



# Hart Engineering Corporation

**SUBMITTAL:**  
16000-01

**PROJECT:** 9722. - Veolia/Taunton WWTP Solids Handling Improvements

**DATE:** 07/19/2024

**SUBMITTAL:** 16000-01 - Electrical Distribution O&M Manual

**REVISION:** 0

**STATUS:** Eng

**SPEC #:** 16000

**TO:**  
**Enea Mushi**  
Veolia North America  
125 S. 84th Street, Suite 175  
Milwaukee, WI 53214  
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**FROM:**  
**Ryan Murphy**  
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Item	Revision	Description	Status	Date Sent	Date Returned
16000-01	0	Electrical Distribution O&M Manual	Eng	07/19/2024	
Notes:					

Additional Notes:

**Status Codes**

- 1-APP – No Exceptions Taken
- 2-ANR – Make Corrections Noted
- 3-R&R – Revise and Resubmit
- 4-REJ – Rejected
- 5-IPO – For Information Purposes Only
- 6-NRR – Not Required for Review
- ENG – Submitted to Engineer

Sincerely,  
Hart Engineering Corporation

DATE: \_\_\_\_\_ 07/19/2024 \_\_\_\_\_



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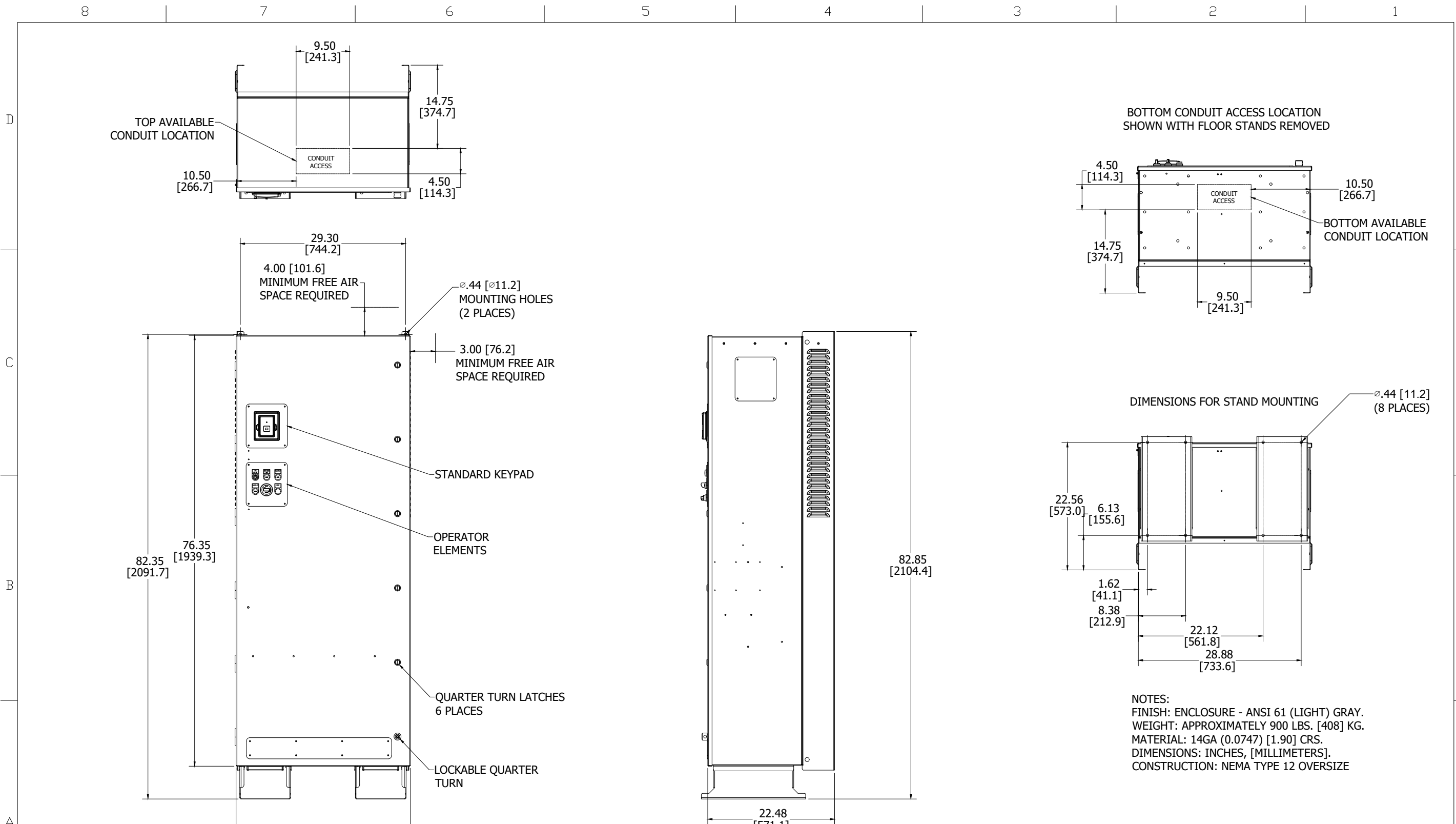
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# Master Document Index

