Ensure that all tanks are clean and free of any dirt or debris (this is to prevent obstruction or damage to the piping, pumps, and membranes).			
Ensure that all connections have been provided and joints have been tightened.			
Check the placement of the air diffusers in the equalization tank(s) and aeration tank(s) if incorrectly positioned, proper adjustment has to be performed.			
Verify membrane modules are secure within the membrane tanks and that there is no lateral movement (less than an inch) of the membrane modules			
Verify building process flow and instrumentation matches P&ID drawing. Check off drawing components against actual (preferably with the customer present). Ensure this document is placed in the commissioning binder			

Commissioning Checklist

	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Measure and Verify influent characterisitics and record.			
Confirm that the custoomers piping and lectrical connections to the WWTP are complete			
Confirm if any grinder pumps are upstream of the WWTP. Advise the newterra project manager as soon as possible.			
Have all rotating equipment oiled and greased as per manufactured recommendations			
Fill system with water and check for leaks (liquid and vapor) by filling the EQ tank first and then process the water thru the system by tank			
Check rotation of all motors that were field wired			
Ensure that proper electrical grounding and lightning protection installed by customer			

Parameters	Unit	Influent*	Effluent
pH	s.u.	6 - 9	6.5 – 8.5
Fat, Oil, Grease (FOG)	mg/L	< 30	< 5
Biological Oxygen Demand (BOD)	mg/L	907.5	< 25
Total Suspended Solids (TSS)	mg/L	262.5	< 25
Total Kjeldahl Nitrogen (TKN)	mgN/L	130	-
Unionized Ammonia Nitrogen (NH_3-N)	mgN/L	-	< 1.25
Nitrate Nitrogen (NO_3-N)	mgN/L	-	< 5
Total Phosphorus (TP)	mgP/L	12	< 0.5
Fecal Coliform	CFU/100mL	-	< 200**
Total Residual Chlorine	mg/L	-	< 0.02
Alkalinity (assumed)	mg/L as $CaCO_3$	471	-
Total Dissolved Solids(TDS)	mg/L	< 1,200	-

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	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Check voltage + amperage + name plate info against mechanical test record on all motors **NOT** recorded in FAT. Please include this in the commissioning binder			
Fill out mechanical test record on each motor and check amperage and voltage. Document amperage on the System test records in the operating manual in the Field test load section			
Check overload settings for all motors			
Test position of ball float switches for proper start/stop level as per the P&ID and control narrative in this manual and observed on the HMI.			
Check that PLC Run light is on and no alarm lights are present on the PLC			
Wet test all control inputs and outputs (See Device Verification section in this checklist)			
Test analogue inputs (See Device Verification section in this checklist)			
Wet test all shut down alarms (See Control Narrative at Appendix K in this manual)			
Manually test all permeate stopping alarms(See Control Narrative at Appendix K in this manual)			
Test vacuum and pressure relief valve			
Check the setting of level switches/transmitters			
Check the hydraulic flow through the plant			
Check if all the ancillary equipment and controls of the plant function as per design			
Fill the system with potable water using the inlet and confirm piping & repair any leaks.			

newterra clean water. modular solutions. simple.	Commissioning Checklist		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Confirm heater and fan operation in the screen container.			
Fill TNK-101/102/103 and check for leaks. FIT-101 operations. Confirm operation of all level switches			
Confirm operation of SCR-201/202 and pump P-201/202. Check for leaks and repair as necessary. Confirm operation of FIT-201. Confirm operation of all level switches			
Fill EQ Tank (TNK-501), check for leaks. Confirm tank heater operation. Confirm LT-301 operation via the HMI display for values. Confirm operation of P-301/302 Confirm B-301/302 operation and Check for o Buoyancy of air diffusers and if this occurs, empty the tank and fix; o Air leakages: if this occurs, tighten up the fittings;			
Confirm operation of H-301/302, TSLL-301 and all level switches			
Fill Pre-Anox tank with water (TNK-401) and confirm operation of educators and P-401/402			
Confirm operation of H-401/402, TSL-401 and all level switches			

newterra clean water. modular solutions. simple.	Commissioning Checklist		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Fill Aeration Tanks (TNK-501/502), check for leaks. Confirm tank heater operation. Confirm LT-501/DO-501/PH-501 operation via the HMI display for values. Confirm operation of P-501/502/503. Confirm operation of the sprayer. Confirm operation of B-501/502 and Check for o Buoyancy of air diffusers and if this occurs, empty the tank and fix; o Air leakages: if this occurs, tighten up the fittings;			
Confirm operation of H-501/502/503/504, TSL-501/502 and all level switches			
Fill Post Post-Anox Tank (TNK-551) with water and check for leaks. Conform operation of P-554/555. Confirm operation of educators. Confirm operation of P-551/552			
Fill MBR tanks with water (TNK-601/602) and check for leaks. Confirm level switch operation. Confirm operation of B-601/602, confirm all level switch operation, and Check for o Buoyancy of air diffusers and if this occurs, empty the tank and fix; o Air leakages: if this occurs, tighten up the fittings;			
Perform electrical and instrumentation (E&I) functional checks and adjustment of level switches.			

newterra clean water. modular solutions. simple.	Commissioning Checklist		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Turn on the air blower(s) for the equalization tank(s) and blower(s) for aeration tank(s), and check for: o Buoyancy of air diffusers and if this occurs, empty the tank and fix; o Air leakages: if this occurs, tighten up the fittings;			
Manually check water temperature and DO (dissolved oxygen): with a hand-held DO meter and adjust air flow to keep it up to 0.5 – 1 mg/L for equalization tank(s) and 2 - 3 mg/L for aeration tank(s); check the DO readings on the touch screen.			
DO Control System: check automatic ON/OFF of Aeration Tank air blowers at low and high settings of DO without the return of aerated water from the membrane tanks to aeration tanks (i.e. turn off transfer pump(s) from aeration tank(s) to membrane tank(s) and turn of recirculation pump(s) from membrane tank(s) to aeration tank(s), if included), and record blower ON/OFF duration.			
Fill membrane Tank, check for leaks. Confirm operation of P-601/701/702/801/6101/6102. Perform manual backwash to confirm operation. Check for o Buoyancy of air diffusers and if this occurs, empty the tank and fix; o Air leakages: if this occurs, tighten up the fittings;			

newterra clean water. modular solutions. simple.	Commissioning Checklist		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Confirm operation of all container fan and heaters.			
Fill sludge holding tank with water. Confirm diffuser operation and level switch operation. Confirm P-901 operation.			
Introduce seed sludge from cusomer thru the influent and process. See Section 6 of the manual for the procedure. If seed sludge is unavailable, then use dry bacteria.			

newterra clean water. modular solutions. simple.	Membrane Inspection (Clean Water)		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Inspect membrane module that all bolts are secure			
Ensure all hose clamps are secure			
Fill tank until membranes are completely submerged, re-check bubble pattern			
Enable membrane operation from the PLC screen			
Start the transfer pump(s) from the Post Anox tank(s) to the membrane tank(s) and fill the membrane tank(s) with potable water.			
Start the air blowers for the membrane tank(s) and check for an even distribution of air across the membrane filter area and air bubble uniformity above the membrane module/cassette.			
Check hydraulic flow pattern through the membranes and between membrane module/ cassette and tank wall.			
Make a clean copy of the Clean Water Testing Sheet presented in Appendix K of this O&M Manual.			
Record all checked parameters in the Clean Water Testing Sheet:			
Pre-prime the permeate pumps according to manufacturer'smfg instructions			
Start the permeate (vacuum) pumps.			

newterra clean water. modular solutions. simple.	Membrane Inspection (Clean Water)		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Record and set the initial vacuum settings on the system to determine correct TMP of the membranes. This step is required based on the Vacuum transmitter located higher than the water level.			
Record the vacuum (TMP) on the gauge(s) on the permeate line [for clean water could be 0.05 to 0.07 bar (20" to 29" WC)].			
Record water temperature and DO with a hand-held DO meter.			
Gradually increase the permeate flow while recording the vacuum (TMP) on the gauges up to the anticipated peak wastewater flow.			
Ensure membrane module is securely fastened to membrane tank and no movement is detected. Ensure wheels are chocked to prevent membrane module movement during operation			

newterra clean water. modular solutions. simple.	Full Automatic System Test		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/*
Record Membrane Performance after 3 min at the design flow for each membrane cassette with clean water record findings in 'MBR Test Preformance' data sheet			
Introduce Waste Activated Sludge (inject slowly through normal waste water inlet, always pre-screen)		Sludge Obtained From: MLSS:	
Record Membrane Performance after 3 min at the design flow for each membrane cassette in 'MBR Preformance' data sheet			

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Membrane Performance (test)

MBR Number	Flow	Flux	Permeability	Date	Operator Initials

Influent-Effluent

1 Confirm Influent/Effluent parameters - below are the design parameters.

Parameters	Unit	Influent*	Effluent
pH	s.u.	6 - 9	6.5 – 8.5
Fat, Oil, Grease (FOG)	mg/L	< 30	< 5
Biological Oxygen Demand (BOD)	mg/L	907.5	< 25
Total Suspended Solids (TSS)	mg/L	262.5	< 25
Total Kjeldahl Nitrogen (TKN)	mgN/L	130	-
Unionized Ammonia Nitrogen (NH_3-N)	mgN/L	-	< 1.25
Nitrate Nitrogen (NO_3-N)	mgN/L	-	< 5
Total Phosphorus (TP)	mgP/L	12	< 0.5
Fecal Coliform	CFU/100mL	-	< 200**
Total Residual Chlorine	mg/L	-	< 0.02
Alkalinity (assumed)	mg/L as $CaCO_3$	471	-
Total Dissolved Solids(TDS)	mg/L	< 1,200	-

	newterra clean water. modular solutions. simple.	**Influent-Effluent**	
2	Record here the actual influent and effluent valves from lab testing		

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Device Verification Checklist

Device Tag	Device Type	Operation Verified	Notes	Train 1	Train 2
FIT-201	Flow Transmitter				
FIT-202	Flow Transmitter				
SCR-201	rotary brush screen				
SCR-202	rotary brush screen				
LSHH-201	Level Switch				
LSHH-202	Level Switch				
LSHH-101	Level Switch				
LSHH-102	Level Switch				
LSHH-103	Level Switch				
LSHH-203	Level Switch				
LSH-203	Level Switch				
LSL-203	Level Switch				
P-201	Pump				
P-202	Pump				
H-7911	Container heaters				
H-7912	Container heaters				
TSL-7911	Temperature low level				
LSHH-7911	Level Switch				
B-7911 and PDS-7911	Blower				
EQ Tank diffuser Grid	diffusers				
B-302/301 and PSL-301	Blower				
LSHH-301	Level Switch				
LSLL-301	Level Switch				
LT-301	Level Transmitter				
TSLL-301	Temperature sensor				
H-301 and H-302	Tank heater				
P-301/302	Pump				
Pre-Anox Educator					
H-7941 and TSLL-7901	Container heater				
P-401 and P-402					
H-401 and H-402	Tank heaters				
LSHH-401	Level Switch				
LSLL-401	Level Switch				
TSL-401	Temperature Sensor				
B-7941	Blower				
Aeration Tank diffuser grid	diffusers - TNK-501				
H-501/502	Tank heater				
LSLL-501	level switch				
TSL-501	temperature sensor				
LSHH-501	level switch				
LT-501	level transmitter				
DO-501	DO sensor				
PH-501	PH sensor				
P-501	pump				
P-502	pump				
P-503	pump				

Device Tag	Device Type	Operation Verified	Notes	Train 1	Train 2
B-501/502 and PSL-501	blower				
P-6101	Soda Ash/Caustic dosing pump				
P-6102	Alum dosing pump				
Aeration Tank diffuser grid	diffusers - TNK-502				
H-503/504	Tank heater				
LSLL-502	level switch				
TSL-501	temperature sensor				
LSHH-502	level switch				
Educators	Post-Anox Educators TNK-551				
P-553/554	Pumps				
P-551/552	Pumps				
P-6103	MicroC dosing				
B-601 and PSL-601	MBR Blower				
LSHH-601	Level Switch				
LSH-601	Level Switch				
MBR tank diffuser grid	diffusers - TNK-601				
P-701	permeate pump				
VT-701	Vacuum transmitter				
MV-701	Soleniod valve				
FIT-701	flow transmitter				
B-602 and PSL-602	MBR Blower				
LSHH-602	Level Switch				
LSH-602	Level Switch				
MBR tank diffuser grid	diffusers - TNK-602				
P-702	permeate pump				
VT-702	Vacuum transmitter				
MV-702	Motorized valve				
FIT-702	flow transmitter				
SV-801	Backwash valve				
P-801	backwash pump				
LSH-801	Level Switch				
LSL-801	Level Switch				
SV-801	Soleniod valve				
H-7961	container heaters				
H-7962	container heaters				
H-7963	container heaters				
TSL-7961	Temperature sensor				
F-7961	Container fan				
LSHH-7961	Level Switch				
LSHH-7962	Level Switch				
LSHH-901	level switch				
sludge inlet tank diffuser grid	diffusers - TNK-901				

Commissioning Acceptance Sign-Off Form

1704432 - Amaruq Mine WWTP

Newterra is pleased to announce that the Commissioning phase of 1704432 - Amaruq Mine WWTP, has successfully been completed. In order to move to the Training phase, a visual inspection and walkthrough of the plant will be required, followed by signoff of this document. Commissioning signoff will be conditional on the completion of items listed in the Punchlist created during this walkthrough.

	Installation Signoff		Customer Acceptance
Name:	_____	**Name:**	_____
Company:	_____	**Company:**	_____
Date:	_____	**Date:**	_____
Signature:	_____	**Signature:**	_____

newterra smart technology. sustainable solutions.™	Customer Training Checklist		
	Has Acceptance Criteria Been Met (Yes/No)	*Details*	*Initial/Date*
Review the operating manual with the customer explaining the various components of the manual and sources of information.			
Review the startup and shutdown procedure with operator.			
Review operation of treatment system and describe the maintenance required for each piece of equipment.			
Describe operation of panel and panel components.			
Run through complete logic and alarm sequence with customer			
Train customer to troubleshoot alarms based on input conditions to the PLC or relays in the panel.			
Discuss the operating logic with the customer so they understand how the system is configured to work.			
Have customer/operator sign training sheet			
Note name of individual and company with whom logic was reviewed:			

Training Completion Sign-Off Form

1704432 - Amaruq Mine WWTP

Newterra is pleased to announce that the training of the following operator(s) has been sucessfully completed:

	Installation Signoff		Customer Acceptance
Name:		**Name:**	
Company:		**Company:**	
Date:		**Date:**	
Signature:		**Signature:**	

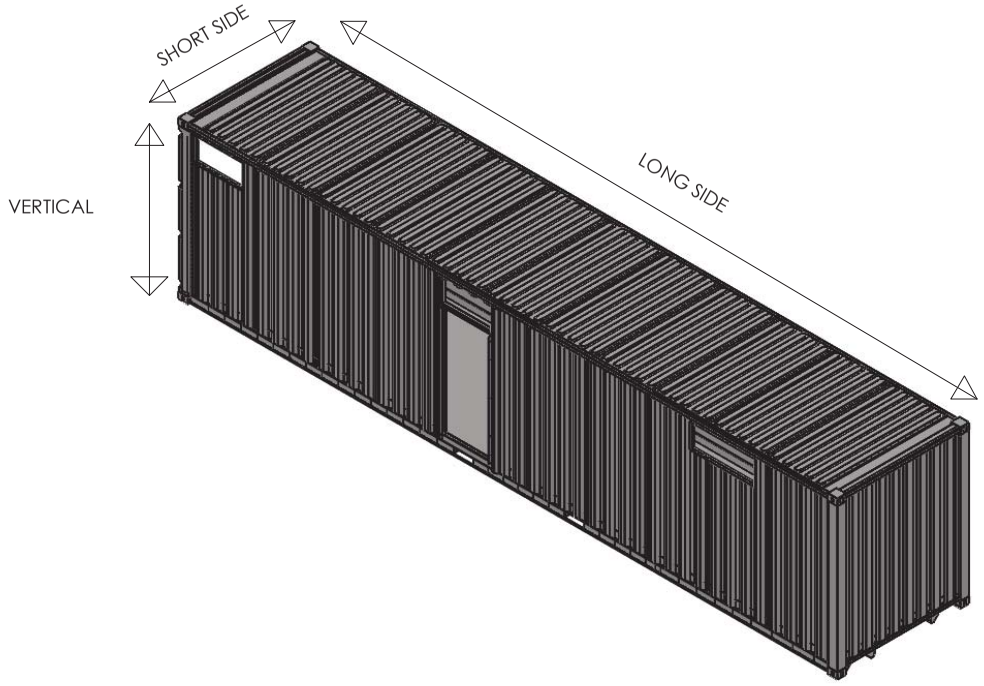
COMPONENT	LONG SIDE (40') QTY.	SHORT SIDE (8') QTY.	VERTICAL (9' 6") QTY.
LIQUID RUBBER (37795)	2 (7.0L)	1 (1.40L)	1 (1.70L)
TAPE (37797)	1 (40')	1 (8')	1 (9' 6")
POLYURETHANE SEALANT (37796)	2 (1.0L)	1 (0.40L)	-
7/8" BACKER ROD (29551)	-	1 (8')	-
3/8" BACKER ROD (37794)	2 (40')	-	1 (9' 6")
SPRAY FOAM (22772)	-	1 (1.33 ft^3)	-

NOTE:

QUANTITIES OF COMPONENTS LISTED ARE FOR A SINGLE SEAL IN THE DIRECTION SPECIFIED.

A COMPLETE SEAL OF A MULTI-CONTAINER SYSTEM MAY REQUIRE THE SUMMATION OF MULTIPLE SEALS IN MULTIPLE DIRECTIONS.

THIS TABLE IS TO GIVE ROUGH ESTIMATES ON THE QUANTITIES REQUIRED.



GENERAL TOLERANCES
.XX ± 1/8"
.XXX ± 1/16"
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

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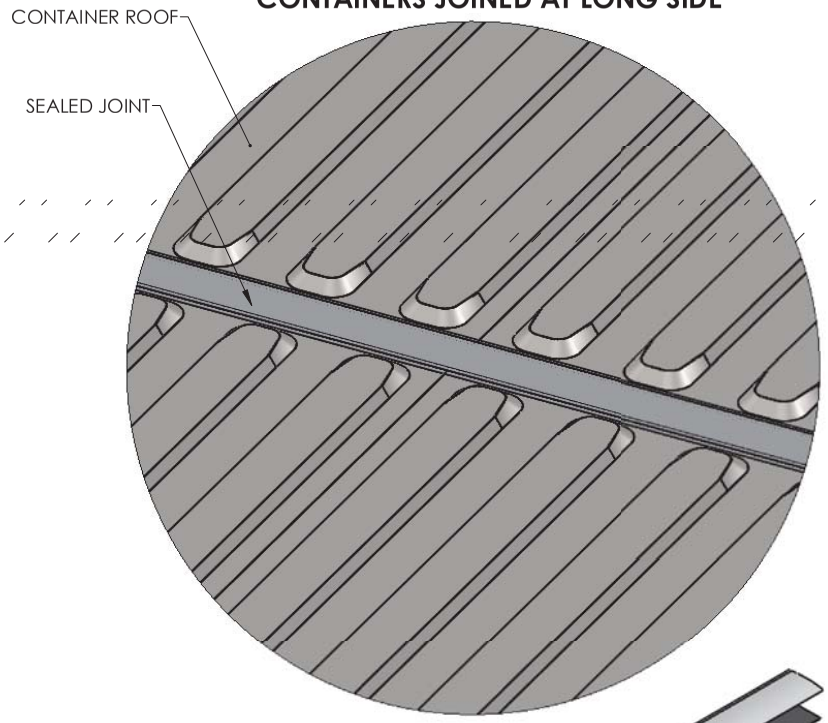
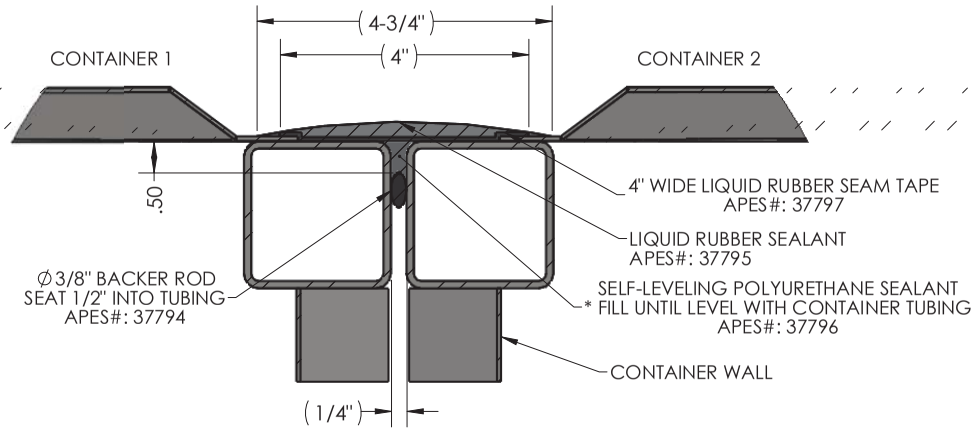
LEVEL	DATE	BY	REVISION
B1	27/02/17	GH	FOR PRODUCTION - REVISED SEALING METHOD
B	11 Nov 2015	OM	FOR PRODUCTION
A1	26 Aug 2015	OM	FOR REVIEW
A	22 July 2015	OM	FOR REVIEW

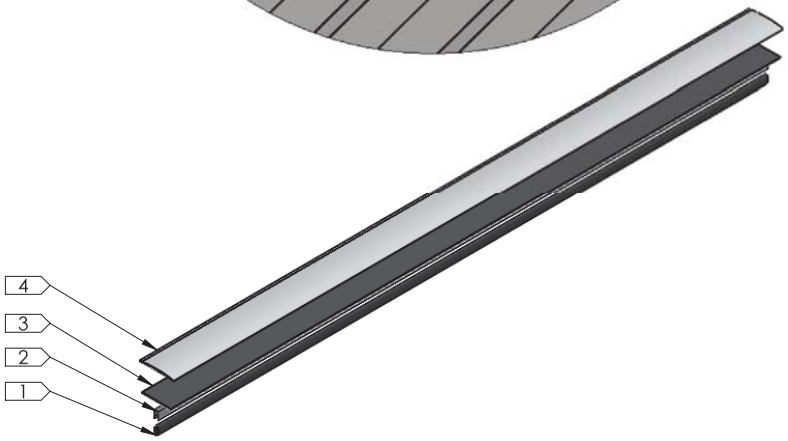
DWG. NO:
PROJECT NUMBER:
TITLE: LIQUID RUBBER CONTAINER SEAL
CUSTOMER: newterra
DRAWN BY: OM
DATE: 22 July 2015
SHEET 1 OF 7

CONTAINERS JOINED AT LONG SIDE





SECTION A-A
CONTAINERS JOINED ALONG LONG SIDE
SCALE 1 : 2



TYPICAL STEPS FOR SEALING LONG SIDE OF CONTAINER JOINTS

1. PUSH BACKER ROD INTO GAP BETWEEN CONTAINER TUBING; 1/2" DOWN.
2. APPLY SELF LEVELING POLYURETHANE SEALANT ON TOP OF BACKER ROD UNTIL LEVEL WITH TUBING.
3. APPLY LIQUID RUBBER TAPE CENTERED OVER GAP, 4" WIDE. ENSURE SMOOTH TIGHT TO SURFACE SEAL.
4. APPLY LIQUID RUBBER SEALANT WITH A MINIMUM CENTERED WIDTH OVER THE GAP OF 4 3/4". ENSURE NONE OF THE TAPE IS VISIBLE AFTER THIS APPLICATION.

GENERAL TOLERANCES
.XX ± 1/8"
.XXX ± 1/16"
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

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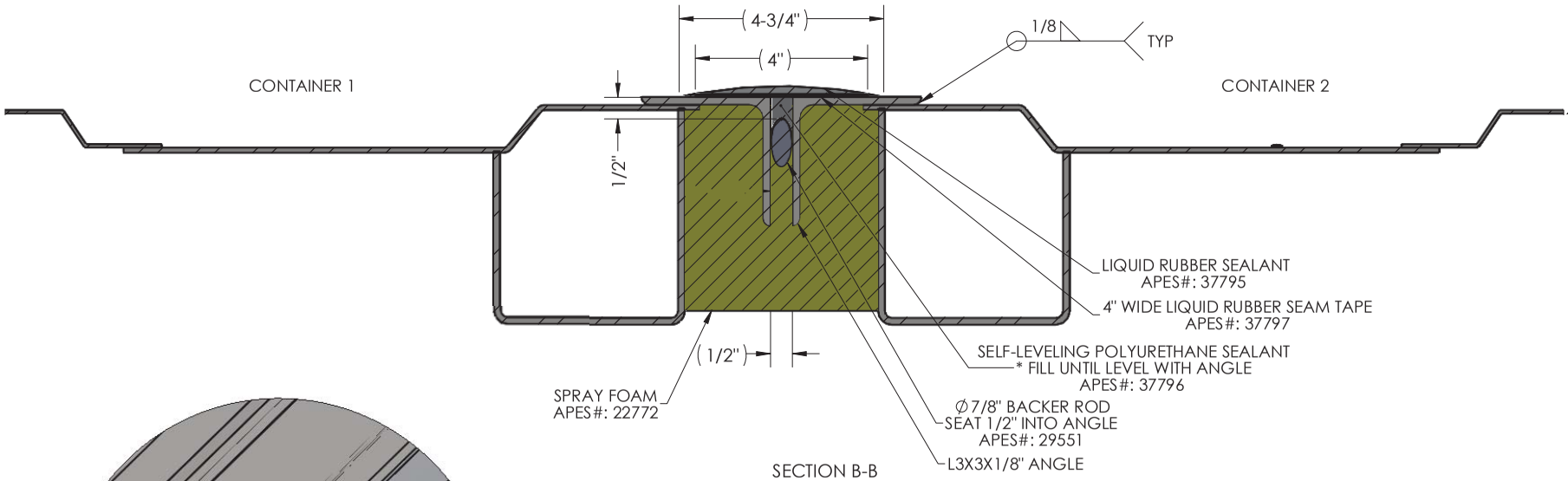
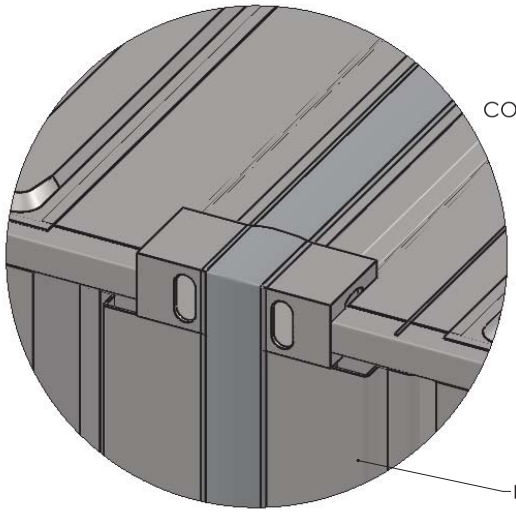
DWG. NO:
PROJECT NUMBER:
TITLE: LIQUID RUBBER CONTAINER SEAL
CUSTOMER: newterra
DRAWN BY: OM
DATE: 22 July 2015
SHEET 2 OF 7

CONTAINERS JOINED ALONG SHORT SIDE - BARN DOOR END TO BARN DOOR END



SECTION B-B
CONTAINERS JOINED ALONG SHORT SIDE - BARN DOOR END TO BARN DOOR END
SCALE 1 : 2.5



STEPS FOR SEALING SHORT SIDE OF CONTAINERS:

1. PERFORM STEPS 1-4 OF TYPICAL SEALING OUTLINED ON PAGE 1 ON TOP OF CONTAINERS.
2. FILL UNDERSIDE AS SHOWN WITH SPRAY FOAM WHEN POLYURETHANE LEVELING SEALANT HAS SET.
3. FOLLOW STEPS 3 & 4 AND ADD SPRAY FOAM TO BARN DOOR END VERTICAL SEALS.

GENERAL TOLERANCES
.XX ± 1/8 "
.XXX ± 1/16 "
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

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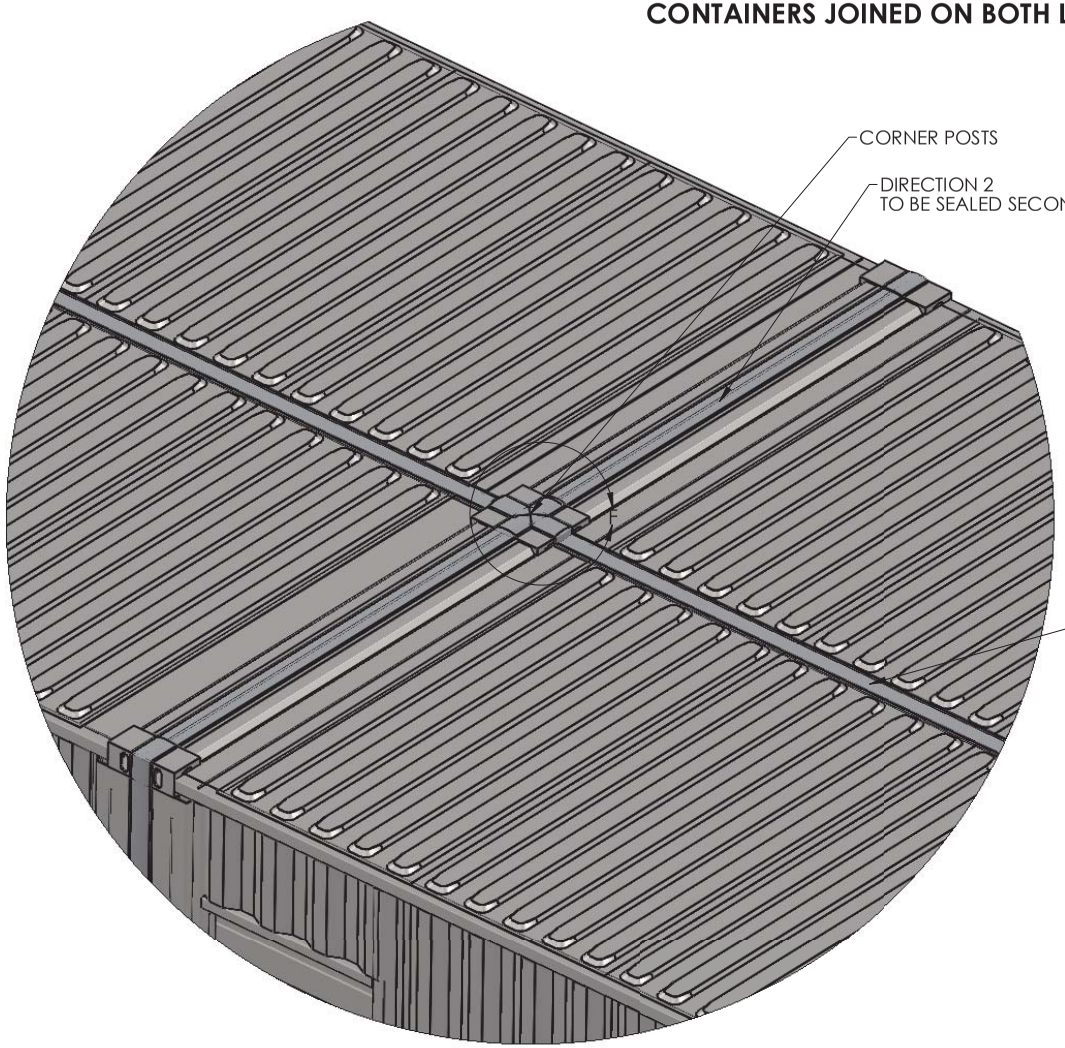
DWG. NO:
PROJECT NUMBER:
TITLE: LIQUID RUBBER CONTAINER SEAL
CUSTOMER: newterra
DRAWN BY: OM
DATE: 22 July 2015
SHEET 3 OF 7

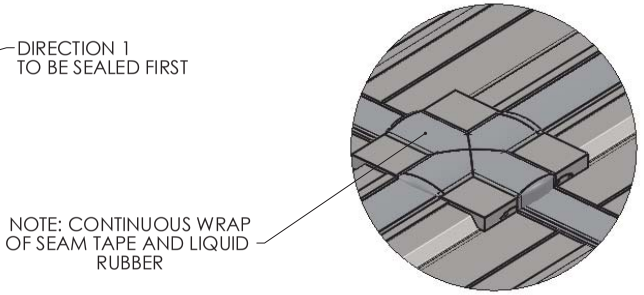
CONTAINERS JOINED ON BOTH LONG AND SHORT SIDES



STEPS FOR SEALING ABOVE CONTAINERS JOINED IN BOTH DIRECTIONS:

1. CLEAN AND PRIME AREA
2. PERFORM STEPS 1 TO 4 OF TYPICAL SEALING ORDER OUTLINED ON PAGE 1 IN DIRECTION 1 - ALONG LONG SIDE FIRST WITH ∅3/8" BACKER ROD.
3. PERFORM STEPS 1 TO 4 OF TYPICAL SEALING ORDER OUTLINED ON PAGE 1 IN DIRECTION 2 - ALONG THE SHORT SIDE WITH ∅7/8" BACKER ROD.
4. PERFORM STEPS 3 & 4 WHEN SEALING CORNER POST JOINTS. (TAPE AND LIQUID RUBBER).

NOTE: WHEN SEALING DIRECTION 1 & 2 CONTINUE WRAP OF TAPE AND RUBBER ACROSS THE CORNER POSTS.



DETAIL F
CORNER POST JOINTS
SCALE 1 : 10

GENERAL TOLERANCES
.XX ± 1/8 "
.XXX ± 1/16 "
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

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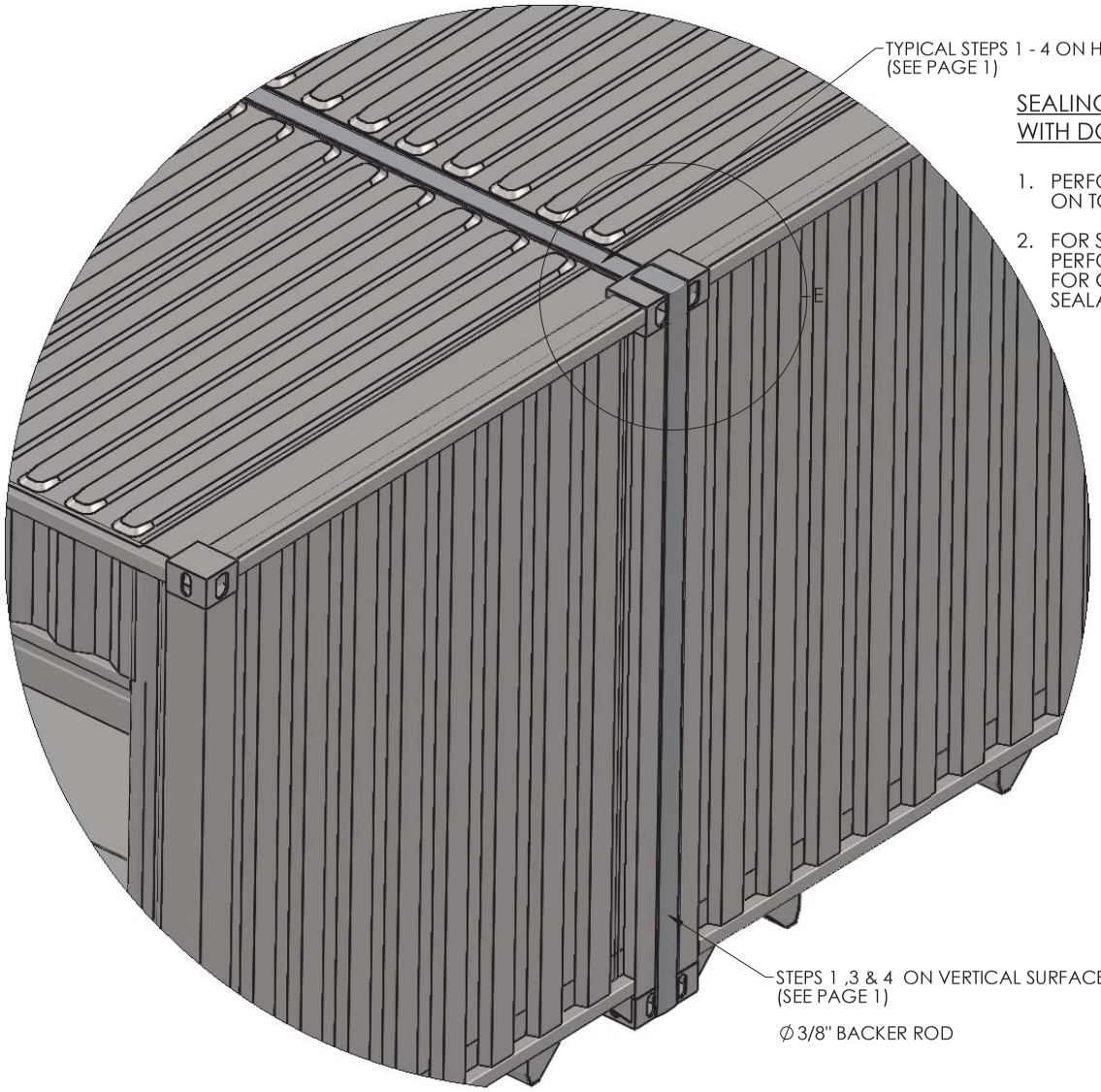
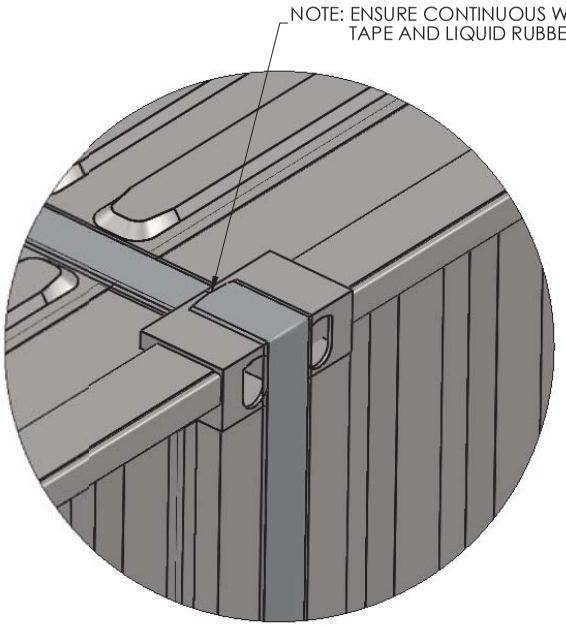
DWG. NO:
PROJECT NUMBER:
TITLE: LIQUID RUBBER CONTAINER SEAL
CUSTOMER: newterra
DRAWN BY: OM
DATE: 22 July 2015
SHEET 4 OF 7



SEALING ABOVE CONTAINERS JOINED ON LONG SIDE WITH DOORWAY / PATH THROUGH CLOSE TO CONTAINERS END

1. PERFORM STEPS 1-4 OF TYPICAL SEALING ORDER OUTLINED ON PAGE 1 ON TOP OF CONTAINERS.
2. FOR SEALING VERTICAL AREA:
   PERFORM STEPS 3 & 4 ON CORNER POSTS.
   FOR GAP USE STEPS 1, 3 & 4 WITH ∅3/8" BACKER ROD. IGNORE USE OF POLYURETHANE SEALANT.



DETAIL E
SCALE 1 : 8

GENERAL TOLERANCES
.XX ± 1/8 "
.XXX ± 1/16 "
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

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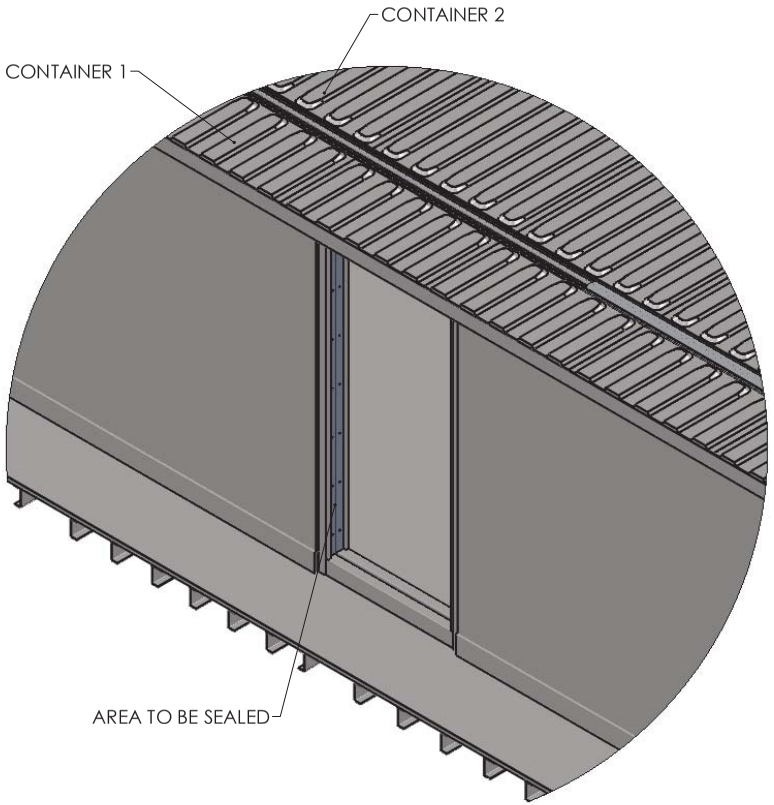
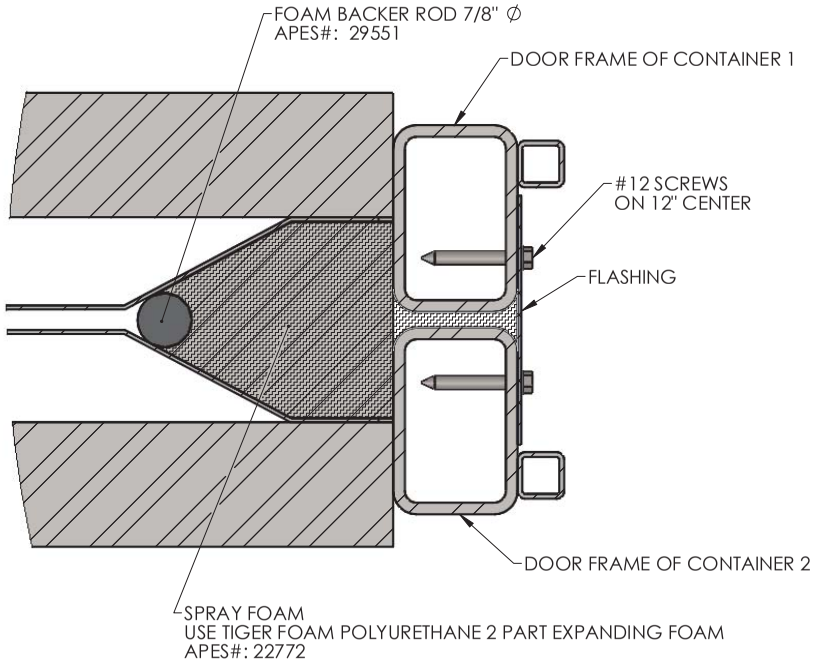
A	22 July 2015	OM	FOR REVIEW

DWG. NO:
PROJECT NUMBER:
TITLE: LIQUID RUBBER CONTAINER SEAL
CUSTOMER: newterra
DRAWN BY: OM
DATE: 22 July 2015
SHEET 5 OF 7

INSIDE SEALING OF WALKWAYS





DETAIL D
DOORWAYS SEALING
SCALE 1 : 2

GENERAL TOLERANCES
.XX ± 1/8 "
.XXX ± 1/16 "
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

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A	22 July 2015	OM	FOR REVIEW

DWG. NO:
PROJECT NUMBER:
TITLE: LIQUID RUBBER CONTAINER SEAL
CUSTOMER: newterra
DRAWN BY: OM
DATE: 22 July 15
SHEET 6 OF 7

newterra ltd.
1291 California Avenue, Brockville, ON K6V 5W3
(800) 420-4056 / www.newterra.com

APPENDIX D

Recommended Spare parts List

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1704432 - AGNICO EAGLE MINE - A1

Qty	Category	Spare/ Maintenance	newterra#	Description
1	**Electrical**	**Spare**	10270	Breaker, SQD QOU115 1240V 15A 1P DIN Mount, 10k SCCR
1	**Electrical**	**Spare**	11482	Breaker Lock for 1 pole QOU breakers
3	**Electrical**	**Spare**	12404	Fuse,GLD AJT250250A 600V Time Delay, Class J
1	**Electrical**	**Spare**	12475	4Ch Discrete, Transistor Output, Intrinsically Safe Barrier
1	**Electrical**	**Spare**	12547	Contactor (TeSys D) Non-Reversing, 9A(AC3) 125A(AC1), 3-Pole (3 NO)
1	**Electrical**	**Spare**	17158	Combination Starter, Busbar Top Mount
1	**Electrical**	**Spare**	18396	190-480V, 3PH Power/Phase Monitor
4	**Electrical**	**Spare**	18642	100W Incandescent, Medium Base, CL1Div2
5	**Electrical**	**Spare**	19029	Breaker, SQD QOB115 120V 15A Bolt On, 10k SCCR
1	**Electrical**	**Spare**	19264	Combination Starter, 12A Power Base, 3/7.5/10HP
1	**Electrical**	**Spare**	19269	Combination Starter, 1NO Ready, 1NO Fault Aux. Contact Module
1	**Electrical**	**Spare**	19503	Combination Starter, TeSysU Standard Control Unit 0.35-1.4A, 24VDC coil
5	**Electrical**	**Spare**	20369	Fuse,GLD GSB1/10100mA 250V Fast Acting, Miniature 5x20mm
1	**Electrical**	**Spare**	21191	Combination Starter, TeSysU Standard Control Unit 1.25-5.0A, 24V/60mA DC coil
1	**Electrical**	**Spare**	21887	Relay, SQT RXM4AB1F7, Miniature Relay, 4PDT, 120VAC, 6A contacts
1	**Electrical**	**Spare**	21888	Relay, SQT RXM4AB1BD, Miniature Relay, 4PDT, 24 VDC, 6A contacts
1	**Electrical**	**Spare**	21889	Relay, SQT RXZE2S114M, Base/Socket for RXM4 4P Relays
2	**Electrical**	**Spare**	22324	Relay, SQT RXM2AB1BD, Miniature Relay 2PDT 24 VDC
2	**Electrical**	**Spare**	22326	Relay, SQT RXZE2S108M, Base/Socket for RXM2 2P Relays
1	**Electrical**	**Spare**	22546	Busbar 4 TeSysU Starters, #6AWG 63A MAX
1	**Electrical**	**Spare**	22706	Combination Starter, TeSysU Standard Control Unit 3-12A, 24V/60mA DC coil
1	**Electrical**	**Spare**	23504	4Ch Power Supply, 15V - 20mA
4	**Electrical**	**Spare**	23751	Relay, SPDT, 24VDC Coil
1	**Electrical**	**Spare**	26829	8GB Micro USB Key
1	**Electrical**	**Spare**	28484	M251 Controller, Dual Ethernet
1	**Electrical**	**Spare**	29140	eWON Cosy 131 LAN/Cell Router, 24VDC Power
2	**Electrical**	**Spare**	35707	24VDC Power Supply, 120W, 5A
1	**Electrical**	**Spare**	36087	TM3 16DI Expansion Module
1	**Electrical**	**Spare**	36088	TM3 16DO Expansion Module
1	**Electrical**	**Spare**	36089	TM3 4-channel AI Expansion Module
1	**Electrical**	**Spare**	36090	TM3 8-channel AI Expansion Module
1	**Electrical**	**Spare**	36126	Touchscreen, 10.4" TOUCH SMART DISPLAY
1	**Electrical**	**Spare**	36316	OTB RIO Adapter, Ethernet
1	**Electrical**	**Spare**	36317	TM2 8 point DI Expansion Module