**Drives - Enclosed**  
**Drives - Enclosed**

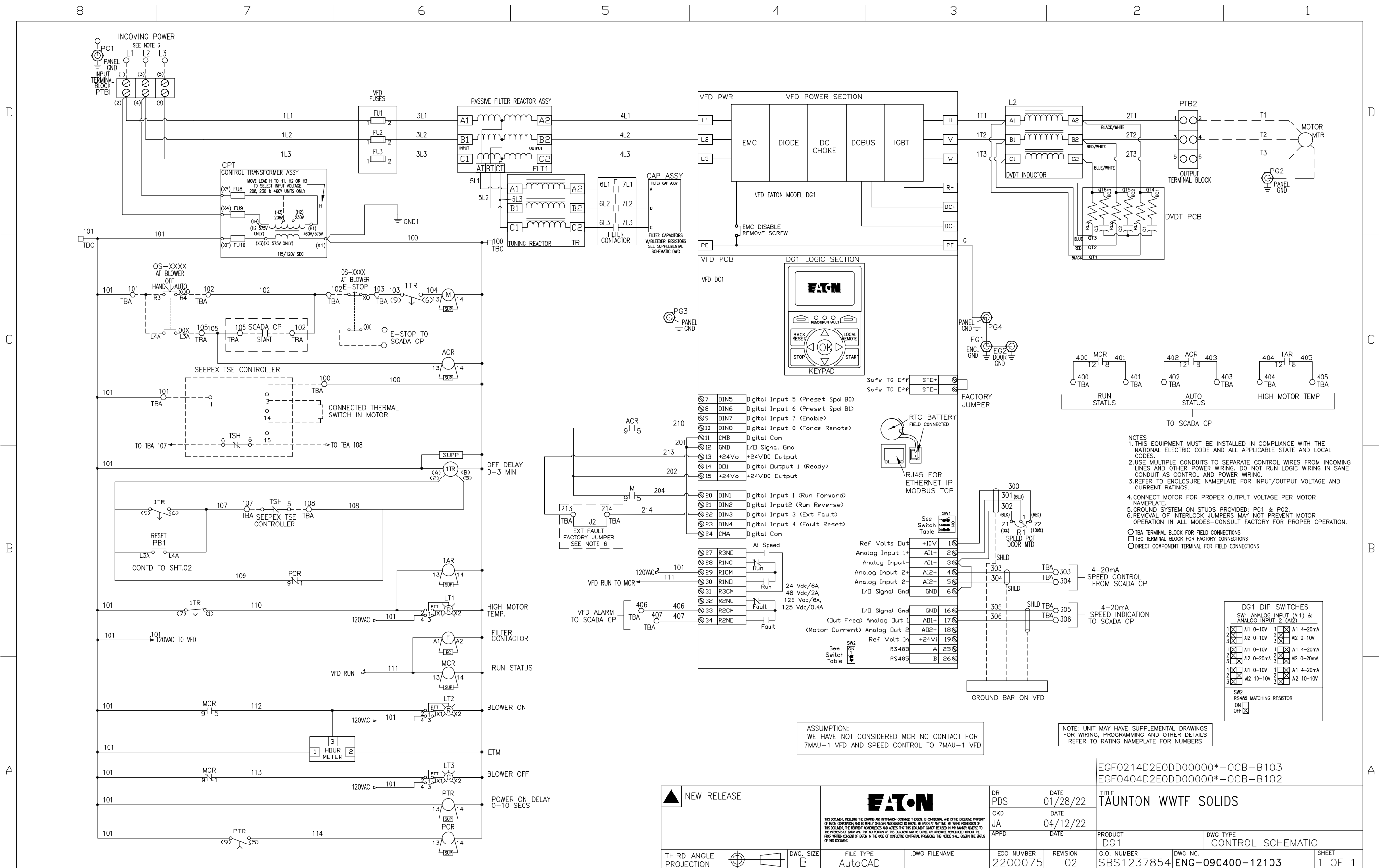
	Drawing Description	Document Name	Rev
1	Master Drawing List	D00FRG8M01.DOC	2
2	SBS1237854 TAUNTON WWTF SOLIDS	ENG-000710-11953.DWG	01
3	SBS1237854 TAUNTON WWTF SOLIDS	ENG-090400-12103.DWG	02
4	SBS1237854 TAUNTON WWTF SOLIDS	ENG-900500-12063.DWG	01