Qty	Category	Spare/ Maintenance	newterra#	Description
1	**Electrical**	**Spare**	36543	TM3 4-channel AO Expansion Module
1	**Electrical**	**Spare**	36555	Fuse, 160mA 250V Fast Acting, Miniature 5x20mm
1	**Electrical**	**Spare**	36557	TME Bus Transmitter Module
1	**Electrical**	**Spare**	36558	TME Bus Receiver Module
1	**Electrical**	**Spare**	37596	TM2 16 point DI Expansion Module
1	**Electrical**	**Spare**	37906	48" x 36" x 12" NEMA4 Steel Enclosure
1	**Electrical**	**Spare**	38069	Breaker, Multi9 480/277V 15 AMP 3P C Trip Curve, 10k SCCR
1	**Electrical**	**Spare**	38070	Breaker, Multi9 480/277V 20 AMP 3P C Trip Curve, 10k SCCR
1	**Electrical**	**Spare**	38071	Breaker, Multi9 480/277V 30 AMP 3P C Trip Curve, 10k SCCR
1	**Electrical**	**Spare**	38092	Breaker, Multi9, 480/277V 15 AMP 2P C Trip Curve, 10k SCCR
1	**Electrical**	**Spare**	38093	Variable Frequency Drive, Danfoss FC202 P1K5, VFD 480V 2HP, 3.4A 3PH, IP55, w/ Line Side Fusible Disc
1	**Electrical**	**Spare**	38094	Variable Frequency Drive, Danfoss FC202 P11K, VFD 480V 15HP, 21A 3PH, IP55, w/ Line Side Fusible Disc
2	**Electrical**	**Spare**	38136	Breaker, 240V 1 AMP 1P C
2	**Electrical**	**Spare**	38137	Breaker, 240V 2 AMP 1P C
2	**Electrical**	**Spare**	38138	Breaker, 240V 3 AMP 1P C
2	**Electrical**	**Spare**	38139	Breaker, 240V 4 AMP 1P C
2	**Electrical**	**Spare**	38204	Wall Pack, 24W LED c/w PhotoEye
1	**Electrical**	**Spare**	38209	TM2 16RO Expansion Module
1	**Mechanical**	**Spare**	9999	Pump, Metering, Prominent, Rebuild Kit, BT4B0708PVT2000UD010A01, Flow: 1.88GPH / 7.10L/H, Pressure: 102PSI / 07BAR
1	**Mechanical**	**Spare**	11518	Blower, Sutorbilt, Model 4L-RHC
1	**Mechanical**	**Maintenance**	11529	Filter, Element, Solberg, 30P, Paper element, for newterra PN M1096
1	**Mechanical**	**Spare**	11772	Blower, Part, Belt drive, 15hp
1	**Mechanical**	**Maintenance**	11792	Filter, Element, Solberg, 230P, Paper element for newterra PN M1489
1	**Mechanical**	**Maintenance**	12014	Filter, Element, Solberg, 18P, Paper element, for newterra PN M1406
1	**Mechanical**	**Spare**	12026	Motor, Teco, 1hp, 1800rpm, 143T
1	**Mechanical**	**Maintenance**	12930	Oil, Blower, Aeon PD blower oil
1	**Mechanical**	**Spare**	15185	Motor, Teco, 15hp, 3600rpm, 254T
1	**Mechanical**	**Spare**	16196	Gauge, Pressure, 0-15psi, Indumart, P16T2-FG-15
5	**Mechanical**	**Spare**	16202	Gauge, Pressure, 0-30psi, Indumart, P16T2-FG-30
4	**Mechanical**	**Spare**	19279	Switch, Level, Mech Float, Narrow Angle, N.C., YEL
2	**Mechanical**	**Spare**	21552	Switch, Level, Tether Weight
10	**Mechanical**	**Spare**	21828	Anode, Magnesium, mounted on wire with washer
1	**Mechanical**	**Spare**	23439	Transmitter, Pressure, KPSI 750 series 0-10ft H20
1	**Mechanical**	**Spare**	24163	Heater, Immersion, Caloritech 6KW 460V 3ph
1	**Mechanical**	**Spare**	25747	Blower, Cincinnati LM-4, 4.3" X 2.9" Width Alum wheel
1	**Mechanical**	**Spare**	27810	Transmitter, Pressure/ Vacuum, IFM efector
1	**Mechanical**	**Spare**	28469	Pump, Centrifugal, Price Pumps Type 26 EPR Seal 0542
1	**Mechanical**	**Spare**	28617	Pump, Centrifugal, Price Pump 1/4hp 460V 3ph 1800RPM

Qty	Category	Spare/ Maintenance	newterra#	Description
1	**Mechanical**	**Spare**	28620	Pump, Centrifugal, Price Pump 2hp 460V 3ph 3600RPM
1	**Mechanical**	**Spare**	28712	Flow meter, IFM efector, SM9000, Magnetic flow meter
1	**Mechanical**	**Spare**	29263	Pump, Centrifugal, Price Pump 3/4hp 460V 3ph 3600RPM
1	**Mechanical**	**Spare**	33737	Switch, Level, Ultrasonic, Flowline, LU10-1405
8	**Mechanical**	**Spare**	35983	#10 Stainless Back 3" Trim, 16" Length, 0.5 Black Poly Brush
1	**Mechanical**	**Spare**	36395	Pump, Sump, Zoeller N72 Non-Automatic Operation
1	**Mechanical**	**Spare**	36870	Transmitter, pH, Prominent pH Sensor PHER 112SE
1	**Mechanical**	**Spare**	36973	Pump, Centrifugal, Price, Misc
2	**Mechanical**	**Spare**	37662	Valve, Ball, PVC, 2", True-Union, FPM O-rings
1	**Mechanical**	**Spare**	38186	Pump, Centrifugal, Price Pump 1hp 460V 3ph 3600RPM
1	**Mechanical**	**Spare**	38219	Gear Motor, 230/460V 50/60 3P, 60/50hz 1/4hp
1	**Mechanical**	**Spare**	38596	Transmitter, Dissolved Oxygen, Optical, RDO PRO-X, Sensor Cap Replacement Kit, 0088720
1	**Mechanical**	**Spare**	M1254	Pump, Progressive Cavity, Moyno, 35601
4	**Mechanical**	**Spare**	M1343	Switch, Level, Mech Float, Narrow Angle, N.O., Blue

newterra ltd.
1291 California Avenue, Brockville, ON K6V 5W3
(800) 420-4056 / www.newterra.com

APPENDIX E

Technical Specs and Brochures for Parts and Equipment

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TAG	newterra Part Number	Part Description	Extended Part Description	Page
-	21299	Valve, Relief, Back Pressure, Kunkle, 1", Liquid Service	Set @ 50 PSI, 0019-E01-MG0050	E-8
-	M1096	Filter, Silencer, Solberg, FS-30P-200		E-40
-	M1406	Filter, Silencer, Solberg, FS-18P-150	1	E-40
B-301/2	25404	Blower, Elmo, 2BH7420-0AH267 2.4HP	230/460V 3ph	E-45
B-501/2	11518	Blower, Sutorbilt, Model 4L-RHC	Orientation: Horizontal (Flow Down) Driven Shaft Position: RHC (Right Hand Central) Flow Requirement: 487 scfm Altitude: 100' Inlet Pressure: Outlet Pressure:4.4 Inlet Air Temp: 68 Discharge Air Temp: 126 Noise: RPM: 3352 Horsepower Consumed:13.2 Motor Included with Package Blower calculation sheet and blower curve supplied by Engineering	E-73
B-501/2	15185	Motor, Teco, 15hp, 3600rpm, 254T	208-230/460, 3ph, CSA/UR	E-73
B-501/2	38094	VFD, Danfoss 15HP, 380-480Vac, IP55	p/n: FC202P11KT4E55H2XGX3SXSXXXXAXBXCXXXXDX	E-159
B-501/2	M1489	Filter, Silencer, Solberg, FS-230P-300	3"	E-249
B601/2	21232	Blower, Elmo G200 2BH-1510-7HH56-Z	230/460V 3P 6.2 HP	E-251
B-7911	25747	Blower, Cincinnati LM-4, 4.3" X 2.9" Width Alum wheel	Arrangement #4, Direct Drive, bottom discharge c/w	E-283
B7914	22618	Blower, Cincinnati, LM-6, Direct drive	- Cast Aluminum Housing -6.3 x 2.5 STEELWheel - Slip fit inlet - Slip fit discharge - Motor base - 1.5hp, 460V, 3ph, 60Hz, 3600 rpm, TEFC, CCW/TH 769CFM @ 2.25	E-283
DO-501	27325	Transmitter, Dissolved Oxygen, Optical	RDO Pro-x (10m cable)	E-298
F-7961	M1072	Fan, Building, 12", 1/4hp, 1750rpm, 120V, 1ph, TEAO	CSA Approved, S12-E1	E-328

TAG	newterra Part Number	Part Description	Extended Part Description	Page
FM 701 702	28712	Flow meter, IFM efector, SM9000, Magnetic flow meter	G2 connection 0 -300 L/min	E-336
FT-102/2	27200	Flow meter, Endress, Promag 10D50 2"	10D50-4LGA1RA0B4AAM1 Compact head	E-381
H	24384	Heater, Forced Air, Ouellet, 4.8kW, OAC04804BL	460V 1ph	E-521
H-301/302 H-401/402 H-501/502 H-503/504	24163	Heater, Immersion, Caloritech 6KW 460V 3ph	3" Flanged Heater with Moisture Resistant Term Box	E-525
H-7911	38187	Heater, Forced Air, Indeeco, 15KW, 233 Series	480V/3ph. EXP, 1/4HP Fan, w thermostat SIZE 2	E-526
H-7912	38188	Heater, Forced Air, Indeeco, 10KW, 233 Series	480V/3ph. EXP, 1/4HP Fan, w thermostat	E-526
HMI	26421	HMI, HMIGTO5310	10.4" TFT Color Touchscreen, Ethernet, USB, Serial	E-534
LS	19279	Switch, Level, Mech Float, Narrow Angle, N.C., YEL	N/C, Yellow float	E-684
LS	M1343	Switch, Level, Mech Float, Narrow Angle, N.O., Blue	Tilt Float Level Switch w 40' cable	E-684
LS-101/2/3	19279	Switch, Level, Mech Float, Narrow Angle, N.C., YEL	N/C, Yellow float	E-684
LSHH	12351	Switch, Level, Almeg, Vertical, ATB3-48B	1/4NPT	E-687
LSHH- 101.102/103 LSHH-301 LSHH-401 LSHH-501 LSHH-502 LSHH-601/602	19279	Switch, Level, Mech Float, Narrow Angle, N.C., YEL	N/C, Yellow float	E-684
LSHH-7901	12351	Switch, Level, Almeg, Vertical, ATB3-48B	1/4NPT	E-687
LSLL-301/401/ 501/502	M1108	Switch, Level, Mech Float, Wide Angle, N.O., Red	13A, SPST, N/O, Red	E-684
LT-301/501	23439	Transmitter, Pressure, KPSI 750 series 0-10ft H20	Part Number 750S14D4A004.334000.000B10015B	E-688
M-701/702	24353	Valve, Actuated Ball Valve 1.5" Brass 2 way	w/ limit switches PMP electric Actuator 120V OM-1	E-722
MCP	28484	PLC, TM251MESE	M251 Controller 2 Ethernet port	E-739
MCP	29140	Modem/Router, EC6133D	eWON Cosy 131 Ethernet plus with GSM 3G+	E-851

TAG	newterra Part Number	Part Description	Extended Part Description	Page
Membranes	28424	Membrane, Microclear Cassette, MCXL2 - Type M	surface area is 8 m2	E-881
Membranes	36037	MBR, Air Diffuser, FLEXAIR 91 1105 T SERIES		E-900
MPP	18396	Motor Saver, 460 w/Diagnostic 3ph	Finger Safe, DIN Rail Mountable	E-920
P-201/2	38186	Pump, Centrifugal, Price Pump 1hp 460V 3ph 3600RPM	PN: RC200AI-300-26566-100-36-3X6	E-928
P-301/2	29263	Pump, Centrifugal, Price Pump 3/4hp 460V 3ph 3600RPM	PN: RC200AI-250-26566-75-36-3T7	E-928
P-401/2	36973	Pump, Centrifugal, Price, Misc	RC300AI-4.33-26566-500-36-3T7 200GPM @ 60 FEET PRESSURE 3600RPM 5HP TEFC 460v3P	E-928
P-501/2	28620	Pump, Centrifugal, Price Pump 2hp 460V 3ph 3600RPM	PN: RC200AI-388-26566-200-36-3T6	E-928
P503	28617	Pump, Centrifugal, Price Pump 1/4hp 460V 3ph 1800RPM	PN: RC200AI-388-26566-25-18-3T6	E-928
P-551/2	29263	Pump, Centrifugal, Price Pump 3/4hp 460V 3ph 3600RPM	PN: RC200AI-250-26566-75-36-3T7	E-928
P-553/4	28620	Pump, Centrifugal, Price Pump 2hp 460V 3ph 3600RPM	PN: RC200AI-388-26566-200-36-3T6	E-928
P-6101,2,3	21192	Pump, Metering, Prominent, Misc	BT4B0708PVT2000UD010A01 Flow: 1.88GPH / 7.10L/H Pressure: 102PSI / 07BAR	E-947
P-610x	25823	Pump, Metering, Parts, Multi-function Valve	PVDF, 87PSIG Size 2	E-1063
P-701/2	38093	VFD, Danfoss 2HP, 380-480Vac, IP55	p/n: FC202P1K5T4E55H2XGX3SXSXXXXAXBXCXXXXDX	E-159
P-701/702	12026	Motor, Teco, 1hp, 1800rpm, 143T	208-230/460V, 3ph, CSA/UR	E-1091
P-701/702	M1254	Pump, Progressive Cavity, Moyno, 35601	15gpm@25psi, 1200rpm, NPSH: 2 feet	E-1125
P-801	36395	Pump, Sump, Zoeller N72 Non-Automatic Operation	All Plastic Construction	E-1129
PH-501	27936	Transmitter, pH, Prominent Dulcometer pH or ORP	4-20mA output, 7781499	E-1145
PI-201/2	16202	Gauge, Pressure, 0-30psi, Indumart, P16T2-FG-30	SS, brass internals, Glyc. Filled, bottom mount	E-1249

TAG	newterra Part Number	Part Description	Extended Part Description	Page
PI-301	16196	Gauge, Pressure, 0-15psi, Indumart, P16T2-FG-15	SS, brass internals, Glyc. Filled, bottom mount	E-1249
PI-301/2	16202	Gauge, Pressure, 0-30psi, Indumart, P16T2-FG-30	SS, brass internals, Glyc. Filled, bottom mount	E-1249
PI-401/2	16202	Gauge, Pressure, 0-30psi, Indumart, P16T2-FG-30	SS, brass internals, Glyc. Filled, bottom mount	E-1249
PI-501/2	16202	Gauge, Pressure, 0-30psi, Indumart, P16T2-FG-30	SS, brass internals, Glyc. Filled, bottom mount	E-1249
PI-551/2	16202	Gauge, Pressure, 0-30psi, Indumart, P16T2-FG-30	SS, brass internals, Glyc. Filled, bottom mount	E-1249
PI-553/554 PI-703/704	16203	Gauge, Pressure, 0-60psi, Indumart, P16T2-FG-60	SS, brass internals, Glyc. Filled, bottom mount	E-1249
PI-601/602	30098	Gauge, Pressure, 0-15psi, Indumart, P16K2-FG-15		E-1249
PSL-301	10218	Switch, Pressure, 1823-2	0.5-2" wc, Dwyer, Nema 1	E-1250
PSL501	10547	Switch, Pressure, 1823-40	5-44" wc, Dwyer, Nema 1	E-1250
PSL-601/2	10547	Switch, Pressure, 1823-40	5-44" wc, Dwyer, Nema 1	E-1250
PSL-7911	10218	Switch, Pressure, 1823-2	0.5-2" wc, Dwyer, Nema 1	E-1250
PSL-7911	12877	Meter, Flow, Pitot Tube, 4"	Multi-Point Averaging	E-1254
SCR-201/2	33737	Switch, Level, Ultrasonic, Flowline, LU10-1405	Long Style	E-1257
SCR-201/2	35907	Filter, Rotary screen, Newterra 17" wide SCR-50	0.5mm Wedge Wire	E-1277
SCR-201/2	38219	Gear Motor, 230/460V 50/60 3P, 60/50hz 1/4hp	SK1SI63/H10-56C-63L/4 FRD DIV2 NSD+ 400:1 Nord Gear, 4.3 RPM, CSA CL1 DIV2	E-1278
TNK-101/2	26009	Tank, Closed Top, Cylindrical, 2100 gal, Norwesco - no drain	87dia 89 tall, 1.9sg, Heavy Walled, blue	E-1348
TNK-103	23980	Tank, closed top, cylindrical, ACO CT-450-DT	450 Imp. Gal., 16" lid with locking strap	E-1364
TNK-201	38224	Tank, Open Top, Rectangular, 192 gal	540 US Gal 72x36x48	E-1365
TNK-401/502	38229	Eductor Mixing, Elmridge ME20P	Poly Pro 3/4" inlet	E-1366

TAG	newterra Part Number	Part Description	Extended Part Description	Page
TNK-801	21203	Tank, Open Top, Cylindrical, 60 Imp gal, OT-60	Aco Tanks With Lid, 22x44 270Liter	E-1368
TNK-901	26009	Tank, Closed Top, Cylindrical, 2100 gal, Norwesco - no drain	87dia 89 tall, 1.9sg, Heavy Walled, blue	E-1348
TSL-301/401/ 501/502	15653	Switch, Temperature, Probe, A19AAF-12C	25-225 deg F, 10 foot Capillary Tube	E-1369
TSLL/TSH	10515	Switch, Temperature Thermostat, CN TF115-001	40F to 100F / 5C to 40C dial	E-1371
TSLL7911	10515	Switch, Temperature Thermostat, CN TF115-001	40F to 100F / 5C to 40C dial	E-1371
TSLL-7941	10515	Switch, Temperature Thermostat, CN TF115-001	40F to 100F / 5C to 40C dial	E-1371
VT-701 702	27810	Transmitter, Pressure/ Vacuum, IFM efector	PG2409 Scale -14.5- 14.5 PSI 4-20mA	E-1375

Valve, Relief, Back Pressure, Kunkle, 1", Liquid Service
Set @ 50 PSI, 0019-E01-MG0050

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Definitions and Commonly Used Terms

A.S.M.E.
American Society of Mechanical Engineers.

A.P.I.
American Petroleum Institute

PRV
Relief Valve, Safety Valve, Safety Relief Valve.

Back Pressure
The pressure that exists at the outlet of a pressure relief device as a result of the pressure in the discharge system. It is the sum of the superimposed and built-up back pressures.

Built-up Back Pressure
The increase in pressure in the discharge header that develops as a result of flow after the pressure relief device opens.

Blowdown
The difference in pressure between the opening pressure and reclose pressure. May be expressed in percent of set pressure or "psig."

Body/Nozzle/Seat
The stationary seating surface, the inlet.

Cap
The pressure screw cover and/or lever housing. May be screwed, bolted, packed, or plain lever.

Chatter
Abnormal, rapid reciprocating movement of the disc on the seat of a pressure relief valve.

Coefficient of Discharge
The ratio of the measured relieving capacity to the theoretical relieving capacity.

Disc
The moveable seating surface.

Gag
A device attached to a safety or safety relief valve that prevents it from opening at the set pressure.

Guide
That portion of the valve used to guide the disc.

Lift
The distance between the seat and disc seating surfaces when the valve is in the full open position.

MAWP
Maximum allowable working pressure. This data is found on the pressure vessel nameplate and is the maximum pressure at which the lowest set safety valve must be set (stamped).

N.B.
National Board of Boiler and Pressure Vessel Inspectors.

Operating Pressure
The gauge pressure at which a pressure vessel is maintained in normal operation. The operating pressure should not be in excess of 90 percent of the PRV set pressure.

Accumulation
The permitted increase in pressure developed after the valve has opened. Usually expressed in percentage, maximum allowable accumulations are established by applicable codes for operating and fire contingencies.

Pre-open/Warn
An audible or visual discharge at a pressure slightly lower than the set pressure. Warns the operator that the valve is about to operate.

Pressure Relief Device
A device actuated by inlet static pressure and designed to open during an emergency or abnormal condition to prevent a rise of internal fluid pressure in excess of a specified value. The device may also be designed to prevent excessive internal vacuum. The device may be a pressure relief valve, a non-reclosing pressure relief device, or a vacuum relief valve.

psia
Pounds per square inch absolute or absolute pressure. Absolute pressure is equal to gauge pressure plus atmospheric pressure (14.7 psi [1.01 barg] at sea level).

psig
Pounds per square inch gauge or gauge pressure. Differential pressure across the valve, equal to absolute pressure inside the pressure vessel minus atmospheric pressure (14.7 psi [1.01 barg] at sea level).

Relief Valve
A spring-loaded pressure relief valve actuated by the static pressure upstream of the valve. The valve opens normally in proportion to the pressure increase over the opening pressure. A relief valve is used primarily with incompressible fluids (liquids).

Safety Relief Valve
A spring-loaded pressure relief valve that may be used as either a safety or relief valve depending on the application.

Safety Valve
A spring-loaded pressure relief valve actuated by the static pressure upstream of the valve and characterized by rapid opening or pop action. A safety valve is normally used with compressible fluids.

Set Pressure
The gauge pressure at which a safety valve visibly and audibly opens or at which a relief valve discharges a 1" long unbroken stream of liquid.

Spindle/Stem
The rod connecting to the disc.

Stamped Capacity
The rated relieving capacity that appears on the device nameplate. The stamped capacity is based on the set pressure or burst pressure plus the allowable overpressure for compressible fluids and the differential pressure for incompressible fluids.

Superimposed Back Pressure
The static pressure that exists at the outlet of a pressure relief device at the time the device is required to operate. It is the result of pressure in the discharge system coming from other sources and may be constant or variable.

Warn Ring or Regulator Ring
The control ring which surrounds the seat, used to control preopen and blowdown.

Yoke/Bonnet
The portion of a safety/relief valve that surrounds the spring; the spring housing.

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ASME Codes

The ASME (American Society of Mechanical Engineers) boiler and pressure vessels code requirements for overpressure protection as they relate to Kunkle products is as follows:

ASME Section I

This code applies to boilers where steam or other vapor is generated at a pressure of 15 psig [1.03 barg] or greater and high temperature water boilers intended for operation at pressures exceeding 160 psig [11.03 barg] and/or temperatures exceeding 250°F [121°C].

Boiler Pressure Accumulation

No more than 6 percent above the highest pressure at which any valve is set, or no more than 6 percent above MAWP.

Set Pressure

The set pressure of a one valve installation cannot be higher than the MAWP. The set pressure of the second or other valves in a multiple valve installation can be up to 3 percent above the MAWP. The complete range of valve settings for multiple valve installations cannot be greater than 10 percent of the highest set pressure. For high temperature water boilers, this 10 percent range may be exceeded.

ASME Section IV

This code applies to steam boilers operating at pressures not greater than 15 psig [1.03 barg] and hot water heating boilers operating at pressures not greater than 160 psig [11.03 barg] and/or temperatures not exceeding 250°F [121°C].

Steam Boilers

Valve capacity must be selected to prevent the boiler pressure from rising more than 5 psig [0.35 barg] above the MAWP.

Hot Water Boilers

Safety valve must be set to relieve at a pressure not greater than the MAWP of the boiler. If more than one safety valve is used, the secondary valve(s) may be set up to 6 psig [0.41 barg] above the MAWP for boilers with MAWPs up to and including 60 psig [4.13 barg], and 5 percent for boilers with MAWPs greater than 60 psig [4.13 barg]. Capacity must be selected to prevent the pressure from rising more than 10 percent above the set pressure of the highest set valve if more than one valve is used.

Tanks/Heat Exchangers High Temperature Water-to-Water Heat Exchangers

Valve(s) must be set at a pressure not greater than the MAWP and with sufficient capacity to prevent the pressure from increasing more than 10 percent above the MAWP.

Steam to Hot Water Supply

Valve(s) must be a least 1" [25 mm] diameter with set pressure not greater than MAWP of the tank.

High Temperature Water to Steam Heat Exchanger

Valve(s) must be set at a pressure not greater than 15 psig [1.03 barg] and with sufficient capacity to prevent the pressure from rising more than 5 psig [0.35 barg] above the MAWP.

ASME Section VIII

This code applies to unfired pressure vessels with an inside diameter larger than 6" [130 mm] and designed for use at or above 15 psig [1.03 barg]. Valve(s) must prevent the pressure from rising more than 10 percent or 3 psig [0.21 barg], whichever is greater, above the MAWP. For a single valve installation, the set pressure may not be greater than the MAWP. For multiple valve installations, the first valve cannot be set higher than the MAWP, but the other valves can be set up to 5 percent above the MAWP. The pressure rise for multiple valve installations can be 16 percent or 4 psig [0.27 barg], whichever is greater. When the vessel is exposed to an external heat source, such as fire, the pressure rise can be 21 percent above the MAWP.

Notes

1. MAWP - Maximum allowable working pressure.
2. Information stated above is based on latest code at time of publication.

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ASME Codes – Requirements

National Board

Kunkle valves are manufactured at facilities that meet the manufacturing requirements of the ASME Sections I, IV, and VIII codes for pressure relief valves. Valves that have the relief capacity certified by the National Board of Boiler and Pressure Vessel Inspectors bear the following code symbol stamp on the nameplate and the letters NB. Most Kunkle Valves have NB certified capacities.

Code Stamps

"V" - applies to all ASME Section I valves

"HV" - applies to all ASME Section IV valves

"UV" - applies to all ASME Section VIII valves

Notes

1. Information stated above is based on latest code at time of publication.
2. Non-code liquid valves are capacity rated at 25 percent overpressure.
3. Non-code air/gas/vapor and steam valves are capacity rated at 10 percent overpressure.

Power Boiler - Section I - Code "V"

Set Pressure psig	[barg]	Set Pressure Tolerance	Blowdown
15 – 66	[1.03 – 4.55]		2 – 4 psig [0.14 – 0.28 barg]
67 – 100	[4.62 – 6.90]		2 psi [0.14 barg] - 6%
101 - 250	[6.96 - 17.24]		2% - 6%
251 – 374	[17.31 – 25.79]		2% - 15 psig [1.03 barg]
375 – 1000	[25.86 – 68.96]		2% - 4%
15 – 69	[1.03 – 4.75]	±2 psig [±0.14 barg]	
70 – 300	[4.83 – 20.69]	±3%	
301 – 1000	[20.95 – 68.96]	±10% psig [±0.69 barg]	
1001 and up	[69.03 and up]	±1%	

1. Overpressure would be 2 psig [0.14 barg] for pressures between 15 psig [1.03 barg] and 70 psig [4.83 barg]. Pressures above 70 psig [4.83 barg] would have an overpressure of 3%.
2. Maximum blowdown for "Special Use" Section I is 10%.

Heating Boiler - Section IV - Code "HV"

	Set Pressure psig	[barg]	Set Pressure Tolerance	Blowdown	Overpressure
15 psig Steam	15	[1.03]	±2 psig [±0.14 barg]	2 – 4 psig [0.14 – 0.28 barg]	5 psig [0.34 barg]
Hot Water	15 – 60	[1.03 – 4.14]	±3 psig [±0.21 barg]	N/A	10%
Hot Water	61 – 160	[4.20 – 11.0]	±5%	N/A	10%

Unfired Pressure Vessel - Section VIII - Code "UV"

Set Pressure psig	[barg]	Set Pressure Tolerance	Blowdown	Overpressure
15 – 30	[1.03 – 2.07 barg]	±2 psig [±0.14 barg]	N/A	3 psig [0.21 barg]
31 – 70	[2.14 – 4.83 barg]	±2 psig [±0.14 barg]	N/A	10%
71 and up	[4.90 barg and up]	±3%	N/A	10%

Non-code Set Pressure Tolerance

Set Pressure, psig [barg]	Set Pressure Tolerance, psig [barg]
Below 15 psig [1.03 barg] to 10 psig [0.69 barg]	+/- 2.0 psig [±0.14 barg]
Below 10 psig [0.69 barg] to 5.0 psig [0.34 barg]	+/- 1.0 psig [±0.07 barg]
Below 5.0 psig [0.34 barg] to 0.0 psig [0.0 barg]	+/- 0.5 psig [±0.003 barg]
Below 0.0-inch Hg [0.0 mb] to 10-inch Hg [337 mb]	+/- 1.0-inch Hg [±33.7 mb]
Below 10-inch Hg [337 mb] to 20-inch Hg [674 mb]	+/- 2.0-inch Hg [±67.4 mb]
Below 20-inch Hg [674 mb]	+/- 4.0-inch Hg [±134.8 mb]

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General Safety and Relief Valve Information

Kunkle Factory Standard Seat Tightness

Code Section	Service	Performance Standard
I and VIII	Steam	No visible leakage for 15 seconds at 20% below nameplate set pressure or at 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.
VIII	Air/Gas	No audible leakage for 15 seconds at 20% below nameplate set pressure or at 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.
IV and VIII	Liquid	No visible leakage for 30 seconds at 20% below nameplate set pressure or at 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.
IV	Steam	No visible leakage for 30 seconds at 12 psig [0.83 barg].

API - 527 Seat Tightness

Model	Code Section	Service	Performance Standard
300/600 6000 900	I and VIII	Steam	API 527 - No visible leakage for 1 minute at 10% below nameplate set pressure or 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.
6010 (O-ring seat) 916/917 (soft seat) 918/919 (soft seat)	VIII	Air/Gas	API 527 - Bubble-tight for 1 minute at 10% below nameplate set pressure or 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.
910/912 911/913	VIII	Air/Gas	API 527 - D and E orifice: 40 bubbles/min, F thru J orifice: 20 bubbles/min at 10% below nameplate set pressure or 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.
916/917 (soft seat) 918/919 (soft seat)	VIII	Liquid	API 527 - No leakage for 1 minute at 10% below nameplate set pressure, or 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.
910/912 911/913	VIII	Liquid	API 527 - 10 cc/h for inlet sizes less than 1" or 10 cc/h/in of inlet valve size for inlet sizes 1" and larger at 10% below nameplate set pressure or 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.

Note

API 527 is not available on air service for:

a. Plain lever "J" orifice Models 900 and 6000.
b. Plain lever Model 900 above 444 psig [30.6 barg] set pressure.

The terms "safety valve" and "relief valve" are frequently used interchangeably. This is satisfactory to the extent that both safety and relief valves of the spring-loaded type are similar in external appearance and both serve the broad general purpose of limiting media (liquid or gaseous) pressures by discharging some of the pressurized liquid or gas. Some authorities restrict "safety valves" to those installed on boilers, superheaters, and fired vessels - all others being classified as relief valves. We prefer, however, to define them briefly as follows:

Safety valves are used on gaseous service (which include air and steam). Their design always includes a huddling chamber which utilizes the expansion forces of these gases to effect quick opening (popping) and closing actions. The difference between the opening and closing pressures is termed "blowdown," and for Section I and IV steam safety valves blowdown limitations are carefully stated in the ASME Power Boiler Code. Relief valves are normally used for liquid service although safety valves may be so used. Ordinarily, relief valves do not have an accentuated huddling chamber nor a regulator ring for varying or adjusting blowdown. They therefore operate with a semi-modulating action in proportion to the system pressure. Such relieving action is desirable to protect piping systems from water hammer.

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Safety and Relief Valve Pointers

1. ASME Codes require that steam and air safety valves have test levers, although levers may be omitted on valves used in hazardous or toxic gas service.
2. Steam safety valves may be used for air service but not vice versa. Liquid valves should be used on liquid only.
3. Safety/relief valves should be installed vertically with the drain holes open or piped to a convenient location.
4. The inlet to and outlet from a safety/relief valve must be at least as large as the valve connections.
5. Every safety/relief valve is individually tested and set by Kunkle.
6. In the event you have safety/relief valve problems, first check the accuracy and cleanliness of pressure gauges and then refer to "Recommended Installation" for help in determining the cause of your problem. Feel free to consult your sales representative.
7. When ordering, we need to know size, type of connections, model number, pressure setting, required relieving capacity, and service media, or advise your complete requirements so that we can make a selection for you.
8. Following are procedures on the operation and testing of safety/relief valves:
   A. Avoid excessive operation of the safety/relief valve as even one opening can provide a means for leakage. Safety/relief valves should be operated only often enough to assure that they are in good working order.
   B. Test the valve by raising the operating pressure to the set pressure of the safety/relief valve, allowing it to open and reset as it would in normal service.
   C. Do not hand operate the valve with less than 75 percent of the stamped set pressure exerted on the underside of the disc. When hand operating, be sure to hold the valve in an open position long enough to purge accumulated foreign material from the seat area and then allow the valve to snap shut.

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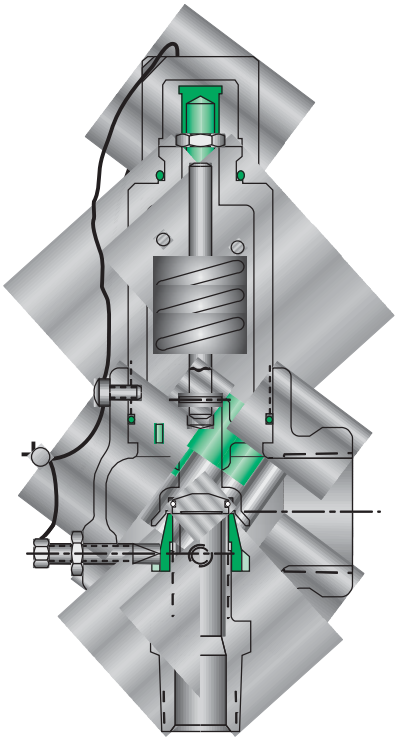
Safety and Relief Valve Principles of Operation

Kunkle direct spring operated pressure relief valves consist of a nozzle threaded into a cast body housing which is flanged to a pressurized system. A disc is held against the nozzle by a spring, which is contained in a bonnet. The spring is adjusted by a compression screw to permit the calibration of opening or set pressure.

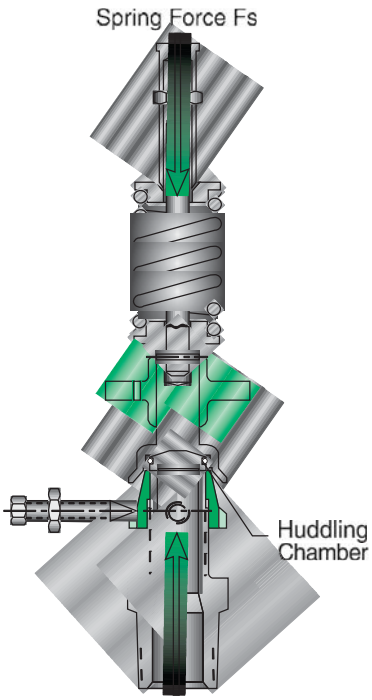


An adjustable nozzle ring, threaded onto the nozzle, controls the geometry of the fluid exit control chamber (huddling chamber). The huddling chamber geometry is very important in controlling valve opening and closing pressures, and stability of operation. The nozzle ring is locked into position by a ring pin assembly. A cap attached to the top of the bonnet seals the internal calibration adjustments. Refer to the illustration above for the location of these important components.

Under normal system operation the valve remains in the closed position because the spring force (Fs) is greater than the system pressure acting on the internal nozzle seating area (PA). If system pressure increases to a point when these forces are equal, the valve begins to simmer. The disc lifts and fluid flows through the valve. When pressure in the system returns to a safe level, the valve closes.

Just prior to reaching set point, the pressure relief valve leaks system fluid into the huddling chamber. The fluid now acts on a larger area of the disc inside the huddling chamber (PAh), causing the valve to experience an instantaneous increase in the opening force. Refer to the Figure on page 7 to see relationship between Nozzle Area (A) and the Huddling Chamber Area (Ah). System pressure acting on the larger area will suddenly open the pressure relief valve at a rapid rate.

Although the opening is rapid and dramatic, the valve does not open fully at set point. The system pressure must increase above the set point to open the valve to its full lift and full capacity position. Maximum lift and certified flow rates will be achieved within the allowable limits (overpressure) established by various codes and standards. All pressure relief valves are allowed an overpressure allowance to reach full rated flow.



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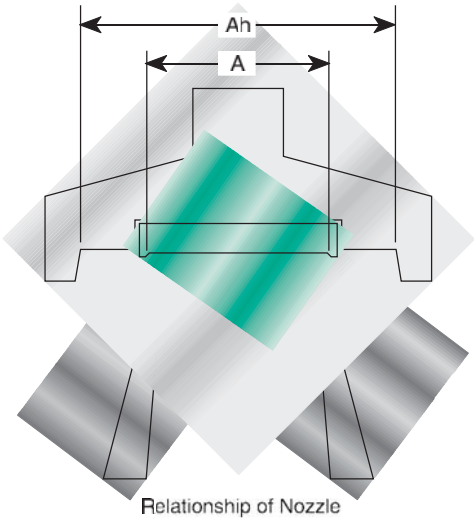
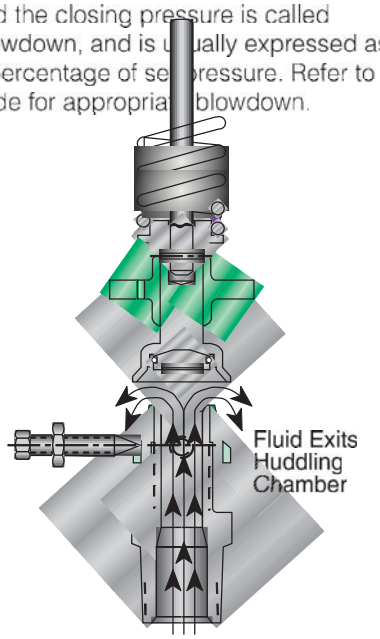
Safety and Relief Valve Principles of Operation



Relationship of Nozzle Area to Huddling Chamber Area

Once the valve has controlled the pressure excursion, system pressure will start to reduce. Since the huddling chamber area is now controlling the exit fluid flow, system pressure must reduce below the set point before the spring force is able to close the valve. The difference between the set pressure and the closing pressure is called blowdown, and is usually expressed as a percentage of set pressure. Refer to code for appropriate blowdown.



Valve Opens, Force P_{Ah} Acting on Disc

The nozzle ring adjustment changes the shape and volume of the huddling chamber, and its position will affect both the opening and closing characteristics of the valve. When the nozzle ring is adjusted to its top position, the huddling chamber is restricted to its maximum. This ring position will usually make the valve pop very distinctly with a minimum simmer (leakage before opening), but the blowdown will increase. When the nozzle ring is lowered to its lowest position, minimal restriction to the huddling chamber occurs. At this position, simmer increases and the blowdown decreases. The final ring position is somewhere between these two extremes to provide acceptable performance.

Liquid Service Operation

On liquid service, a different dynamic situation exists. Liquids do not expand when flowing across orifices, and a small amount of fluid flow across the nozzle will produce a large local pressure drop at the nozzle orifice. This local pressure drop causes the spring to reclose the valve if the fluid flow is minimal. Liquids leaking into the huddling chamber can quickly drain out by gravity and prevent fluid pressure from building up on the secondary area of the huddling chamber. Liquid relief valves are thus susceptible to a phenomenon called chatter, especially at low fluid flow rates. Chatter is the rapid opening and closing of the pressure relief valve and is often destructive in nature.

Since no visible or audible pop is heard at set point, liquid set pressure is defined as the pressure when the first heavy flow occurs (first steady vertical flow).

Ordering Information

Purchase orders must show the Size, Model Number, Set Pressure, and Service. (Include flange rating with size when applicable.)

1. To make a proper catalog selection, the following information will be needed:
   - A. Connection sizes (in and out), and types (male, female, flanged; 125#, 150#, 250#, 300#, etc.)
   - B. Material of construction
     - a. Bronze
     - b. Iron
     - c. Steel
     - d. Stainless Steel or other
   - C. Pressure setting
   - D. Service (steam, air, gas, etc., including any applicable codes or standards)
   - E. Capacity required, if available
   - F. Unusual conditions (temperature, location, etc.)

     Be sure to use the capacity correction factors for superheated steam, liquid overpressure (10 percent), air-gas temperature and density correction.
   - G. If valve is to be "equal to" another brand, provide nameplate information or specification data from brand being replaced.
2. Ordering data for replacement valves may be obtained from the valve nameplate or stamping.

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Valve Selection

The most critical consideration when selecting a pressure relief valve is that the valve will be capable of passing the maximum expected flow capacity. To properly select a relief valve the user must first determine the following:

1. The set pressure at which the valve is to operate. This pressure is based on the pressure limits of the system and the applicable codes. The set pressure of the primary pressure relief valve must not exceed the maximum allowable pressure of the system, but should be at least 10 percent above the maximum operating pressure.
2. The physical properties of the fluid media to be relieved. Capacity values are given in the Kunkle catalogs based on air, saturated steam, and water. Kunkle valves will relieve many other fluids, but information such as molecular weight, specific gravity, viscosity, ratio of specific heats, compressibility factor, and process temperature may be necessary to insure accurate valve selection.
3. The required relieving capacity. The ASME Boiler and Pressure Vessel Code, American Petroleum Institute Recommended Practices, and other applicable standards have many rules for obtaining the required relieving capacity and should be referenced when making this determination. The user must consider all sources of pressure generation in the system that will be protected by the pressure relief valve. Examples of pressure generation sources are pumps, heat input that may cause the system fluid to boil or expand, etc. The pressure relief valve(s) selected must exceed the worst case source of flow generation to prevent the system pressure from exceeding acceptable limits.

Once the previous information has been collected, the pressure relief valve may be sized by using the capacity charts (included in each model's catalog sheet) or by performing sizing calculations (see Valve Sizing, pages 14-25). The user will also want to consider other important factors such as:

- Connection size and type. This information is given in the Valve Selection Guide and in each of the Model Catalog sheets. Please note that the inlet to and outlet from a pressure relief valve must be at least as large as the valve connections to prevent valve malfunction.
- Pipe Size. Connection pipe sizes should not be determined by equipment connections, but rather by the relieving capacity of the PRV.
- Applicable code compliance. The ASME Code Summary section gives important information about pressure relief valves from the code. Pressure relief valve users are strongly encouraged to reference the full version of the code for important rules that may not be included in this manual.
- Maximum allowable seat leakage. The General Safety and Relief Valve Information (page 6) section of this manual shows the leakage acceptance criteria applied to each Kunkle valve. Pressure relief valve users should keep in mind that if "zero leakage" is a requirement, a soft seated valve must be selected.
- Environmental conditions. Environmental conditions play a significant role in how pressure relief valves operate. Extremely high ambient temperatures may affect the set pressure of the valve, extremely low temperatures combined with moisture can cause valves to "freeze up" and prevent proper operation, and vibration may severely shorten the service life of the valve. The Valve Selection Guide (pages 11-13) in this manual has general information on the pressure and temperature limits for each valve series. For specific model limitations refer to the individual model catalog. For vibration service, please contact your local Kunkle representative for assistance.
- Valve options. Each Kunkle model is offered with useful options such as pressure tight caps, lift lever options, or vibration dampening preparation. When selecting valve options, keep in mind that there are code requirements that may dictate what options may be used. For instance the ASME code dictates that all air, steam and hot water (140°F+[60°C+]) pressure relief valves must be equipped with a lift lever. Refer to the individual model catalogs for listings of available options.
- Installation space. The individual model catalogs show envelope dimensions for each configuration and size.

For assistance on valve sizing and selection, please contact your local sales representative.

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Valve Selection Guide

(For specific minimum/maximum temperature/pressure ranges refer to individual product sections.)

Steam (ASME Section I - Power Boilers)

Model(s)	Material		Connections		Inlet Size Range		Min/Max[1] Press.		Min/Max Temp.	
	Body	Trim	NPT	FLGD	in	[mm]	psig	[barg]	°F	[°C]
300, 600	CS	SS		X	1¼ - 6"	[31.75 - 152.4]	15/1000	[1.0/69]	-20/800	[-29/427]
920, 921, 927 (special use – 10% blowdown)	CS	SS	X		½ - 2"	[12.7 - 50.8]	15/1400	[1.0/96.5]	-20/800	[-29/427]
6010, 6021, 6121, 6182 6186, 6221, 6283	Bronze	Brass	X		½ - 2½"	[12.7 - 63.5]	3/250	[0.69/17.2]	-60/406	[-51/208]
6030, 6130, 6230	Bronze	SS	X		½ - 2½"	[12.7 - 63.5]	3/300	[0.69/20.7]	-60/425	[-51/219]
6252	Iron	SS	X	X	1½ - 6"	[38.1 - 152.4]	10/250	[0.69/17.2]	-20/406	[-29/208]

Steam (ASME Section VIII - Unfired Steam Equipment)

1 and 2	Bronze	Brass	X		½ - 1"	[12.7 - 25.4]	5/250	[0.34/17.2]	-60/406	[-51/208]
264, 265	CS	SS	X		½ - 1"	[12.7 - 25.4]	4/3300	[0.28/227.6]	-20/750	[-29/399]
266, 267	SS	SS	X		½ - 1"	[12.7 - 25.4]	4/3300	[0.28/227.6]	-20/750	[-29/399]
300, 600	CS	SS		X	1¼ - 6"	[31.75 - 152.4]	15/1000	[1.0/69]	-20/750	[-29/399]
910	CS	SS	X	O	½ - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-20/800	[-29/427]
911	SS	SS	X	O	½ - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-320/800	[-195/427]
912	Bronze	Brass	X		½ - 2"	[12.7 - 50.8]	3/250	[0.21/17.2]	-320/406	[-195/208]
913	Bronze	SS	X		½ - 2"	[12.7 - 50.8]	3/300	[0.21/20.7]	-320/425	[-195/219]
6010, 6021, 6121, 6182, 6186, 6221, 6283	Bronze	Brass	X		½ - 2½"	[12.7 - 63.5]	3/250	[0.21/17.2]	-60/406	[-51/208]
6030, 6130, 6230	Bronze	SS	X		½ - 2½"	[12.7 - 63.5]	3/300	[0.21/20.7]	-60/425	[-51/219]
6252	Iron	SS	X	X	1½ - 6"	[38.1 - 152.4]	10/250	[0.69/17.2]	-20/406	[-29/208]

Steam (ASME Section IV - Low Pressure Steam Heating Boilers)

930	Iron	Bronze	X		2 - 3"	[50.8 - 76.2]	15 only	[1.0]	250 only	[122]
6933, 6934	Bronze	Brass	X		½ - 2"	[12.7 - 50.8]	15 only	[1.0]	250 only	[122]
6935	Bronze	SS	X		½ - 2"	[12.7 - 50.8]	15 only	[1.0]	250 only	[122]
6254	Iron	SS	X	X	1½ - 6"	[38.1 - 152.4]	15 only	[1.0]	250 only	[122]

Steam (Non-code)[2]

40R, 40RL	SS	SS	X		½ - ¾"	[12.7 - 19.05]	1/400	[0.07/27.6]	-60/850	[-51/454]

X = Standard O = Optional

Notes

1. Set pressures less than 15 psig [1.0 barg] are non-code only.
2. See also ASME Section VIII steam valves for non-code steam applications.

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Valve Selection Guide

(For specific minimum/maximum temperature/pressure ranges refer to individual product sections.)

Air/Gas (ASME Section VIII)

Model(s)	Material		Connections		Inlet Size Range		Min/Max[3] Press.		Min/Max[4] Temp.	
	Body	Trim	NPT	FLGD	in	[mm]	psig	[barg]	°F	[°C]
1 and 2	Brass	Brass	X		1/2 - 1"	[12.7 - 25.4]	5/250	[0.34/17.2]	-60/406	[-51/208]
30	Brass	Brass	X		1/4"	[6.35]	60/4000	[4.1/275.8]	20/300	[-6.6/150]
189	Bronze	SS	X		1/2 - 3/4"	[12.7 - 19.05]	1000/2500	[69/344.8]	-320/350	[-195/177]
264, 265	CS	SS	X		1/2 - 1"	[12.7 - 25.4]	4/3300	[0.28/227.6]	-20/750	[-29/399]
266, 267	SS	SS	X		1/2 - 1"	[12.7 - 25.4]	4/3300	[0.28/227.6]	-20/750	[-29/399]
300, 600	CS	SS		X	1 1/4 - 6"	[31.75 - 152.4]	15/1000	[1.0/69]	-20/800	[-195/427]
330[5]	Aluminum	SS	X		1/4"	[6.35]	1000/5500	[69/379.3]	-20/185	[-29/85]
330S, 333S[5]	Aluminum	SS			1/4"	[6.35]	2000/6500	[138/448.3]	-20/185	[-29/85]
337	Iron	Bronze	X		2 - 3"	[50.8 - 76.2]	1/60	[0.07/4.14]	-20/406	[-29/208]
338	Aluminum	Brass	X		2"	[50.8]	5/30	[0.3/2.07]	-30/400	[-34/204]
363	Bronze	SS	X		1/2 - 3/4"	[12.7 - 19.05]	50/1000	[3.4/69]	-320/350	[-195/177]
389	SS	SS	X		1/2 - 3/4"	[12.7 - 19.05]	50/2500	[3.4/172.4]	-320/350	[-195/177]
541 (Buna disc), 542 (Viton® disc), 548 (SS disc)	Brass	Brass	X		1/4 - 1/2"	[6.35 - 12.7]	3/400	[0.21/27.6]	-20/400	[-29/204]
910, 916 (soft seat)[4]	CS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-20/800	[-29/427]
911, 917 (soft seat)[4]	SS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-320/800	[-195/427]
912, 918 (soft seat)[4]	Bronze	Brass	X		1/2 - 2"	[12.7 - 50.8]	3/300	[0.21/20.7]	-320/406	[-195/208]
913, 919 (soft seat)[4]	Bronze	SS	X		1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-320/425	[-195/219]
6010, 6121, 6182 6186, 6221, 6283[1]	Bronze	Brass	X		1/2 - 2 1/2"	[12.7 - 63.5]	3/250	[0.21/17.2]	-60/406	[-51/208]
6030, 6130, 6320	Bronze	SS	X		1/2 - 2 1/2"	[12.7 - 63.5]	3/300	[0.21/20.7]	-60/425	[-51/219]
6252	Iron	SS	X	X	1 1/2 - 6"	[38.1 - 152.4]	10/250	[0.69/17.2]	-20/406	[-29/208]

Air/Gas[2] (Non-code)

230 (Kynar® seat)	Aluminum	SS	X		1/4"	[6.35]	300/1500	[20.7/103.4]	-20/185	[-29/85]
803 (Kynar® seat)	Aluminum	SS	X		1/4"	[6.35]	1000/6000	[69/413.8]	-20/185	[-29/85]
818 (Teflon® seat)	CS	SS/Brass	X		2"	[50.8]	120/150	[8.3/10.3]	-20/300	[-29/150]

Air/Gas (Vacuum) in Hg [mm Hg]

215V	Iron	Bronze	X		2 - 3"	[50.8 - 76.2]	2/29	[50/736]	-20/406	[-29/208]
910, 916 (soft seat)[4]	CS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	6/29	[152/736]	-20/800	[-29/427]
911, 917 (soft seat)[4]	SS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	6/29	[152/736]	-320/800	[-195/427]
912, 918 (soft seat)[4]	Bronze	Brass	X		1/2 - 2"	[12.7 - 50.8]	6/29	[152/736]	-320/406	[-195/208]
913, 919 (soft seat)[4]	Bronze	SS	X		1/2 - 2"	[12.7 - 50.8]	6/29	[152/736]	-320/425	[-195/219]

X = Standard O = Optional

Notes

1. Soft seat available on some models.
2. See also Section VIII air valves for non-code air/gas applications.
3. Set pressures less than 15 psig [1.0 barg] are non-code only.
4. Temperature limits of soft seats determine operating limits of valve.
5. Kynar® or Urethane Seat.

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Valve Selection Guide

(For specific minimum/maximum temperature/pressure ranges refer to individual product sections.)

Model(s)	Material Body	Material Trim	Connections NPT	Connections FLGD	Inlet Size Range in	Inlet Size Range [mm]	Min/Max[1] Press. psig	Min/Max[1] Press. [barg]	Min/Max[2] Temp. °F	Min/Max[2] Temp. [°C]
Liquid (ASME Section IV - Hot Water Boilers)										
537 (soft seat)	Iron/Bronze		Brass	X	3/4 - 2"	[19.05 - 50.8]	15/160	[1.0/11]	-20/250	[-29/121]
Liquid (ASME Section VIII)										
910, 916 (soft seat)[2]	CS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-20/800	[-29/427]
911, 917 (soft seat)[2]	SS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-320/800	[-195/427]
912, 918 (soft seat)[2]	Bronze	Brass	X		1/2 - 2"	[12.7 - 50.8]	3/300	[0.21/20.7]	-320/406	[-195/208]
913, 919 (soft seat)[2]	Bronze	SS	X		1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-320/425	[-195/219]
Liquid (Non-code)										
19, 20	Bronze	Bronze	X	O	1/2 - 3"	[12.7 - 76.2]	1/300	[0.07/20.7]	-60/406	[-51/208]
19M, 20M	Bronze	SS	X	O	2 1/2 - 3"	[63.5 - 76.2]	1/500	[0.07/34.5]	-60/406	[-51/208]
71S	Iron	SS	X		1/2 - 2"	[12.7 - 50.8]	1/250	[0.07/17.2]	-20/406	[-29/208]
171, 171P	CS	SS	X		1/2 - 2"	[12.7 - 50.8]	1/400	[0.07/27.6]	-20/550	[-29/288]
171S	SS	SS	X		1/2 - 2"	[12.7 - 50.8]	1/400	[0.07/27.6]	-20/550	[-29/288]
91	Iron	Bronze	X	X	1 1/2 - 6"	[38.1 - 152.4]	5/400	[0.34/27.6]	-20/406	[-29/208]
218,228	Iron	Bronze	X		3, 4, and 6"	[76.2 - 152.4]	60/200	[4.1/13.8]	-20/406	[-29/208]
140	SS	SS	X		3/8 - 1/2"	[9.5 - 12.7]	10/300	[0.69/20.7]	-60/406	[-51/208]
264, 265	CS	SS	X		1/2 - 1"	[12.7 - 25.4]	4/3300	[0.28/227.6]	-20/750	[-29/399]
266, 267	SS	SS	X		1/2 - 1"	[12.7 - 25.4]	4/3300	[0.28/227.6]	-20/750	[-29/399]
910, 916 (soft seat)[2]	CS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-20/800	[-29/427]
911, 917 (soft seat)[2]	SS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-320/800	[-195/427]
912, 918 (soft seat)[2]	Bronze	Brass	X		1/2 - 2"	[12.7 - 50.8]	3/300	[0.21/20.7]	-320/406	[-195/208]
913, 919 (soft seat)[2]	Bronze	SS	X		1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-320/425	[-195/219]
Liquid - Underwriters Laboratories (UL) For Oil Services										
200A	Bronze	Brass	X		3/4 - 1 1/2"	[19.05 - 38.1]	1/200	[0.07/13.8]	-60/406	[-51/208]
200H	Bronze	SS	X	O	3/4 - 2"	[19.05 - 50.8]	1/200	[0.07/13.8]	-60/406	[-51/208]
Liquid - Underwriters Laboratories (UL) and Factory Mutual Research (FM) For Fire Pump Water Relief										
218, 228	Iron	Bronze	X	X	3, 4 and 6"	[76.2 - 152.4]	60/200	[4.1/13.8]	-20/406	[-29/208]
918 (soft seat)[2, 3]	Bronze	Brass	X		3/4 - 1"	[19.05 - 25.4]	60/250	[4.1/17.2]	-20/406	[-29/208]
Other - Drip Pan Elbow										
299	Iron	N/A	X	X	2 - 8"	[50.80 - 203.2]	N/A	N/A	-20/406	[-29/208]

X = Standard O = Optional

Notes

1. Set pressures below 15 psig [1.0 barg] are non-code only.
2. Temperature limits of soft seats determine operating limits of valve.
3. FM Approved only.

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Valve Sizing

After the required relieving capacity has been determined, the pressure relief valve may be sized by using the capacity charts that are included in each model's catalog sheet. The capacities given in those charts may be adjusted for special conditions such as fluid density and temperature by using the correction factors given in Tables B through D (pages 18-20). Valves may also be sized by performing sizing calculations per the formulas (pages 15 and 16) in this section.

Most Kunkle valves may be sized by using the "Coefficient Method" (listed below). These valves typically are high lift valves where the nozzle bore is the flow controlling orifice. This calculation method involves selecting the valve model and corresponding flow coefficient and orifice area from Table A (page 16) and then using the capacity formula (page 14) for the service in which the valve will function.

Kunkle Models 30, 541, 542, and 548 use the "Slope Method" for sizing calculations. These valves are typically low lift valves, where the annular orifice between the disc and the nozzle seat is the flow controlling orifice. These models are characterized by having a linear increase in capacity with respect to inlet pressure. The "slope" defines this direct relationship of inlet pressure to capacity. Consult your sales representative for sizing assistance.

Kunkle Models 1, 2, 19, 20, 200, 71S, 171, 171S, 91, 218, 228, and 140 use the "KA Method" for sizing calculations. This method is similar to the slope method, in that it is used for low lift valves and is empirically derived. The major difference is that the relationship between inlet pressure and capacity is not linear. These valves are characterized by having low lift that varies with inlet pressure, which makes the flow controlling orifice area indeterminate. Consult your sales representative for sizing assistance.

IV-A Coefficient Method

Follow these steps for calculating what orifice size is necessary to flow the required capacity:

1. Select the Model Family that you are interested in from the Valve Selection Guide (pages 10-13).
2. From Table A (page 17), record the Flow Coefficient (K_d) corresponding to the service in which the valve will operate.
3. Select the proper formula(s) for the service in which the valve will operate. Calculate the minimum required orifice area.
4. Select the Orifice/Size Designation from Table A (page 17) that has a Flow Area closest to, but not less than the minimum required orifice area calculated in step 3.

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Valve Sizing

U.S. Units | **Metric Units**

Steam - Sections I, IV and VIII (15 psig and above)

$$A = \frac{W}{51.5\ K_d\ P_1\ K_{sh}}$$

$$A = \frac{W}{52.5\ K_d\ P_1\ K_{sh}}$$

Steam - Non Code (less than 15 psig)

$$A = \frac{W}{735\ F_2\ K_d}\sqrt{\frac{TZ}{M\ P_1\ (P_1 - P_2)}}$$

$$A = \frac{W}{558\ F_2\ K_d}\sqrt{\frac{TZ}{M\ P_1\ (P_1 - P_2)}}$$

Air - Section VIII (15 psig and above)

$$A = \frac{V\sqrt{MTZ}}{6.32\ C\ K_d\ P_1}$$

Volumetric Flow

$$A = \frac{V\sqrt{MTZ}}{17.02\ C\ K_d\ P_1}$$

Volumetric Flow

$$A = \frac{W}{C\ K_d\ P_1}\sqrt{\frac{TZ}{M}}$$

Mass Flow

$$A = \frac{1.316W}{C\ K_d\ P_1}\sqrt{\frac{TZ}{M}}$$

Mass Flow

Air - Non-Code (less than 15 psig)

$$A = \frac{V}{4645.2\ F_2\ K_d}\sqrt{\frac{MTZ}{P_1\ (P_1 - P_2)}}$$

$$A = \frac{V}{12503\ F_2\ K_d}\sqrt{\frac{MTZ}{P_1\ (P_1 - P_2)}}$$

Liquid - Section VIII (15 psig and above)

$$A = \frac{Q}{38\ K_d}\sqrt{\frac{G}{(1.1\ p_1 - p_2)}}$$

$$A = \frac{Q}{5.094\ K_d}\sqrt{\frac{G}{(1.1\ p_1 - p_2)}}$$

Liquid - Non-Code

$$A = \frac{Q}{38\ K_d}\sqrt{\frac{G}{(1.25\ p_1 - p_2)}}$$

$$A = \frac{Q}{5.094\ K_d}\sqrt{\frac{G}{(1.25\ p_1 - p_2)}}$$

F_2 - Coefficient of Subcritical Flow

$$F_2 = \sqrt{\left(\frac{k}{k-1}\right)\left(r\right)^{2/k}\left[\frac{1 - r^{(k-1)/k}}{1 - r}\right]}$$

Note

1. Consult your sales representative for sizing assistance for product groups: Fig. 1 and 2; Fig. 19, 20, 200; Fig. 30; Fig. 71S, 171, 171S; Fig. 91, 218, 228; Fig. 140; and Fig. 541, 542 and 548.

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Valve Sizing

Sizing Coefficient Method

A = Required effective discharge area of the valve, in^2 [cm^2]

W = Mass Flow Rate, lb/hr [kg/hr]

V = Volumetric Flow Rate (gases, vapors) in SCFM [Nm^3/hr] at standard atmospheric conditions of 14.7 psia and 60°F [1.013 bara/0°C]

Q = Volumetric Flow Rate (liquids) in GPM [m^3/hr] at standard atmospheric conditions of 14.7 psia and 70°F [1.013 bara/21°C]

K_d = ASME Flow Coefficient of Discharge

P_1 = See chart below

P_2 = Atmospheric Pressure = 14.7 psia

p_1 = Set Pressure (psig)

p_2 = Back Pressure (psig)

F_2 = Coefficient of Subcritical Flow

k = Ratio of Specific Heat - 1.31 for Steam, 1.4 for Air

r = Ratio of Back Pressure to Upstream Relieving Pressure = P_2/P_1

M = Molecular Weight of Process Medium

T = Relieving Temperature, °R = °F + 460 [°K = °C + 273]

Z = Compressibility Factor (assume Z = 1 if unknown)

C = Gas Constant based on k (if unknown, use C = 315)

G = Specific Gravity of process fluid at 70°F [21°C]

K_{sh} = Superheat Steam Correction Factor

Allowable Overpressure

Designation	Section	Definition
P_1	Section I Steam (15 psig and above)	Set pressure + 3% or 2 psi overpressure (whichever is greater) + 14.7 psia
P_1	Section IV Steam (15 psig and above)	Set pressure + 5 psi overpressure + 14.7 psia for Low Pressure Steam Boilers
P_1	Section IV Hot Water (15 psig and above)	Set pressure + 10% overpressure + 14.7 psia for Hot Water Boilers
P_1	Non-Code Steam (below 15 psig)	Set pressure + 10% overpressure + 14.7 psia
P_1	Section VIII Steam (15 psig and above)	Set pressure + 10% or 3 psi overpressure (whichever is greater) + 14.7 psia
P_1	Non-Code Air (below 15 psig)	Set pressure + 10% overpressure + 14.7 psia
P_1	Section VIII Air (15 psig and above)	Set pressure + 10% or 3 psi overpressure (whichever is greater) + 14.7 psia
P_1	Non-Code Liquid (below 15 psig)	Set pressure (psig)
P_1	Section VIII Liquid (15 psig and above)	Set pressure (psig)

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Valve Sizing

Table A

Model Family	Orifice/Size Designation	Flow Area in²	Flow Area [cm²]	Flow Coefficient (K_d) Non-Code and ASME Section VIII Air/Gas and Steam	ASME Section I Steam	ASME Section IV Steam	Non-Code and ASME Section VIII Liquid
189	C	0.034	[0.219]	0.874			
	D	0.034	[0.219]	0.874			
264	C	0.110	[0.710]	0.766			0.408
	D	0.110	[0.710]	0.766			0.408
	E	0.110	[0.710]	0.766			0.408
337	H	1.838	[11.858]	0.860			
	J	2.786	[17.974]	0.860			
	K	4.037	[26.045]	0.860			
537	D	0.533	[3.439]			0.806	
	E	0.833	[5.374]			0.806	
	G	1.767	[11.400]			0.806	
	H	3.142	[20.271]			0.806	
910	D	0.121	[0.781]	0.878	0.878		0.710
	E	0.216	[1.394]	0.878	0.878		0.710
	F	0.337	[2.174]	0.878	0.878		0.710
	G	0.553	[3.568]	0.878	0.878		0.710
	H	0.864	[5.574]	0.878	0.878		0.710
	J	1.415	[9.129]	0.878	0.878		0.710
930	H	5.080	[32.774]			0.818	
	J	6.350	[40.968]			0.818	
	K	7.620	[49.161]			0.818	
6010	D	0.121	[0.781]	0.878	0.878	0.878	
	E	0.216	[1.394]	0.878	0.878	0.878	
	F	0.337	[2.174]	0.878	0.878	0.878	
	G	0.553	[3.568]	0.878	0.878	0.878	
	H	0.864	[5.574]	0.878	0.878	0.878	
	J	1.415	[9.129]	0.878	0.878	0.878	
6252	J	1.414	[9.123]	0.878	0.878	0.878	
	K	2.022	[13.045]	0.878	0.878	0.878	
	L	3.138	[20.245]	0.878	0.878	0.878	
	M	3.960	[25.548]	0.878	0.878	0.878	
	N	4.774	[30.800]	0.878	0.878	0.878	
	P	7.018	[45.277]	0.878	0.878	0.878	
	Q	12.155	[78.419]	0.878	0.878	0.878	
	R	17.600	[113.548]	0.878	0.878	0.878	

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Valve Sizing

Table B - Steam Super Heat Correction Factor, K_{sh}

Set Pressure psig	[barg]	Saturated Steam Temp. °F	[°C]	Total Steam Temperature °F [°C] 280 [138]	300 [149]	320 [160]	340 [171]	360 [182]	380 [193]	400 [205]	420 [216]	440 [227]	460 [238]	480 [249]	500 [260]	520 [271]	540 [282]	560 [293]
15	[1.03]	250	[121]	1.00	1.00	1.00	.99	.99	.98	.98	.97	.96	.95	.94	.93	.92	.91	.90
20	[1.38]	259	[126]	1.00	1.00	1.00	.99	.99	.98	.98	.97	.96	.95	.94	.93	.92	.91	.90
40	[2.76]	287	[142]		1.00	1.00	1.00	.99	.99	.98	.97	.96	.95	.94	.93	.92	.91	.90
60	[4.14]	308	[153]			1.00	1.00	.99	.99	.98	.97	.96	.95	.94	.93	.92	.91	.90
80	[5.52]	324	[162]				1.00	1.00	.99	.99	.98	.97	.96	.94	.93	.92	.91	.90
100	[6.90]	338	[170]					1.00	1.00	.99	.98	.97	.96	.95	.94	.93	.92	.91
120	[8.27]	350	[177]					1.00	1.00	.99	.98	.97	.96	.95	.94	.93	.92	.91
140	[9.65]	361	[183]						1.00	1.00	.99	.98	.96	.95	.94	.93	.92	.91
160	[11.0]	371	[188]						1.00	1.00	.99	.98	.97	.95	.94	.93	.92	.91
180	[12.4]	380	[193]							1.00	.99	.98	.97	.96	.95	.93	.92	.91
200	[13.8]	388	[198]							1.00	.99	.99	.97	.96	.95	.93	.92	.91
220	[15.2]	395	[202]							1.00	1.00	.9	.98	.96	.95	.94	.93	.92
240	[16.6]	403	[206]								1.00	.99	.98	.97	.95	.94	.93	.92
260	[17.9]	409	[210]								1.00	.99	.98	.97	.96	.94	.93	.92
280	[19.3]	416	[213]								1.00	1.00	.98	.97	.96	.95	.93	.92
300	[20.7]	422	[217]									1.00	.99	.98	.96	.95	.93	.92
350	[24.1]	436	[225]									1.00	1.00	.99	.96	.96	.94	.93
400	[27.6]	448	[231]										1.00	.99	.96	.96	.95	.93
450	[31.0]	460	[238]											1.00	.96	.96	.96	.94
500	[34.5]	470	[243]											1.00	.96	.96	.96	.94
550	[37.9]	480	[249]												.97	.97	.97	.95
600	[41.4]	489	[254]												.97	.97	.97	.97
650	[44.8]	497	[258]													1.00	.99	.97
700	[48.3]	506	[263]													1.00	.99	.97
750	[51.7]	513	[267]													1.00	1.00	.98
800	[55.2]	520	[271]														1.00	.99
850	[58.6]	527	[275]														1.00	.99
900	[62.1]	533	[278]														1.00	1.00
950	[65.5]	540	[282]															1.00
1000	[69.0]	546	[286]															1.00
1050	[72.4]	552	[289]															1.00
1100	[75.9]	558	[292]															
1150	[79.3]	563	[295]															
1200	[82.7]	569	[298]															

Note

Revised capacity for "Super Heat Steam:" multiply capacity of Valve x Factor noted above.

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Valve Sizing

Table B - Steam Super Heat Correction Factor, K_{sh}

Set Pressure psig	[barg]	Saturated Steam Temp. °F	[°C]	Total Steam Temperature °F [°C] 580 [305]	600 [316]	620 [326]	640 [338]	660 [349]	680 [360]	700 [371]	720 [382]	740 [393]	760 [405]	780 [416]	800 [427]	900 [482]	1000 [537]	1100 [593]
15	[1.03]	250	[121]	.89	.88	.87	.86	.86	.85	.84	.83	.83	.82	.81	.81	.78	.75	.72
20	[1.38]	259	[126]	.89	.88	.87	.86	.86	.85	.84	.83	.83	.82	.81	.81	.78	.75	.72
40	[2.40]	287	[142]	.89	.88	.87	.87	.86	.85	.84	.84	.83	.82	.82	.81	.78	.75	.72
60	[4.14]	308	[153]	.89	.88	.87	.87	.86	.85	.84	.84	.83	.82	.82	.81	.78	.75	.72
80	[5.52]	324	[162]	.89	.89	.88	.87	.86	.85	.84	.84	.83	.82	.82	.81	.78	.75	.72
100	[6.90]	338	[170]	.90	.89	.88	.87	.86	.85	.85	.84	.83	.82	.82	.81	.78	.75	.72
120	[8.27]	350	[177]	.90	.89	.88	.87	.86	.85	.85	.84	.83	.82	.82	.81	.78	.75	.72
140	[9.65]	361	[183]	.90	.89	.88	.87	.86	.85	.85	.84	.83	.82	.82	.81	.78	.75	.72
160	[11.0]	371	[188]	.90	.89	.88	.87	.86	.86	.85	.84	.83	.82	.82	.81	.78	.75	.72
180	[12.4]	380	[193]	.90	.89	.88	.87	.86	.86	.85	.84	.83	.82	.82	.81	.78	.75	.72
200	[13.8]	388	[198]	.90	.89	.88	.87	.86	.86	.85	.84	.83	.83	.82	.81	.78	.75	.72
220	[15.2]	395	[201]	.91	.90	.89	.88	.87	.86	.85	.84	.8	.83	.82	.81	.78	.75	.72
240	[16.6]	403	[206]	.91	.90	.89	.88	.87	.86	.85	.84	.84	.83	.82	.81	.78	.75	.72
260	[17.9]	409	[209]	.91	.90	.89	.88	.87	.86	.85	.85	.84	.83	.82	.81	.78	.75	.72
280	[19.3]	416	[213]	.91	.90	.91	.88	.87	.86	.85	.85	.84	.83	.82	.82	.78	.75	.72
300	[20.7]	422	[217]	.91	.90	.89	.88	.87	.86	.86	.85	.84	.83	.82	.82	.78	.75	.72
350	[24.1]	436	[224]	.92	.91	.90	.89	.88	.87	.86	.85	.84	.83	.83	.82	.78	.76	.72
400	[27.6]	448	[231]	.92	.91	.90	.89	.88	.87	.86	.85	.84	.84	.83	.82	.79	.76	.72
450	[31.0]	460	[238]	.93	.92	.91	.89	.88	.87	.86	.86	.85	.84	.83	.82	.79	.76	.72
500	[34.5]	470	[243]	.93	.92	.91	.90	.89	.88	.87	.86	.85	.84	.83	.82	.79	.76	.73
550	[37.9]	480	[249]	.94	.92	.91	.90	.89	.88	.87	.86	.85	.84	.83	.82	.79	.76	.73
600	[41.4]	489	[254]	.94	.93	.92	.90	.89	.88	.87	.86	.85	.84	.84	.83	.79	.76	.73
650	[44.8]	497	[258]	.95	.94	.92	.91	.90	.89	.87	.86	.86	.85	.84	.83	.79	.76	.73
700	[48.3]	506	[263]	.96	.94	.93	.91	.90	.89	.88	.87	.86	.85	.84	.83	.79	.76	.73
750	[51.7]	513	[267]	.96	.95	.93	.92	.90	.89	.88	.87	.86	.85	.84	.83	.79	.76	.73
800	[55.2]	520	[271]	.97	.95	.94	.92	.91	.90	.88	.87	.86	.85	.84	.84	.80	.76	.73
850	[58.6]	527	[275]	.98	.96	.94	.93	.92	.90	.89	.88	.87	.86	.85	.84	.80	.76	.73
900	[62.1]	533	[278]	.99	.97	.95	.93	.92	.90	.89	.88	.87	.86	.85	.84	.80	.77	.73
950	[65.5]	540	[282]	.99	.97	.95	.94	.92	.91	.89	.88	.87	.86	.85	.84	.80	.77	.73
1000	[69.0]	546	[286]	.99	.98	.96	.94	.93	.91	.90	.89	.87	.86	.85	.84	.80	.77	.73
1050	[72.4]	552	[289]	1.00	.99	.97	.95	.93	.92	.90	.89	.88	.87	.86	.85	.80	.77	.73
1100	[75.9]	558	[292]	1.00	.99	.98	.95	.94	.92	.91	.89	.88	.87	.86	.85	.81	.77	.73
1150	[79.3]	563	[295]	1.00	.99	.98	.96	.94	.92	.91	.90	.88	.87	.86	.85	.81	.77	.73
1200	[82.7]	569	[298]	1.00	.99	.98	.97	.95	.93	.91	.90	.89	.87	.86	.85	.81	.77	.73

Note

Revised capacity for "Super Heat Steam:" multiply capacity of Valve x Factor noted above.

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Valve Sizing

Table C - Air and Gas Temperature Correction Factors

Temperature °F	Tc	Temperature °F	Tc	Temperature °F	Tc	Temperature °F	Tc
0	1.062	90	0.972	260	0.849	440	0.760
10	1.051	100	0.964	280	0.838	460	0.752
20	1.041	120	0.947	300	0.828	480	0.744
30	1.030	140	0.931	320	0.817	500	0.737
40	1.020	160	0.916	340	0.806	550	0.718
50	1.009	180	0.902	360	0.796	600	0.701
60	1.000	200	0.888	380	0.787	650	0.685
70	0.991	220	0.874	400	0.778	700	0.669
80	0.981	240	0.862	420	0.769	750	0.656

For temperatures other than 60°F at valve inlet, multiply standard SCFM by Tc.

Table D - Gas and Liquid Relative Density Correction Factors

Specific Gravity	Dc	Specific Gravity	Dc	Specific Gravity	Dc	Specific Gravity	Dc
0.07	3.770	0.60	1.290	1.05	0.975	1.70	0.768
0.08	3.530	0.65	1.240	1.10	0.955	1.80	0.745
0.09	3.333	0.70	1.195	1.15	0.933	1.90	0.725
0.10	3.160	0.75	1.155	1.20	0.913	2.00	0.707
0.20	2.240	0.80	1.117	1.25	0.895	2.50	0.633
0.30	1.825	0.85	1.085	1.30	0.877	3.00	0.577
0.40	1.580	0.90	1.055	1.40	0.845	3.50	0.535
0.50	1.414	0.95	1.025	1.50	0.817	4.00	0.500
0.55	1.350	1.00	1.000	1.60	0.791	4.50	0.471

For a specific gravity other than air or water (=1.0), multiply CFM or GPM by Dc.

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Valve Sizing

Physical Properties

Gas or Vapor	M Molecular Weight	k Specific Heat Ratio	C Gas Constant
Acetone	58.08	1.12	329
Acetylene (Ethyne)	26.04	1.26	343
Air	28.97	1.40	356
Ammonia, Anhydrous	17.03	1.31	348
Argon	39.95	1.67	378
Benzene (Benzol or Benzole)	78.11	1.12	329
Boron Trifluoride	67.82	1.20	337
Butadiene-1,3 (Divinyl)	54.09	1.12	329
Butane-n (Normal Butane)	58.12	1.09	326
Butylene (1-Butene)	56.11	1.11	328
Carbon Dioxide	44.01	1.29	346
Carbon Disulfide (C. Bisulfide)	76.13	1.21	33
Carbon Monoxide	28.01	1.40	356
Carbon Tetrachloride	153.82	1.11	328
Chlorine	70.91	1.36	353
Chloromethane (Methyl Chloride)	50.49	1.28	345
Cyclohexane	84.16	1.09	326
Cyclopropane (Trimethylene)	42.08	1.11	328
Decane-n	142.29	1.04	320
Diethylene Glycol (DEG)	106.17	1.07	323
Dimethyl Ether (Methyl Ether)	46.07	1.11	328
Dowtherm A	165.00	1.05	321
Dowtherm E	147.00	1.00	315
Ethane	30.07	1.19	336
Ethyl Alcohol (Ethanol)	46.07	1.13	330
Ethylene (Ethene)	28.05	1.24	341
Ethylene Glycol	62.07	1.09	326
Ethylene Oxide	44.05	1.21	338
Fluorocarbons:			
12, Dichlorodifluoromethane	120.93	1.14	331
13, Chlorotrifluoromethane	104.47	1.17	334
13B1, Bromotrifluoromethane	148.93	1.14	331
22, Chlorodifluoromethane	86.48	1.18	335
115, Chloropentafluoroethane	154.48	1.08	324
Glycerine (Glycerin or Glycerol)	92.10	1.06	322
Helium	4.00	1.67	378
Heptane	100.21	1.05	321

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Valve Sizing

Physical Properties

Gas or Vapor	M Molecular Weight	k Specific Heat Ratio	C Gas Constant
Hexane	86.18	1.06	322
Hydrogen	2.02	1.41	357
Hydrogen Chloride, Anhydrous	36.46	1.41	357
Hydrogen Sulfide	34.08	1.32	349
Isobutane (2-Methylpropane)	58.12	1.10	327
Isoprene (2-Methyl-1, 3 Butadiene)	68.12	1.09	326
Isopropyl Alcohol (Isopropanol)	60.10	1.09	326
Krypton	83.80	1.71	380
Methane	16.04	1.31	348
Methyl Alcohol (Methanol)	32.04	1.20	337
Methylamines, Anhydrous			
Monomethylamine (Methylamine)	31.06	1.02	317
Dimethylamine	45.08	1.15	332
Trimethylamine	59.11	1.18	335
Methyl Mercapton (Methanethiol)	48.11	1.20	337
Naphthalene (Napthaline)	128.17	1.07	323
Natural Gas (specific gravity = 0.60)	17.40	1.27	344
Neon	20.18	1.64	375
Nitrogen	28.01	1.40	356
Nitrous Oxide	44.01	1.30	347
Octane	114.23	1.05	321
Oxygen	32.00	1.40	356
Pentane	72.15	1.07	323
Propadiene (Allene)	40.07	1.69	379
Propane	44.10	1.13	330
Propylene (Propene)	42.08	1.15	332
Propylene Oxide	58.08	1.13	330
Styrene	104.15	1.07	323
Sulfur Dioxide	64.06	1.28	345
Sulfur Hexafluoride	146.05	1.09	326
Steam	18.02	1.31	348
Toluene (Toluol or Methylbenzene)	92.14	1.09	326
Triethylene Glycol (TEG)	150.18	1.04	320
Vinyl Chloride Monomer (VCM)	62.50	1.19	336
Xenon	131.30	1.65	376
Xylene (p-Xylene)	106.17	1.07	323

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Valve Sizing

Physical Properties

Liquid	G Specific Gravity Water = 1	°F	°C
Acetaldehyde	0.779	68	20
Acetic Acid	1.051	68	20
Acetone	0.792	68	20
Ammonia, Anhydrous	0.666	68	20
Automotive Crankcase and Gear Oils:			
SAE-5W Through SAE 150	0.88-0.94	60	15.6
Beer	1.01	60	15.6
Benzene (Benzol)	0.880	68	20
Boron Trifluoride	1.57	-148	-100
Butadiene - 1, 3	0.622	68	20
Butane-n (Normal Butane)	0.579	68	20
Butylene (1-Butene)	0.600	68	20
Carbon Dioxide	1.03	-4	-20
Carbon Disulfide (C. Bisulfide)	1.27	68	20
Carbon Tetrachloride	1.60	68	20
Chlorine	1.42	68	20
Chloromethane (Methyl Chloride)	0.921	68	20
Crude Oils:			
32.6 Deg API	0.862	60	15.6
35.6 Deg API	0.847	60	15.6
40 Deg API	0.825	60	15.6
48 Deg API	0.79	60	15.6
Cyclohexane	0.780	68	20
Cyclopropane (Trimethylene)	0.621	68	20
Decane-n	0.731	68	20
Diesel Fuel Oils	0.82-0.95	60	15.6
Diethylene Glycol (DEG)	1.12	68	20
Dimethyl Ether (Methyl Ether)	0.663	68	20
Dowtherm A	0.998	68	20
Dowtherm E	1.087	68	20
Ethane	0.336	68	20
Ethyl Alcohol (Ethanol)	0.79	68	20
Ethylene (Ethene)	0.569	-155	-104
Ethylene Glycol	1.115	68	20
Ethylene Oxide	0.901	68	20

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Valve Sizing

Physical Properties

Liquid	G Specific Gravity Water = 1	°F	°C
Fluorocarbons:			
R12, Dichlorodifluoromethane	1.34	68	20
R13, Chlorotrifluoromethane	0.916	68	20
R13B1, Bromotrifluoromethane	1.58	68	20
R22, Chlorodifluoromethane	1.21	68	20
R115, Chloropentafluoromethane	1.31	68	20
Fuel Oils, Nos. 1, 2, 3, 5 and 6	0.82-0.95	60	15.6
Gasolines	0.68-0.74	60	15.6
Glycerine (Glycerin or Glycerol)	1.26	68	20
Heptane	0.685	68	20
Hexane	0.660	68	20
Hydrochloric Acid	1.64	60	15.6
Hydrogen Sulfide	0.78	68	20
Isobutane (2-Methylpropane)	0.558	68	20
Isoprene (2-Methyl - 1, 3-Butadiene)	0.682	68	20
Isopropyl Alcohol (Isopropanol)	0.786	68	20
Jet Fuel (average)	0.82	60	15.6
Kerosene	0.78-0.82	60	15.6
Methyl Alcohol (Methanol)	0.792	68	20
Methylamines, Anhydrous:			
Monomethylamine (Methylamine)	0.663	68	20
Dimethylamine	0.656	68	20
Trimethylamine	0.634	68	20
Methyl Mercapton (Methanethiol)	0.870	68	20
Nitric Acid	1.50	60	15.6
Nitrous Oxide	1.23	-127	-88.5
Octane	0.703	68	20
Pentane	0.627	68	20
Propadiene (Allene)	0.659	-30	-34.4
Propane	0.501	68	20
Propylene (Propene)	0.514	68	20
Propylene Oxide	0.830	68	20
Styrene	0.908	68	20
Sulfur Dioxide	1.43	68	20

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Valve Sizing

Physical Properties

Liquid	G Specific Gravity Water = 1	°F	°C
Sulfur Hexafluoride	1.37	68	20
Sulfuric Acid:			
95–100%	1.839	68	20
60%	1.50	68	20
20%	1.14	68	20
Toluene (Toluol or Methylbenzene)	0.868	68	20
Triethylene Glycol (TEG)	1.126	68	20
Vinyl Chloride Monomer (VCM)	0.985	-4	-20
Water, fresh	1.00	68	20
Water, sea	1.03	68	20
Xylene (p-Xylene)	0.862	68	20

Sizing - Determining K_v and K_w

U.S. Units

$$R = \frac{V_L\,(2{,}800\ G)}{\mu\sqrt{A}}$$

or

$$R = \frac{12{,}700\ V_L}{U\sqrt{A}}$$

Metric Units

$$R = \frac{31{,}313\ V_L\ G}{\mu\sqrt{A}}$$

Determining K_v

V_L = Flow rate at the flowing temperature, in U.S. gpm [m³/hr]

V_L = Flow rate at the flowing temperature, in U.S. gpm [m³/hr]

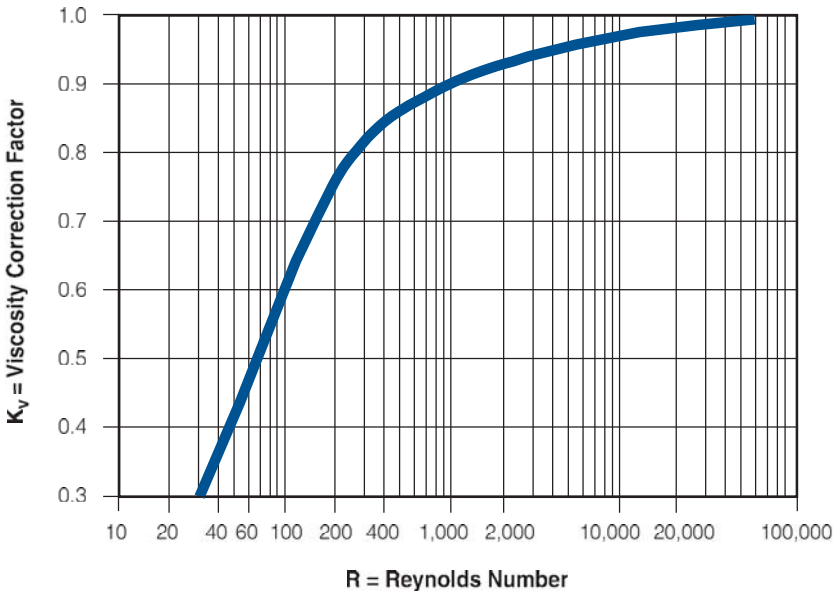
G = Specific gravity of liquid at flowing temperature referred to water = 1.00 at 70°F [21°C]

μ = Absolute viscosity at the flowing temperature, in centipoises

A = Effective discharge area, in square inches [cm²] (from manufacturer's standard orifice areas)

U = Viscosity at the flowing temperature, in Saybolt Universal seconds

After the value of R is determined, the factor K_V is obtained from the graph. Factor K_V is applied to correct the "preliminary required discharge area." If the corrected area exceeds the "chosen standard orifice area," the calculations should be repeated using the next larger standard orifice size.



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Conversion Factors

Absolute Viscosity

Given	To find desired value, multiply "Given" value by factor below			
	poise	Centipoise	$\frac{gm}{cm-sec}$	$\frac{lb}{ft-sec}$
poise	—	100	1	0.0672
centipoise	0.01	—	0.01	0.000672
$\frac{gm}{cm-sec}$	1	100	—	0.0672
$\frac{lb}{ft-sec}$	14.88	1488	14.88	—

Notes

1. Kinematic viscosity x specific gravity = absolute viscosity.
2. Centistokes x specific gravity = centipoise.
3. Saybolt Second Universal (SSU) x 0.216 x specific gravity = centipoise.

Kinematic Viscosity

Given	To find desired value, multiply "Given" value by factor below			
	stoke	Centistoke	$\frac{cm^2}{sec}$	$\frac{ft^2}{sec}$
stoke	—	100	1	0.001076
centistoke	0.01	—	0.01	1.076 x 10-5
$\frac{cm2}{sec}$	1	100	—	0.001076
$\frac{ft2}{sec}$	929.0	92900	929.0	—

Liquid Flow Conversions

Given	To find desired value, multiply "Given" value by factor below				
	l/hr	gpm - US	gpm - Imp	barrels/day	m^3/hr
l/hr (litres/hour)	—	0.00440	0.003666	0.1510	0.0010
gpm (US gallons per minute)	227.1	—	0.8327	34.29	0.2271
gpm (Imperial gallons per minute)	272.8	1.201	—	41.18	0.2728
barrels/day (petroleum - 42 US gallons)	6.624	0.02917	0.02429	—	0.006624
$m^3$3/hr (cubic meters per hour)	1000	4.403	3.666	151.0	—
m^3/s (cubic meters per second)	3.6×10^6	0.02917	0.02429	—	0.006624
kg/hr (kilograms per hour)	$\frac{1}{G}$	$\frac{1}{227.1G}$	$\frac{1}{272.8G}$	$\frac{0.151}{G}$	$\frac{1}{1000G}$
lb/hr (pounds per hour)	$\frac{1}{2.205G}$	$\frac{1}{500.8G}$	$\frac{1}{601.5G}$	$\frac{1}{14.61G}$	$\frac{1}{2205G}$

Note

1. G = Specific gravity of liquid at its relieving temperature compared to that of water at 68°F [20°C], where $G_{water} = 1.00$.

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Conversion Factors

Notes

1. M = Molecular weight of vapor or gas.
2. Volumetric flow (per time unit of hour or minute as shown) in standard cubic feet per minute at 14.7 psia [1.013 bara], 60°F [16°C].
3. Weight flow in pounds per hour.
4. Weight flow in kilograms per hour.
5. Volumetric flow (per time unit of hour or minute as shown) at 1.013 bara 32°F [0°C]. This represents the commercial standard, known as the Normal Temperature and Pressure (NTP).

   Conversions from one volumetric flow rate to another or to weight flow (and vice versa) may only be done when the volumetric flow is expressed in the standard conditions shown above. If flows are expressed at temperature or pressure bases that differ from those listed above, they must first be converted to the standard base.

Gas Flow Conversions

Given	To find desired value, multiply "Given" value by factor below					
	SCFM	SCFH	lb/hr	[kg/hr]	[Nm³/hr]	[Nm³/min]
scfm[2]	—	60	$\frac{M}{6.32}$	$\frac{M}{13.93}$	1.608	0.0268
scfh[2]	0.01677	—	$\frac{M}{379.2}$	$\frac{M}{836.1}$	0.0268	0.000447
lb/hr[3] or #/hr[3]	$\frac{6.32}{M}$	$\frac{379.2}{M}$	—	0.4536	$\frac{10.17}{M}$	$\frac{0.1695}{M}$
kg/hr[4]	$\frac{13.93}{M}$	$\frac{836.1}{M}$	2.205	—	$\frac{22.40}{M}$	$\frac{0.3733}{M}$
Nm³/hr[5]	0.6216	37.30	$\frac{M}{10.17}$	$\frac{M}{22.40}$	—	0.01667
Nm³/min[5]	37.30	2238	5.901 M	2.676 M	60	—

If flow is expressed in actual volume, such as cfm (cubic feet per minute) or acfm (actual cfm) as is often done for compressors, where the flow is described as displacement or swept volume, the flow may be converted to scfm as follows (or from flow expressed in m³/hr to Nm³/hr).

Inch-Pound Units

$$SCFM = \left(\begin{matrix}cfm \\ or \\ acfm\end{matrix}\right) x \frac{14.7 + p}{14.7} \times \frac{520}{460 + t}$$

Where:

p = gauge pressure of gas or vapor in psig

t = temperature of gas or vapor in °F

Metric Units

$$Nm^3/hr = m^3hr = x \frac{1.013 + p}{1.013} \times \frac{273}{273 + t}$$

Where:

p = gauge pressure of gas or vapor in barg

t = temperature of gas or vapor in °C

Notes

1. Also expressed as kp/cm² and kgf/cm².
2. Normal Temperature and Pressure (NTP) Conditions are, at sea level, equal to 1.013 bara or 1.033 kg/cm² (kilograms force per square centimeter absolute) at a base temperature of 32°F [0°C]. This differs slightly from Metric Standard Conditions (MSC), which uses 1.013 bara 60°F [15°C] for the base temperature.
3. Inch-Pound Standard Conditions are, at sea level, equal to 14.7 psia (pounds force per square inch absolute), rounded up from 14.696 psia, and at a base temperature of 60°F [16°C].

Pressure Conversion

Given	To find desired value, multiply "Given" value by factor below			
	kPa	psig	kg/cm²	barg
kPa (kilopascal)	—	0.1450	0.0102	0.0100
psig (pounds/in²)[3]	6.895	—	0.0703	0.06895
kg/cm²[1][1](kilograms/cm²)	98.07	14.22	—	0.9807
barg	100.00	14.50	1.020	—

Area Conversion

Given	To find desired value, multiply "Given" value by factor below			
	in²	ft²	mm²	cm²
in²	—	0.006944	645.16	6.4516
cm²	0.155	1.076×10^{-3}	100	—
ft²	144	—	92900	929
mm²	0.00155	1.076×10^{-5}	—	0.01

Temperature Conversion

Degrees Celsius (°C)	Degrees Fahrenheit (°F)
C + 273.15 = K (Kelvin)	F + 459.67 = R (Rankine)
(C x 1.8) + 32 = F (Fahrenheit)	(F - 32) x 0.556 = C (Celsius)

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Installation

1. Before installing a new safety/relief valve, we recommend that a pipe tap be used to assure clean-cut and uniform threads in the vessel opening and to allow for normal hand engagement followed by a half to one turn by wrench.
2. Install the valve in a vertical position so that discharge piping and code required drains can be properly piped to prevent build-up of back pressure and accumulation of foreign material around the valve seat area.
3. Avoid over-tightening as this can distort safety/relief valve seats. One need only remember that as the vessel and valve are heated, the expansion involved will grasp the valve more firmly.
4. When installing flange connected valves, use new gaskets and draw the mounting bolts down evenly.
5. Do not use the valve outlet or cap as a lever for installation. Use only flat jawed wrenches on the flats provided.
6. Avoid excessive "popping" of the safety/relief valve as even one opening can provide a means for leakage. Safety/relief valves should be operated only often enough to assure that they are in good working order.
7. Avoid wire, cable, or chain pulls for attachment to levers that do not allow a vertical pull. The weight of these devices should not be directed to the safety/relief valve.
8. Avoid having the operating pressure too near the safety/relief valve set pressure. A very minimum differential of 5 psig or 10 percent (whichever is greater) is recommended. An even greater differential is desirable, when possible, to assure better seat tightness and valve longevity. Safety/relief valves in high-temperature hot water and organic fluid service are more susceptible to damage and leakage than safety valves for steam. It is recommended that the maximum allowable working pressure of the boiler and the safety/relief valve setting be selected substantially higher than the operating pressure. A differential of 30-40 percent is recommended.
9. Avoid discharge piping where its weight is carried by the safety/relief valve. Even though supported separately, changes in temperature alone can cause piping strain. We recommend that drip pan elbows or flexible connections be used wherever possible (see Type A, B, C Installation, page 29).
10. Apply a moderate amount of pipe compound to male threads only, leaving the first thread clean. Compound applied to female threads or used to excess can find its way into the valve, causing leakage.