<b>User</b> Jesus D Vega	<b>Date</b> 2/15/2023 2:56:19 PM	THE INFORMATION ON THIS DOCUMENT WAS CREATED BY EATON CORPORATION. IT WAS DISCLOSED IN CONFIDENCE AND IS ONLY TO BE USED FOR THE PURPOSE IN WHICH IT WAS SUPPLIED.	 <small>Powering Business Worldwide</small>
		<b>D7580421X1K1</b>	
		<b>001</b>	<b>Construction Drawings</b>
<b>REVISION</b>	<b>DWG SIZE</b>	<b>G.O.</b>	<b>DWG</b>
<b>2</b>	<b>A</b>	<b>SBS1237854-001</b>	<b>D00FRG8M01.DOC</b>
			<b>SHEET</b> 1 of 1



**NOTES:**  
 FINISH: ENCLOSURE - ANSI 61 (LIGHT) GRAY.  
 WEIGHT: APPROXIMATELY 900 LBS. [408] KG.  
 MATERIAL: 14GA (0.0747) [1.90] CRS.  
 DIMENSIONS: INCHES, [MILLIMETERS].  
 CONSTRUCTION: NEMA TYPE 12 OVERSIZE

NEW RELEASE				DR PDS DATE 01/28/22 CKD JA DATE 04/12/22 APPD DATE	EGF0404D2E0DD00000*-OCB-B102 TITLE TAUNTON WWTF SOLIDS	
THIRD ANGLE PROJECTION		DWG. SIZE B	FILE TYPE AutoCAD	ECO NUMBER 2200075	REVISION 01	PRODUCT DG1 DWG TYPE OUTLINE DIMENSION
			.DWG FILENAME	G.O. NUMBER SBS1237854	DWG NO. ENG-000710-11953	SHEET 1 OF 1



- NOTES
1. THIS EQUIPMENT MUST BE INSTALLED IN COMPLIANCE WITH THE NATIONAL ELECTRIC CODE AND ALL APPLICABLE STATE AND LOCAL CODES.
  2. USE MULTIPLE CONDUITS TO SEPARATE CONTROL WIRES FROM INCOMING LINES AND OTHER POWER WIRING. DO NOT RUN LOGIC WIRING IN SAME CONDUIT AS CONTROL AND POWER WIRING.
  3. REFER TO ENCLOSURE NAMEPLATE FOR INPUT/OUTPUT VOLTAGE AND CURRENT RATINGS.
  4. CONNECT MOTOR FOR PROPER OUTPUT VOLTAGE PER MOTOR NAMEPLATE.
  5. GROUND SYSTEM ON STUDS PROVIDED: PG1 & PG2.
  6. REMOVAL OF INTERLOCK JUMPERS MAY NOT PREVENT MOTOR OPERATION IN ALL MODES—CONSULT FACTORY FOR PROPER OPERATION.