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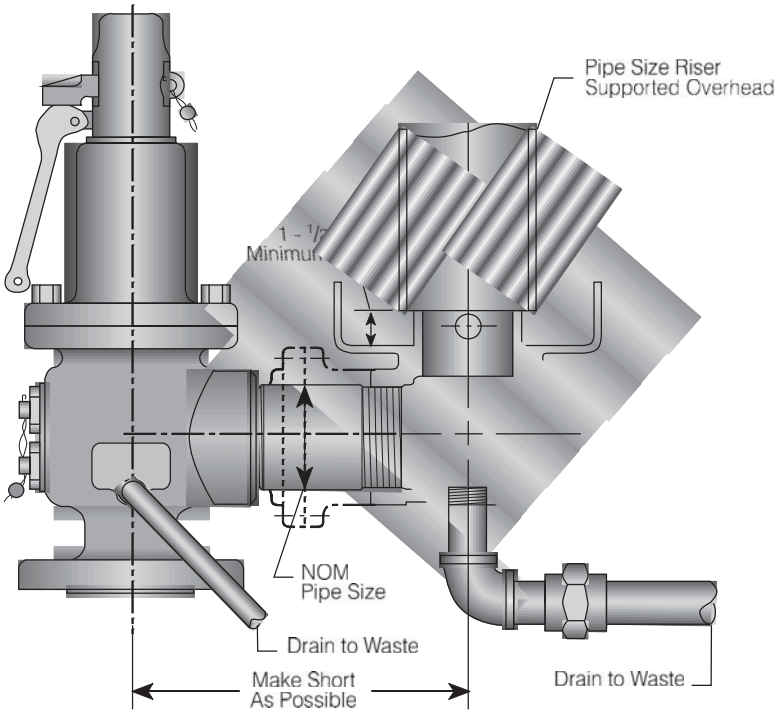
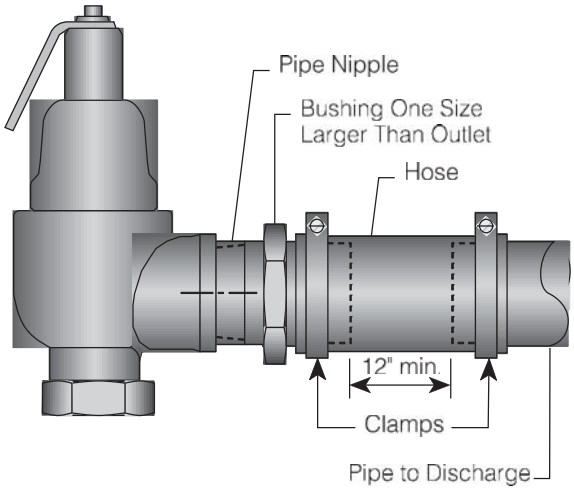
Installation

Recommended Discharge Installation

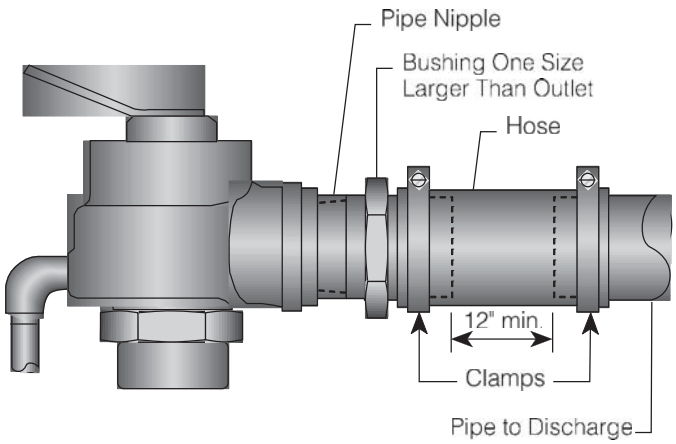
Type "A" Installation



Type "B" Installation



Type "C" Installation



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Maintenance

1. Develop a regular program of visual inspection, looking for clogged drains and discharge pipe, dirt build-up in and around the valve seat and broken or missing parts.
2. Test the valve every two to six months (depending on valves' age and condition) preferably by raising the system pressure to the valves set pressure or operating the hand lever (see #3 in Operation).
3. Do not paint, oil, or otherwise cover any interior or working parts of any safety valve. They do not require any lubrication or protective coating to work properly.

When safety/relief valves require repair, service adjustments, or set pressure changes, work shall be accomplished by the manufacturer, or holders of "V," "UV," and/or "VR" stamps.

Guarantee

Tyco Valves & Controls LP, Black Mountain (Kunkle) warrants only that the goods delivered hereunder when paid for and properly installed, operated, and maintained shall be free from defects in material and workmanship under normal use and service for a period of twelve (12) months from the date of installation by the first user of such goods or eighteen (18) months from date of shipment from the factory, whichever period shall be first completed. The warranty hereunder granted does not apply to products or components (such as electric or pneumatic mechanisms) manufactured by other companies or to any goods manufactured by Tyco Valves & Controls LP, Black Mountain (Kunkle) that have been subjected to misuse, improper installation, improper storage or protection prior to installation or use, negligence by buyer or user, accident, corrosion, chemical attack, or misapplication, or that have been modified or repaired by unauthorized persons. Tyco Valves & Controls LP, Black Mountain's (Kunkle) obligation and buyer's remedy under this warranty are limited to: (a) correction, repair, or replacement, at Tyco Valves & Controls LP, Black Mountain's (Kunkle) option, of any defective unit of goods or (b) refund to buyer of the purchase price allocable to the defective unit of goods if Tyco Valves & Controls LP, Black Mountain (Kunkle) is unable to repair, replace or correct such defect in a reasonable time. Tyco Valves & Controls LP, Black Mountain's (Kunkle) liability under this warranty is conditioned upon buyer giving Tyco Valves & Controls LP, Black Mountain (Kunkle) immediate (but in any event within five (5) working days) written notice of any such defect. Any goods repaired or replaced hereunder shall continue to be warranted for the remainder of the unexpired warranty period, if any. Any repair or replacement of defective goods or parts shall, at Tyco Valves & Controls LP, Black Mountain's (Kunkle) option, occur at its plant in Black Mountain, North Carolina and Tyco Valves & Controls LP, Black Mountain (Kunkle) shall reimburse buyer all reasonable freight costs incurred in transporting defective goods or parts to and from Tyco Valves & Controls LP, Black Mountain's (Kunkle) plant in the event of a valid warranty claim. In the event Tyco Valves & Controls LP, Black Mountain (Kunkle) elects to provide replacement goods or parts to buyer to repair defective goods, buyer agrees to install sold replacement parts or goods at its cost and, further, Tyco Valves & Controls LP, Black Mountain (Kunkle) shall in no event be liable for any labor or material costs of buyer with respect to de-installing or repairing defective goods or installing replacement parts or goods. Tyco Valves & Controls LP, Black Mountain (Kunkle) shall have the option of requiring the return of the defective goods or parts thereof, transportation prepaid, to establish the claim. Tyco Valves & Controls LP, Black Mountain (Kunkle) shall not be held liable for damages caused by delays in repair or replacement of any defective items. Certification by a separate writing as to compliance with specifications, blueprints, part numbers, quality tests or otherwise will not create any warranty by or obligation of Tyco Valves & Controls LP, Black Mountain (Kunkle) The provisions in Tyco Valves & Controls LP, Black Mountain's (Kunkle) literature and specifications are descriptive only, unless expressly stated as warranties. Except for the limited express warranty set forth in this section, Tyco Valves & Controls LP, Black Mountain (Kunkle) expressly disclaims all warranties, express and implied, oral and written, including, without limitation, any warranties regarding services rendered ancillary hereto, and the implied warranties of merchantability and fitness for a particular purpose, whether arising from statute, common law, civil code, custom or otherwise. Tyco Valves & Controls LP, Black Mountain's (Kunkle) warranty obligations and buyer's remedies for breach of warranty, except as to title, are solely and exclusively as stated in this section. No modification or addition to this document with respect to the foregoing warranty by Tyco Valves & Controls LP, Black Mountain (Kunkle), either before or after execution of this document, shall be made except in writing by the President, Vice President, or Director, Sales and Marketing of Tyco Valves & Controls LP, Black Mountain (Kunkle).

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8. Warranties; Remedies. Tyco Valves & Controls LP, Black Mountain (Kunkle) warrants only that the goods delivered hereunder when paid for and properly installed, operated, and maintained shall be free from defects in material and workmanship under normal use and service for a period of twelve (12) months from the date of installation by the first user of such goods or eighteen (18) months from date of shipment from the factory, whichever period shall be first completed. The warranty hereunder granted does not apply to products or components (such as electric or pneumatic mechanisms) manufactured by other companies or to any goods manufactured by Tyco Valves & Controls LP, Black Mountain (Kunkle) that have been subjected to misuse, improper installation, improper storage or protection prior to installation or use, negligence by Buyer or user, accident, corrosion, chemical attack or misapplication, or that have been modified or repaired by unauthorized persons. Tyco Valves & Controls LP, Black Mountain's (Kunkle) obligation and Buyer's remedy under this warranty are limited to: (a) correction, repair, or replacement, at Tyco Valves & Controls LP, Black Mountain's (Kunkle) option, of any defective unit of goods or (b) refund to Buyer of the purchase price allocable to the defective unit of goods if Tyco Valves & Controls LP, Black Mountain (Kunkle) is unable to repair, replace or correct such defect in a reasonable time. Tyco Valves & Controls LP, Black Mountain's (Kunkle) liability under this warranty is conditioned upon Buyer giving Tyco Valves & Controls LP, Black Mountain (Kunkle), immediate (but in any event within five (5) working days) written notice of any such defect. Any goods repaired or replaced of defective goods or parts shall, at Tyco Valves & Controls LP, Black Mountain's (Kunkle) option, occur at its plant in Houston, Texas and Tyco Valves & Controls LP, Black Mountain (Kunkle) shall reimburse Buyer all reasonable freight costs incurred in transporting defective goods or parts to and from Tyco Valves & Controls LP, Black Mountain's (Kunkle) plant in the event of a valid warranty claim. In the event Tyco Valves & Controls LP, Black Mountain (Kunkle) elects to provide replacement good or parts to buyer to repair defective goods, Buyer agrees to install said replacement parts or goods at its cost and, further, Tyco Valves & Controls LP, Black Mountain (Kunkle), shall in no event be liable for any labor or material costs of Buyer with respect to de-installing or repairing defective goods or installing replacement parts or goods. Tyco Valves & Controls LP, Black Mountain (Kunkle) shall have the option of requiring the return of the defective goods or parts thereof, transportation prepaid, to establish the claim. Tyco Valves & Controls LP, Black Mountain (Kunkle) shall not be held liable for damages caused by delays in repair or replacement of any defective items. Certification by a separate writing as to compliance with specifications, blueprints, part numbers, quality test or otherwise will not create any warranty by or obligation of Tyco Valves & Controls LP, Black Mountain (Kunkle). The provisions in Tyco Valves & Controls LP, Black Mountain's (Kunkle) literature and specifications are descriptive only unless expressly stated as warranties. EXCEPT FOR THE LIMITED EXPRESS WARRANTY SET FORTH IN THIS SECTION, KUNKLE EXPRESSLY DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, ORAL AND WRITTEN, INCLUDING, WITHOUT LIMITATION, AND FITNESS FOR A PARTICULAR PURPOSE, WHETHER ARISING FROM STATUTE, COMMON LAW, CIVIL CODE, CUSTOM OR OTHERWISE. KUNKLE'S WARRANTY OBLIGATIONS AND BUYER'S REMEDIES FOR BREACH OF WARRANTY, EXCEPT AS TO TITLE, ARE SOLELY AND EXCLUSIVELY AS STATED IN THIS SECTION. No modification or addition to this document with respect to the foregoing warranty by Tyco Valves & Controls LP, Black Mountain (Kunkle) either before or after execution of this document, shall be made except in writing by the President or a Vice President of Tyco Valves & Controls LP, Black Mountain (Kunkle).
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KUNKLE
953 Old U.S. Highway 70
Black Mountain, North Carolina 28711-2549
Customer Service Phone: 1-828-669-3700
www.kunklevalve.com

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SMALL COMPACT FILTER SILENCERS
w/ "Hockey Puck" *Patented* Element
"FS" Series 1/4" - 1" BSPT

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
- Piston Compressors
- Screw Compressors
- Blowers - Side Channel & Roots
- Hydraulic Breathers – fine filtration
- Engines
- Construction\Contractor Industry
- Workshop
- Medical\Dental Industry
- Hobby
- Pneumatic Conveying
- Waste Water Aeration
- Nailers and Staplers

FEATURES & SPECIFICATIONS

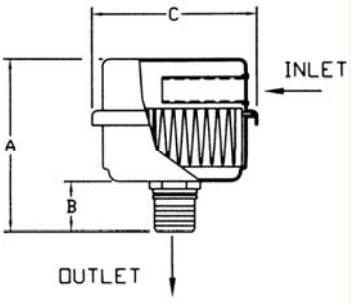
- Patented high grade element w/**Built-in** Butterfly gasket seal
  Creates positive seal between housing hemispheres
  New seal with each element, Minimizes parts
- Fully drawn weatherhood - no welds to rust or vibrate apart
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable **Compact** carbon steel construction with black powder coated finish
- Ability to mount vertically, horizontally
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Interchangeable media: Polyester, Paper, HEPA
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255-380 mm H_2O over initial delta P
- A single noise attenuation graph is insufficient; please inquire for your specific requirement

OPTIONS (Inquiries Encouraged)

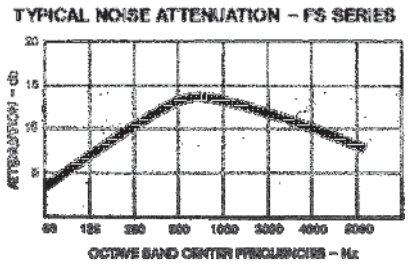
- Various media available
- Epoxy coated housings
- Straight Through Design (Vertical)
- Custom connections

CONFIGURATION

DRAWING



Dimension tolerance ± 6 mm



- Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty

	with Polyester Element	with Paper Element	BSPT Outlet	DIMENSIONS - mm A	B	C	Rated Flow m^3/h Piston	Screw, Blower, Fan	Element Rating	No. of Silencing Tubes	Approx. Wt. Kg
I	FS-05-025	FS-04-025	1/4"	70	16	64	7	7	14	1	0.11
I	FS-05-038	FS-04-038	3/8"	70	16	64	10	14	14	1	0.11
S	FS-07-038	FS-06-038	3/8"	90	16	83	14	14	20	1	0.23
I	FS-05-050	FS-04-050	1/2"	76	22	64	10	14	14	1	0.11
I	FS-07-050	FS-06-050	1/2"	97	22	83	17	20	20	1	0.23
S	FS-11-050	FS-10-050	1/2"	105	22	105	20	20	60	1	0.45
I	FS-07-075	FS-06-075	3/4"	106	32	83	20	20	20	1	0.23
I	FS-11-075	FS-10-075	3/4"	114	32	105	34	43	60	1	0.45
I	FS-11-100	FS-10-100	1"	114	32	105	43	60	60	1	0.45

Note: Model offerings and design parameters may change without notice.

1151 Ardmore Ave. ♦ Itasca, IL 60143 USA
Tel: +1 630 616 4900 ♦ Fax: +1 630 773 2643
E-mail: sales@solbergmfg.com ♦ Web Site: www.solbergmfg.com

SMALL COMPACT FILTER SILENCERS
w/ Standard Filter Design
"FS" Series 1/2" - 3" BSPT

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
- Piston Compressors
- Screw Compressors
- Blowers - Side Channel & Roots
- Hydraulic Breathers – fine filtration
- Engines
- Construction\Contractor Industry
- Workshop
- Medical\Dental Industry
- Pneumatic Conveying
- Waste Water Aeration
- Nailers and Staplers
- Vacuum Vent Breathers

FEATURES & SPECIFICATIONS

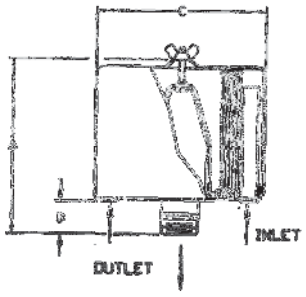
- Fully drawn weatherhood - no welds to rust or vibrate apart
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable carbon steel construction with baked enamel finish and powder coated weatherhood
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Interchangeable media: Polyester, Paper, HEPA
- Several element sizes available per given connection (safety factor)
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255-380 mm H_2O over initial delta P
- Pressure drop graphs available upon request

OPTIONS (Inquiries Encouraged)

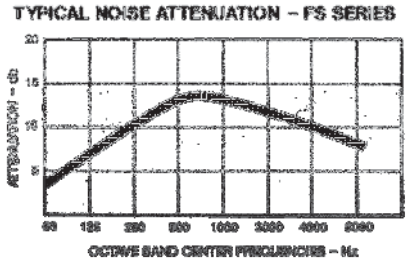
- 1/8" tap holes
- Pressure Drop Indicator
- Available in ***Stainless Steel***
- Epoxy coated housings
- Various media available
- Custom connections, MPT

CONFIGURATION

DRAWING



Dimension tolerance ± 6 mm



- Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty

	with Polyester Element	with Paper Element	BSPT Outlet	DIMENSIONS - mm A	B	C	Rated Flow m^3/h Piston	Screw, Blower, Fan	Element Rating	No. of Silencing Tubes	Approx. Wt. Kg
I	FS-15-050	FS-14-050	1/2"	102	38	152	17	17	60	1	0.8
I	FS-15-075	FS-14-075	3/4"	102	38	152	34	43	60	2	0.9
I	FS-15-100	FS-14-100	1"	102	38	152	43	60	60	3	0.9
S	FS-19P-100	FS-18P-100	1"	168	41	152	60	94	170	3	1.4
I	FS-19P-126	FS-18P-126	1 1/4"	168	41	152	94	119	170	5	1.5
I	FS-19P-151	FS-18P-151	1 1/2"	168	41	152	119	145	170	5	2
I	FS-31P-201	FS-30P-201	2"	184	57	254	145	230	332	5	4
S	FS-231P-201	FS-230P-201	2"	311	57	254	230	230	510	5	6
I	FS-31P-251	FS-30P-251	2 1/2"	191	64	254	170	332	332	5	4
S	FS-231P-251	FS-230P-251	2 1/2"	318	64	254	332	332	510	9	7
I	FS-231P-301	FS-230P-301	3"	330	76	254	340	510	510	9	7

Note: Model offerings and design parameters may change without notice.

1151 Ardmore Ave. ♦ Itasca, IL 60143 USA
Tel: +1 630 616 4900 ♦ Fax: +1 630 773 2643
E-mail: sales@solbergmfg.com ♦ Web Site: www.solbergmfg.com

COMPACT FILTER SILENCERS

"FS" Series 3" - 6" BSPT

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
- Blowers - Side Channel & Roots
- Piston Compressors
- Screw Compressors
- Hydraulic Breathers – fine filtration
- Engines
- Fans
- Construction\Contractor Industry
- Medical
- Pneumatic Conveying
- Waste Water Aeration
- Sparging
- Factory Air
- Vacuum Vent Breathers

FEATURES & SPECIFICATIONS

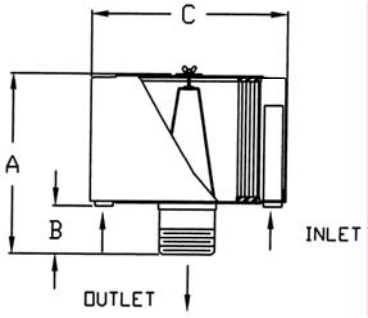
- Fully drawn weatherhood - no welds to rust or vibrate apart
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable carbon steel construction with gray baked enamel finish and powder coated weatherhood
- Low pressure drop center bracket and outlet pipe design
- 1/8" tap hole
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Interchangeable media: Polyester, Paper, HEPA
- Several element sizes available per given connection (safety factor)
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255-380mm H_2O over initial delta P
- Pressure drop graphs available upon request

OPTIONS (Inquiries Encouraged)

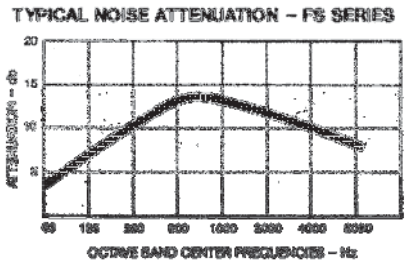
- Various media available
- Pressure Drop Indicator
- Epoxy coated housings
- Available in ***Stainless Steel***
- Custom connections, NPT
- Side Access QB Series Filters for space restricted enclosures (Selected models)

CONFIGURATION

DRAWING



Dimension tolerance ± 6 mm



- Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty E = Extreme Duty

	with Polyester Element	with Paper Element	BSPT Outlet	DIMENSIONS - mm A	B	C	Rated Flow m^3/h Piston	Screw, Blower, Fan	Element Rating	No. of Silencing Tubes	Approx. Wt. Kg
S	FS-235P-301	FS-234P-301	3"	330	76	406	340	510	970	9	13
S	FS-245P-301	FS-244P-301	3"	330	76	406	340	510	1500	9	14
E	FS-275P-301	FS-274P-301	3"	330	76	406	340	510	1870	9	15
I	FS-235P-401	FS-234P-401	4"	356	102	406	510	885	970	9	14
S	FS-245P-401	FS-244P-401	4"	356	102	406	765	885	1500	9	14
E	FS-275P-401	FS-274P-401	4"	356	102	406	765	885	1870	9	15
I	FS-245P-501	FS-244P-501	5"	356	102	406	850	1360	1500	14	15
S	FS-275P-501	FS-274P-501	5"	356	102	406	1105	1360	1870	14	16
I	FS-275P-601	FS-274P-601	6"	394	133	406	1105	1870	1870	18	17

Note: Model offerings and design parameters may change without notice.

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COMPACT FILTER SILENCERS

"FS" Series DN80 - DN150 PN10 Pattern Flange

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
- Blowers - Side Channel & Roots
- Piston Compressors
- Screw Compressors
- Hydraulic Breathers – fine filtration
- Engines
- Fans
- Construction\Contractor Industry
- Medical
- Pneumatic Conveying
- Waste Water Aeration
- Sparging
- Factory Air
- Vacuum Vent Breathers

FEATURES & SPECIFICATIONS

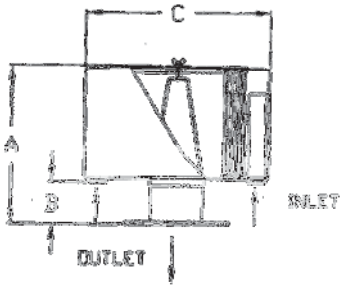
- Fully drawn weatherhood - no welds to rust or vibrate apart
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable carbon steel construction with gray baked enamel finish and powder coated weatherhood
- Low pressure drop center bracket and outlet pipe design
- 1/8" tap hole
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Interchangeable media: Polyester, Paper, HEPA
- Several element sizes available per given connection (safety factor)
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255-380 mm H_2O over initial delta P
- Pressure drop graphs available upon request

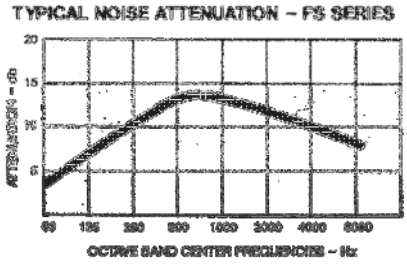
OPTIONS (Inquiries Encouraged)

- Various media available
- Pressure Drop Indicator
- Epoxy coated housings
- Available in ***Stainless Steel***
- Custom connections, NPT
- Side Access QB Series Filters for space restricted enclosures (Selected models)

CONFIGURATION

DRAWING





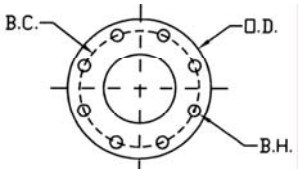
- Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty E = Extreme Duty

Dimension tolerance ± 6 mm

	with Polyester Element	with Paper Element	Flange Outlet	DIMENSIONS - mm A	B	C	Rated Flow m^3/h Piston	Screw, Blower, Fan	Element Rating	No. of Silencing Tubes	Approx. Wt. Kg
S	FS-235P-DN80	FS-234P-DN80	DN80	330	76	406	340	510	970	9	13
S	FS-245P-DN80	FS-244P-DN80	DN80	330	76	406	340	510	1500	9	14
E	FS-275P-DN80	FS-274P-DN80	DN80	330	76	406	340	510	1870	9	15
I	FS-235P-DN100	FS-234P-DN100	DN100	356	102	406	510	885	970	9	15
S	FS-245P-DN100	FS-244P-DN100	DN100	356	102	406	765	885	1500	9	16
E	FS-275P-DN100	FS-274P-DN100	DN100	356	102	406	765	885	1870	9	18
I	FS-245P-DN125	FS-244P-DN125	DN125	356	102	406	850	1360	1500	14	17
S	FS-275P-DN125	FS-274P-DN125	DN125	356	102	406	1105	1360	1870	14	18
I	FS-275P-DN150	FS-274P-DN150	DN150	394	133	406	1105	1870	1870	18	19

PN10 Pattern Flg	DIMENSIONS - mm O.D.	B.C.	B.H.	No. of Holes	Thickness Flg - mm
DN80	200	160	18	8	10
DN100	220	180	18	8	10
DN125	250	210	18	8	10
DN150	285	240	22	8	10



Note: Model offerings and design parameters may change without notice.

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“BIG BOY” FILTER SILENCERS

"FS" Series DN200-DN300 PN10 Pattern Flange

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
- Blowers - Side Channel & Roots
- Piston Compressors
- Screw Compressors
- Hydraulic Breathers – fine filtration
- Engines
- Fans
- Construction Industry
- Medical
- Pneumatic Conveying
- Waste Water Aeration
- Sparging
- Cement
- Power Plants
- Vacuum Vent Breathers

FEATURES & SPECIFICATIONS

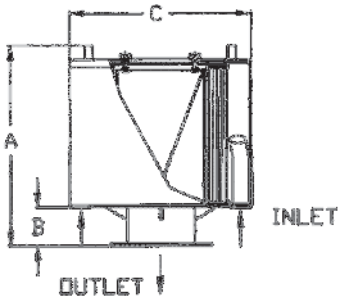
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable carbon steel construction with gray baked enamel finish
- Low pressure drop center bracket and outlet pipe design
- 1/8” tap hole
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Several element sizes available per given connection (safety factor)
- Interchangeable media: Polyester, Paper, HEPA
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255-380 mm H_2O over initial delta P
- Pressure drop graphs available upon request

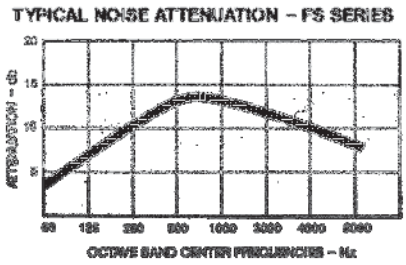
OPTIONS (Inquiries Encouraged)

- Various media available
- Pressure Drop Indicator
- Epoxy coated housings
- Available in ***Stainless Steel***
- Custom connections, NPT
- Side Access QB Series Filters for space restricted enclosures (Selected models)

CONFIGURATION

DRAWING





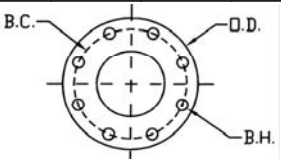
- Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty E = Extreme Duty

Dimension tolerance ± 6 mm

	with Polyester Element	with Paper Element	Flange Outlet	DIMENSIONS - mm A	B	C	Rated Flow m^3/h Piston	Screw, Blower, Fan	Element Rating	No. of Silencing Tubes	Approx. Wt. Kg
I	FS-377P-DN200	FS-376P-DN200	DN200	584	152	572	2450	3060	3105	12	54
S	FS-385P-DN200	FS-384P-DN200	DN200	584	152	724	2450	3060	5605	12	56
E	FS-485P-DN200	FS-484P-DN200	DN200	787	152	724	3060	3060	8000	12	62
I	FS-385P-DN250	FS-384P-DN250	DN250	584	152	724	3060	5610	5610	16	59
S	FS-485P-DN250	FS-484P-DN250	DN250	787	152	724	4420	5610	8000	16	64
E	FS-685P-DN250	FS-384P(2)-DN250	DN250	965	152	724	4900	5610	11220	16	74
I	FS-385P-DN300	FS-384P-DN300	DN300	584	152	724	4420	5610	5610	24	61
S	FS-485P-DN300	FS-484P-DN300	DN300	787	152	724	4420	7990	8000	24	70
E	FS-685P-DN300	FS-384P(2)-DN300	DN300	965	152	724	5950	7990	11220	24	79
E	FS-485P(2)-DN300	FS-484P(2)-DN300	DN300	1346	152	724	7345	7990	16000	24	88

PN10 Pattern Flg	DIMENSIONS - mm O.D.	B.C.	B.H.	No. of Holes	Thickness Flg - mm
DN200	340	295	22	8	14
DN250	395	350	22	12	14
DN300	445	400	22	12	14



Note: Model offerings and design parameters may change without notice.

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Tel: +1 630 616 4900 ♦ Fax: +1 630 773 2643
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B-301/2 - Blower, Elmo, 2BH7420-0AH267 2.4HP

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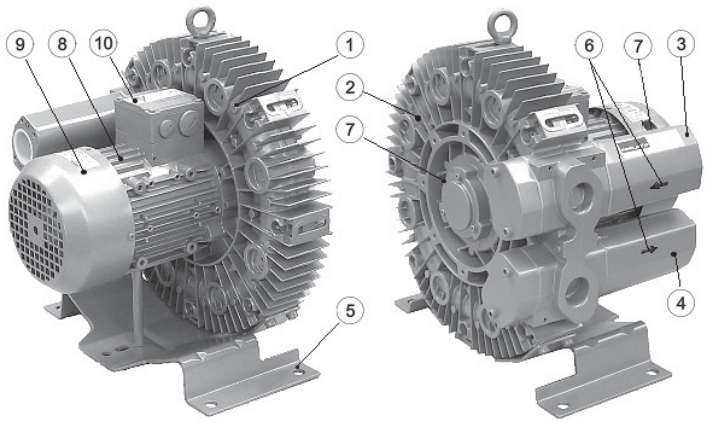

Fig. 1: Design of gas-ring vacuum pump/compressor

1 Vacuum pump/compressor housing
2 Vacuum pump/compressor cover
3 Inlet connection with muffler
4 Discharge connection with muffler
5 Base
6 Flow direction arrow
7 Rotating direction arrow
8 Drive motor
9 Fan guard (over external fan)
10 Terminal box

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1 Safety

1.1 Definitions

To point out dangers and important information, the following signal words and symbols are used in these operating instructions:

1.1.1 Safety alert symbol

The **safety alert symbol** ⚠ is located in the safety precautions in the highlighted heading field on the left next to the signal word (DANGER, WARNING, CAUTION).

Safety precautions **with** a safety alert symbol indicate a danger of **injuries**.

Be sure to follow these safety precautions to protect against **injuries or death**!

Safety precautions **without** a safety alert symbol indicate a danger of **damage**.

1.1.2 Signal words

DANGER
WARNING
CAUTION
NOTICE
NOTE

The **signal words** are located in the safety precautions in the highlighted heading field.

They follow a certain hierarchy and indicate (in conjunction with the safety alert symbol, see Chapter 1.1.1) the **seriousness of the danger** and the **type of warning.**

See the following explanations:

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1.3 Residual risks

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2 Intended Use

These operating instructions

- apply to gas-ring vacuum pumps/compressors of the G-BH7 series, models 2BH72, 2BH73, 2BH74, 2BH75 and 2BH76,
- contains instructions concerning transport and handling, installation, commissioning, operation, shut-down, storage, servicing and disposal of the G-BH7,
- must be completely read and understood by all operating and servicing personnel before beginning to work with or on the G-BH7,
- must be strictly observed,
- must be available at the site of operation of the G-BH7.

About the operating and servicing personnel of the G-BH7

- These persons must be trained and authorized for the work to be carried out.
- Work on electrical installations may be carried out by trained and authorized electricians only.

The G-BH7s

- are pump-motor units for generating vacuum or gauge pressure;
- are used to **extract, pump and compress the following gases**:
  - Air,
  - Non-flammable, non-aggressive, non-toxic and non-explosive gases or gas-air mixtures.
  - For differing gases/gas-air mixtures, inquire with the Service Department.
- are equipped with one of the following kind of drive motors:
  - 3-phase AC drive motor with a standard or explosion-protected design
  - Single-phase AC drive motor

  These operating instructions apply **only to** pump-motor units with a **standard design**.

  For the explosion-protected design

3 Technical Data

3.1 Mechanical data

Weight

Single-impeller design		
Model	**Weight**	
	[kg] approx.	**[lbs] approx.**
2BH7210-0..1.-.	**16**	35
2BH7310-0..1.-.	**16**	35
2BH7310-0..2.-.	**17**	38
2BH7410-0..1.-.	**23**	51
2BH7510-0..1.-.	**26**	57
2BH7510-0..2.-.	**29**	64
2BH7610-0..1.-.	**32**	71
2BH7610-0..3.-.	**35**	77

Two-impeller design		
Model	**Weight**	
	[kg] approx.	**[lbs] approx.**
2BH7220-0..2.-.	**24**	53
2BH7220-0..5.-.	**28**	62
2BH7320-0..5.-.	**30**	66
2BH7420-0..2.-.	**33**	73
2BH7420-0..5.-.	**39**	86
2BH7520-0..2.-.	**40**	88
2BH7520-0..7.-.	**51**	112
2BH7620-0..3.-.	**48**	106
2BH7620-0..5.-.	**65**	143

Three-impeller design		
Model	**Weight**	
	[kg] approx.	**[lbs] approx.**
2BH7530-0..8.-.	**68**	150
2BH7630-0..6.-.	**94**	207

Minimum distances

Minimum distance to fan guard (for sucking in cooling air):

Model	[mm] approx.	[inches] approx.
2BH72	**34**	1.34
2BH73	**34**	1.34
2BH74	**52**	2.05
2BH75	**52**	2.05
2BH76	**53**	2.09

Minimum distance to face of vacuum pump/compressor cover:

Model	[mm] approx.	[inches] approx.
2BH7…	**30**	1.18

Vibrations

The following table provides information on the maximum permissible loading due to vibrations.

Model	Vibration velocity V_{eff}	
	[mm/s] ≤	**[ft/s] ≤**
2BH72.. - 2BH75..	**3.0**	0.010
2BH76..	**3.5**	0.011

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Noise level

Measuring-surface sound-pressure level as per EN ISO 3744, measured at a distance of **1 m** [3.28 ft] at an operating point of approximately 2/3 of the permissible total pressure difference with the lines connected without a vacuum or pressure relief valve, tolerance ±3 dB (A).

Single-impeller design

Model	1-m measuring-surface sound pressure level L [dB (A)]	
	50 Hz	60 Hz
2BH7210-0..1.-.	70	70
2BH7310-0..1.-.		70
2BH7310-0..2.-.		70
2BH7410-0..1.-.		70
2BH7510-0..1.-.		70
2BH7510-0..2.-.		70
2BH7610-0..1.-.		71
2BH7610-0..3.-.		71

Two-impeller design

Model	1-m measuring-surface sound pressure level L [dB (A)]	
	50 Hz	60 Hz
2BH7220-0..2.-.	70	70
2BH7220-0..5.-.		70
2BH7320-0..5.-.		70
2BH7420-0..2.-.		70
2BH7420-0..5.-.		70
2BH7520-0..2.-.		70
2BH7520-0..7.-.		71
2BH7620-0..3.-.		71
2BH7620-0..5.-.		72

Three-impeller design

Model	1-m measuring-surface sound pressure level L [dB (A)]	
	50 Hz	60 Hz
2BH7530-0..8.-.	67	73
2BH7630-0..6.-.	77	80

Temperature increase

The information listed in the following tables corresponds to the heating of vacuum pump/compressor housings and the air exiting compared to the ambient temperature during operation with a permissible total pressure difference and an air pressure of **1,013 mbar** [14.7 psi]. At lower air pressures these values increase.

Single-impeller design

Model	Temperature increase			
	ΔT [K] approx.		Δϑ [F] approx.	
	50 Hz	60 Hz	50 Hz	60 Hz
2BH7210-0..1.-.	**52**	**61**	94	110
2BH7310-0..1.-.	**61**	**61**	110	110
2BH7310-0..2.-.	**81**	**86**	146	155
2BH7410-0..1.-.	**90**	**101**	162	182
2BH7510-0..1.-.	**93**	**111**	167	200
2BH7510-0..2.-.	**120**	**112**	216	202
2BH7610-0..1.-.	**118**	**124**	212	223
2BH7610-0..3.-.	**118**	**124**	212	223

Two-impeller design

Model	Temperature increase			
	ΔT [K] approx.		Δϑ [F] approx.	
	50 Hz	60 Hz	50 Hz	60 Hz
2BH7220-0..2.-.	**55**	**77**	99	139
2BH7220-0..5.-.	**74**	**110**	133	198
2BH7320-0..5.-.	**81**	**124**	146	223
2BH7420-0..2.-.	**89**	**80**	160	144
2BH7420-0..5.-.	**121**	**117**	218	211
2BH7520-0..2.-.	**89**	**102**	160	184
2BH7520-0..7.-.	**125**	**110**	225	198
2BH7620-0..3.-.	**124**	**126**	223	227
2BH7620-0..5.-.	**124**	**128**	223	230

Three-impeller design

Model	Temperature increase			
	ΔT [K] approx.		Δϑ [F] approx.	
	50 Hz	60 Hz	50 Hz	60 Hz
2BH7530-0..8.-.	**120**	**120**	216	216
2BH7630-0..6.-.	**120**	**120**	216	216

Tightening torques for screw connections

The following values apply if no other information is available.

With non-electrical connections, property classes of 8.8 and 8 or higher as per ISO 898-1 are assumed.

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3.2 Electrical data

See rating plate.

3.3 Operating conditions

Temperatures

Temperature of pumped gases:	max. permissible temperature: **+40°C** [+104°F] Nominal value: **+15°C** [+59°F] Pump-motor units for higher fluid temperatures on request.
Ambient temperature (standard design)[1]:	max. permissible temperature: **+40°C** [+104°F] min. permissible temperature: **-15°C** [+5°F] Nominal value: **+25°C** [+77°F] Ambient temperatures between **25°C** [+77°F] and **40°C** [+104°F] affect the permissible total pressure difference (see Section "Permissible total pressure difference"). At higher temperatures the winding may be damaged and the grease change interval may be shortened.

Pressures

Min. inlet pressure:	See rating plate.
Max. discharge pressure during compressor operation:	See rating plate.
Max. permissible pressure in pump-motor unit:	**2.5 bar abs.** [36.2 psia] At this pressure the operation of the pump-motor unit may be considerably impaired. Provide a corresponding protective device (e.g. pressure relief valve) if necessary.
Permissible total pressure difference:	The total pressure difference specified on the rating plate only applies under the following conditions: • Ambient temperature: **25°C** [77°F]. • Inlet temperature (temperature of pumped gases at inlet connection): **15°C** [59°F]. • Pressure: during vacuum-pump operation: **1,013 mbar** [14.7 psia] at discharge connection; during compressor operation: **1,013 mbar** [14.7 psia] at inlet connection; At an ambient temperature of **40°C** [104°F] the total pressure difference specified on the rating plate must be reduced by 10%. If the ambient temperature is between **25°C** [77°F] and **40°C** [104°F], then the total pressure difference specified on the rating plate must be reduced linearly to the temperature by between 0 and 10 %.

Installation altitude

Max. of **1,000 m** [3,280 ft] above sea level.

When installing the pump-motor unit at an altitude of more than **1,000 m** [3,280 ft] above sea level, first inquire with the Service department.

[1] For design with frequency converter, see separate operating instructions.

4 Transport and Handling

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5 Installation

The pump-motor unit is ready to connect on delivery.

However, if the time from delivery to commissioning of the pump-motor unit exceeds a certain period, the lubrication of the rolling bearings must be renewed.
See Chapter 8.2, "Storage conditions", Section "Lubrication of rolling bearings after longer storage", Pg. 23 for information on this topic.

Carry out the following work to install the pump-motor unit:

- Installation and securing,
- Attachment of the included loose muffler if necessary,
- Attachment of threaded flange or hose flange (available as accessories) for the connection of inlet or discharge pipe to the muffler,
- Electrical connection,
- Connection of inlet and discharge connection to the system.

5.1 Installation

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Components for reducing noise on the pump-motor unit:

- **Mufflers** (included as standard equipment): On delivery the pump-motor units are equipped with attached mufflers as standard. The noise radiation is considerably reduced by the mufflers. See Fig. 2 to Fig. 4, Pg. 18 ff.
- **Additional mufflers** (available as an option): The additional mufflers enable a further noise reduction. They may only be used with free entry and exit of gases, i.e. with direct intake out of or direct feeding into the atmosphere **without piping**.
- **Noise protection hoods** (available as an option): Noise protection hoods are suitable for installation in rooms and in the open. They reduce both the total sound pressure level and tonal components that are perceived as particularly annoying.

Installation variants/axis position:

Basically, when installing the pump-motor unit, the following variants are possible with a different axis position (horizontal or vertical):

- Horizontal installation
- Vertical installation on the vacuum pump/compressor cover ("cover installation")
- Vertical mounting on the wall.

Basically, all variants are possible with all models.

However, a distinction must be made between a design with and a design without a **condensed water opening** for the axis position:

- The pump-motor units without a condensed water opening can be installed and secured in any axis position.
- The pump-motor unit with a condensed water opening may only be installed and secured horizontally with the base at the bottom.

Horizontal installation

Screw the base of the pump-motor unit to the surface with suitable mounting elements.

Proceed as follows:

- Provide the base of the pump-motor unit with mounting holes.
- Select the suitable screw type.
- Screw the base of the pump-motor unit to the surface with the screws.
  When doing so, be sure to provide **all** mounting holes with screws!

Vertical installation on the vacuum pump/compressor cover ("cover installation")

With vertical installation of the pump-motor unit with the vacuum pump/compressor cover facing downward, rubber feet must be used.

Proceed as follows:

- The rubber feet are available as accessories. They are delivered in a set of 3.
  On the upper section they are provided with stud bolts and on the lower section with a threaded hole.
- Mount the rubber feet on the pump-motor unit: Screw the stud bolts of the rubber feed into the holes on the face of the vacuum pump/compressor cover and tighten them.
- Mount the pump-motor unit together with the rubber feet on the installation surface:
  Select suitable mounting elements for the threaded hole.
  Screw the rubber feet to the surface or foundation via the threaded hole.

Vertical mounting on the wall

With vertical mounting of the pump-motor unit on the wall, the pump-motor unit is mounted via the holes in the base.

Proceed as follows:

- Position the pump-motor unit as close to the wall as possible on a stable supporting plate with sufficient load-bearing capacity.
  The pump-motor unit must be positioned with the base toward the wall.
- Provide the base of the pump-motor unit with mounting holes.
- Select the suitable screw type.
- Screw the base of the pump-motor unit to the wall with the screws.
  When doing so, be sure to provide **all** mounting holes with screws!
- Remove the supporting plate.

Eye bolt:

Following installation, the eye bolt must be either firmly tightened or removed.

5.2 Electrical connection (motor)

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- For the tightening torques for terminal board connections (except terminal strips), see Chapter 3.1, "Mechanical data", Section "Tightening torques for screw connections", Pg. 10.
- For terminals with clamping straps (e.g. as per DIN 46282), the conductors must be inserted so that approximately the same clamping height results on both sides of the bar. Individual conductors must therefore be bent into a U-shape or connected with a cable lug (DIN 46234).

This also applies to:

- the protective conductor,
- the outer ground conductor.

Both conductors can be recognized from their color (green/yellow).

5.3 Connecting pipes/hoses (vacuum pump/compressor)

Mufflers:

The pump-motor units are delivered with mufflers (indicated with arrows in the following illustrations) for the inlet and discharge connections as standard equipment.

With **single-impeller pump-motor units**, the mufflers are already mounted on delivery.

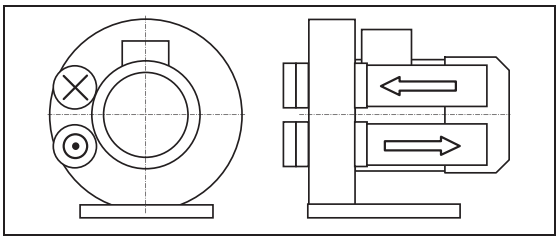

Fig. 2: 2BH721 ... 2BH761 (single-impeller pump-motor units)

With **two-impeller and three-impeller pump-motor units**, the inlet-side muffler is included loose for packaging-related reasons and must be mounted by the operator.

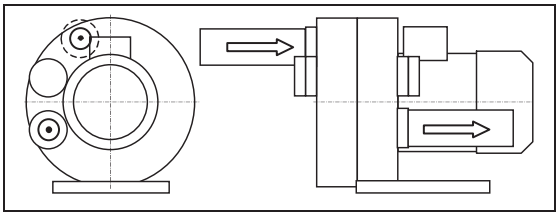

Fig. 3: 2BH722 ... 2BH762 (two-impeller pump-motor units with two-stage design)

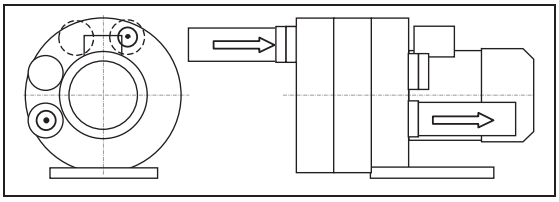

Fig. 4: 2BH723 ... 2BH763 (three-impeller pump-motor units with three-stage design)

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6 Commissioning

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6.2 Start-up and shut-down

Start-up

- Open shut-off device in intake/discharge pipe.
- Switch on power supply for drive motor.

Shut-down:

- Switch off power supply for drive motor.
- Close shut-off device in intake/discharge pipe.

7 Operation

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- Provide mufflers on inlet and discharge side with sealing plugs.

8.2 Storage conditions

To prevent standstill damage during storage, the environment must provide the following conditions:

- dry,
- dust-free,
- low-vibration (effective value of vibration speed $v_{eff} \leq 2.8$ mm/s).
- Ambient temperature: max. **+40°C** [+104°F].

9.1 Repairs/troubleshooting

Fault	Cause	Remedy	Carried out by
Motor does not start; no motor noise.	At least two power supply leads interrupted.	Eliminate interruption by fuses, terminals or power supply cables.	Electrician
Motor does not start; humming noise.	One power supply lead interrupted.	Eliminate interruption by fuses, terminals or power supply cables.	Electrician
	Impeller is jammed.	Open vacuum pump/compressor cover, remove foreign body, clean.	Service*)
		Check or correct impeller gap setting if necessary.	Service
	Impeller defective.	Replace impeller.	Service*)
	Rolling bearing on drive motor side or vacuum pump/compressor side defective.	Replace motor bearing or vacuum pump/compressor bearing.	Service*)
Protective motor switch trips when motor is switched on. Power consumption too high.	Winding short-circuit.	Have winding checked.	Electrician
	Motor overloaded. Throttling does not match specification on rating plate.	Reduce throttling.	Service*)
		Clean filters, mufflers and connection pipes if necessary.	Service*)
	Compressor is jammed.	See fault: "Motor does not start; humming noise" with cause: "Impeller is jammed.".	Service*)
Pump-motor unit does not generate any or generates insufficient pressure difference.	Leak in system.	Seal leak in the system.	Operator
	Wrong direction of rotation.	Reverse direction of rotation by interchanging two connecting leads.	Electrician
	Incorrect frequency (on pump-motor units with frequency converter).	Correct frequency.	Electrician
	Shaft seal defective.	Replace shaft seal.	Service*)
	Different density of pumped gas.	Take conversion of pressure values into account. Inquire with Service Department.	Service
	Change in blade profile due to soiling.	Clean impeller, check for wear and replace if necessary.	Service*)
Abnormal flow noises.	Flow speed too high.	Clean pipes. Use pipe with larger cross-section if necessary.	Operator
	Muffler soiled.	Clean muffler inserts, check condition and replace if necessary.	Service*)
Abnormal running noise.	Ball bearing lacking grease or defective.	Regrease or replace ball bearing.	Service*)
Compressor leaky.	Seals on muffler defective.	Check muffler seals and replace if necessary.	Service*)
	Seals in motor area defective.	Check motor seals and replace if necessary.	Service

*) Only when the maintenance manual is at hand: rectification by the operator.

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9.2 Service/After-sales service

Our Service is available for work (in particular the installation of spare parts, as well as maintenance and repair work), not described in these operating instruction.

A list of spare parts with an exploded drawing is available on the Internet at www.gd-elmorietschle.com.

Observe the following when **returning** pump-motor unit:

- The pump-motor unit must be delivered complete, i.e. not dismantled.
- The pump-motor unit may not present a danger to the workshop personnel.
  If the pump-motor unit has come into contact with dangerous substances, then the procedure described in Chapter 9.3, "Decontamination and Declaration of Clearance", Pg. 25, must be used.
- The original rating plate of the pump-motor unit must be properly mounted, intact and legible.
  All warranty claims are voided for pump-motor units delivered for a damage expertise without the original rating plate or with a destroyed original rating plate.
- In case of warranty claims, the manufacturer must be informed of the operating conditions, operating duration etc. and additional detailed information provided on request if necessary.

9.3 Decontamination and Declaration of Clearance

EU declaration of conformity

Manufacturer:	Gardner Denver Deutschland GmbH Industriestraße 26 97616 Bad Neustadt • Germany
Representative for the compilation of technical documents:	Holger Krause Industriestraße 26 97616 Bad Neustadt • Germany
Description and identification of the machine:	Vacuum pumps/Compressors (Side channel blower) Series G-BH7 Types 2BH72..-.....-. 2BH73..-.....-. 2BH74..-.....-. 2BH75..-.....-. 2BH76..-.....-.

The machine described above meets the following applicable Community harmonisation legislation:

2006/42/EC	European Parliament and Council Directive 2006/42/EC from 17th May 2006 on machinery and amending Directive 95/16/EC.
2004/108/EC*)	Directive 2004/108/EC of the European Parliament and Council from 15th December 2004 for the application of the legal regulations of the EU member states concerning electrical devices and repealing Directive 89/336/EEC

Harmonised standards applied:

EN 1012-1:2010	Compressors and vacuum pumps - Safety requirements - Part 1: Compressors
EN 1012-2:1996 +A1:2009	Compressors and vacuum pumps - Safety requirements - Part 2: Vacuum pumps
EN ISO 12100:2010	Safety of machinery - General principles for design - Risk assessment and risk reduction (ISO 12100:2010)
EN 60204-1:2006	Safety of machinery - Electrical equipment of machines Part 1: General requirements IEC 60204-1:2005 (amended)
EN 60034-1:2010/ AC:2010	Rotating electrical machines - Part 1: Rating and performance IEC 60034-1:2010 (amended)

Bad Neustadt, 18.04.2012
(Place and date of issue)

Andreas Bernklau, product management/attorney
(Name and function)

Dr. Rudi Dittmar, development
(Name and function)

*) Only applicable for version with frequency converter 2FC

664.44436.40.000

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Statement on health safety and on the protection of the environment

- For the safety of our employees and to comply with statutory requirements on handling substances harmful to the health and the environment, this statement must be enclosed, fully completed, with **each** unit/system sent.
- **Without the fully completed statement, repair/disposal is not possible and delays are unavoidable!**
- The statement is to be completed and signed by suitably qualified, authorised personnel at the operating organisation.
- In the case of shipment to Germany, the statement is to be completed in German or English.
- The statement is to be attached to the outside of the packing on shipment.
- If necessary, the carrier is to be informed.

1. **Product designation (type):** .....
2. **Serial number (no. BN):** .....
3. **Reason for sending:** .....
4. **The unit/system**
   has **not** come into contact with hazardous substances. There will be **no** hazards for personnel or the environment during repair/disposal. Continue with "6. Legally binding statement“
   has come into contact with hazardous substances. Continue with "5. Information on the contamination“
5. **Information on the contamination** (if necessary provide more information on an additional sheet)
   The unit/system was used in the following application:

   .....
   and has come into contact with the following classifiable substances or substances presenting a hazard to health/environment:

Trade name:	Chemical designation:	Hazardous substance class:	Properties (e.g. toxic, inflammable, caustic, radioactive):

   The unit/system has been emptied in accordance with the operating instructions, flushed and cleaned externally.

   Safety data sheets in accordance with the applicable regulations are enclosed (sheet).

   The following safety precautions are necessary for handling (e.g. personal protective equipment):

   .....

   .....
6. **Legally binding statement**
   I herewith guarantee that the details specified are true and complete and that I, as signatory, am in a position to judge that this is so.
   We are aware that we are liable to the contractor for any damages arising from incomplete or incorrect specifications. We are obliged to indemnify the contractor against claims for damages by third parties arising from incomplete or incorrect specifications. We are aware that, irrespective of this statement, we are directly liable to third parties - in particular including the contractor's employees tasked with repair/disposal.

Company/institute: .....

Name, position: ..... Phone: .....

Street: ..... Fax: .....

Post code, city: .....

Country: ..... Stamp:

Date, signature: .....

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P.O. box 1510
97605 Bad Neustadt
Phone: +49 7622 392 0
Fax: +49 7622 392 300
E-mail: er.de@gardnerdenver.com
Internet: www.gd-elmorietschle.com
610.44436.40.000
Edition: 04.2012
English

AIRCOM TECHNOLOGIES inc.

16781, Hymus, Kirkland (Québec) H9H 3L4
T.: 514 695-4740 F.: 514 695-0581
www.aircom.ca info@aircom.ca

Pression & Vide • Pressure & Vacuum

B-501/2 - Blower, Sutorbilt, Model 4L-RHC, Orientation: Horizontal (Flow Down) Driven Shaft Position: RHC (Right Hand Central) Flow Requirement: 487 scfm

OPERATION & MAINTENANCE MANUAL

AIRCOM PACKAGE

WITH

SUTORBILT

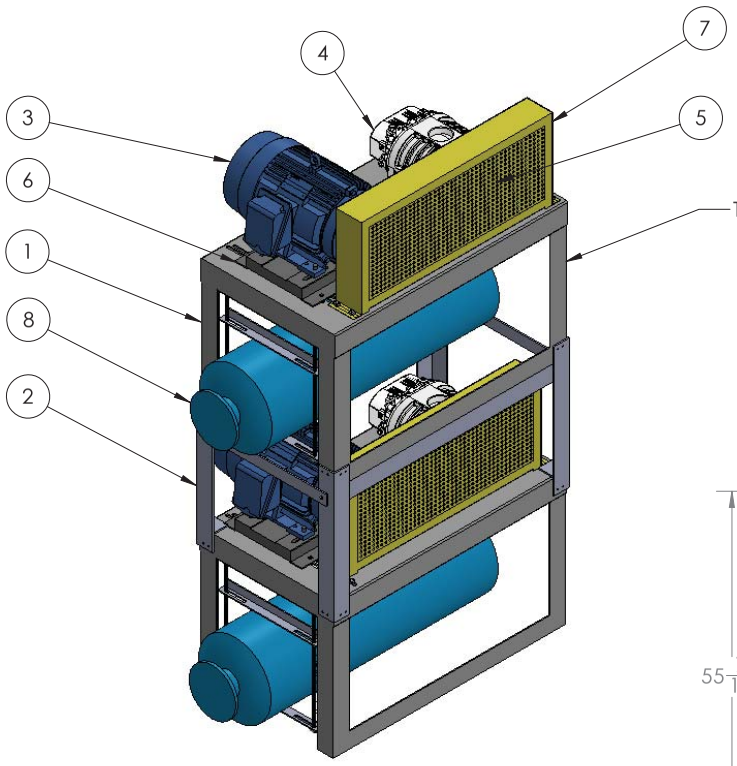
POSITIVE DISPLACEMENT BLOWER

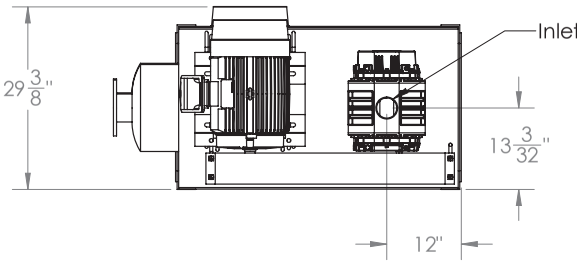
YOUR REFERENCE: PO # 1704432-0008 (Blower) & 1704432-0009 (Package)

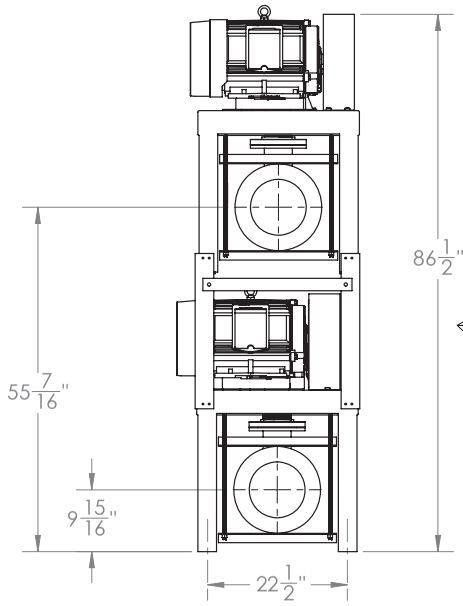
OUR REFERENCE: 222850 & 222851

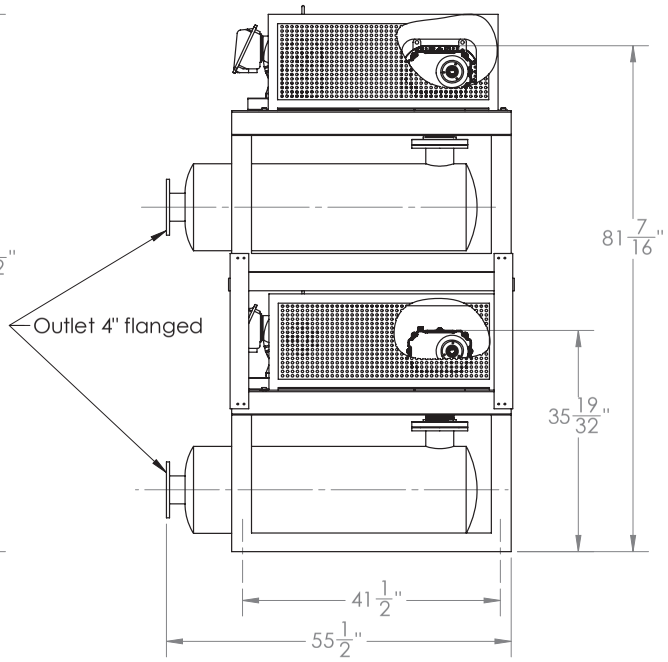
TABLE OF CONTENTS

	ITEM
Package drawing(s) including scope of supply …….…… ……..…	1
Drive (belt or coupling) data sheet(s)…….……	2
Blower performance data sheet(s)……..	3
Motor manual(s) / data sheet(s)…..…..… ……..…….……..….	4
Gardner Denver blower parts list, operating and service manual …….…...	5
Maintenance data sheet – Spare parts list ……..…	6









ITEM NO.	DESCRIPTION	QTY.
1	Elevated base, Steel	2
2	Extension base, Steel	1
3	Motor,15HP (supplied by Newterra)	2
4	Blower, Sutorbilt, Model 4L	2
5	Belt Drive 15HP	2
6	Motor slide base	2
7	Guard for belt drive, Steel	2
8	Silencer, URBY4 4in flanged	2

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
NEXT ASSY | USED ON
APPLICATION | DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	Alex C.	01/06/2017
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

AIRCOM TECHNOLOGIES

TITLE:
Blower Package
Sutorbilt 4L Stacked

SIZE	DWG. NO.	REV
B	0960	1

SCALE: 1:20 | WEIGHT: | SHEET 1 OF 1

E-75

Maska Pulleys Inc.
180, Boul. Gagnon, Ste-Claire
Qc, Canada G0R 2V0
Tel:(418)883-4322 Fax:(418)883-5015
www.maskapulleys.com

Selection Parameters

Family: Classic & Narrow belts drives

Shaft diameter Driver: 1-5/8 Inch
Shaft diameter Driven: 7/8 Inch
Service Factor: 1.4
Driver power: 13.3 hp
Rpm Driver: 3525
Rpm Driven: 3364 **Tolerance:** -0% +3%
Center distance : Minimum: 23.5 Inch
Maximum: 24.5 Inch
Belts: A,AX,B,BX,C,CX,3V,3VX,5V,5VX,8V

Max. Hub Load: 9999
Rim Speed min.: 900 FPM
Rim Speed max.: 6500 FPM
Nbr of Grooves min.: 1
Nbr of Grooves max.: 15

Pitch Diameter (Inch)

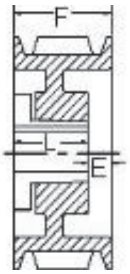
	Min.	Max.
Driver	0.50	71.00
Driven	0.50	71.00

Actual Drive Values

Maximum number of results: 20

Rpm: 3417
Service Factor: 1.55
BeltSpeed (fpm): 5859
List Price: 194.90
Center distance (Inch): 23.6
Power/Belt (hp): 10.3
Deflection (inch): 0.37
Deflection Force (lbs): 3.1
Hub Loads (lbs): 130

Driver Sheave: 2B64

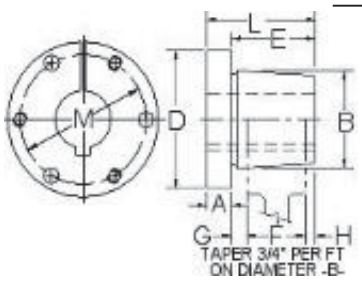


List Price: 68.00
Weight: 7.35 lbs

D.D. A or 4L Belt: 6.00"
D.D. B or 5L Belt: 6.40"
E: 7/16"
F: 1 3/4"
L: 1 5/16"
O.D.: 6.75"

Constuction type: Web

Driver Bushing: SDSX1-5/8

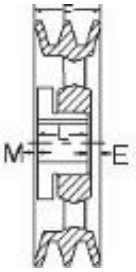


List Price: 17.30
Weight: 1.10 lbs

A: 7/16"
B: 2 3/16"
D: 3 3/16"
E: 7/8"
F: 3/4"
G: 1/4"
H: -1/8"
Keyseat: 3/8 x 3/16"
L: 1 5/16"
M: 2 11/16"

Set screw - Dimensions: 1/4-20 UNC x 1/4
Product specifications: Standard with set screw over keyway.
Hex bolt: 3=1/4-20 UNC x 1-3/8

Driven Sheave: 2MBL69



List Price: 64.60
Weight: 6.55 lbs

D.D. A or 4L Belt: 6.2"
D.D. B or 5L Belt: 6.6"
E: 1/16"
F: 1 3/4"
L: 1 11/32"
M: 11/32"
O.D.: 6.95"

Constuction type: Arms

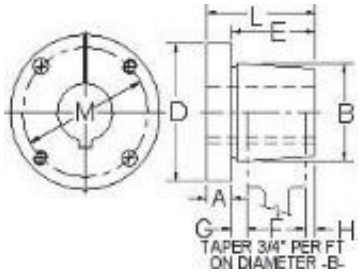
Recommended Drive Selections are designed for use with Maska components (sheaves, bushings and V-belts) which meet or exceed MPTA & RMA standards. The use of lesser quality products could affect life expectancy of drive.Selections and Pricing are as accurate as possible. Maska is not responsible for ANY pricing or design errors.Price shown are for standard products only. For non-standard products or products that need dynamic balancing, contact Maska for pricing.

Driven Bushing: LX7/8

List Price: 9.00
Weight: 0.90 lbs

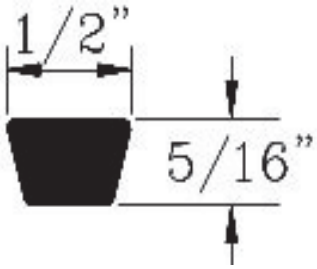
Set screw - Dimensions: 1-8UNCx1-1/2
Hex bolt: 2 = 1/4-20UNC X 7/8

A: 11/32"
B: 1 5/8"
D: 2 1/2"
E: 1"
F: 29/32"
G: 3/16"
H: -3/32"
Keyseat: 3/16 x 3/32"
L: 1 11/32"
M: 2"



Belts: VBA65 (Qty:2)

List Price: 18.00
Weight: 0.30 lbs



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QuickPik™

Sutorbilt Legend - 4L

Product Information

CORRECTED VALUES	ORIGINAL UNITS	ENGLISH UNITS	METRIC UNITS
Ambient Pressure	100 ALTI-FT	14.642 PSIA	1.01 bar a
Elevation	100 ALTI-FT	100 ALTI-FT	30 alti-m
Inlet Pressure	14.642 PSIA	0.000 PSIG	0 bar g
Inlet Pressure Loss	0.3 PSIG	0.300 PSIG	0.021 bar g
Inlet Temp	68 F	68 °F	20 °C
Inlet Flow	487 SCFM	499 ICFM	848 m³/h
Discharge Pressure	4.4 PSIG	4.400 PSIG	0.303 bar g
Discharge Pressure Loss	0.2 PSIG	0.200 PSIG	0.014 bar g
MEASURED VALUES	**ORIGINAL UNITS**	**ENGLISH UNITS**	**METRIC UNITS**
Speed	3364 RPM	3364 RPM	3364 RPM
RPM % Of Max	93	93	93
Power	13.3 HP	13.3 HP	9.9 kW
Discharge Temp	126 °F	126 °F	52 °C
Temp % of Max	48	48	48
Noise	88 dBa	88 dBa	88 dBa
Pressure % of Max	70	70	70

PHYSICAL	
Weight	155 lbs.
Gear Diameter / Center Distance	4 in.
Connection Size	3i/3d in.
Case Length	8 in.
WR^2	0.924 lb-ft^2
Orientation	horizontal
PERFORMANCE	
Max Delta P	7 PSI
Max Temp	260 °F
Max Speed	3600 RPM
Min Speed	955 RPM
Max Case Pressure	25 PSIG
Max Delta T	160 °F

QuickPik™

AMBIENT GAS PARAMETERS	ENGLISH UNITS	METRIC UNITS
Molecular Weight	28.866 lbm/lbmol	28.866 kg/kgmol
R Value	53.523 ft.lbf/lbm.R	0.288 kJ/kg.K
Density	0.075 lbm/ft ^{3}	1.196 kg/m^3

GAS MIX:	VOL
Air	100%

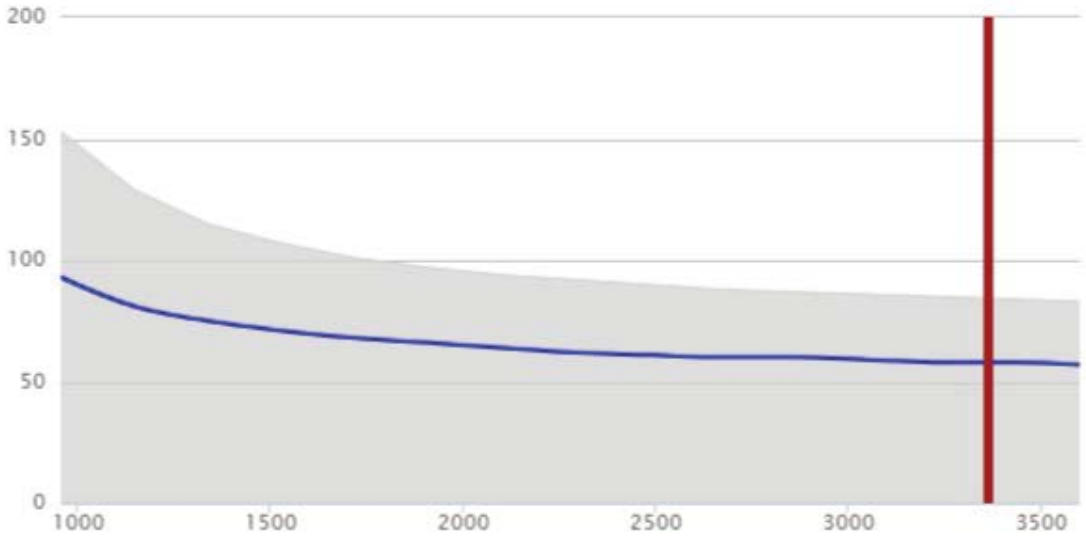
Performance Curves

Temperature Rise

DEFINED CONDITIONS
58 F

RPM
3364

Published Data
Defined Conditions

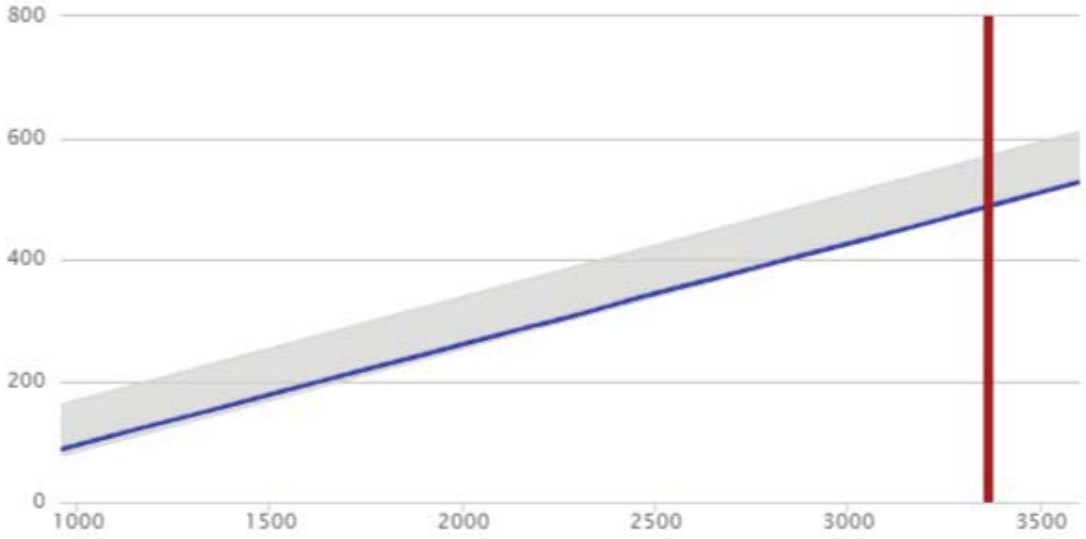


Flow

DEFINED CONDITIONS
487 SCFM

RPM
3364

Published Data
Defined Conditions



QuickPik™

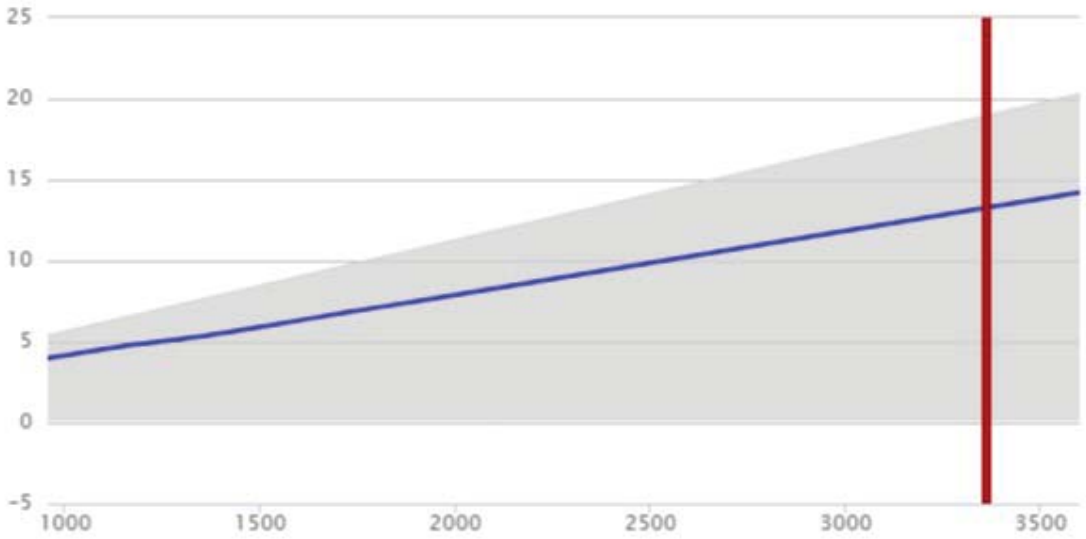
Performance Curves

Power

DEFINED CONDITIONS
13.3 HP

RPM
3364

Published Data
Defined Conditions

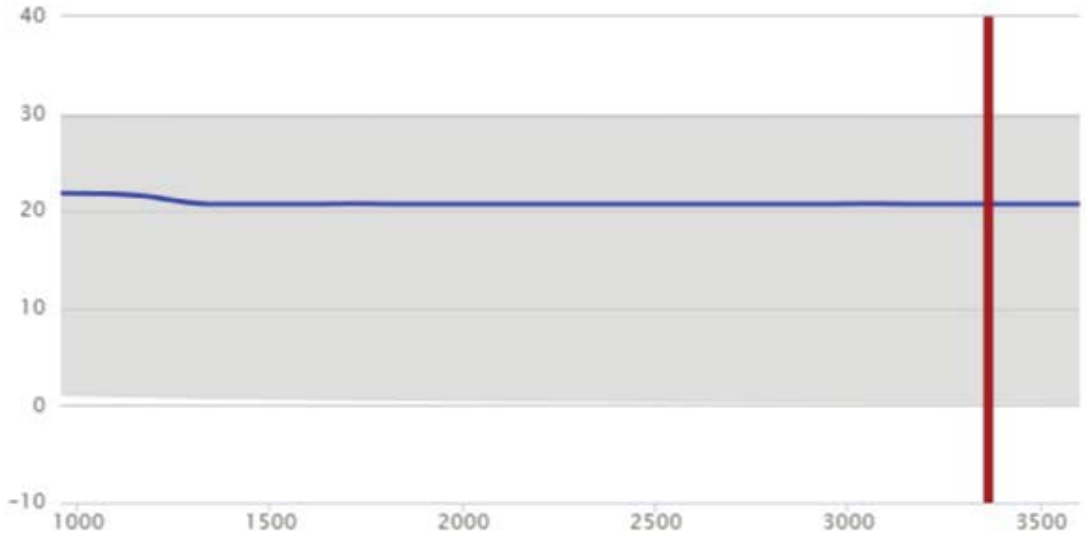


Torque

DEFINED CONDITIONS
20.8 ft-lb

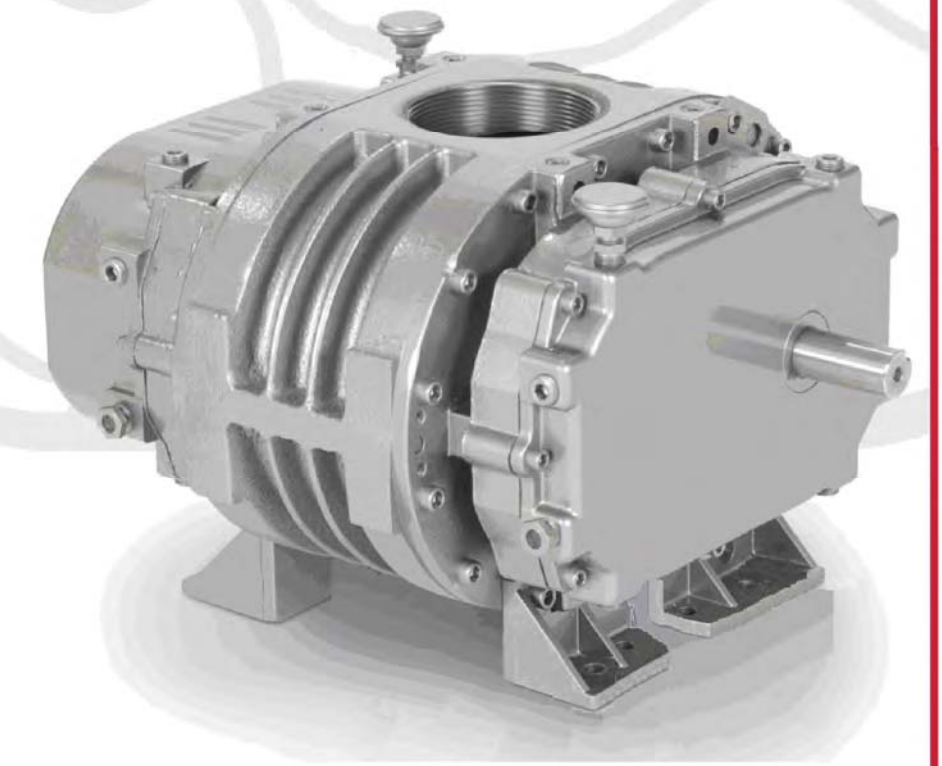
RPM
3364

Published Data
Defined Conditions



Gardner Denver

PARTS LIST OPERATING AND SERVICE MANUAL



LEGEND
"R" SERIES BLOWERS

3" – 5" GEAR DIAMETER

Models
GAB_ _ R _
GAC_ _ R _
GAE_ _ R _

ENERGY STAR PARTNER

SB-7-632
Version 05
July 8, 2015

MAINTAIN BLOWER RELIABILITY AND PERFORMANCE
WITH GENUINE GARDNER DENVER
PARTS AND SUPPORT SERVICES

Factory genuine parts, manufactured to design tolerances, are developed for optimum dependability - - - specifically for your blower. Design and material innovations are born from years of experience with hundreds of different blower applications. When you specify factory genuine parts you are assured of receiving parts that incorporate the most current design advancements manufactured in our state-of-the-art blower factory under exacting quality standards.

Your AUTHORIZED DISTRIBUTOR offers all the backup you require. A worldwide network of authorized distributors provides the finest product support in the blower industry.

1. Trained technical representatives to assist you in selecting the correct replacement parts.

2. Complete inventory of new machines and new, genuine factory parts.

3. A full line of factory tested AEON® PD blower lubricants, specifically formulated for optimum performance in all blowers.

4. Authorized distributor service technicians are factory-trained and skilled in blower maintenance and repair. They are ready to respond and assist you by providing fast, expert maintenance and repair service.

INSTRUCTIONS FOR DETERMINING BLOWER CONFIGURATION

1. Face the blower drive shaft.
2. In a **VERTICAL** configuration, air flow is horizontal.
3. In a **HORIZONTAL** configuration, air flow is vertical.
4. In a vertical configuration, a **BOTTOM HAND** exists when the drive shaft is below the horizontal center line of the blower. A **TOP HAND** exits when the drive shaft is above the horizontal center line of the blower.
5. In a horizontal configuration, a **RIGHT HAND** exists when the drive shaft is to the right of the vertical center line of the blower. A **LEFT HAND** exists when the drive shaft is to the left of the vertical center line of the blower.

INSTRUCTIONS FOR ORDERING REPAIR PARTS

For pricing, and ordering information contact your nearest AUTHORIZED FACTORY DISTRIBUTOR. When ordering parts, specify Blower **MODEL** and **SERIAL NUMBER** (see nameplate on unit).

Rely upon the knowledge and experience of your AUTHORIZED DISTRIBUTOR and let them assist you in making the proper parts selection for your blower.

To Contact Gardner Denver or locate your local distributor:
Visit: www.contactgd.com/mobile

Or

Call: (217)222-5400

GARDNER DENVER LUBRICANT ORDER INFORMATION

Re-order Part Numbers for Factory Recommended Lubricants.

Gear and Drive End

AEON PD Synthetic Lubricant, AEON PD-XP—Extreme Duty Synthetic Lubricant or AEON PD-FG—Food Grade Synthetic Lubricant

AEON PD Synthetic Lubricant

Description	Part Number
1 Quart	28G23
Case/12Quarts	28G24
1 Gallon Container	28G40
Case/6 Gallons	28G41
5 Gallon Pail	28G25
55 Gallon Drum	28G28

AEON PD-XD – Extreme Duty Synthetic Lubricant

Description	Part Number
1 Quart	28G46
Case/12Quarts	28G47
1 Gallon Container	28G42
Case/6 Gallons	28G43
5 Gallon Pail	28G44
55 Gallon Drum	28G45

AEON PD-FG – Food Grade Synthetic Lubricant

Description	Part Number
1 Quart	28H97
Case/12Quarts	28H98
1 Gallon Container	28H333
Case/6 Gallons	28H334
5 Gallon Pail	28H99
55 Gallon Drum	28H100

Drive End

AEON PD Grease

Description	Part Number
Case/10 Tubes (14oz/Tube	28H283

Call your local Gardner Denver Distributor to place your order for Gardner Denver lubricants. Your Authorized Gardner Denver Distributor is:

FOREWORD

Sutorbilt® blowers are the result of advanced engineering and skilled manufacturing. To be assured of receiving maximum service from this machine, the owner must exercise care in its operation and maintenance. This manual is written to give the operator and maintenance department essential information for day-to-day operation, maintenance and adjustment. Careful adherence to these instructions will result in economical operation and minimum downtime.

⚠ DANGER
Danger is used to indicate the presence of a hazard which will cause severe personal injury, death, or substantial property damage if the warning is ignored.

⚠ WARNING
Warning is used to indicate the presence of a hazard which can cause severe personal injury, death, or substantial property damage if the warning is ignored.

⚠ CAUTION
Caution is used to indicate the presence of a hazard which will or can cause minor personal injury or property damage if the warning is ignored.

NOTICE
Notice is used to notify people of installation, operation or maintenance information which is important but not hazard-related.

SAFETY PRECAUTIONS

Safety is everybody's business and is based on your use of good common sense. All situations or circumstances cannot always be predicted and covered by established rules. Therefore, use your past experience, watch out for safety hazards and be cautious. Some general safety precautions are given below:

⚠ DANGER

Failure to observe these notices could result in injury to or death of personnel.

- **Keep fingers and clothing away from revolving fan, drive coupling, etc.**
- **Do not use the air discharge from this unit for breathing – not suitable for human consumption.**
- **Do not loosen or remove the oil filler plug, drain plugs, covers or break any connections, etc., in the blower air or oil system until the unit is shut down and the air pressure has been relieved.**
- **Electrical shock can and may be fatal.**
- **Blower unit must be grounded in accordance with the National Electrical Code. A ground jumper equal to the size of the equipment ground conductor must be used to connect the blower motor base to the unit base.**
- **Open main disconnect switch, tag and lockout before working on the control.**
- **Disconnect the blower from its power source, tag and lockout before working on the unit – this machine may be automatically controlled and may start at any time.**

⚠ WARNING

Failure to observe these notices could result in damage to equipment.

- **Stop the unit if any repairs or adjustments on or around the blower are required.**
- **Disconnect the blower from its power source, tag and lockout before working on the unit – this machine maybe automatically controlled and may start at any time.**
- **Do not exceed the rated maximum speed shown on the nameplate.**
- **Do not operate unit if safety devices are not operating properly. Check periodically. Never bypass safety devices.**

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SUTORBILT LEGEND SERIES BLOWERS
MATRIX/MENU

NOTICE TO CUSTOMER – To find the construction options for Your blower unit, FILL IN THE BALANCE OF LETTERS OR NUMBERS FROM YOUR UNIT NAMEPLATE

	G	A				R	
COLUMN NUMBER:	1	2	3	4	5	6	7

FOLLOW THE LINE DOWN AND OVER FROM EACH SPACE THUS FILLED IN TO FIND THE APPROPRICATE CONSTRUCTION OPTION WITH WHICH YOUR MACHINE IS EQUIPPED.

COLUMN 1 – BASIC DESIGNATOR

COLUMN 2 – PRODUCT FAMILY

COLUMN 3 – GEAR DIAMETER

B	3”	E	5”
C	4”		

COLUMN 4 – CASE LENGTH

- L - Low Pressure
- M - Medium Pressure
- H - High Pressure

COLUMN 5 – CONFIGURATION

- A Vertical-Top Hand -Central Timed
- B Vertical-Bottom Hand – Central Timed
- C Horizontal – Left Hand – Central Timed
- D Horizontal – Right Hand – Central Timed

COLUMN 6 – DESIGN VERSION

COLUMN 7 – ADDITIONAL DESCRIPTION

	SEALS	CLEARANCES	LUBRICATION
A.	Lip	Standard	Grease-Splash
B.	Mechanical	Standard	Grease-Splash
C.	Lip	High Temperature	Grease-Splash
D.	Lip	Standard	Dual-Splash
E.	Mechanical	Standard	Dual-Splash
F.	Lip	High Temperature	Dual-Splash
G.	Mechanical	High Temperature	Dual-Splash

INTRODUCTION
YOUR KEY TO TROUBLE FREE SERVICE

Thank you for investing in Gardner Denver quality. The Gardner Denver reputation for rugged dependability has been earned by over 50 years of service in demanding, industrial operations where downtime cannot be tolerated and efficient blower performance is expected.

Your Gardner Denver Sutorbilt blower is a precision engineered blower that has been carefully manufactured and thoroughly tested at the state-of the art Gardner Denver Blower Factory in Sedalia, Missouri.

As with other precision machinery, there are several relatively simple installation, operation and maintenance procedures that you must observe to assure optimum blower performance. There is no guesswork in the manufacture of your highly advanced Sutorbilt blower and there must be none in preparing the blower to get the job done in the field.

The purpose of this manual is to help you properly install, operate and maintain your Sutorbilt blower. It is essential that you review all sections of this manual in preparation for installing your blower. Follow the instructions for installing your blower. Follow the instructions carefully and you will be rewarded with trouble-free Gardner Denver Sutorbilt service year in and year out.

SECTION 1
EQUIPMENT CHECK

Before uncrating, check the packing slip carefully to be sure all the parts have been received. All accessories are listed as separate items on the packing slip, and small important accessories such as relief valves can be overlooked or lost. After every item on the packing slip has been checked off, uncrate carefully.

NOTICE
Register a claim with the carrier for lost or damaged equipment.

⚠WARNING
Customers are cautioned to provide adequate protection, warning and safety equipment necessary to protect personnel against hazards involved in installation and operation of this equipment in the system or facility.

STORAGE

Your Gardner Denver Blower was packaged at the factory with adequate protection to permit normal storage for up to six (6) months.

If the unit is to be stored under adverse conditions or for extended periods of time, the following additional measures should be taken to prevent damage.

1. Store the blower in a clean, dry, heated (if possible) area.
2. Make certain inlet and discharge air ports are tightly covered to prevent foreign material from entering the air box.
3. All exposed, non-painted surfaces should be protected against rust and corrosion.
4. Provide adequate protection to avoid accidental mechanical damage.
5. In high humidity or corrosive environments, additional measures may be required to prevent rusting of the blower internal surfaces.
6. To prevent rusting of gears, bearings, etc., the oil reservoirs may be filled with normal operating oil.

⚠CAUTION
Before running the blower, drain the oil and replace to the proper operating level with clean, fresh lubricant.

7. Rotate the blower shaft (10 to 25 turns) weekly during storage. Inspect the blower shaft (near the shaft seal area) monthly and spray with rust inhibitor if needed.
8. For long term storage (over six (6) months), contact Gardner Denver Compressor Division Customer Service for recommendations.

REMOVING PROTECTIVE MATERIALS

The shaft extension is protected with rust inhibitor which can be removed with any standard solvent.

⚠CAUTION
Follow the safety directions of the solvent manufacturer.

Blower inlet and outlet are temporarily capped to keep out dirt and other contaminants during shipment. These covers must be removed before start-up.

The internal surfaces of all Sutorbilt units are mist sprayed with a rust preventative to protect the machine during shipment. Remove this film upon initial startup, using any commercial safety solvent. Position the blower so that the inlet and discharge connections are in the vertical position (vertical airflow). On vertically mounted units, it will be necessary to lay the unit on its side supporting the ends of the unit so as not to restrict the port on the bottom side. Place a shallow pan on the under side of the unit. With the blower disconnected from power, spray the solvent in the top port, rotating the impellers by spinning the shaft manually. Continue this procedure until the unit is visibly clean.

⚠WARNING
Rotating components will cause severe injury in case of personal contact. Keep hands and loose clothing away from blower inlet and discharge ports.

SECTION 2
INSTALLATION

LOCATION

Install the blower in a well lit, clean dry place with plenty of room for inspection and maintenance.

FOUNDATIONS

For permanent installation we recommend concrete foundations be provided, and the equipment should be grouted to the concrete. It is necessary that a suitable base be used, such as a steel combination base under blower and motor, or a separate sole plate under each. Before grouting, equipment must be leveled, free of all strains, and anchored so no movement will occur during setting of grout. After grout has completely hardened, a recheck is necessary to compensate for shrinkage, etc. If required, add shims under blower feet after final tightening of foundation anchor bolts to remove strain from the blower housing.

Where jack screws or wedges are used during grouting, they must be backed off and wedges removed before final tightening of anchor bolts. Refer to grouting instructions.

Where a concrete foundation is not feasible, care must be taken to insure that equipment is firmly anchored to adequate structural members, restricting movement and vibration.

MOUNTING CONFIGURATIONS

The blower flex-mount design enables horizontal and vertical mounting configurations with top or bottom hand, right or left hand shaft positioning. The units are center timed allowing rotation in either direction (refer to Figure 2-1).

REPOSITIONING THE MOUNTING FEET.

1. Position the mounting feet to the desired location and snug the capscrew.
2. Place the blower on its feet on a flat surface.
3. Loosen mounting feet capscrews and level unit up. The bench or blower base flatness should be within .002 of an inch.

NOTICE
If the unit is not flat within .002 of an inch, it will be necessary to shim the blower feet at installation.

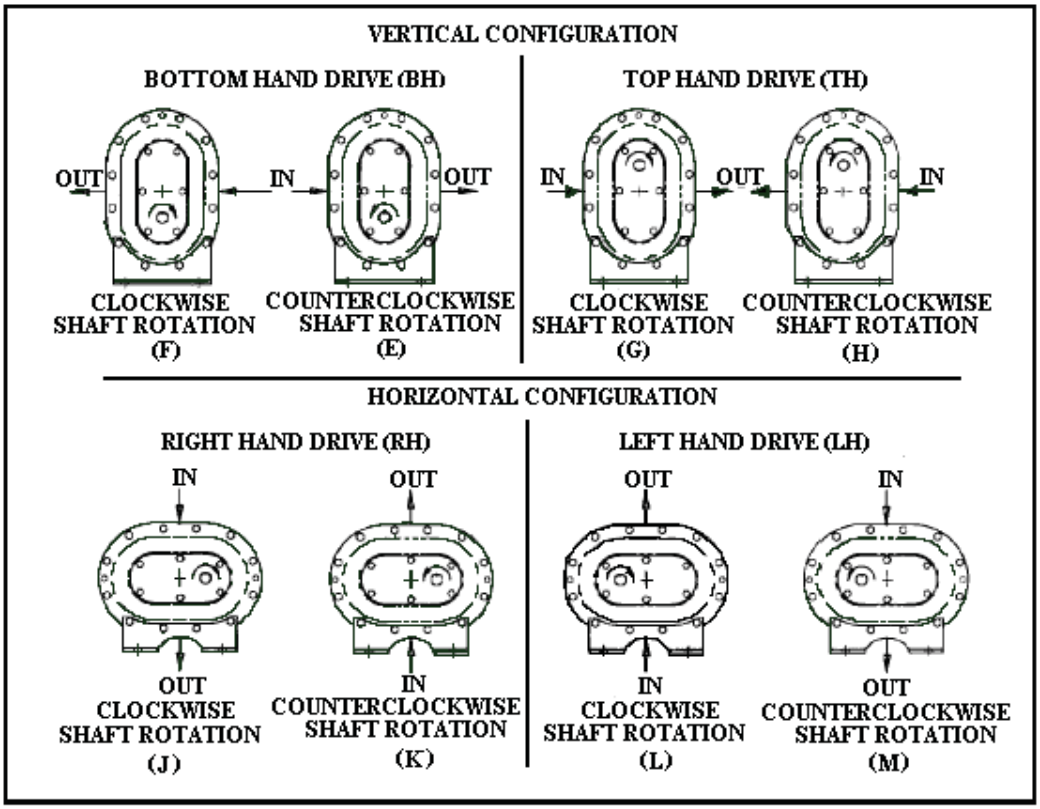


FIGURE 2-1 – BLOWER MOUNTING CONFIGURATIONS

4. Secure the mounting feet capscrews to the torque value in Figure 7-9, page 38.

NOTICE
When changing mounting configuration, it may be necessary to reposition breather/oil fill (B), oil level gauge (H) and drain plug (A). Refer to Figure 3-1, page 17, for correct location.

DRIVE INSTALLATION

When selecting a V-belt drive, check to be sure the shaft overhung load limitation is not exceeded. Refer to FIGURE 2-2, page 15, for overhung load calculations and limitations.

Belt drives must be carefully aligned. Motor and blower pulleys must be parallel to each other and in the same plane within 1/32 inch. Belt tension should be carefully adjusted to the belt manufacturer's recommendation using a belt tension gauge. Check tension frequently during the first day of operation.

⚠WARNING
Over tightening belts leads to heavy bearing loads and premature failure.

On the direct connected units, alignment and lubrication of couplings to specifications of the coupling manufacturer is very important. When mounted drives are supplied from the factory proper alignment has been established before shipment. However, during shipping, handling and installation, it is likely that the alignment has been disturbed and final adjustment must be made before startup.

⚠WARNING

Exceeding overhung load limitations leads to unwarrantable premature bearing failure and shaft breakage.