- TBA TERMINAL BLOCK FOR FIELD CONNECTIONS
- TBC TERMINAL BLOCK FOR FACTORY CONNECTIONS
- DIRECT COMPONENT TERMINAL FOR FIELD CONNECTIONS

DG1 DIP SWITCHES

1	A1	0-10V	1	A1	4-20mA
2	A2	0-10V	2	A2	0-10V
3	A2	0-20mA	3	A2	0-20mA
1	A1	0-10V	1	A1	4-20mA
2	A2	0-20mA	2	A2	0-20mA
3	A2	10-10V	3	A2	10-10V

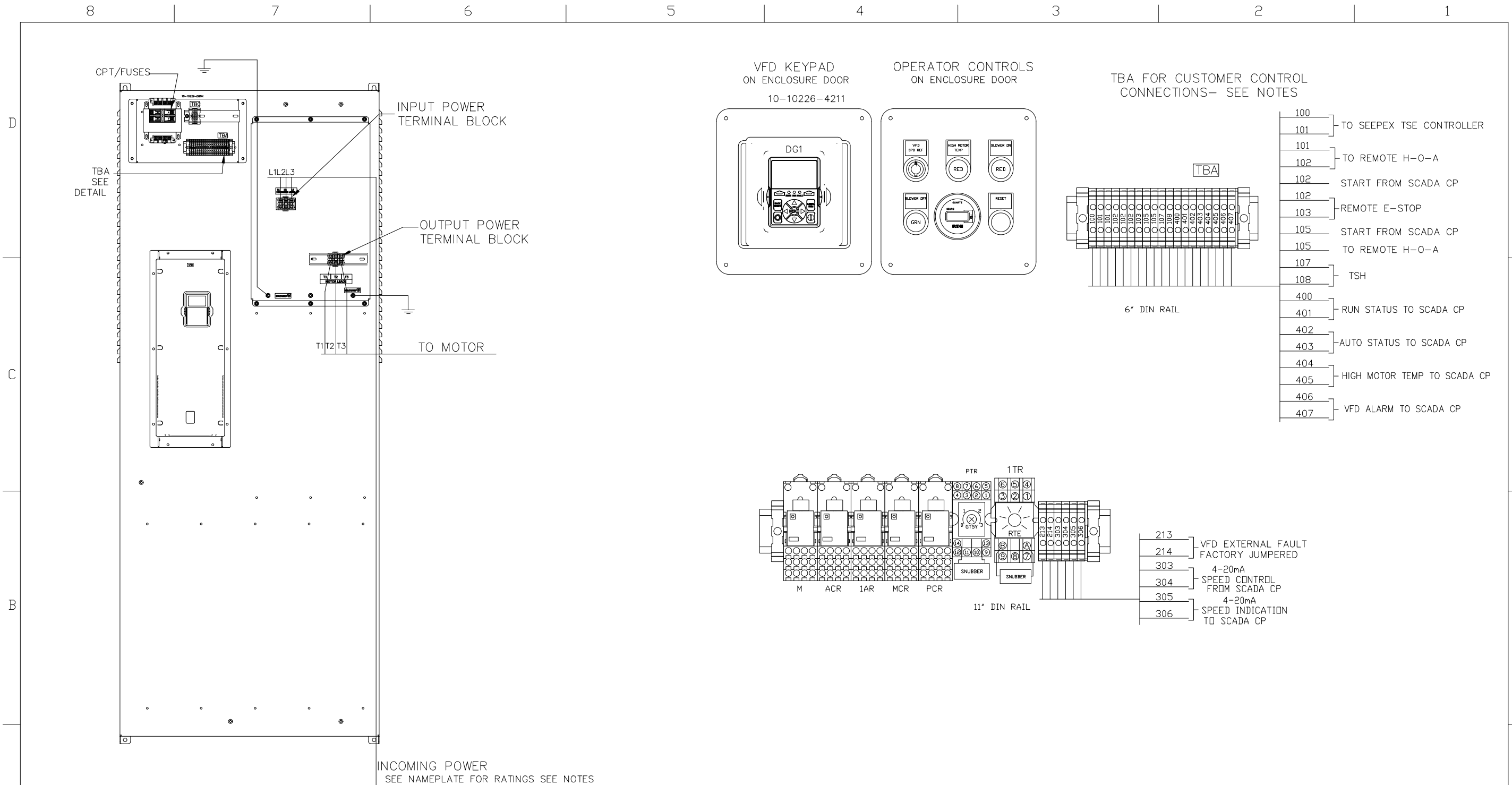
SW2 RS485 MATCHING RESISTOR  
ON  OFF

ASSUMPTION:  
WE HAVE NOT CONSIDERED MCR NO CONTACT FOR 7MAU-1 VFD AND SPEED CONTROL TO 7MAU-1 VFD

NOTE: UNIT MAY HAVE SUPPLEMENTAL DRAWINGS FOR WIRING, PROGRAMMING AND OTHER DETAILS REFER TO RATING NAMEPLATE FOR NUMBERS

EGF0214D2E0DD00000\*-OCB-B103  
EGF0404D2E0DD00000\*-OCB-B102

		DR PDS	DATE 01/28/22	TITLE TAUNTON WWTF SOLIDS
		CKD JA	DATE 04/12/22	PRODUCT DG1
THIRD ANGLE PROJECTION	DWG. SIZE B	FILE TYPE AutoCAD	DWG. FILENAME	ECO NUMBER 2200075
				REVISION 02
				G.O. NUMBER SBS1237854
				DWG NO. ENG-090400-12103
				SHEET 1 OF 1



**NOTES**

- SEE SCHEMATIC FOR DETAILS AND CONTROL LOGIC – FACTORY WIRING DETAILS OMITTED.
- REFER TO ENCLOSURE NAMEPLATE FOR INPUT/OUTPUT VOLTAGES AND CURRENT RATINGS.
- ENCLOSURE MUST BE GROUNDED USING INPUT AND OUTPUT STUDS PROVIDED.
- THIS EQUIPMENT MUST BE INSTALLED IN COMPLIANCE WITH THE NATIONAL ELECTRIC CODE AND ALL STATE/LOCAL CODES.
- USE MULTIPLE CONDUITS TO SEPARATE 120 CONTROL (TBA 101/102 & 106/104) WIRING FROM INCOMING POWER WIRING.
- 4-20MA AUTO SPEED SIGNAL CONNECTIONS ARE MADE DIRECTLY TO VFD CONTROL MODULE.
- DO NOT RUN LOGIC WIRES (TBA 213/214 VFD EXT FAULT) IN SAME CONDUIT AS 120V OR POWER WIRING.
- REMOVAL OF INTERLOCKS (TBA 101/102;213/214) MAY NOT PREVENT MOTOR OPERATION IN ALL MODES—CONSULT FACTORY FOR DETAILS.


NEW RELEASE		DR PDS	DATE 01/31/22	EGF0404D2E0DD00000*-OCB-B102	
		CKD	DATE	TITLE TAUNTON WWTF SOLIDS	
		APPD	DATE	PRODUCT DG1	DWG TYPE CONNECTION DIAGRAM
THIRD ANGLE PROJECTION	DWG. SIZE B	FILE TYPE AutoCAD	.DWG FILENAME	ECO NUMBER 2200075	REVISION 01
				G.O. NUMBER SBS1237854	DWG NO. ENG-900500-12063
					SHEET 1 OF 1