The location of the sheave on the blower shaft greatly affects the stress in the shaft. The optimum blower sheave positioning is as close as possible to the blower drive cover, not to exceed dimension "C" in Drive Shaft Illustration, FIGURE 2-2, page 15

The calculated shaft moment must not exceed the maximum allowable moment listed in Maximum Allowable Moment Chart, FIGURE 2-2 page 15. If the calculated shaft moment exceed the maximum allowable moment:

- Increase Sheave Diameters to Reduce Belt Pull
- Use Jackshaft Drive
- Use Direct Coupled or Gearbox Drive

To calculate shaft moment for a given V-Belt Drive Arrangement:

1. Use the formula for Calculation of Belt Pull, FIGURE 2-2, page 15, to calculate belt pull. Refer to Arc of Contact Factor Chart, Figure 2-2, page 15.
2. Insert the calculated belt pull into the formula for Calculation of Shaft Moment, FIGURE 2-2, page 15 to arrive at the calculated shaft moment.

PIPING

Inlet and discharge connections on all blowers are large enough to handle maximum volume with minimum friction loss. Reducing the pipe diameter on either inlet or discharge will only create additional line loss and increase the overall pressure differential. Excessive weight of piping and fittings will cause internal misalignment and premature wear. Never allow the blower to carry the weight of the pipe. If possible, a spool or sleeve-type expansion joint should be installed between the unit and the piping. Where a flexible connection is not practical, the weight of the rigid connection must be separately supported.

All system piping must be cleaned internally before connecting to the blower.

⚠WARNING

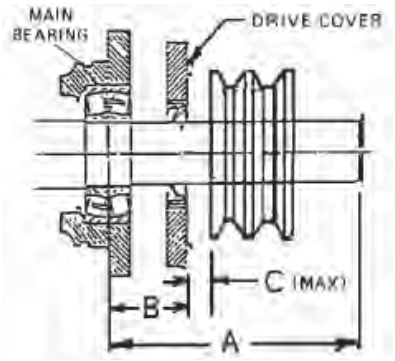
Sutorbilt blowers are shipped dry from the factory. Do not attempt to operate the blower before following proper lubrication instructions. Permanent damage to the gears, bearings and seals will occur.

Gear Diameter (Inches)	GREASE SPLASH Dimensions (Inches)			Maximum Allowable Moment (LB-IN)
	A	B	C (Max)	
3	2.88	.85	.38	385
4	3.49	1.10	.38	490
5	3.90	1.40	.38	1245

MAXIMUM ALLOWABLE MOMENT

Gear Diameter (Inches)	DUAL SPLASH LUBE Dimensions (Inches)			Maximum Allowable Moment (LB-IN)
	A	B	C (Max)	
3	3.07	1.18	.25	385
4	3.62	1.27	.25	650
5	3.85	1.39	.25	1370

MAXIMUM ALLOWABLE MOMENT



Z	Ac	Z	Ac	Z	Ac	Z	Ac	Z	Ac	Z	Ac
0.000	1.000	0.250	0.966	0.500	0.926	0.750	0.879	1.000	0.823	1.250	0.751
0.025	0.997	0.275	0.962	0.525	0.922	0.775	0.874	1.025	0.816	1.275	0.742
0.050	0.994	0.300	0.958	0.550	0.917	0.800	0.869	1.050	0.810	1.300	0.734
0.075	0.990	0.325	0.954	0.575	0.913	0.825	0.864	1.075	0.803	1.325	0.725
0.100	0.987	0.350	0.951	0.600	0.908	0.850	0.858	1.100	0.796	1.350	0.716
0.125	0.983	0.375	0.947	0.625	0.904	0.875	0.852	1.125	0.789	1.375	0.706
0.150	0.980	0.400	0.943	0.650	0.899	0.900	0.847	1.150	0.782	1.400	0.697
0.175	0.977	0.425	0.939	0.675	0.894	0.925	0.841	1.175	0.774	1.425	0.687
0.200	0.973	0.450	0.935	0.700	0.889	0.950	0.835	1.200	0.767		
0.225	0.969	0.475	0.930	0.725	0.884	0.975	0.829	1.225	0.759		

ARC OF CONTACT FACTORS

$$\text{Belt Pull} = \left[\frac{2.5 - Ac}{Ac}\right] \times \left[\frac{125954 \times Hp \times S.F.}{D \times RPM}\right]$$

Key:
- Ac = Arc of Contact Factor (Refer to Arc of Contact Factor Chart above)
- Hp = Blower Horsepower for Operating Conditions
- S.F. = Actual Drive Service Factor
- D = Blower Sheave Pitch Diameter in Inches
- RPM = Blower Sheave Speed
- Z = $\left[\frac{\text{Large Sheave Pitch Diameter (in)} - \text{Small Sheave Pitch Diameter (in)}}{\text{Sheave Center Distance (in)}}\right]$

CALCULATION OF BELT PULL

$$\text{Shaft Moment (LB-IN)} = \text{Belt Pull} \times \left[B + C + \left(\frac{\text{Sheave Width}}{2}\right)\right]$$

CALCULATION OF SHAFT MOMENT

FIGURE 2-2 – BELT DRIVE OVERHUNG LOAD CALCULATIONS

AIR FILTERS AND FILTER SILENCERS

⚠WARNING

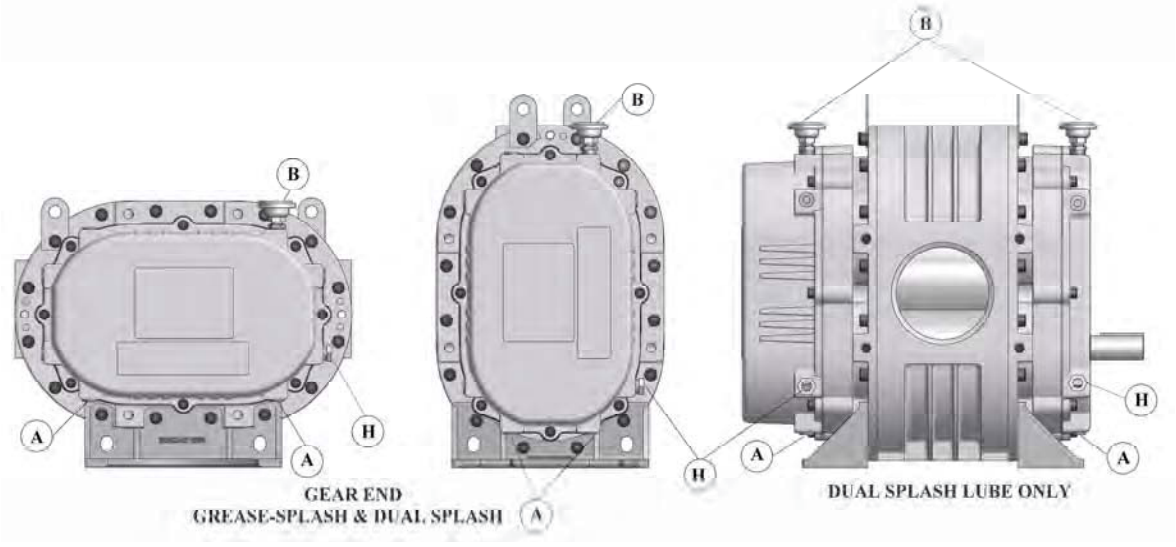
Servicing the air filters is one of the most important maintenance operations to be performed to insure long blower life.

Servicing frequency of filter elements is not time predictable. A differential pressure indicator, with a continuous gauge reading, should be installed across the inlet filter. It will tell how much of the service life of the filter element has been used. It will also eliminate both premature filter servicing and premature blower failure due to a plugged filter when the filter pressure drop is used to establish maintenance points. In all cases refer to the filter manufacturer's service instructions. Due to the many types of filters, it is not practical to give specific instructions covering all models.

NOTICE

No matter what type of filter is used, always make sure all seats, gaskets, clamps and hose connections on the filter and inlet line are absolutely air tight. Each time the filter is serviced, inspect interior of the blower for dirt.

SECTION 3
LUBRICATION



A. OIL DRAIN PLUG
B. BREATHER/OIL FILL
C. GREASE FITTING
E. GREASE VENTS
H. OIL LEVEL GAUGE

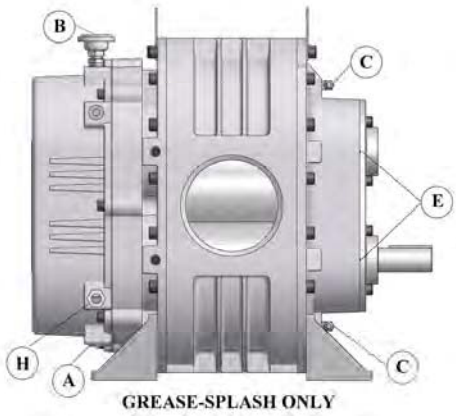


FIGURE 3-1 - LUBRICATION

DRIVE END LUBRICATION (For Grease – Splash Lube Blowers)

Drive end bearings are grease lubricated at the factory with Lithium Complex based grease. **For relubrication, use Gardner Denver AEON PD Grease, Part Number 28H283.** AEON PD Grease is a high temperature, high performance grease that is formulated with antiwear additives to provide superior service under the severe operating conditions of positive displacement blowers. It contains rust inhibitors which provide excellent protection against rust and corrosion.
If you choose not to use AEON PD Grease, select compatible base grease. The grease should be NLGI Grade 2 EP, contain rust inhibitors, and be suitable for blower discharge temperatures up to 350° F (177° C). Completely clean or purge the factory--filled grease from the blower. **Do not mix different types of grease as they may not be compatible. Substitutions may cause early bearing failure.**

Re-grease bearings every 500 hours of operation. Lubricate each bearing through the grease fittings located at C in FIGURE 3-1 (2 places). When re-greasing, the old grease will be forced out of the vents (E in FIGURE 3-1). To prevent damage to seals, these vents must be open at all times.

⚠ WARNING
Do not over--grease bearings as this could cause premature bearing failure.

DRIVE END LUBRICATION (For Dual Splash Lube Blowers)

At the drive end, the bearings are lubricated by the slinger, which must be on the lowest rotor when in a vertical configuration.

Approximate oil sump capacities are listed in Figure 3-2.

NOTICE
Machines are shipped without oil in the sump. Do not operate before adding lubricant.

Lubrication Instructions

Filling procedure
Refer to Figure 3-1, page 17. Remove the breather (B) from the drive cover. Add oil to the drive sump until oil reaches the center of the oil level gauge (H). Secure breather (B) in the drive cover.

Add fresh oil as required to maintain proper level. The oil level should be at the middle of the sight glass when the machine is not operating. Refer to Figure 3-2, for approximate oil capacities.

Legend "R" Series, Grease-Splash Lube Blower Oil Capacities

		Approximate Sump capacity in pints or ounces					
		Vertical Configuration			Horizontal Configuration		
Series	**Gear Diameter (in)**	**Gear End**	**Drive End**	**Total**	**Gear End**	**Drive End**	**Total**
3	3.5	0.6 PT (9 oz.)	grease	0.6 PT (9 oz.)	1.1 PT (18 oz.)	grease	1.1 PT (18 oz.)
4	4	0.9 PT (14 oz.)	grease	0.9 PT (14 oz.)	1.5 PT (24 oz.)	grease	1.5 PT (24 oz.)
5	5	1.1 PT (18 oz.)	grease	1.1 PT (18 oz.)	2.5 PT (40 oz.)	grease	2.5 PT (40 oz.)

Note: Quantities are for purchase estimates only.

Legend "R" Series, Dual Splash Lube Blower Oil Capacities

		Approximate Sump capacity in pints or ounces					
		Vertical Configuration			Horizontal Configuration		
Series	**Gear Diameter (in)**	**Gear End**	**Drive End**	**Total**	**Gear End**	**Drive End**	**Total**
3	3.5	0.6 PT (9 oz.)	0.3 PT (5 oz.)	0.9 PT (14 oz.)	1.1 PT (18 oz.)	0.6 PT (9 oz.)	1.7 PT (27 oz.)
4	4	0.9 PT (14 oz.)	0.4 PT (6 oz.)	1.3 PT (20 oz.)	1.5 PT (24 oz.)	0.7 PT (11 oz.)	2.2 PT (35 oz.)
5	5	1.1 PT (18 oz.)	0.6 PT (9 oz.)	1.7 PT (27 oz.)	2.5 PT (40 oz.)	1.2 PT (19.1 oz)	3.7 PT (59.1 oz.)

Note: Quantities are for purchase estimates only.

FIGURE 3-2 – APPROXIMATE OIL CAPACITIES

GEAR END LUBRICATION (For Grease – Splash Lube and Dual Splash Lube Blowers)
At the gear end, the timing gear teeth are lubricated by being partially submerged in oil. The gear teeth serve as oil slingers for gear end bearings.

Approximate oil sump capacities are listed in Figure 3-2.

⚠WARNING

Do not overfill as this will tend to cause excessive heating of the gears and may damage the unit.

NOTICE

Machines are shipped without oil in the sump. Do not operate before adding lubricant.

LUBRICATION INSTRUCTIONS

Filling procedure Refer to FIGURE 3-1, page 17. Remove the breather (B) from the gear cover. Add oil to the gear case until oil reaches the center of the oil level gauge (H). Secure breather (B) in the gear cover.

Add fresh oil as required to maintain proper level. The oil level should be at the middle of the sight glass when the machine is not operating. Refer to Figure 3-2, page 18, for approximate oil capacities.

RECOMMENDED LUBRICANT

AEON PD Synthetic Blower Lubricant is recommended. Refer to FIGURE 3-3, for AEON PD, AEON PD-FG (Food Grade) and AEON PD-XD (Extreme Duty) part numbers. Order AEON PD from your Gardner Denver Distributor or call Gardner Denver directly.

Convenient Package Sizes	AEON PD Part No.	AEON PD-FG Part No.	AEON PD-XD Part No.
1 quart	28G23	28H97	28G46
Case 12 quarts	28G24	28H98	28G47
1 gallon	28G40	28H333	28G42
Case 6 gallons	28G41	28H334	28G43
5 gallon pail	28G25	28H99	28G44
55 gallon drum	28G28	28H100	28G45

FIGURE 3-3 – AEON PD SYNTHETIC LUBRICANT

AEON PD is formulated especially for positive displacement blower service to provide maximum blower protection at any temperature. One fill of AEON PD will last a minimum of 4 times longer than a premium mineral oil. Refer to FIGURE 3-4.

		Ambient Temperatures			
		Less than 10° F	10°F to 32°F	32°F to 90°F	Greater than 90°F
Blower Discharge Temperature	Less than 32°F	AEON PD AEON PD-FG	AEON PD AEON PD-FG		
	32° F to 100° F	AEON PD AEON PD-FG	AEON PD AEON PD-FG	AEON PD AEON PD-FG	
	100° F to 225°F	AEON PD AEON PD-FG	AEON PD AEON PD-FG	AEON PD AEON PD-FG	AEON PD AEON PD-FG
	225° F to 300° F	AEON PD AEON PD-FG	AEON PD AEON PD-FG	AEON PD AEON PD-FG	AEON PD XD
	Greater than 300°F			AEON PD XD	AEON PD XD

FIGURE 3-4 – SYNTHETIC LUBRICANT CHART

AEON PD Synthetic Lubricant should be drained after 6000 hours of operation. Re-fill with fresh AEON PD oil. If mineral oil is used, perform the above oil change maintenance every 1500 hours. Recommended service intervals are for normal blower operating conditions. Severe operating conditions may warrant more frequent oil changes. Laboratory analysis of lubricant should be used to help determine the optimum oil change interval.

For best performance and equipment protection, use AEON PD Synthetic Lubricant, which has been specifically formulated for positive displacement blowers. If you choose not to use AEON PD Synthetic Blower Lubricant, select an oil with rust and oxidation inhibitors, anti-foam additives, and the viscosities listed in FIGURE 3-5. Do not use an oil that contains EP additives.

NOTICE
Flush the oil whenever a change is made from one type of oil to another.

Drain the current lubricant as thoroughly as possible. Refill with the new lubricant. Fill to normal level of the blower, which is at the middle of the sight glass when the machine is not operating. Run the blower for one hour. Shut off the blower and drain the lubricant completely. Refill the blower again with the new lubricant.

Blower Discharge Temperature	Ambient Temperature			
	Less than 10° F*	10° F to 32° F**	32° F to 90° F	Greater than 90° F
Less than 32° F (0° C)	ISO 100	ISO 100		
32° F to 100° F (0° C to 38° C)	ISO 100	ISO 100	ISO 150	
100° F to 225° F (38° C to 105° C)	ISO 100	ISO 100	ISO 150	ISO 220
225° F to 300° F (105° C to 149° C)	ISO 150	ISO 150	ISO 220	ISO 220
Greater than 300° F (149° C)			***	***

* For ambient temperatures less than 10° F, but not less than –20° F, the use of oil sump heaters, heated enclosures or synthetic lubricant is required.

** For ambient temperatures 10° F to 32° F, the use of oil sump heaters, heated enclosures or synthetic lubricant is recommended.

*** The lubricant viscosity must be 70 SUS minimum at the lubricant operating temperature.

The pour point of the lubricant should be at least 5° to 10° F below the minimum expected ambient temperature.

For continuous operation, where the lubricant temperature exceeds 200° F, synthetic lubricant is recommended.

FIGURE 3-5 – LUBRICATION RECOMMENDATION

SECTION 4
OPERATION

Future operating problems can be avoided if proper precautions are observed when the equipment is first put into service.

Before starting under power, the blower should be turned over by hand to make certain there is no binding or internal contact.

Each size blower has limits on pressure differential, running speed and discharge temperature which must not be exceeded. These limits are shown in "Maximum Operating Limitations", FIGURE 4-1, below.

⚠WARNING

Operating beyond the specified operating limitations will result in damage to the unit.

It is important that the pressures and temperatures are measured directly at the ports of the blower to avoid error that may be caused by intervening pipe runs, fittings, etc.

Relief valves must be used to protect against excessive pressure or vacuum conditions. These valves should be tested at initial startup to be sure they are adjusted to relieve at or below the maximum pressure differential rating of the blower.

NOTICE

Relief valves should be placed as close as possible to the blower inlet or discharge.

In some instances, pressure may be relieved at a lower point than the blower maximum in order to protect the motor or the equipment served by the blower.

Discharge temperature switches are recommended to protect against excessive inlet restriction or inlet temperatures. Check valves in the discharge line on pressure blowers and in the inlet line on vacuum blowers are recommended to protect the blower from motoring backwards when shut down under load.

LIMITATIONS

For information regarding limitations, refer to FIGURE 4-1, below.

MAXIMUM / MINIMUM OPERATING LIMITATIONS

SIZE	MAX. RPM	MIN. RPM VERT.	MIN RPM HORIZ.	MAX. PRESSURE PSI	MAX VAC IN HG	MAX. TEMPERATURE RISE ° F	MAX. DISCHARGE TEMPERATURE ° F
3LR	3600	1528	1091	7	14	160	260
3MR	3600	1528	1091	12	15	180	280
3HR	3600	1528	1091	15	16	220	320
4LR	3600	1337	955	7	14	160	260
4MR	3600	1337	955	10	16	185	285
4HR	3600	1337	955	15	16	210	310
5LR	2850	1070	764	7	14	160	260
5MR	2850	1070	764	13	16	180	280
5HR	2850	1070	764	15	16	200	300

DO NOT EXCEED THESE LIMITS

NOTICE

Blower speed, line losses, elevation, and increased inlet temperatures will affect the maximum operating limitations. The minimum RPM for the blowers is based on lubrication only. The blowers may only be operated down to the minimum RPM, when the temperature rise and discharge temperature are below the maximum limitations as shown.

FIGURE 4-1 – MAXIMUM / MINIMUM OPERATING LIMITATIONS

BLOWER STARTUP CHECKLIST

This startup procedure should be followed during the initial installation and after any shutdown periods or after the blower has been worked on or moved to new location. It is suggested that the steps be followed in sequence and checked off (√) in the boxes provided.

- ☐ 1. Check the unit and all piping for foreign material and clean if required.
- ☐ 2. Check the flatness of the feet and the alignment of the drive. Feet that are bolted down in a bind can cause housing distortion and internal rubbing. Misaligned V-drives can cause the rotors to rub against the headplates and cause a reduction in the volumetric efficiency of the unit. Misaligned couplings can ruin bearings.
- ☐ 3. If the blower is V-belt driven, check the belt tension and alignment. Over-tensioned belts create heavy bearing/shaft loads which lead to premature failure.
- ☐ 4. Be sure adequate drive guards are in place to protect the operator from severe personal injury and incidental contact.
- ☐ 5. Check the unit for proper lubrication. Proper oil level cannot be over-emphasized. Too little oil will ruin bearings and gears. Too much oil will cause overheating and can ruin gears and cause other damage. Insure that grease lubricated bearings are properly lubricated.
- ☐ 6. With motor electrical power locked out and disconnected, turn the drive shaft by hand to be certain the impellers do not bind.
- ☐ 7. “Jog” the unit with the motor a few times to check that rotation is in the proper direction, and to be certain it turns freely and smoothly.
- ☐ 8. The internal surfaces of all Sutorbilt units are mist sprayed with a rust preventive to protect the machine during the shipping and installation period. This film should be removed upon initial startup.
- ☐ 9. Start the unit and operate 15 minutes at no load. During this time, check for hot spots and other indications of interference.
- ☐ 10. Apply the load and observe the operation of the unit for one hour. Check frequently during the first day of operation.
- ☐ 11. If malfunctions occur, do not continue to operate. Problems such as knocking rotors can cause serious damage if the unit is operated without correction.

SAFETY PRECAUTIONS

1. Do not operate blower with open inlet or outlet port.
2. Do not exceed specified vacuum or pressure limitations.
3. Do not operate above or below recommended blower speed range.
4. Blower is not to be used where non-sparking equipment is specified.
5. Do not operate without belt guard or coupling shield.

Do not exceed sheave or coupling manufacturer's rim speed limit.

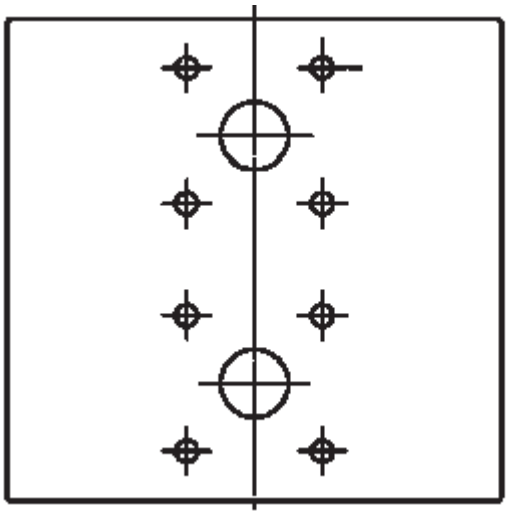
6. The blower and blower discharge piping may be extremely hot and cause skin burns on contact.

TROUBLE SHOOTING

No matter how well the equipment is designed and manufactured, there may be times when servicing will be required due to normal wear, the need for adjustment, or various external causes. Whenever equipment needs attention, the operator or repairman should be able to locate the cause and correct the trouble quickly. The Trouble Shooting Chart below is provided to assist the mechanic in those respects.

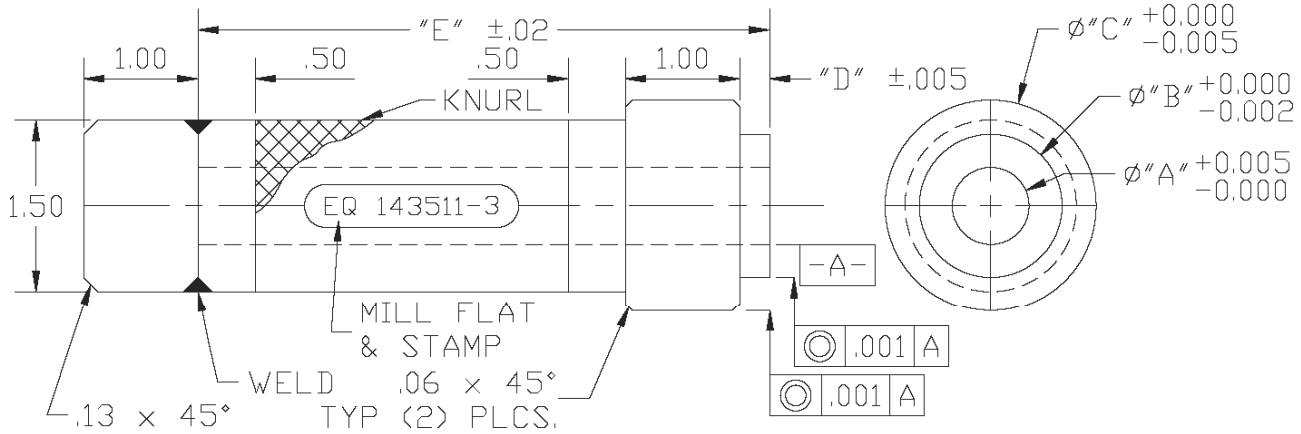
PROBLEM	POSSIBLE CAUSES	SOLUTION
Knocking	1. Unit out of time. 2. Distortion due to improper mounting or pipe strains. 3. Excessive pressure differential. 4. Worn gears. 5. Worn bearings.	1. Re-time impellers 2. Check mounting alignment and relieve pipe strains. 3. Reduce to manufacturer's recommended pressure. Examine relief valve, re-set if necessary. 4. Replace timing gears. 5. Replace bearings..
Excessive blower temperature.	1. Too much oil in gear case. 2. Too low operating speed. 3. Dirty air Filter. 4. Clogged filter or muffler. 5. Excessive pressure differential. 6. Worn impeller clearances. 7. Internal contact.	1. Reduce oil level. 2. Increase blower speed. 3. Clean or replace air filter 4. Remove cause of obstruction. 5. Reduce pressure differential across the blower. 6. Replace impeller. 7. Correct clearances.
Impeller end or tip drag.	1. Insufficient assembled clearances. 2. Case or frame distortion. 3. Excessive operating pressure. 4. Excessive operating temperature.	1. Correct clearances. 2. Check mounting and pipe strain. 3. Remove cause. 4. Remove cause
Lack of volume.	1. Slipping belts. 2. Worn clearances. 3. Dirty air filter	1. Tighten belts. 2. Re-establish proper clearances. 3. Clean or replace air filter.
Excessive bearing or gear wear.	1. Improper lubrication.	1. Correct lubrication level. Replace dirty oil.
Loss of oil.	1. Headplate, gear case or drive cover vents plugged. 2. Worn Seal.	1. Clean vents. 2. Replace seals.

ORDER SPECIAL TOOLS BY PART NUMBER. SEE PAGE 2 FOR ORDERING INSTRUCTIONS.



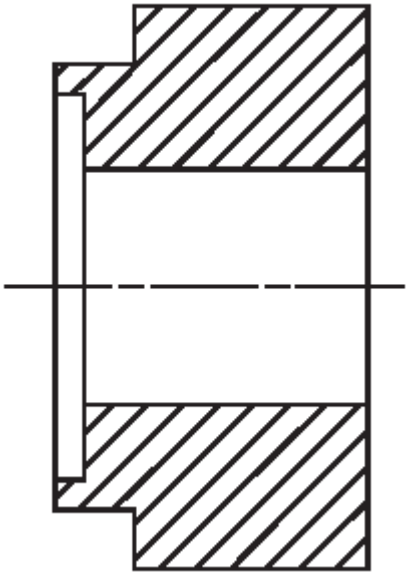
Unit Size	Part Number
3”	201GAA340
4”	202GAA340
5”	203GAA340

FIGURE 5-1 – PULLER PLATE



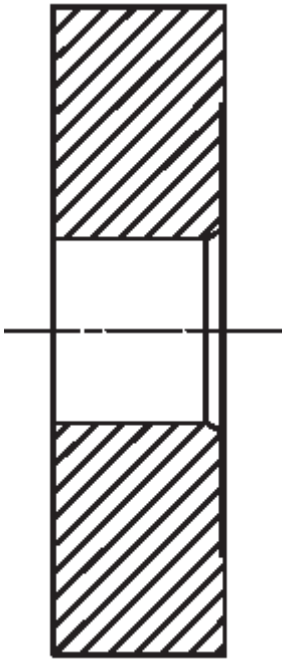
PART NO.	SIZE	"A"	"B"	"C"	"D"	"E"
EQ 143511-3	3"	.790	1.435	2.044	.335	5.50
EQ 143511-4	4"	1.000	1.624	2.436	.395	6.25
EQ 143511-5	5"	1.184	2.247	2.829	.695	7.00

FIGURE 5-2 – SEAL DRIVE



Unit Size	Part Number
3”	205GAA074
4”	206GAA074
5”	207GAA074

FIGURE 5-3 – MECHANICAL SEAL INSTALLATION TOOL



Unit Size	Part Number
3”	201GAA074
4”	202GAA074
5”	203GAA074

FIGURE 5-4 – BEARING PRESS TOOL – MECHANICAL SEAL UNITS

SECTION 6
DISASSEMBLY INSTRUCTIONS

NOTICE
Numbers in parentheses ( ) refer to key numbers in assembly drawings on pages 39 and 43.

1. Drain oil from gear case by removing drain plug (2).
2. Remove the socket head bolts (5) from the gear cover (3).
3. Remove the gear cover from the gear headplate.

NOTICE
The cover and gear headplate gasket tends to bond tightly to both surfaces. After socket head bolt removal, it is sometimes necessary to take a ball peen hammer and a blunt chisel and drive off the cover.

IMPORTANT:

MARK ALL PARTS WITH A CENTER PUNCH SO THEY CAN BE REASSEMBLED IN THE SAME POSITION (IMPELLERS, HEADPLATES, AND GEARS).

4. If the timing gears appear undamaged, the gear backlash must be checked to see if the gears can be salvaged.
   - A. Mount a magnetic base dial indicator on the gear headplate (see FIGURE 6-1).
   - B. Lock one impeller stationary by wedging a feeler gauge between the impeller and the headplate.
   - C. The tip of the indicator should be placed at the center of the contact surface on a tooth of the gear on the free shaft.
   - D. Rock the impeller back and forth by hand and read the total rotational movement to the nearest .0005 inches. Do this at four gear mesh positions 90 degrees apart.
   - E. Permissible gear backlash is shown below.

GEAR DIA.	GEAR BACKLASH
3”	.0015 - .0025
4”	.0015 - .0025
5”	.002 - .003

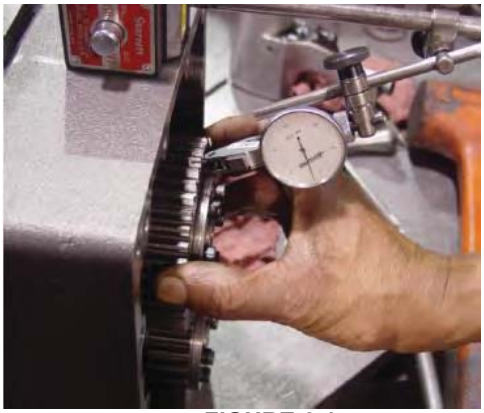


FIGURE 6-1

FIGURE 6-2

FIGURE 6-3

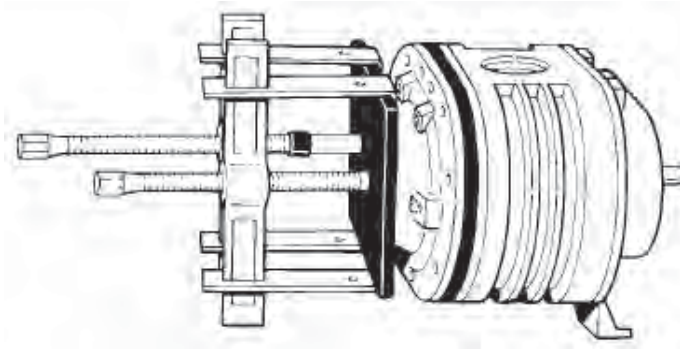


FIGURE 6-4

NOTICE
If backlash is above the specified limit, the gears are not necessarily unusable. Excessive play could be caused by worn bearings.

5. If timing gears appear to be reusable, match marktiming gear toothmesh by making small punch marks on the ends of meshing gear teeth with a pin punch and hammer (see FIGURE 6-2, page 27). The impeller tip to valley (throat) and the case to headplates should also be matchmarked to facilitate blower reassembly.
6. Remove all cap screws from both gear locking assemblies (see FIGURE 6-3). Thread 3 of these cap screws into the threaded holes in the outer ring of each locking assembly. Tighten the screws evenly to remove the locking assembly from each gear. Remove the gears (9) from both rotor shafts.

NOTICE
Blowers with mechanical seals have two wavy washers (28) located between the bearings and the cover on the drive end.

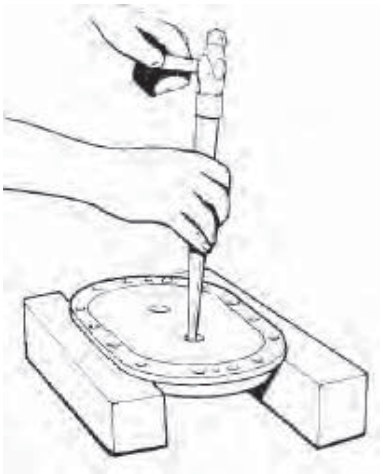


FIGURE 6-5

7. Remove the socket head cap screws (30) from the drive end bearing cover (29) and remove the cover. Support the external surface of the drive end cover near the oil seal with blocks of wood. Drive the oil seal from the cover using a hammer and punch. Discard the seal as it will not be reused. Replace oil seals each time the drive end cover is removed.

   For Dual Splash Version
   Remove the socket cap screws (84) from each slinger and remove slingers.

   For Dual Splash Version with Mechanical Seal
   Remove the socked cap screws (84) from each slinger and remover slingers. Remove flat head cap screws (86) from wavy spring retainer plates and remove retainer plate and wavy spring.

8. Remove mounting foot (17) from the drive headplate (24) by removing the capscrews (16).
9. Remove the capscrews (21) which secure the drive headplate (24) to the impeller case (22).
10. Using the puller plate shown on page 25, bolt to the drive headplate using the tapped holes on used to secure the drive cover.
11. Install a gear puller to each shaft and attach puller arms to the plate. Turn each puller only half a revolution at a time keeping the advance of the shafts as uniform as possible (see Figure 6-4). After the headplate has been removed, detach the puller plate.
12. Remove the two drive end bearings (35 and 80 for dual splash lube) or (14 and 35 for grease) from the drive headplate (24) using a ball peen hammer and punch (see Figure 6-5, page 28).

⚠ CAUTION
Exercise care not to damage the headplate bearing bores when removing bearings.

13. The oil seals can now be driven out of the drive headplate with hammer and punch (see Figure 6-5, page 28). Discard the seals as they will not be reused. Replace oil seals each time the headplate is removed.

   For Mechanical Seal Version
   Remove mechanical seal from the drive headplate.

NOTICE
Seals and bearings should be replaced during overhaul as a matter of service policy.

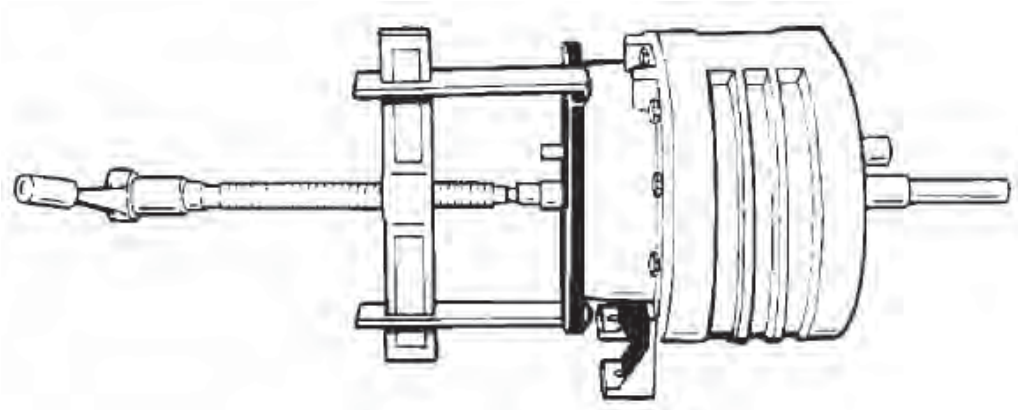


FIGURE 6-6

14. Remove the four bearing retaining screws (10), and washers (12) from the gear headplate.

    For Mechanical Seal Version
    Remove bearing retainer plate by removing 8 screws.

15. Attach puller plate to the gear headplate using the tapped holes on the bearing housing.

16. Install a gear puller to one of the shafts and attach puller arms to the plate (see Figure 6-6).

17. Remove mounting foot (17) from the gear headplate by removing 4 capscrews (16).

18. Push the impeller shaft through the gear headplate and remove the impeller assembly(23) (see Figure 6-6). Remove the other impeller assembly following the same procedure.

19. Remove the cap screws (21) securing the gear headplate to the impeller case. Located near each dowel pin on the headplate is a threaded hole. Insert a 5/16-18 UNC capscrew into each of the threaded holes. Tighten the screws evenly until the headplate separates from the impeller case.

20. Remove the two gear and bearings (14) from the gear headplate (18) as done in step 12.

21. Remove the oil seals (15) from gear headplate (19) as done in step 13.

SECTION 7
ASSEMBLY INSTRUCTIONS

NOTICE
Numbers in parentheses ( ) refer to key numbers in assembly drawings on pages 39 and 43.

1. Make sure all metallic parts are clean and free of any nicks or burrs.
2. Lubricate the outside diameter of the lip seal (15) with a light oil or grease. Install seals in both the drive headplate (24) and gear headplate (18). Use the seal driver (Figure 5-2). The seal lip should always face towards the bearing or lubricant. New seals should be installed each time the headplate is removed.

NOTICE
Make sure seals are fully seated. Use extreme care when installing.

MECHANICAL SEALS ONLY

A. Lightly coat the headplate bores with assembly lubricant.

B. Refer to Figure 7-1. Install mechanical seal (A) into the headplate bore (C) using a press and the correct driver shown on page 26. Drive the seal securely on to its seat.

⚠ CAUTION
Use extreme care when installing seals in the headplate bores. Do not attempt to install the mechanical seals without the use of a press. Blows from a hammer or mallet can damage the fragile seal surface. Too much force can crush the seal casing. Make certain the seal is properly seated and undamaged before proceeding.

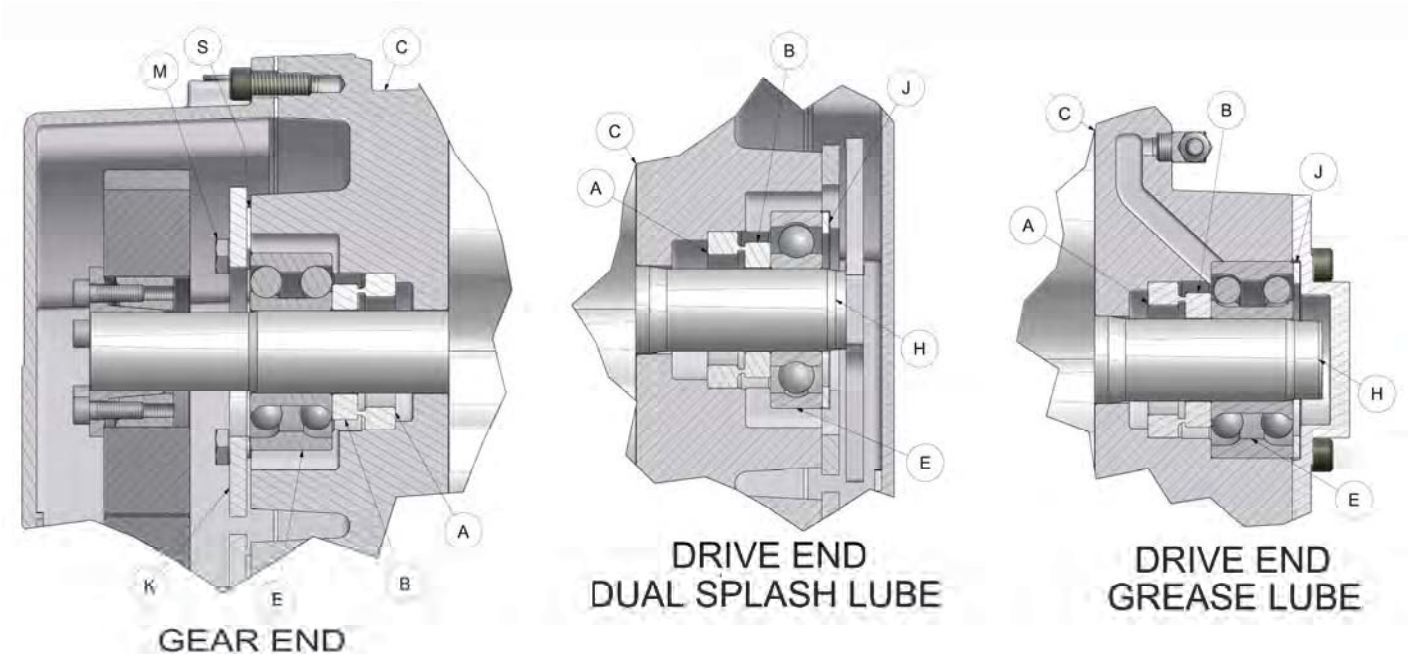


FIGURE 7-1

FIGURE 7-2

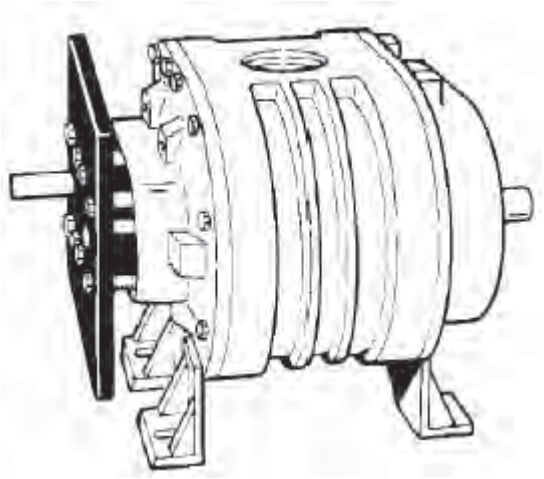


FIGURE 7-3

3. Assemble gear headplate (18) and mounting foot (17) to the impeller case with cap screws (21) and where the mounting foot is secured to the headplate use capscrews (16). The two positioning dowel pins (19) will ensure proper alignment of the headplate and impeller case. Also secure lifting lugs using capscrews (21) (see exploded assembly drawing on page 39. Refer to Figure 7-9, page 38, for torque specifications.

⚠ CAUTION
Seals are delicate; use extreme care when installing impeller shafts in the headplate bores. A piece of light shim stock wrapped around the shaft keyway will prevent cutting the seal lip.

4. Apply a light oil or grease on the shaft seal areas and the bearing areas. Insert impellers into the gear headplate using the same headplate bores as used in the original assembly.
5. Position blower so that impellers are vertical, with the drive end on top. It will be necessary to use blocks in order for the unit to set level. Measure the total end clearance using a depth micrometer (see Figure 7-2).

NOTICE
If more than .007" shim is required, put .007" on the drive end and the remaining on the gear end.

If total clearance is not within the limits specified in Figure 7-4, page 33, it may be necessary to shim the case to obtain the proper total end clearance. The shim should be placed between the drive headplate and impeller case.

6. Assemble drive headplate (24) to impeller case as in step 3 with the gear headplate. If shims were required, place shims between drive headplate and impeller case.

MECHANICAL SEALS ONLY

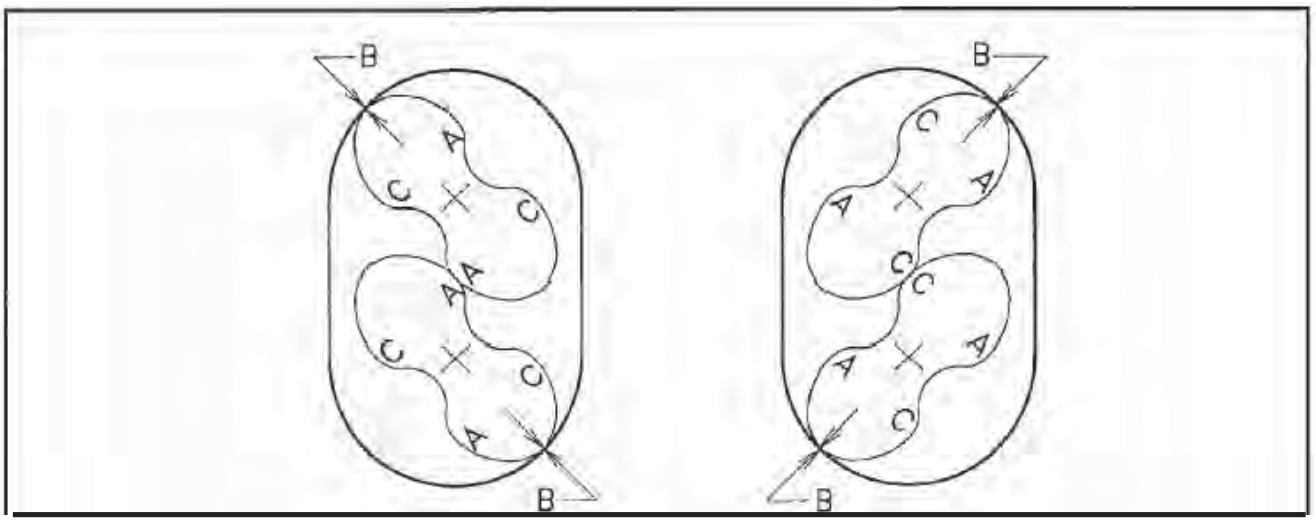
A. Refer to Figure 7-1, page 31. Lightly coat the impeller shaft (H) and the inside diameter of the mating ring (B) with assembly lubricant.

B. Install the mating ring (B) on the shaft only far enough to get the bearing (E) started on the shaft.

⚠ CAUTION
Do not drive the mating ring down to the mechanical seal, as this can damage the seal.

C. Lightly lubricate the bearing inner race (E) with a light oil or grease.

D. Using a press, install the bearing on the shaft with the bearing driver shown on page 24.



INTERNAL CLEARANCES FOR STANDARD UNITS ONLY

	3H	3M	3L	4H	4M	4L	5H	5M	5L
TOTAL END CLEARANCE	0.007-0.011			0.007-0.011			0.007-0.011		
IMPELLER TO GEAR HEADPLATE	0.003-0.005			0.003-0.005			0.003-0.005		
IMPELLER TIMING (A-A) (C-C)	0.005-0.007	.006-.008		0.006-0.008	.007-.010		.007-.010	.008-.010	
TIP TO CASE CLEARANCE (B-B)	0.002 min.			0.002 min.			0.002 min.		

FIGURE 7-4

The bearing driver will position the mating ring (B) to the correct depth with respect to the mechanical seal (A).

7. Apply a light oil to the drive headplate bearing bore, bearing inside diameter, and shaft seat. Install the drive end bearings (14and 35 for grease) or (80 and 35 for dual splash lube) as far as possible without force.
8. Attach the puller plate shown on page 25, to the drive headplate using the tapped holes used on the drive headplate (see FIGURE 7-3, page 32). Tighten the bolts so that the advance of the bearings stay as uniform as possible. Bearings should be pressed until flush with the drive headplate.
9. Lubricate the gear end bearing fits with a light oil as described previously. Install gear end bearings (14) as far as possible without force. Use the plate, used to install the drive end bearings, to press the bearings on the shafts as described in Step 8. Press bearings into the gear headplate until completely seated in the bearing bore.

NOTICE
Bearings will not be flush with gear headplate bores when completely seated.

10. Impellers should now be checked for free axial movement by hitting the ends of the impeller shafts with the palm of your hand.
11. Push the impellers against the gear headplate and recheck the total end clearance between the drive headplate and the impellers (see FIGURE 7-4).
    A. If total end clearance is insufficient, loosen impeller case to headplate bolts on either headplate, and move the headplate away from the case far enough to insert a paper shim in the amount equal to the insufficient clearance. Retighten case bolts and again check the total end clearance. Refer to FIGURE 7-4 for correct clearance.
    B. Excessive end clearances normally will require new impeller assemblies, but in some circumstances the impeller case can be removed and reduced in width by machining off the amount of excess clearance.
    C. Apply Loctite 246 on the 4 bearing retaining screws. Install 4 bearing screws and washers into the gear end headplate. Tighten screws evenly to the torque value given in FIGURE 7-9.

For Mechanical Seal Version

Install 8 bearing retaining screws and washers into the gear bearing retainer plates. Tighten screws evenly.

12.

A. Dual Splash Version

Install slingers on both shafts. Hold .31" +/_.01" gap between face of the bearing and back of the slingers. Rotate slingers approximately 90 degree apart, apply Loctite 246 on the socket cup screw and tight. Recommended torque is 3-3.5 FT-LBS. (See FIGURE 7-5).

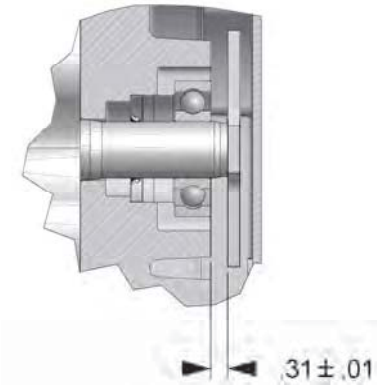


Figure 7-5

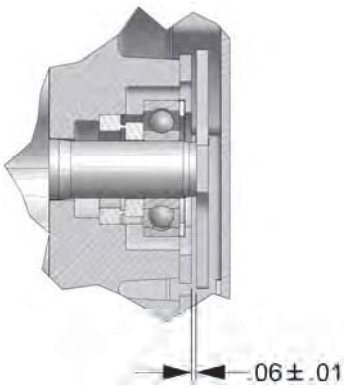


Figure 7-6

B. For Dual Splash Version with Mechanical Seal

Install slingers on both shafts. Hold .06"+_.01" gap between wavy spring retainer plates and back of the slingers. Rotate slingers approximately 90 degree apart, apply Loctite 246 on the socket cup screw and tight. Recommended torque is 3-3.5 FT-LBS. (See FIGURE 7-6).

13. **SETTING IMPELLER END CLEARANCES**

Refer to FIGURE 7-7, page 34. The outer races of the gear end bearings are clamped against the headplate (F) by the bearing retaining screws or by bearing retainer plate (mechanical seal version) (B).

This is referred to as the "fixed end". The interference fit between the shaft and the bearing inner race (H) keeps the shaft from moving axially. Adjustment is by movement of the shaft through the gear end bearing inner race (H).

A. Check the total end clearance by adding the clearance between the impellers and the drive headplate to the clearance between the impellers and the gear headplate.

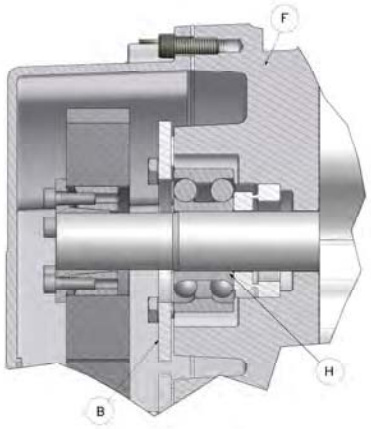


Figure 7-7

NOTICE
Check the clearance over the entire width of the impeller and consider the tightest spot.

B. Divide the end clearance by 3 and distribute approximately 1/3 on the gear end and the remaining 2/3 on the drive end.
C. To move the impeller assembly toward the drive end, lightly tap the shaft at the gear end with a soft face mallet.

D. To move the impeller assembly toward the gear end, lightly tap the shaft at the drive end with a soft face mallet.

E. To set the fixed end, insert the feeler gauge in the amount specified in FIGURE 7-4, page 33, between the headplate and the impeller at the gear end.

F. Tap lightly until the feeler gauge is snug. Adjust both impellers using the same procedure. Rotate the impellers checking for clearance through a complete revolution.

SETTING IMPELLER END CLEARANCE WITH MECHANICAL SEALS

Refer to FIGURE 7-1, page 31. The gear end bearings are held in position by the force created by the wavy spring (J) on the drive end and the bearing retainer (K) on the gear end. This is referred to as the fixed end. The interference fit between the shaft (H) and the bearing inner race (E) keeps the shaft from moving axially.

End clearance adjustment is by movement of the bearing retainer (K). Tightening the bearing retainer screws (M) moves the bearing to load the wavy spring (J), and the impeller is forced toward the drive end. Relaxing the screws allows the wavy spring to return the impeller toward the gear end.

A. Assemble drive cover to drive headplate. Refer to Step 15 with the exception of the use of wavy springs (J) installed between the drive end bearings and the wavy spring retainer plates.

B. Back out retainer screws (M) until both impellers are tight against the gear headplate.

C. With feeler gauge, measure the clearance between each impeller and the drive headplate. This value is the total end clearance.

D. Measure the clearance between the gear headplate and bearing retainer (K) at point (S).

E. Subtract 1/3 of the total end clearance from the clearance measured at point (S). This value is the amount of shim (13) that should be placed between the retainer and the headplate at point (S).

F. Tighten the bearing retainer screws (M) to the torque value given in FIGURE 7-9, page 38. With the retainer screws secure, approximately 1/3 of the total end clearance should be on the gear end and the remaining 2/3 on the drive end.

1. INSTALLING THE TIMING GEARS

If reusing the timing gears, the gears should be returned to their original positions.

A. Obtain 2 gear locking assemblies. Clean the inside and outside diameters of both locking assemblies. Clean the inside diameter of 2 gears. Clean the outside diameter of the both rotor shafts. Lightly oil the surfaces that have been cleaned. Note: DO NOT USE MOLYBDENUM DISULFIDE, MOLYKOTOE, OR ANY OTHER SIMILAR LUBRICANTS.

B. Slide a locking assembly into a gear. Install the gear and locking ring assembly onto the idler rotor shaft. Push the locking assembly firmly until flush with the end of the idler rotor shaft and hand tighten the 7 cap screws. Align and adjust the connections.

C. Use a torque wrench to tighten the screws to 75 in. lbs. in a diametrically opposite sequence. Ensure that none of the screws will turn when 75 in. lbs. is applied to them a second time.

D. Tighten the screws further to 150 in. lbs. in a diametrically opposite sequence. Ensure that none of the screws will turn when 150 in. lbs. is applied to them a second time.

E. Slide the second locking assembly into a gear. Install the gear and locking ring assembly onto the drive rotor shaft. Note the circular mark on each gear indicates the position of the largest runout. These marks must be 180 degrees apart when the gears are installed.

F. Push the locking assembly firmly until flush with the end of drive rotor shaft and hand tighten all cap screws but leave them loose enough that the gear can be rotated on the shaft.

G. The first step in setting the interlobe clearance is to measure the total clearance between two meshing lobes. This is accomplished by determining the maximum feeler gauge thickness that will fit between the rotor lobes near the pitch diameter. The clearance should be measured along the entire length of the meshing lobes. This measurement should be taken for each of the 2 interlobe meshes. The location of the smallest total interlobe clearance should be marked on the rotor lobes. Refer to diagram in FIGURE 7-4, page 33. Use feeler gauges to check clearances between impeller lobes at positions A—A and C—C. Add the clearances, and divide the total clearance evenly between A—A and C—C.

H. Rotate the rotors until the two lobes that have the smallest total interlobe clearance (as determined in step G) are visible through the discharge port. Lock the idler rotor from turning by wedging a shop rag between the tip of a lobe and the air cylinder. Insert feeler gauges with a thickness equal to the half clearance (determined in step G) between the drive rotor and the idler rotor lobe. Pull the drive rotor tight against the feeler gauges (drive rotor, feeler gauges, and idler rotor must be tight against each other). While holding the drive rotor tight against the feeler gages rotate (in the direction that the rotor turns) the gear on the drive rotor until a tooth on it contacts a tooth on the gear on the idler rotor. Hand tighten the 7 capscrews in the drive gear locking assembly. Align and adjust the connection.

I. Use a torque wrench to tighten the screws to 75 in. lbs in a diametrically opposite sequence. Ensure that none of the screws will turn when 75 in. lbs is applied to them a second time.

J. Tighten the screws further to 150 in. lbs in a diametrically opposite sequence. Ensure that none of the screws will turn when 150 in. lbs is applied to them a second time.

K. Check gear backlash four places at 90 degree intervals as described in the disassembly procedure (Item 4).

⚠ CAUTION

These impeller-to-impeller and impeller-to-case clearances are extremely critical. Even though the blower may turn freely by hand when cold, under operating conditions, the parts expand, and the rotors are subject to slight defection.

If the clearances are not sufficient, the impellers may contact each other or the housing with destructive results. If the clearances are too great, the blower may not develop the pressure or airflow that is required to perform its function.

14. Impeller tip to case clearance should be checked at this time by inserting the correct thickness feeler gauge between the tip and the case and rotating the impeller (see FIGURE 7-4, page 34). Repeat the procedure on both impellers.

NOTICE

When checking the tip to case clearance, move the feeler gauge over the entire length of the impeller to ensure that the tips do not bind along their length.

FIGURE 7-8

NOTICE

Replacement gears have minimum backlash marks on the outside diameter of the gear face. These marks should be located 180 degrees from each other (see FIGURE 7-8).

NOTICE

The gear used for adjustment should be flush with its mate on completion of the timing.

NOTICE

If any of the four gear backlash readings are not within the specified limits, the gears must be replaced.

15. Replace drive shaft oil seal (31) in the drive end cover (29). The seal lip should always face towards the bearing or lubricant.

Grease Units

Pack bearing cavities with recommended grease and secure drive cover with socket head cap screws (30) to drive headplate.

Dual Splash Units

Install drive end gasket (7). Gently slide the drive end cover (29) over the drive shaft and tap cover down over dowel pins until flush. Install and tighten drive cover bolts (30).

Refer to FIGURE 7-9, for torque specifications.

⚠ CAUTION
Exercise care not to damage the seal lip as it passes over the shaft keyway.

16. Assemble the gear cover (3) and gasket (7) to the gear headplate (18) using socket head screw (5). Tighten the capscrews alternately and evenly. Refer to FIGURE 7-9 for torque specifications.

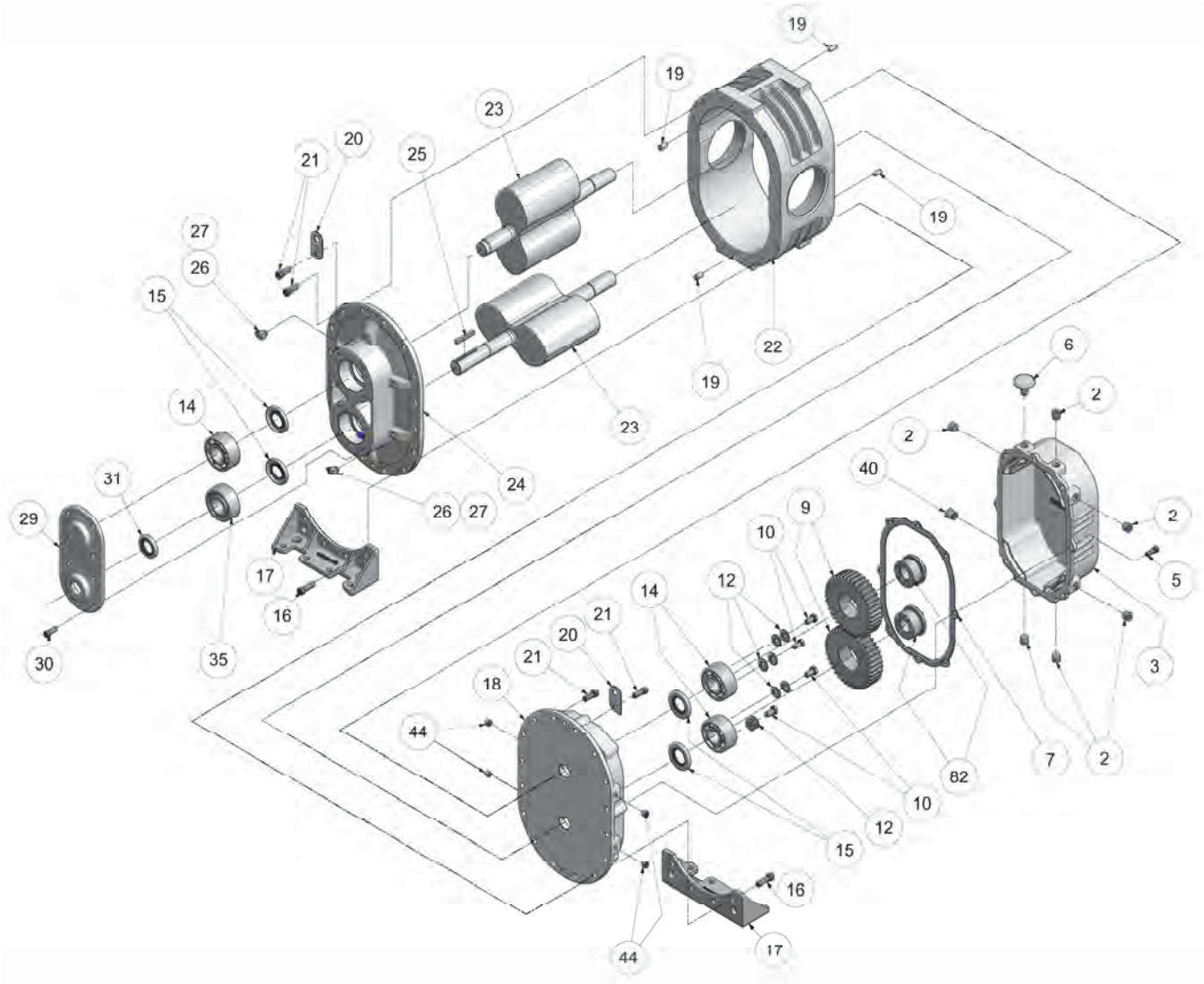
17. Place the blower on its feet on a flat surface. Loosen cap screws (16) and level the unit up. The bench or blower base flatness should be within .002 of an inch. Re-tighten cap screws (16) to the specification in FIGURE 7-9.

NOTICE
If the unit is not flat within .002 of an inch, it will be necessary to shim the blower feet at installation.

	GEAR DIAMETER		
FASTENERS	**3**	**4**	**5**
CAPSCREW (21)	23 – 30	42 – 45	42 – 45
CAPSCREW (16)	23 – 30	42 – 45	42 – 45
SOCKET HD CAPSCREW (5)	6 – 8	16 – 18	11 – 13
SOCKET HD CAPSCREW (30)	6 – 8	16 – 18	11 – 13
CAPSCREW (10)	6 – 8	38 – 42	38 – 42

NOTE: ( ) DENOTES ITEMS IN EXPLODED VIEW DRAWINGS ON PAGES 39 AND 43.

FIGURE 7-9 – TORQUE (FT-LBS)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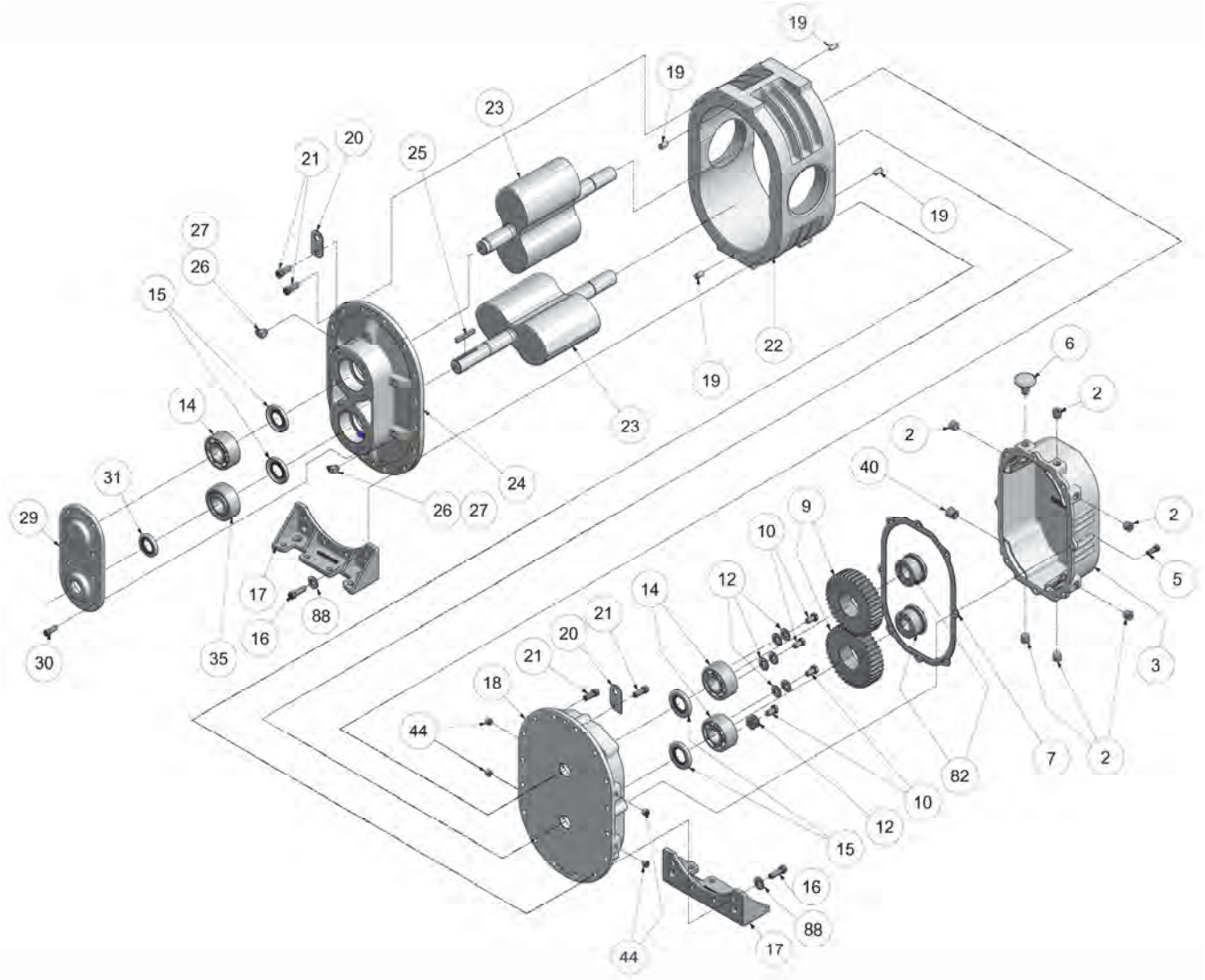
Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAB Lip Seal — Grease Splash Lube

Ref. No.	Description	No. Req'd	Size – 3H GABH_R Δ Δ= (A or C)	Size – 3M GABM_R Δ Δ= (A or C)	Size -- 3L GABL_R Δ Δ= (A or C)
2	Plug	6	64AC2	64AC2	64AC2
3	Gear Case	1	303GAB602	303GAB602	303GAB602
5	Screw	8	75P7	75P7	75P7
6	Breather	1	5L358	5L358	5L358
* 7	Gasket	1	300GAB715	300GAB715	300GAB715
9	Gear Kit	1	300GAB6008	300GAB6008	300GAB6008
* 10	Screws	4	75A33P	75A33P	75A33P
12	Washer	4	95A2	95A2	95A2
* 14	Ball Bearing	3	12BA143	12BA143	12BA143
* 15	Oil Seal	4	900891030601	900891030601	900891030601
16	Screw	4	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	303GAB166	303GAB166	303GAB166
18	Bearing Housing Gear End	1	302GAB006	302GAB006	302GAB006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	20	75P55	75P55	75P55
22	Impeller Case	1	900873034301	900873033801	900873034201
23	Rotor Group				
	3" Standard Clearances	1	307GAB4028	309GAB4028	308GAB4028
	3" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	900873033501	900873033501	900873033501
25	Key-Square	1	900639910304	900639910304	900639910304
26	Pipe Fitting	2	40E9	40E9	40E9
27	Cap	2	40P58	40P58	40P58
29	Drive Cover	1	900873033701	900873033701	900873033701
30	Screw	6	75P22	75P22	75P22
* 31	Oil Seal	1	60DD725	60DD725	60DD725
* 35	Bearing – Roller	1	12BA153	12BA153	12BA153
40	Oil Level Gauge	1	40P82	40P82	40P82
44	Screw	4	76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
** 54	Shim Case .0025/.0035"	1	200GAB732	200GAB732	200GAB732
** 55	Shim Case .010"	1	201GAB732	201GAB732	201GAB732
** 56	Shim Case .0015/.002"	1	202GAB732	202GAB732	202GAB732
82	Locking Assembly	2	22G45	22G45	22G45
** 105	Overhaul Kit 3" R VERS Lip Seal, Grease Splash Lube	1	302GAB6010	302GAB6010	302GAB6010
** 900	Group-Indent & Instruction Legend Series 3" R VERS	1	303GAB4011	303GAB4011	303GAB4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION.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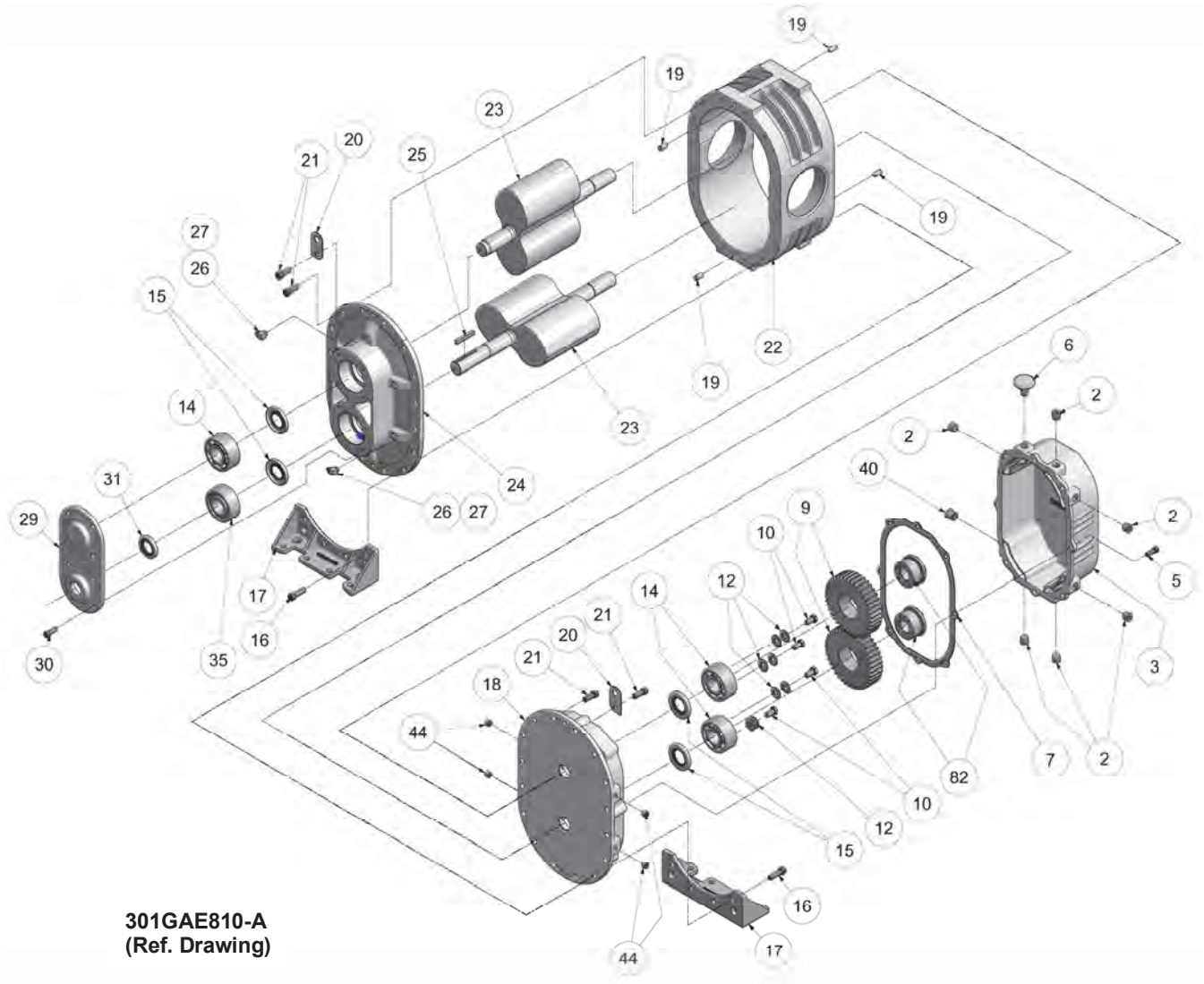
Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAC Lip Seal — Grease Splash Lube

Ref. No.	Description	No. Req'd	Size – 4H GACH_R Δ Δ= (A or C)	Size – 4M GACM_R Δ Δ= (A or C)	Size -- 4L GACL_R Δ Δ= (A or C)
2	Plug	6	64AC3	64AC3	64AC3
3	Gear Case	1	304GAC602	304GAC602	304GAC602
5	Screw	8	75P40	75P40	75P40
6	Breather	1	5L359	5L359	5L359
* 7	Gasket	1	301GAC715	301GAC715	301GAC715
9	Gear Kit	1	300GAC6008	300GAC6008	300GAC6008
* 10	Screws	4	655ED03P	655ED03P	655ED03P
12	Washer	8	95A3	95A3	95A3
* 14	Ball Bearing	3	12BA144	12BA144	12BA144
* 15	Oil Seal	4	60DD630	60DD630	60DD630
16	Screw	8	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	300GAC166	300GAC166	300GAC166
18	Bearing Housing Gear End	1	302GAC006	302GAC006	302GAC006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	16	75P55	75P55	75P55
22	Impeller Case	1	900883042201	900883041801	900883042001
23	Rotor Group				
	4" Standard Clearances	1	307GAC4028	306GAC4028	305GAC4028
	4" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	300GAC006	300GAC006	300GAC006
25	Key-Square	1	900639910304	900639910304	900639910304
26	Pipe Fitting	2	40E9	40E9	40E9
27	Cap	2	40P58	40P58	40P58
29	Drive Cover	1	900883040301	900883040301	900883040301
30	Screw	8	75P189	75P189	75P189
* 31	Oil Seal	1	60DD716	60DD716	60DD716
* 35	Bearing – Roller	1	12BA154	12BA154	12BA154
40	Oil Level Gauge	1	40P34	40P34	40P34
44	Screw	4	76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
** 54	Shim Case .0025/.0035"	1	200GAC732	200GAC732	200GAC732
** 55	Shim Case .010"	1	201GAC732	201GAC732	201GAC732
** 56	Shim Case .0015/.002"	1	202GAC732	202GAC732	202GAC732
82	Locking Assembly	2	22G44	22G44	22G44
88	Washer	4	95A3	95A3	95A3
** 105	Overhaul Kit 4" R VERS Lip Seal, Grease Splash Lube	1	300GAC6010	300GAC6010	300GAC6010
** 900	Group-Indent & Instruction Legend Series 4" R VERS	1	201GAC4011	201GAC4011	201GAC4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION.



301GAE810-A
(Ref. Drawing)

Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAE Lip Seal Grease Splash Lube

Ref. No.	Description	No. Req'd	Size – 5H GAEH_R Δ Δ= (A or C)	Size – 5M GAEM_R Δ Δ= (A or C)	Size -- 5L GAEL_R Δ Δ= (A or C)
2	Plug	6	64AC3	64AC3	64AC3
3	Gear Case	1	304GAE602	304GAE602	304GAE602
5	Screw	8	75P40	75P40	75P40
6	Breather	1	5L359	5L359	5L359
* 7	Gasket	1	300GAE715	300GAE715	300GAE715
9	Gear Kit	1	300GAE6008	300GAE6008	300GAE6008
* 10	Screws	4	655ED03P	655ED03P	655ED03P
12	Washer	8	95A3	95A3	95A3
* 14	Ball Bearing	3	8500397	8500397	8500397
* 15	Oil Seal	4	60DD714	60DD714	60DD714
16	Screw	8	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	300GAE166	300GAE166	300GAE166
18	Bearing Housing Gear End	1	301GAE006	301GAE006	301GAE006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	24	75P55	75P55	75P55
22	Impeller Case	1	900883051701	900883051801	900883051901
23	Rotor Group				
	5" Standard Clearances	1	327GAE4028	326GAE4028	325GAE4028
	5" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	206GAE006	206GAE006	206GAE006
25	Key-Square	1	900639910305	900639910305	900639910305
26	Pipe Fitting	2	40E9	40E9	40E9
27	Cap	2	40P58	40P58	40P58
29	Drive Cover	1	900883050401	900883050401	900883050401
30	Screw	8	75P189	75P189	75P189
* 31	Oil Seal	1	60DD726	60DD726	60DD726
* 35	Bearing – Roller	1	12BA155	12BA155	12BA155
40	Oil Level Gauge	1	40P34	40P34	40P34
44	Screw	4	76F92	76F92	76F92
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
** 54	Shim Case .0025/.0035"	1	200GAE732	200GAE732	200GAE732
** 55	Shim Case .010"	1	201GAE732	201GAE732	201GAE732
** 56	Shim Case .0015/.002"	1	202GAE732	202GAE732	202GAE732
82	Locking Assembly	2	22G43	22G43	22G43
** 105	Overhaul Kit 5" R VERS Lip Seal, Grease Splash Lube	1	300GAE6010	300GAE6010	300GAE6010
** 900	Group-Indent & Instruction Legend Series 5" R VERS	1	205GAE4011	205GAE4011	205GAE4011

* INCLUDED IN OVERHAUL KIT.
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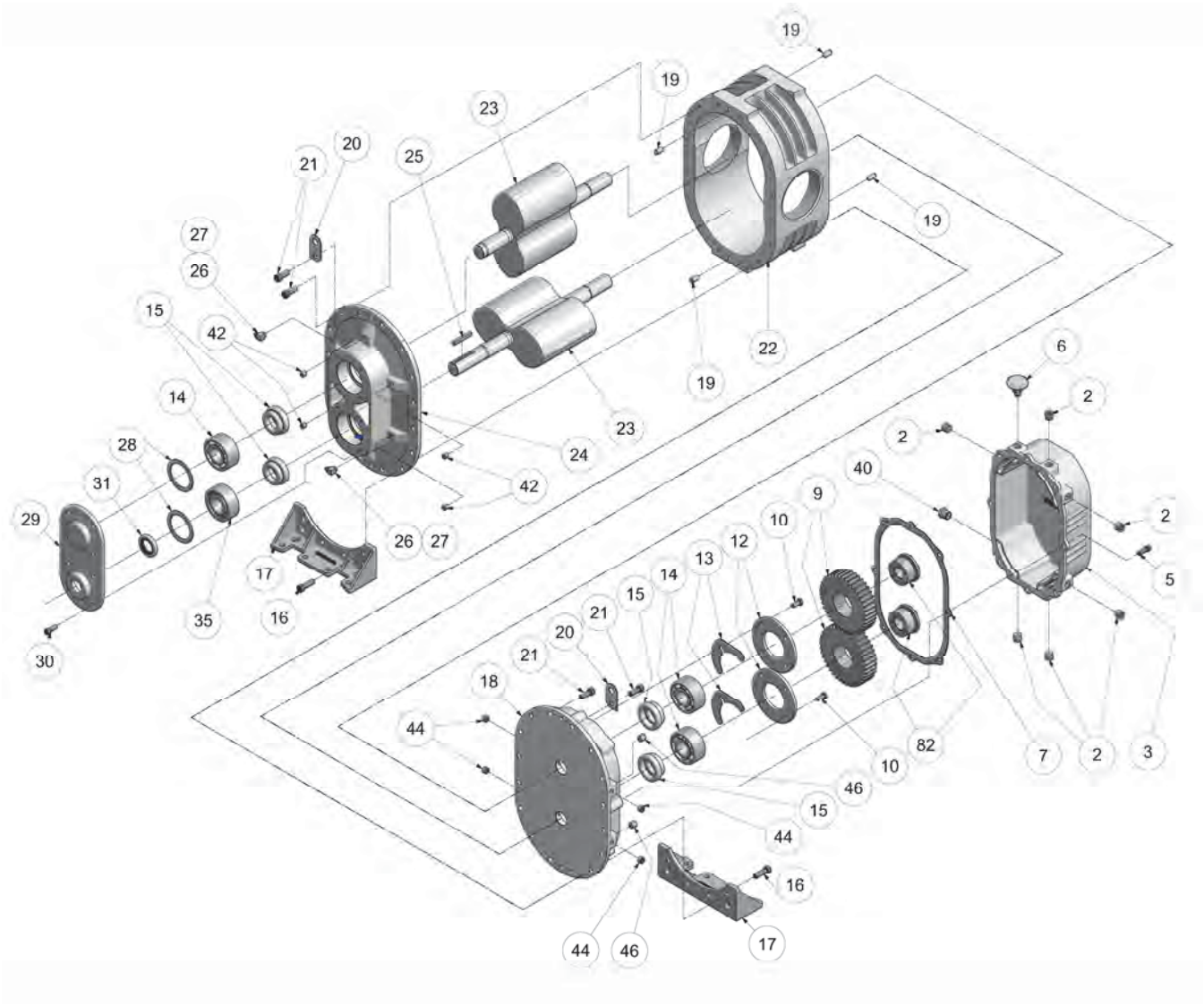
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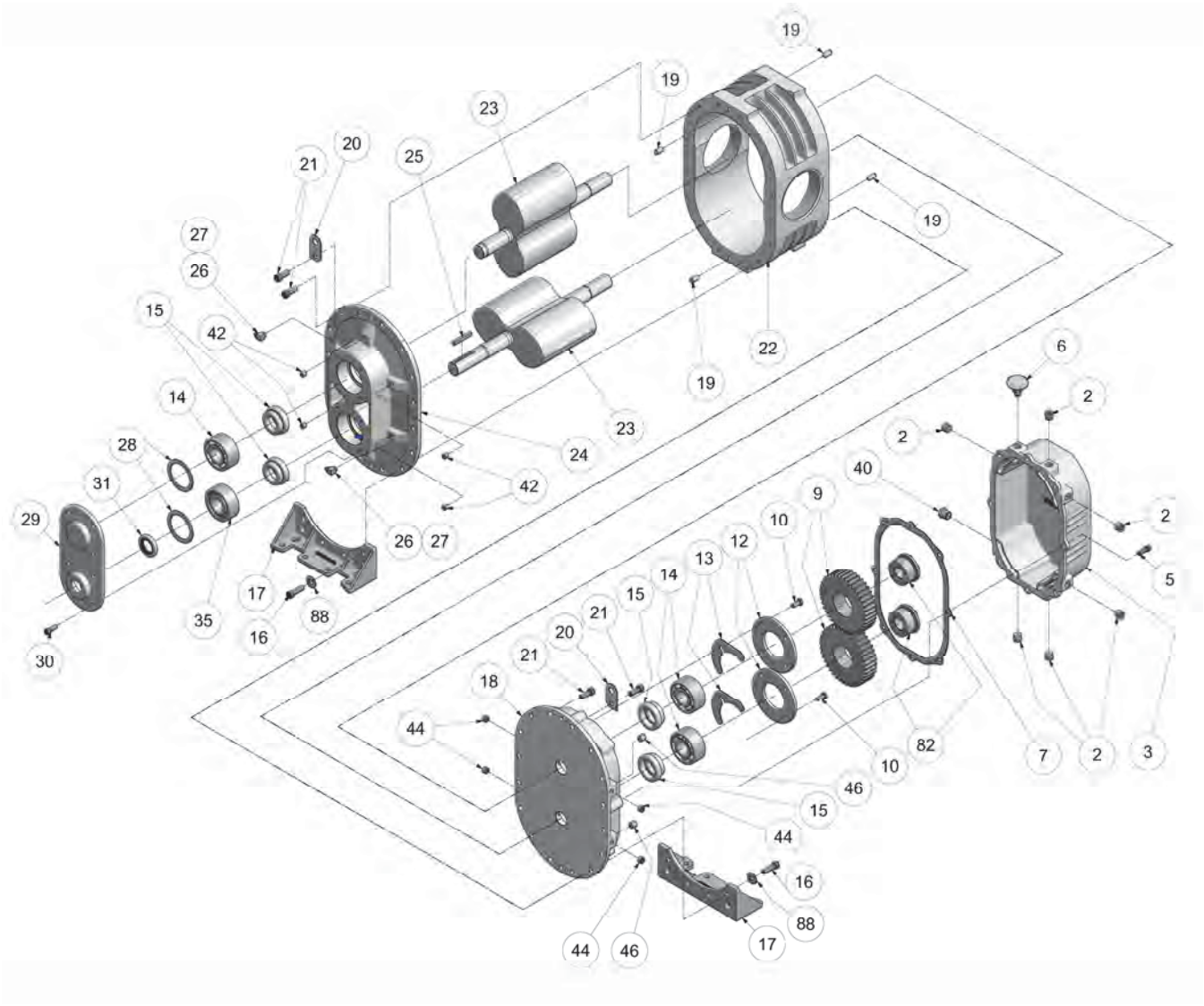
Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAB Mechanical Seal Grease Splash Lube

Ref. No.	Description	No. Req'd	Size – 3H GABH_RB	Size – 3M GABM_RB	Size -- 3L GABL_RB
2	Plug	6	64AC2	64AC2	64AC2
3	Gear Case	1	303GAB602	303GAB602	303GAB602
5	Screw	8	75P7	75P7	75P7
6	Breather	1	5L358	5L358	5L358
* 7	Gasket	1	300GAB715	300GAB715	300GAB715
9	Gear Kit	1	300GAB6008	300GAB6008	300GAB6008
* 10	Screws	4	75A33P	75A33P	75A33P
12	Bearing Retainer	2	300GAB205	300GAB205	300GAB205
* 13	Shim Set	1	900881032200	900881032200	900881032200
* 14	Ball Bearing	3	12BA143	12BA143	12BA143
* 15	Mechanical Seal	4	900871020003	900871020003	900871020003
16	Screw	4	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	303GAB166	303GAB166	303GAB166
18	Bearing Housing Gear End	1	304GAB006	304GAB006	304GAB006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	20	75P55	75P55	75P55
22	Impeller Case	1	900873034301	900873033801	900873034201
23	Rotor Group				
	3" Standard Clearances	1	307GAB4028	309GAB4028	308GAB4028
	3" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	900883030301	900883030301	900883030301
25	Key-Square	1	900639910304	900639910304	900639910304
26	Pipe Fitting	2	40E9	40E9	40E9
27	Cap	2	40P58	40P58	40P58
* 28	Wavy Spring	2	900669170203	900669170203	900669170203
29	Drive Cover	1	900873033701	900873033701	900873033701
30	Screw	6	75P22	75P22	75P22
* 31	Oil Seal	1	60DD725	60DD725	60DD725
* 35	Bearing – Roller	1	12BA153	12BA153	12BA153
40	Oil Level Gauge	1	40P82	40P82	40P82
42	Plug	4	64AC1	64AC1	64AC1
44	Screw	4	76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
46	Plug	4	64AC1	64AC1	64AC1
** 54	Shim Case .0025/.0035"	1	200GAB732	200GAB732	200GAB732
** 55	Shim Case .010"	1	201GAB732	201GAB732	201GAB732
** 56	Shim Case .0015/.002"	1	202GAB732	202GAB732	202GAB732
82	Locking Assembly	2	22G45	22G45	22G45
** 105	Overhaul Kit 3" R VERS Mechanical Seal, Grease Splash Lube	1	303GAB6010	303GAB6010	303GAB6010
** 900	Group-Indent & Instruction Legend Series 3" R VERS	1	303GAB4011	303GAB4011	303GAB4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION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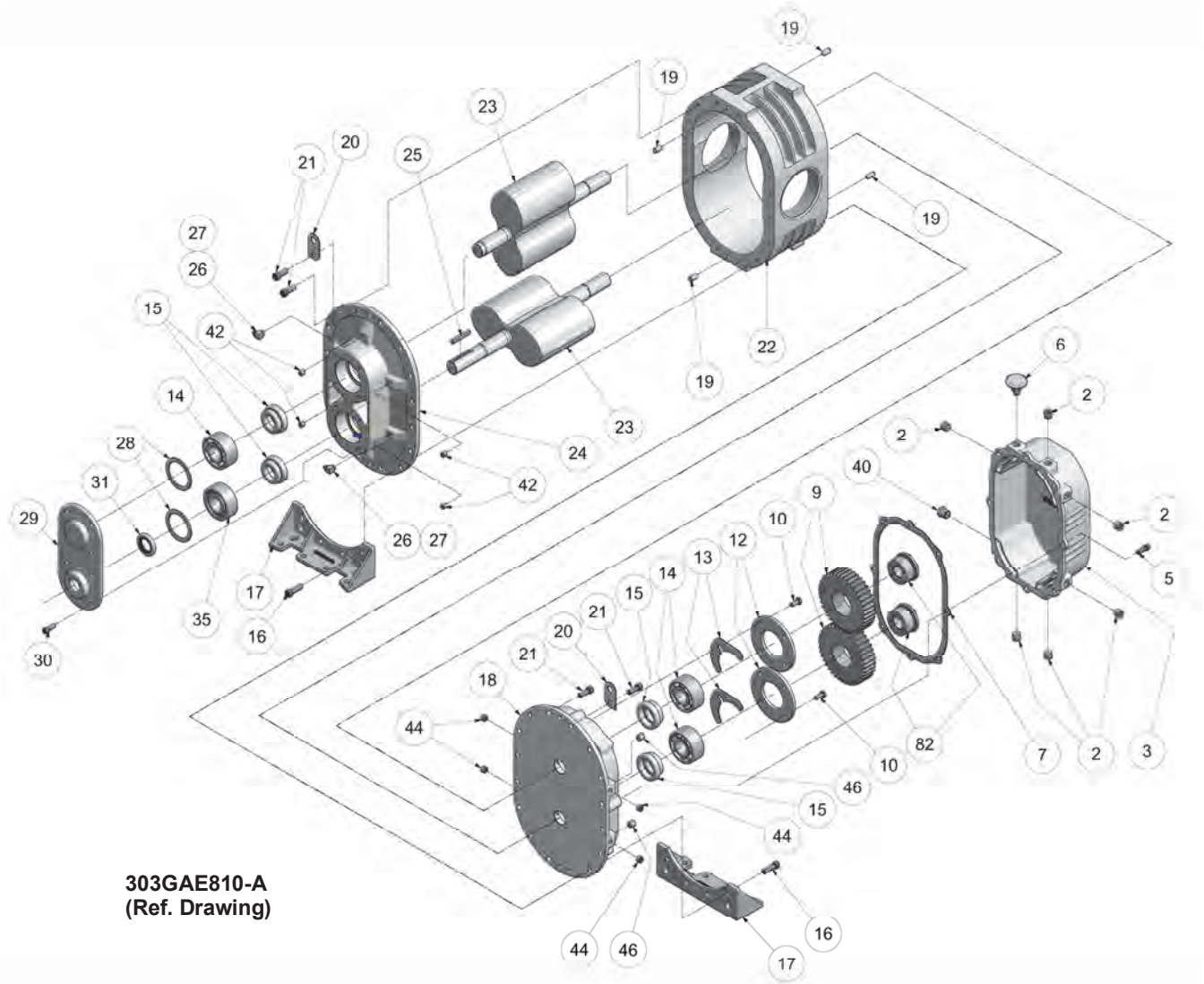
Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAC Mechanical Seal Grease Splash Lube

Ref. No.	Description	No. Req'd	Size – 4H GACH_RB	Size – 4M GACM_RB	Size -- 4L GACL_RB
2	Plug	6	64AC3	64AC3	64AC3
3	Gear Case	1	304GAC602	304GAC602	304GAC602
5	Screw	8	75P40	75P40	75P40
6	Breather	1	5L359	5L359	5L359
* 7	Gasket	1	301GAC715	301GAC715	301GAC715
9	Gear Kit	1	300GAC6008	300GAC6008	300GAC6008
* 10	Screws	8	75A33P	75A33P	75A33P
12	Bearing Retainer	2	900883040201	900883040201	900883040201
* 13	Shim Set	1	900881042900	900881042900	900881042900
* 14	Ball Bearing	3	12BA144	12BA144	12BA144
* 15	Mechanical Seal	4	900871020004	900871020004	900871020004
16	Screw	8	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	300GAC166	300GAC166	300GAC166
18	Bearing Housing Gear End	1	304GAC006	304GAC006	304GAC006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	16	75P55	75P55	75P55
22	Impeller Case	1	900883042201	900883041801	900883042001
23	Rotor Group				
	4" Standard Clearances	1	307GAC4028	306GAC4028	305GAC4028
	4" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	900883041201	900883041201	900883041201
25	Key-Square	1	900639910304	900639910304	900639910304
26	Pipe Fitting	2	40E9	40E9	40E9
27	Cap	2	40P58	40P58	40P58
* 28	Wavy Spring	2	900669170304	900669170304	900669170304
29	Drive Cover	1	900883040301	900883040301	900883040301
30	Screw	8	75P189	75P189	75P189
* 31	Oil Seal	1	60DD716	60DD716	60DD716
* 35	Bearing – Roller	1	12BA154	12BA154	12BA154
40	Oil Level Gauge	1	40P34	40P34	40P34
42	Plug	4	64AC1	64AC1	64AC1
44	Screw	4	76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
46	Plug	4	64AC1	64AC1	64AC1
** 54	Shim Case .0025/.0035"	1	200GAC732	200GAC732	200GAC732
** 55	Shim Case .010"	1	201GAC732	201GAC732	201GAC732
** 56	Shim Case .0015/.002"	1	202GAC732	202GAC732	202GAC732
82	Locking Assembly	2	22G44	22G44	22G44
88	Washer	4	95A3	95A3	95A3
** 105	Overhaul Kit 4" R VERS Mechanical Seal, Grease Splash Lube	1	302GAC6010	302GAC6010	302GAC6010
** 900	Group-Indent & Instruction Legend Series 4" R VERS	1	201GAC4011	201GAC4011	201GAC4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION