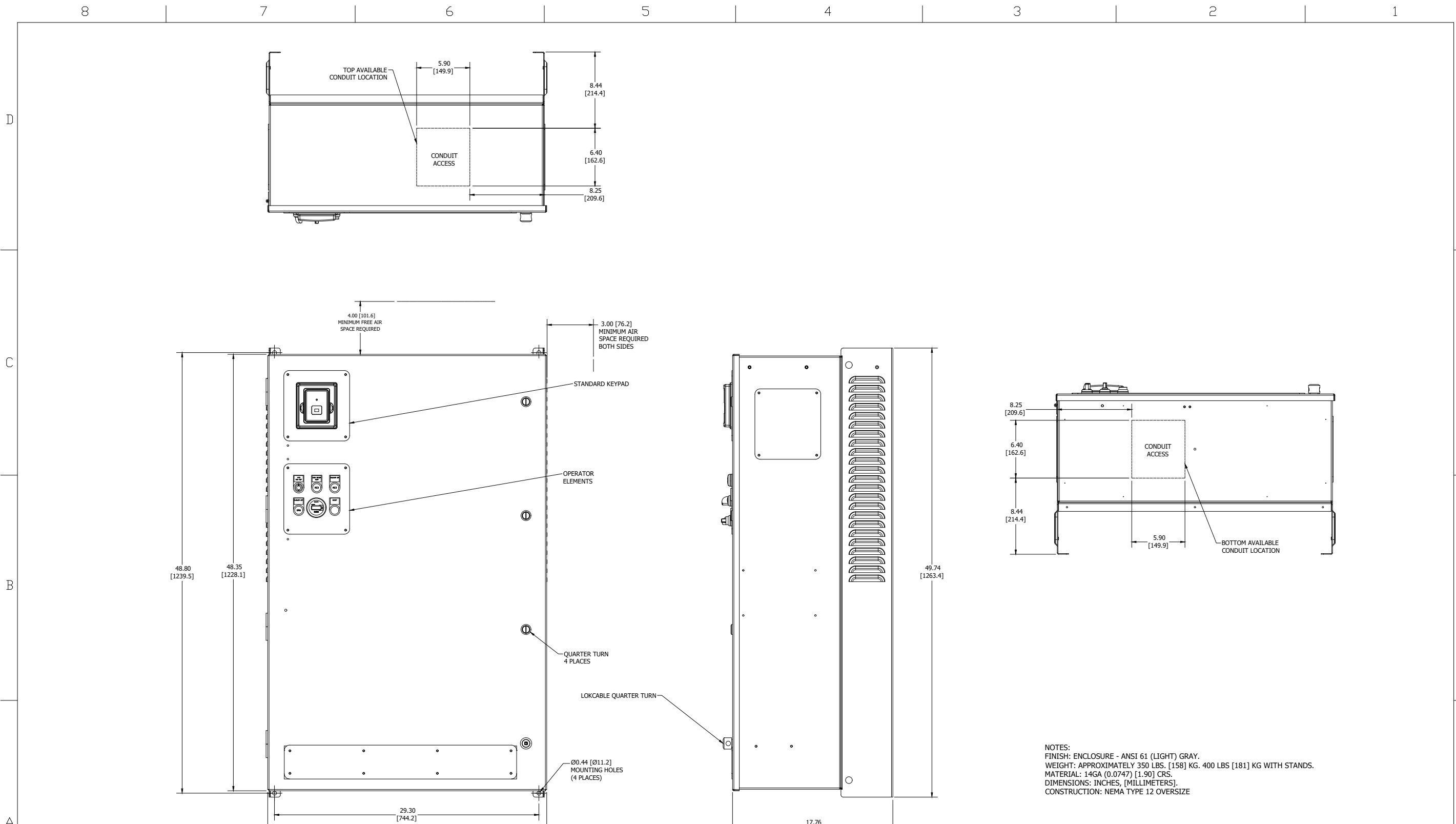
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2	SBS1237854 TAUNTON WWTF SOLIDS	ENG-090400-12103.DWG	02
3	SBS1237854 TAUNTON WWTF SOLIDS	ENG-900500-12064.DWG	01

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		<b>D7580421X1K1</b>		
		<b>002</b>	<b>Construction Drawings</b>	
REVISION	DWG SIZE	G.O.	DWG	SHEET
1	A	SBS1237854-002	D00FTO3M01.DOC	1 of 1