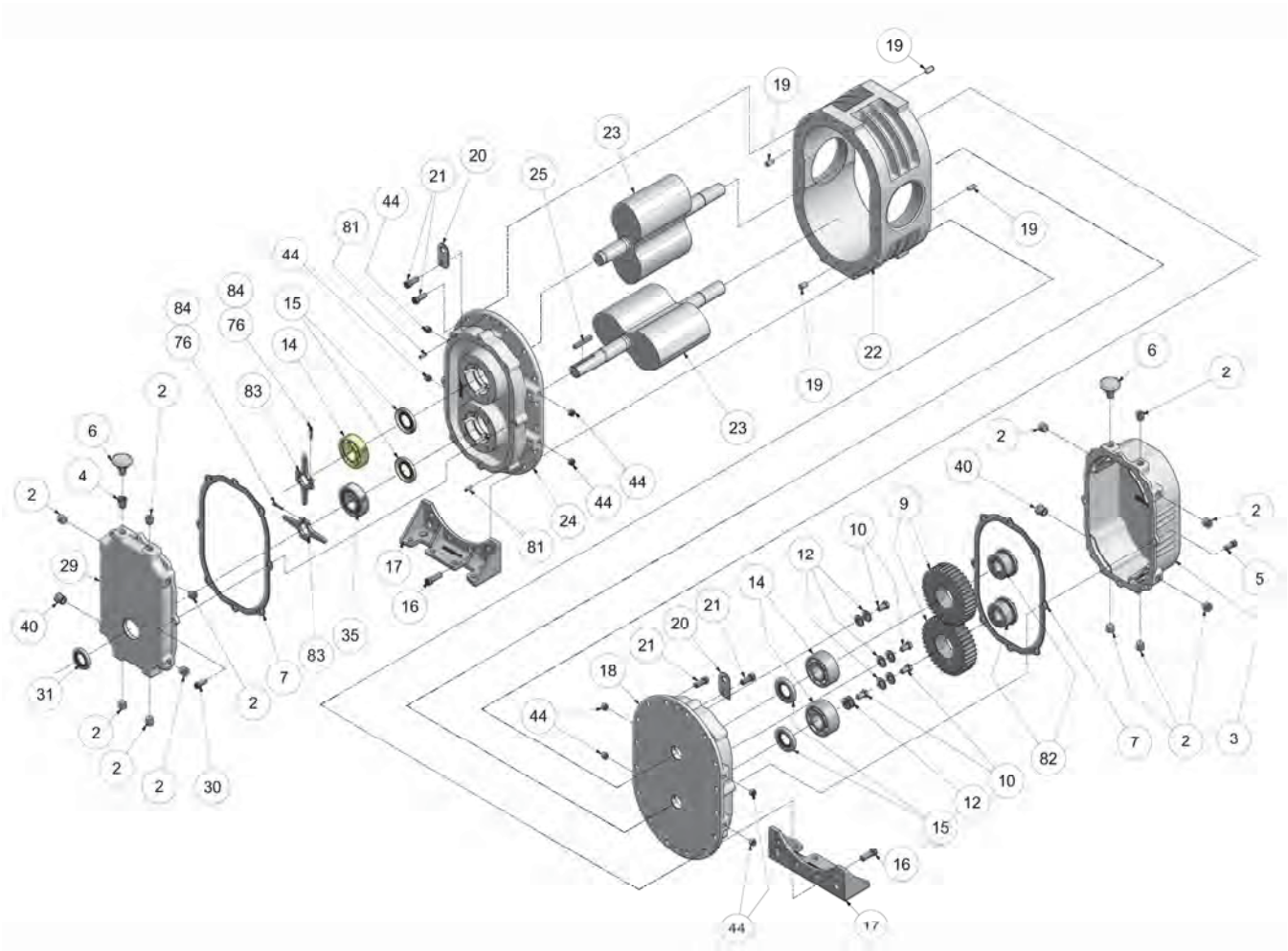
303GAE810-A
(Ref. Drawing)

Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAE Mechanical Seal Grease Splash Lube

	Ref. No.	Description	No. Req'd	Size – 5H GAEH_RB	Size – 5M GAEM_RB	Size -- 5L GAEL_RB
	2	Plug	6	64AC3	64AC3	64AC3
	3	Gear Case	1	304GAE602	304GAE602	304GAE602
	5	Screw	8	75P40	75P40	75P40
	6	Breather	1	5L359	5L359	5L359
*	7	Gasket	1	300GAE715	300GAE715	300GAE715
	9	Gear Kit	1	300GAE6008	300GAE6008	300GAE6008
*	10	Screws	8	75A33P	75A33P	75A33P
	12	Bearing Retainer	2	900883050501	900883050501	900883050501
*	13	Shim Set	1	900881052900	900881052900	900881052900
*	14	Ball Bearing	3	8500397	8500397	8500397
*	15	Mechanical Seal	4	900871020005	900871020005	900871020005
	16	Screw	8	75P56	75P56	75P56
	17	Foot – Vert. & Horiz.	2	300GAE166	300GAE166	300GAE166
	18	Bearing Housing Gear End	1	303GAE006	303GAE006	303GAE006
	19	Dowel Pin	4	62M48	62M48	62M48
	20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
	21	Screw	24	75P55	75P55	75P55
	22	Impeller Case	1	900883051701	900883051801	900883051901
	23	Rotor Group				
		5" Standard Clearances	1	327GAE4028	326GAE4028	325GAE4028
		5" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
	24	Bearing Housing Drive End	1	207GAE006	207GAE006	207GAE006
	25	Key-Square	1	900639910305	900639910305	900639910305
	26	Pipe Fitting	2	40E9	40E9	40E9
	27	Cap	2	40P58	40P58	40P58
*	28	Wavy Spring	2	900669170405	900669170405	900669170405
	29	Drive Cover	1	900883050401	900883050401	900883050401
	30	Screw	8	75P189	75P189	75P189
*	31	Oil Seal	1	60DD726	60DD726	60DD726
*	35	Bearing – Roller	1	12BA155	12BA155	12BA155
	40	Oil Level Gauge	1	40P34	40P34	40P34
	42	Plug	4	64AC1	64AC1	64AC1
	44	Screw	4	76F92	76F92	76F92
**	45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
	46	Plug	4	64AC2	64AC2	64AC2
**	54	Shim Case .0025/.0035"	1	200GAE732	200GAE732	200GAE732
**	55	Shim Case .010"	1	201GAE732	201GAE732	201GAE732
**	56	Shim Case .0015/.002"	1	202GAE732	202GAE732	202GAE732
	82	Locking Assembly	2	22G43	22G43	22G43
**	105	Overhaul Kit 5" R VERS Mechanical Seal, Grease Splash	1	302GAE6010	302GAE6010	302GAE6010
**	900	Group-Indent & Instruction Legend Series 5" R VERS	1	205GAE4011	205GAE4011	205GAE4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION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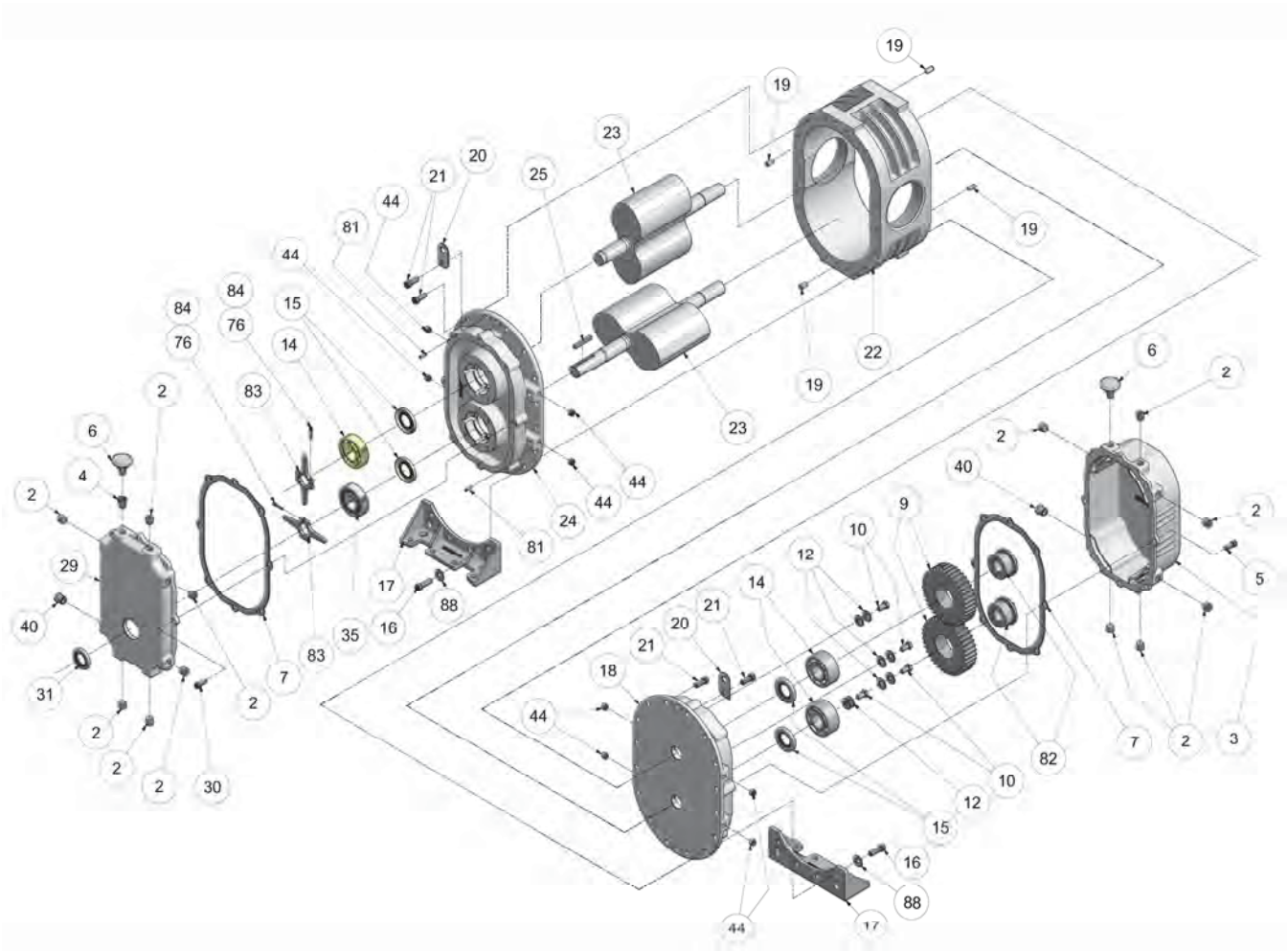
Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAB Lip Seal Dual Splash Lube

	Ref. No.	Description	No. Req'd	Size – 3H GABH_R △ △= (D or F)	Size – 3M GABM_R △ △= (D or F)	Size -- 3L GABL_R △ △= (D or F)
	2	Plug	12	64AC2	64AC2	64AC2
	3	Gear Case	1	303GAB602	303GAB602	303GAB602
	5	Screw	8	75P7	75P7	75P7
	6	Breather	2	5L358	5L358	5L358
*	7	Gasket	2	300GAB715	300GAB715	300GAB715
	9	Gear Kit	1	300GAB6008	300GAB6008	300GAB6008
*	10	Screws	4	75A33P	75A33P	75A33P
	12	Washer	8	95A2	95A2	95A2
*	14	Ball Bearing	3	12BA143	12BA143	12BA143
*	15	Oil Seal	4	900891030601	900891030601	900891030601
	16	Screw	4	75P56	75P56	75P56
	17	Foot – Vert. & Horiz.	2	303GAB166	303GAB166	303GAB166
	18	Bearing Housing Gear End	1	302GAB006	302GAB006	302GAB006
	19	Dowel Pin	4	62M48	62M48	62M48
	20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
	21	Screw	20	75P55	75P55	75P55
	22	Impeller Case	1	900873034301	900873033801	900873034201
	23	Rotor Group				
		3" Standard Clearances	1	307GAB4028	309GAB4028	308GAB4028
		3" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
	24	Bearing Housing Drive End	1	303GAB006	303GAB006	303GAB006
	25	Key-Square	1	900639910304	900639910304	900639910304
	29	Drive Cover	1	302GAB477	302GAB477	302GAB477
	30	Screw	8	75P7	75P7	75P7
*	31	Oil Seal	1	60DD725	60DD725	60DD725
*	35	Bearing – Spherical	1	12BA153	12BA153	12BA153
	40	Oil Level Gauge	2	40P82	40P82	40P82
	44	Screw	8	76F1	76F1	76F1
**	45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
**	54	Shim Case .0025/.0035"	1	200GAB732	200GAB732	200GAB732
**	55	Shim Case .0010"	1	201GAB732	201GAB732	201GAB732
**	56	Shim Case .0015/.002"	1	202GAB732	202GAB732	202GAB732
	76	Compound, Loctite	50	25BC877	25BC877	25BC877
	81	Dowel Pin	2	62M13	62M13	62M13
	82	Locking Assembly	2	22G45	22G45	22G45
	83	Slinger	2	300GAB173	300GAB173	300GAB173
	84	Screw	2	75LM13	75LM13	75LM13
**	105	Overhaul Kit 3" R VERS Lip Seal, Dual Splash Lube	1	301GAB6010	301GAB6010	301GAB6010
**	900	Group-Indent & Instruction Legend Series 3" R VERS	1	303GAB4011	303GAB4011	303GAB4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION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Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAC Lip Seal Dual Splash Lube

Ref. No.	Description	No. Req'd	Size – 4H GACH_R Δ Δ= (D or F)	Size – 4M GACM_R Δ Δ= (D or F)	Size -- 4L GACL_R Δ Δ= (D or F)
2	Plug	12	64AC3	64AC3	64AC3
3	Gear Case	1	304GAC602	304GAC602	304GAC602
5	Screw	8	75P40	75P40	75P40
6	Breather	2	5L359	5L359	5L359
* 7	Gasket	2	301GAC715	301GAC715	301GAC715
9	Gear Kit	1	300GAC6008	300GAC6008	300GAC6008
* 10	Screws	4	655ED03P	655ED03P	655ED03P
12	Washer	8	95A3	95A3	95A3
* 14	Ball Bearing	3	12BA144	12BA144	12BA144
* 15	Oil Seal	4	60DD630	60DD630	60DD630
16	Screw	8	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	300GAC166	300GAC166	300GAC166
18	Bearing Housing Gear End	1	302GAC006	302GAC006	302GAC006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	16	75P55	75P55	75P55
22	Impeller Case	1	900883042201	900883041801	900883042001
23	Rotor Group				
	4" Standard Clearances	1	307GAC4028	306GAC4028	305GAC4028
	4" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	303GAC006	303GAC006	303GAC006
25	Key-Square	1	900639910304	900639910304	900639910304
29	Drive Cover	1	302GAC477	302GAC477	302GAC477
30	Screw	8	75P40	75P40	75P40
* 31	Oil Seal	1	60DD716	60DD716	60DD716
* 35	Bearing – Spherical	1	12BA255	12BA255	12BA255
40	Oil Level Gauge	2	40P34	40P34	40P34
44	Screw	8	76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
** 54	Shim Case .0025/.0035"	1	200GAC732	200GAC732	200GAC732
** 56	Shim Case .0015/.002"	1	202GAC732	202GAC732	202GAC732
76	Compound, Loctite	50	25BC877	25BC877	25BC877
81	Dowel Pin	2	62M13	62M13	62M13
82	Locking Assembly	2	22G44	22G44	22G44
83	Slinger	2	300GAC173	300GAC173	300GAC173
84	Screw	2	75LM14	75LM14	75LM14
88	Washer	4	95A3	95A3	95A3
** 105	Overhaul Kit 4" R VERS Lip Seal, Dual Splash Lube	1	301GAC6010	301GAC6010	301GAC6010
** 900	Group-Indent & Instruction Legend Series 4" R VERS	1	201GAC4011	201GAC4011	201GAC4011

* INCLUDED IN OVERHAUL KIT.
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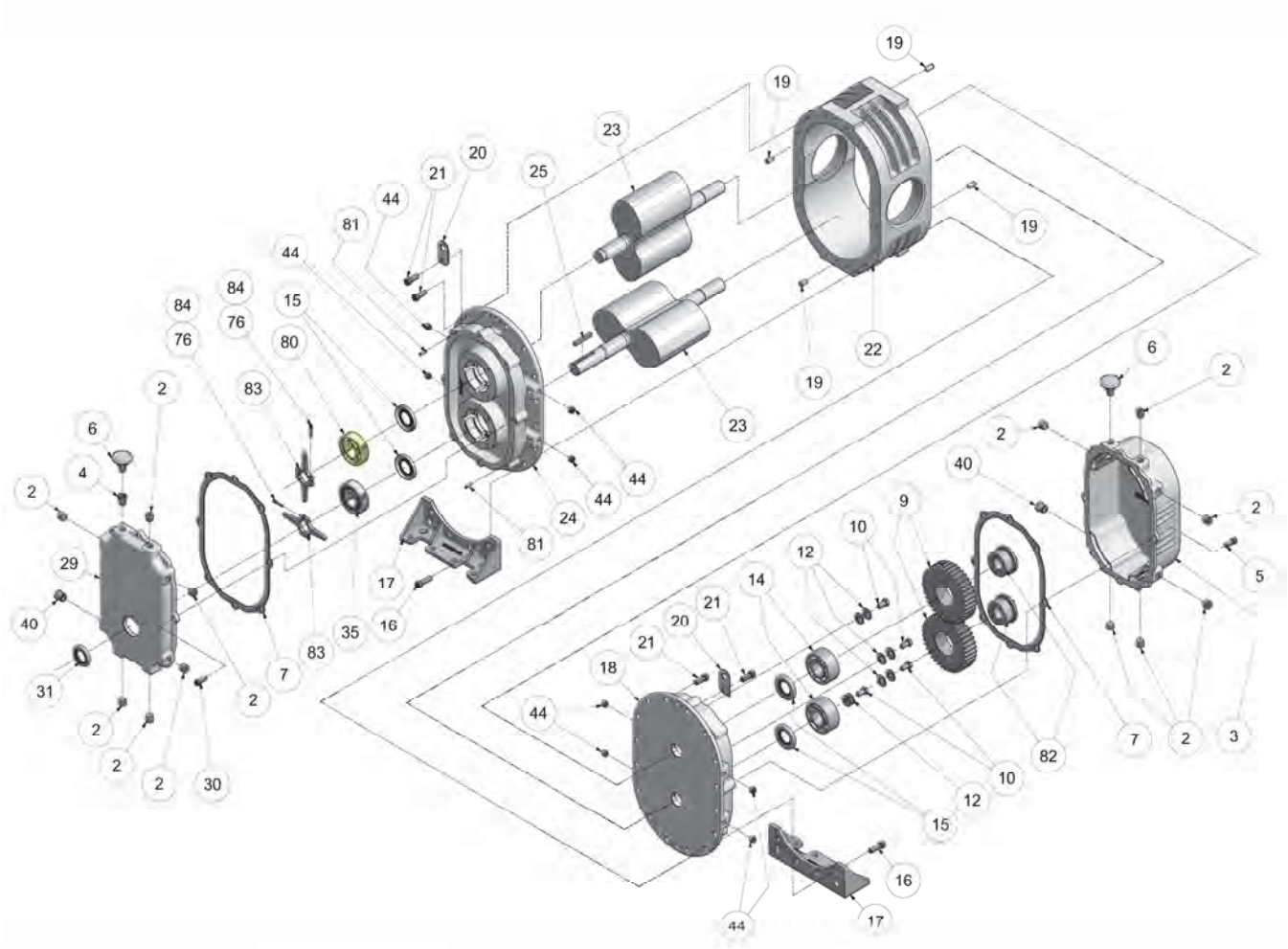


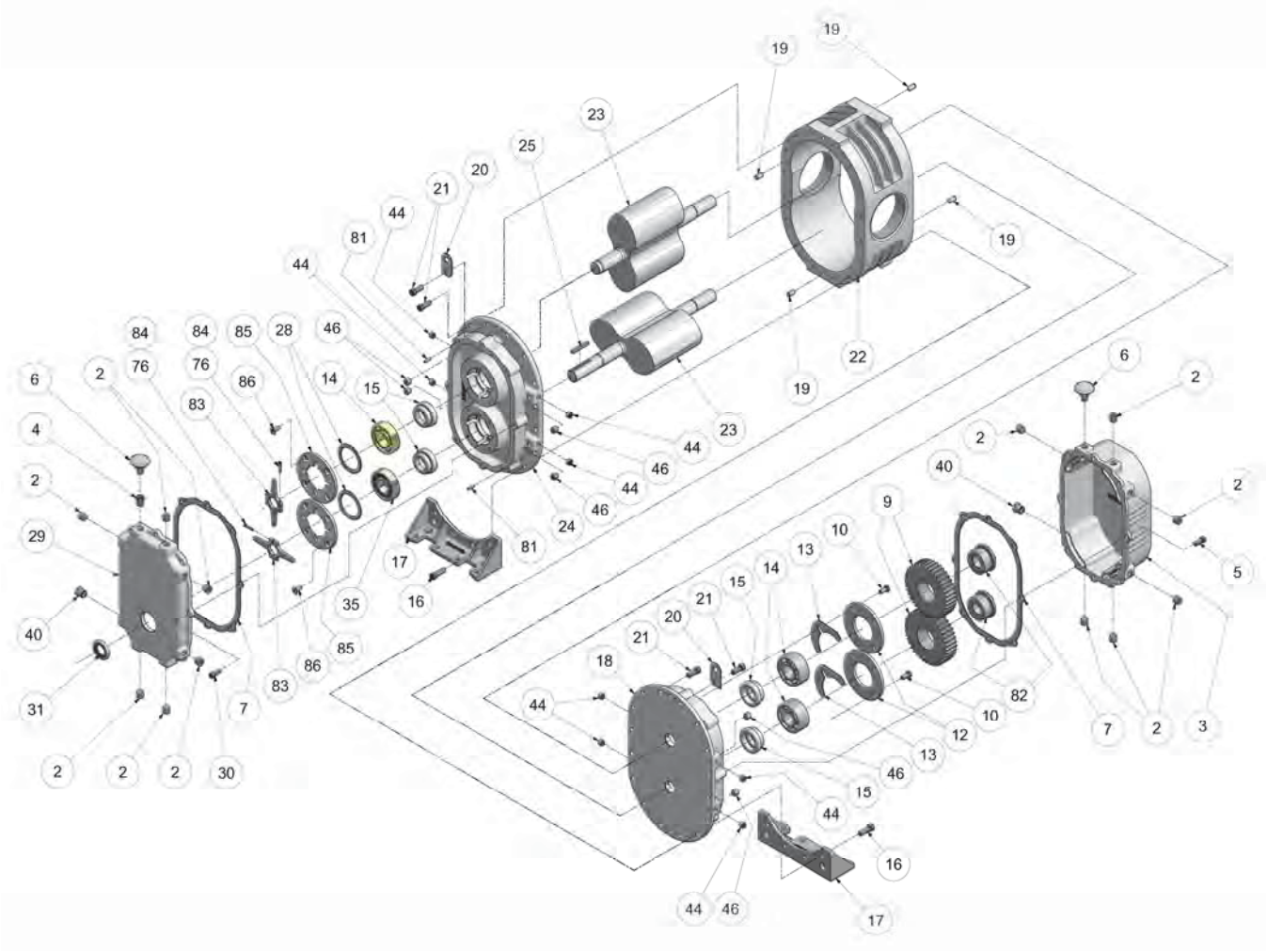
300GAE810-A
(Ref. Drawing)

Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAE Lip Seal — Dual Splash Lube

Ref. No.	Description	No. Req'd	Size – 5H GAEH_R Δ Δ= (D or F)	Size – 5M GAEM_R Δ Δ= (D or F)	Size -- 5L GAEL_R Δ Δ= (D or F)
2	Plug	12	64AC3	64AC3	64AC3
3	Gear Case	1	304GAE602	304GAE602	304GAE602
5	Screw	8	75P40	75P40	75P40
6	Breather	2	5L359	5L359	5L359
* 7	Gasket	2	300GAE715	300GAE715	300GAE715
9	Gear Kit	1	300GAE6008	300GAE6008	300GAE6008
* 10	Screws	4	655ED03P	655ED03P	655ED03P
12	Washer	8	95A3	95A3	95A3
* 14	Ball Bearing	2	8500397	8500397	8500397
* 15	Oil Seal	4	60DD714	60DD714	60DD714
16	Screw	8	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	300GAE166	300GAE166	300GAE166
18	Bearing Housing Gear End	1	301GAE006	301GAE006	301GAE006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	24	75P55	75P55	75P55
22	Impeller Case	1	900883051701	900883051801	900883051901
23	Rotor Group				
	5" Standard Clearances	1	327GAE4028	326GAE4028	325GAE4028
	5" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
25	Key-Square	1	900639910305	900639910305	900639910305
29	Drive Cover	1	300GAE477	300GAE477	300GAE477
30	Screw	8	75P40	75P40	75P40
* 31	Oil Seal	1	60DD726	60DD726	60DD726
* 35	Bearing – Spherical	1	12BA253	12BA253	12BA253
40	Oil Level Gauge	2	40P34	40P34	40P34
44	Screw	8	76F92	76F92	76F92
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
** 54	Shim Case .0025/.0035"	1	200GAE732	200GAE732	200GAE732
** 55	Shim Case .010"	1	201GAE732	201GAE732	201GAE732
** 56	Shim Case .0015/.002"	1	202GAE732	202GAE732	202GAE732
76	Compound, Loctite	5	25BC877	25BC877	25BC877
* 80	Bearing – Conrad	1	12BA254	12BA254	12BA254
81	Dowel Pin	2	62M13	62M13	62M13
82	Locking Assembly	2	22G43	22G43	22G43
83	Slinger	2	300GAE173	300GAE173	300GAE173
84	Screw	2	75LM14	75LM14	75LM14
** 105	Overhaul Kit 5" R VERS Lip Seal, Dual Splash Lube	1	301GAE6010	301GAE6010	301GAE6010
** 900	Group-Indent & Instruction Legend Series 5" R VERS	1	205GAE4011	205GAE4011	205GAE4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION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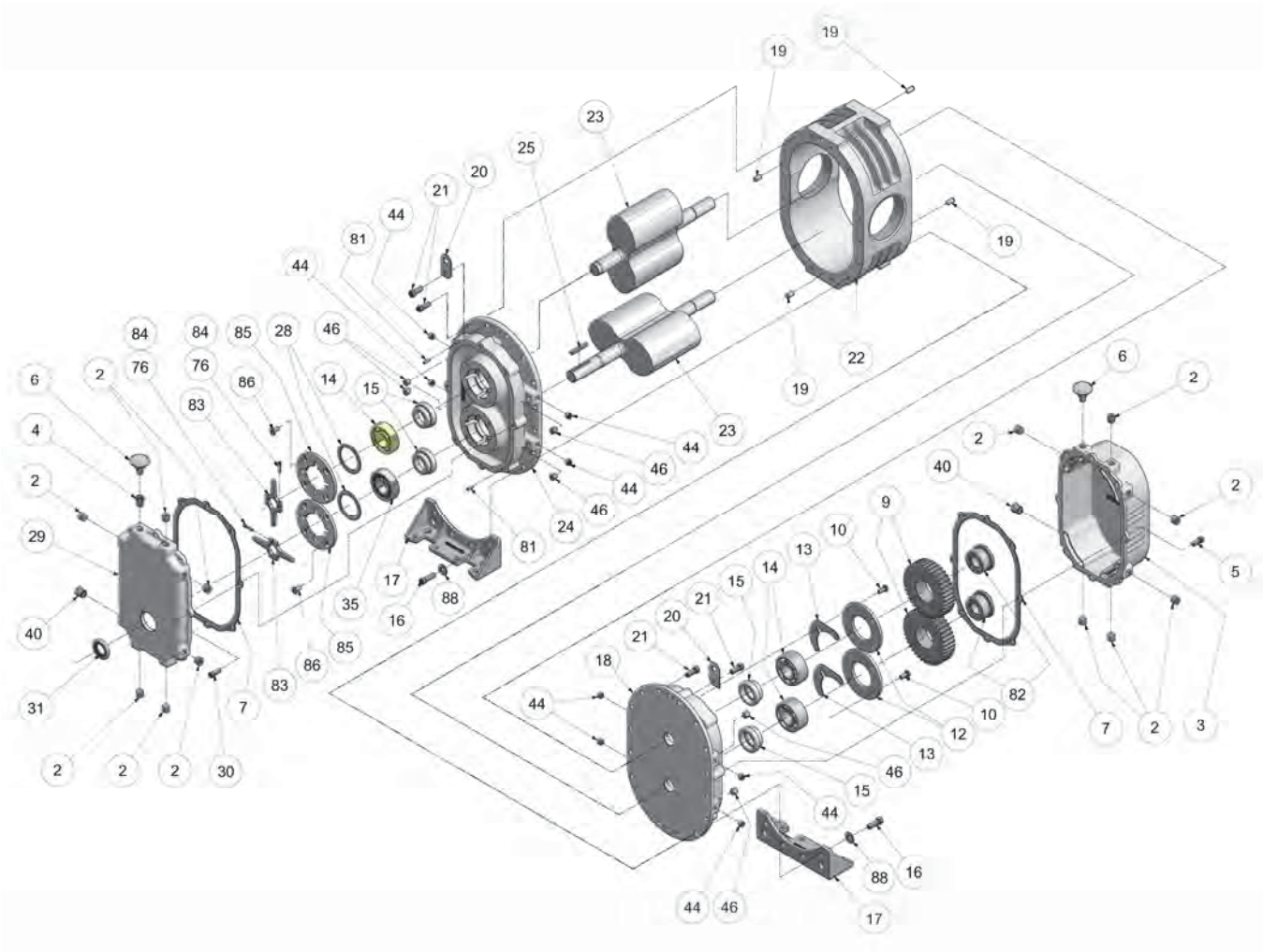
Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAB Mechanical Seal Dual Splash Lube

Ref. No.	Description	No. Req'd	Size – 3H GABH_R △ △= (E or G)	Size – 3M GABM_R △ △= (E or G)	Size -- 3L GABL_R △ △= (E or G)
2	Plug	12	64AC2	64AC2	64AC2
3	Gear Case	1	303GAB602	303GAB602	303GAB602
5	Screw	8	75P7	75P7	75P7
6	Breather	2	5L358	5L358	5L358
* 7	Gasket	2	300GAB715	300GAB715	300GAB715
9	Gear Kit	1	300GAB6008	300GAB6008	300GAB6008
* 10	Screws	4	75A33P	75A33P	75A33P
12	Bearing Retainer	2	300GAB205	300GAB205	300GAB205
* 13	Shim Set	1	900881032200	900881032200	900881032200
* 14	Ball Bearing	3	12BA143	12BA143	12BA143
* 15	Mechanical Seal	4	900871020003	900871020003	900871020003
16	Screw	4	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	303GAB166	303GAB166	303GAB166
18	Bearing Housing Gear End	1	304GAB006	304GAB006	304GAB006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	20	75P55	75P55	75P55
22	Impeller Case	1	900873034301	900873033801	900873034201
23	Rotor Group				
	3" Standard Clearances	1	307GAB4028	309GAB4028	308GAB4028
	3" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	305GAB006	305GAB006	305GAB006
25	Key-Square	1	900639910304	900639910304	900639910304
* 28	Wavy Spring	2	900669170203	900669170203	900669170203
29	Drive Cover	1	302GAB477	302GAB477	302GAB477
30	Screw	6	75P7	75P7	75P7
* 31	Oil Seal	1	60DD725	60DD725	60DD725
* 35	Bearing – Spherical	1	12BA153	12BA153	12BA153
40	Oil Level Gauge	2	40P82	40P82	40P82
44	Screw	8	76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
46	Plug	8	64AC1	64AC1	64AC1
** 54	Shim Case .0025/.0035"	1	200GAB732	200GAB732	200GAB732
** 55	Shim Case .010"	1	201GAB732	201GAB732	201GAB732
** 56	Shim Case .0015/.002"	1	202GAB732	202GAB732	202GAB732
76	Compound, Loctite	50	25BC877	25BC877	25BC877
81	Dowel Pin	2	62M13	62M13	62M13
82	Locking Assembly	2	22G45	22G45	22G45
83	Slinger	2	300GAB173	300GAB173	300GAB173
84	Screw	2	75LM13	75LM13	75LM13
85	Bearing Retainer	2	300GAB205	300GAB205	300GAB205
86	Screw	8	75LM214	75LM214	75LM214
** 105	Overhaul Kit 3" R VERS Mechanical Seal Dual, Splash	1	304GAB6010	304GAB6010	304GAB6010
** 900	Group-Indent & Instruction Legend Series 3" R VERS	1	303GAB4011	303GAB4011	303GAB4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION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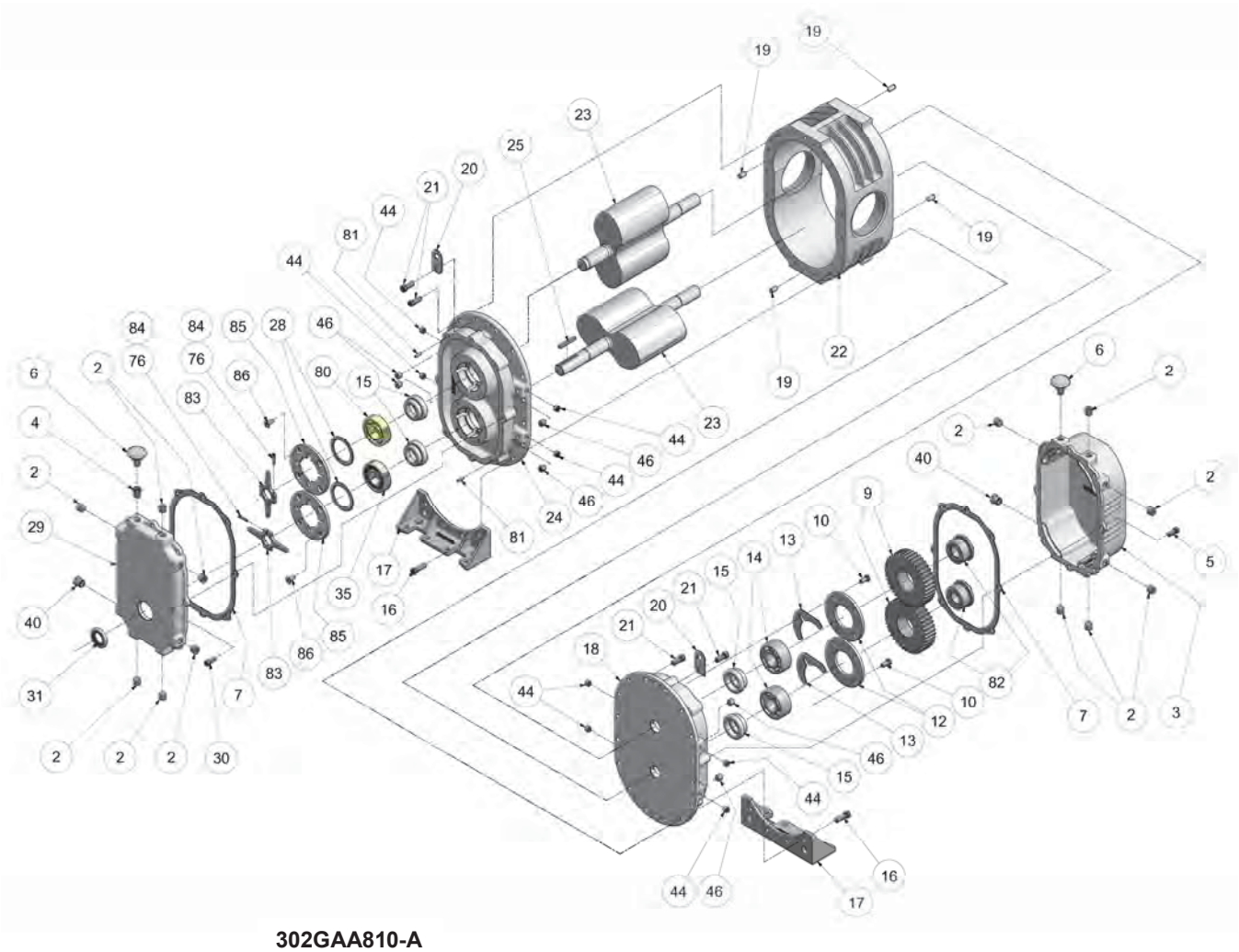
Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAC Mechanical Seal Dual Splash Lube

Ref. No.	Description	No. Req'd	Size – 4H GACH_R △ △= (E or G)	Size – 4M GACM_R △ △= (E or G)	Size -- 4L GACL_R △ △= (E or G)
2	Plug	12	64AC3	64AC3	64AC3
3	Gear Case	1	304GAC602	304GAC602	304GAC602
5	Screw	8	75P40	75P40	75P40
6	Breather	2	5L359	5L359	5L359
* 7	Gasket	2	301GAC715	301GAC715	301GAC715
9	Gear Kit	1	300GAC6008	300GAC6008	300GAC6008
* 10	Screws	8	75A33P	75A33P	75A33P
12	Bearing Retainer	2	900883040201	900883040201	900883040201
* 13	Shim Set	1	900881052900	900881052900	900881052900
* 14	Ball Bearing	3	12BA144	12BA144	12BA144
* 15	Mechanical Seal	4	900871020004	900871020004	900871020004
16	Screw	8	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	300GAC166	300GAC166	300GAC166
18	Bearing Housing Gear End	1	304GAC006	304GAC006	304GAC006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	16	75P55	75P55	75P55
22	Impeller Case	1	900883042201	900883041801	900883042001
23	Rotor Group				
	4" Standard Clearances	1	307GAC4028	306GAC4028	305GAC4028
	4" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	305GAC006	305GAC006	305GAC006
25	Key-Square	1	900639910304	900639910304	900639910304
* 28	Wavy Spring	2	900669170304	900669170304	900669170304
29	Drive Cover	1	302GAC477	302GAC477	302GAC477
30	Screw	8	75P40	75P40	75P40
* 31	Oil Seal	1	60DD716	60DD716	60DD716
* 35	Bearing – Spherical	1	12BA255	12BA255	12BA255
40	Oil Level Gauge	2	40P34	40P34	40P34
44	Screw	8	76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
46	Plug	8	64AC1	64AC1	64AC1
** 54	Shim Case .0025/.0035"	1	200GAC732	200GAC732	200GAC732
** 56	Shim Case .0015/.002"	1	202GAC732	202GAC732	202GAC732
76	Compound, Loctite	50	25BC877	25BC877	25BC877
81	Dowel Pin	2	62M13	62M13	62M13
82	Locking Assembly	2	22G44	22G44	22G44
83	Slinger	2	300GAC173	300GAC173	300GAC173
84	Screw	2	75LM14	75LM14	75LM14
85	Bearing Retainer	2	300GAC205	300GAC205	300GAC205
86	Screw	8	75LM214	75LM214	75LM214
88	Washer	4	95A3	95A3	95A3
** 105	Overhaul Kit 4" R VERS Mechanical Seal, Dual Splash	1	303GAC6010	303GAC6010	303GAC6010
** 900	Group-Indent & Instruction Legend Series 4" R VERS	1	201GAC4011	201GAC4011	201GAC4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION



302GAA810-A
(Ref. Drawing)

Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAE Mechanical Seal Dual Splash Lube

Ref. No.	Description	No. Req'd	Size – 5H GAEH_R Δ Δ= (E or G)	Size – 5M GAEM_R Δ Δ= (E or G)	Size -- 5L GAEL_R Δ Δ= (E or G)
2	Plug	12	64AC3	64AC3	64AC3
3	Gear Case	1	304GAE602	304GAE602	304GAE602
5	Screw	8	75P40	75P40	75P40
6	Breather	2	5L359	5L359	5L359
* 7	Gasket	2	300GAE715	300GAE715	300GAE715
9	Gear Kit	1	300GAE6008	300GAE6008	300GAE6008
* 10	Screws	8	75A33P	75A33P	75A33P
12	Bearing Retainer	2	900883050501	900883050501	900883050501
* 13	Shim Set	1	900881052900	900881052900	900881052900
* 14	Ball Bearing	2	8500397	8500397	8500397
* 15	Mechanical Seal	4	900871020005	900871020005	900871020005
16	Screw	8	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	300GAE166	300GAE166	300GAE166
18	Bearing Housing Gear End	1	303GAE006	303GAE006	303GAE006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	24	75P55	75P55	75P55
22	Impeller Case	1	900883051701	900883051801	900883051901
23	Rotor Group				
	5" Standard Clearances	1	327GAE4028	326GAE4028	325GAE4028
	5" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	304GAE006	304GAE006	304GAE006
25	Key-Square	1	900639910305	900639910305	900639910305
* 28	Wavy Spring	2	900669170405	900669170405	900669170405
29	Drive Cover	1	300GAE477	300GAE477	300GAE477
30	Screw	8	75P40	75P40	75P40
* 31	Oil Seal	1	60DD726	60DD726	60DD726
* 35	Bearing – Spherical	1	12BA253	12BA253	12BA253
40	Oil Level Gauge	2	40P34	40P34	40P34
44	Screw	8	76F92	76F92	76F92
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
46	Plug	8	64AC2	64AC2	64AC2
** 54	Shim Case .0025/.0035"	1	200GAE732	200GAE732	200GAE732
** 55	Shim Case .010"	1	201GAE732	201GAE732	201GAE732
** 56	Shim Case .0015/.002"	1	202GAE732	202GAE732	202GAE732
76	Compound, Loctite	5	25BC877	25BC877	25BC877
* 80	Bearing – Conrad	1	12BA254	12BA254	12BA254
81	Dowel Pin	2	62M13	62M13	62M13
82	Locking Assembly	2	22G43	22G43	22G43
83	Slinger	2	300GAE173	300GAE173	300GAE173
84	Screw	2	75LM14	75LM14	75LM14
85	Bearing Retainer	2	300GAE205	300GAE205	300GAE205
86	Screw	8	75LM214	75LM214	75LM214
** 105	Overhaul Kit 5" R VERS Mechanical Seal, Dual	1	303GAE6010	303GAE6010	303GAE6010
** 900	Group-Indent & Instruction Legend Series 5" R	1	205GAE4011	205GAE4011	205GAE4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION

Gardner Denver

WARRANTY
SUTORBILT BLOWERS
Legend SERIES

GENERAL PROVISIONS AND LIMITATIONS

Gardner Denver (the "Com pany") warrants to each original retail purchaser ("Purchaser") of its products from the Company or its authorized distributor that such products are, at the time of delivery to the Purchaser, made with good material and workmanship. No warranty is made with respect to:

1. Any product which has been repaired or altered in such a way, in the Company's judgment, as to affect the product adversely.
2. Any product which has, in the Company's judgment, been subject to negligence, accident, improper storage, or improper installation or application.
3. Any product which has not been operated or maintained in accordance with the recommendations of the Company.
4. Components or accessories manufactured, warranted and serviced by others.
5. Any reconditioned or prior owned product.

Claims for items described in (4) above should be submitted directly to the manufacturer.

WARRANTY PERIOD

The Company's obligation under this warranty is limited to repairing or, at its option, replacing, during normal business hours at an authorized service facility of the Company, any part which in its judgment proved not to be as warranted within the applicable Warranty Period as follows.

BARE BLOWERS

Basic grease lubricated bare blowers, consisting of all parts within, are warranted for 18 months from date of initial use or 24 months from date of shipment to the first purchaser, whichever occurs first. Basic dual splash lubricated bare blowers, consisting of all parts within, are warranted for 24 months from date of initial use or 30 months from date of shipment to the first purchaser, whichever occurs first. Any disassembly or partial disassembly of the blower, or failure to return the "unopened" blower per Company instructions, will be cause for denial of warranty.

OTHER COMPONENTS

All other components are warranted for 12 months from date of initial use or 18 months from date of shipment to first purchaser, whichever comes first. The Company reserves the right to withdraw the Warranty where evidence indicates application outside the stated performance area, or where there is evidence of abuse.

LABOR TRANSPORTATION AND INSPECTION

The Company will provide labor, by Company representative or authorized service personnel, for repair or replacement of any product or part thereof which in the Company's judgment is proved not to be as warranted. Labor shall be limited to the amount specified in the Company's labor rate schedule.

Labor costs in excess of the Company rate schedules caused by, but not limited to, location or inaccessibility of equipment, or labor provided by unauthorized service personnel is not provided by this warranty.

All costs of transportation of product, labor or parts claimed not to be as warranted and, of repaired or replacement parts to or from such service facilities shall be borne by the Purchaser. The Company may require the return of any part claimed not to be as warranted to one of its facilities as designated by the Company, transportation prepaid by Purchaser, to establish a claim under this warranty. Replacement parts provided under the terms of the warranty are warranted for the remainder of the Warranty Period of the product upon which installed to the same extent as if such parts were original components.

DISCLAIMER

THE FOREGOING WARRANTY IS EXCLUSIVE AND IT IS EXPRESSLY AGREED THAT, EXCEPT AS TO TITLE, THE COMPANY MAKES NO OTHER WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY.

THE REMEDY PROVIDED UNDER THIS WARRANTY SHALL BE THE SOLE, EXCLUSIVE AND ONLY REMEDY AVAILABLE TO THE PURCHASER AND IN NO CASE SHALL THE COMPANY BE SUBJECT TO ANY OTHER OBLIGATIONS OR LIABILITIES. UNDER NO CIRCUMSTANCES SHALL THE COMPANY BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, EXPENSES, LOSSES OR DELAYS HOWSOEVER CAUSED.

No statement, representation, agreement, or understanding, oral or written, made by any agent, distributor, representative, or employee of the Company which is not contained in this Warranty will be binding upon the Company unless made in writing and executed by an officer of the Company.

This warranty shall not be effective as to any claim which is not presented within 30 days after the date upon which the product is claimed not to have been as warranted. Any action for breach of this warranty must be commenced within one year after the date upon which the cause of action occurred.

Any adjustment made pursuant to this warranty shall not be construed as an admission by the Company that any product was not as warranted.

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NOTES

NOTES

Gardner Denver®

For additional information, contact your local representative or visit:
www.contactgd.com/mobile

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ENERGY STAR PARTNER

Member

NTTC

Please recycle after use.

NOTES

MAINTENANCE DATA SHEET

FOR POSITIVE DISPLACEMENT BLOWER

-

SPARE PARTS

MODEL: Sutorbilt 4L, GACLBRA (modified to horizontal)
SERIAL NUMBER: S520806 & S520818

MAINTENANCE FOR ONE UNIT

Item	**Type / Part number**	**Qty.**	**Maintenance /Replacement**	**Unit price**
Oil / Blower gear side *	AEON PD*	1.5 pt.	6000 hours	34$ for 1 L, 365 $ for 12x1L
Grease / Blower drive side	28H282	**	500 hours	34$ for 14 oz.
Overhaul Kit***	300GAC6010	1	When needed	428$
Belts	VBA65	2	When needed	24$

* AEON PD is synthetic oil with superior properties than mineral oil. If mineral oil is used instead of AEON PD oil, replacement must be done after 500 hours.

** Fill with new grease until old grease is flushed.

*** Overhaul kit consist of bearings, seals, gaskets, shims, taper pins and bearing retainer screws.

Conditions : CAD Dollar, net 30, taxes extra, price valid for 2017, minimum order of 75 $, FOB Montreal, PQ.

B-501/2	38094	VFD, Danfoss 15HP, 380-480Vac, IP55	p/n: FC202P11KT4E55H2XGX3SXSXXXXAXBXCXXXXDX
P-701/2	38093	VFD, Danfoss 2HP, 380-480Vac, IP55	p/n: FC202P1K5T4E55H2XGX3SXSXXXXAXBXCXXXXDX

Operating Guide

VLT® AQUA Drive FC 202

0.25–90 kW

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