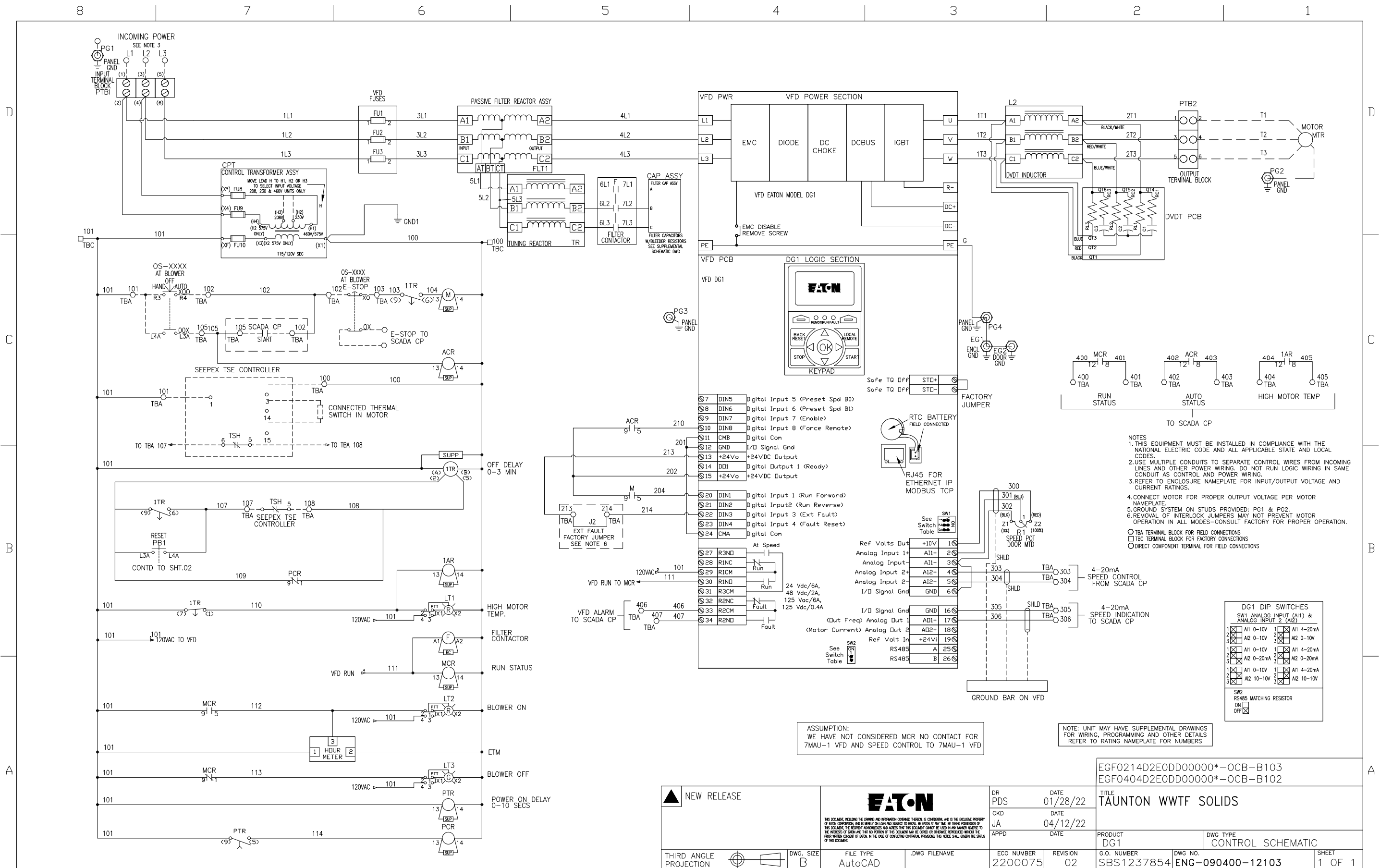


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 CONSTRUCTION: NEMA TYPE 12 OVERSIZE

EGF0214D2E0DD00000\*-OCB-B103

NEW RELEASE		DR	DATE	TITLE
		PDS	01/28/22	
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	JA	04/12/22		DG 1
THIRD ANGLE PROJECTION		APPD	DATE	DWG TYPE
DWG. SIZE	FILE TYPE	ECO NUMBER	REVISION	G.O. NUMBER
B	AutoCAD	2200075	01	SBS1237854
	.DWG FILENAME			DWG NO.
				ENG-000710-11954
				SHEET
				1 OF 1





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1. THIS EQUIPMENT MUST BE INSTALLED IN COMPLIANCE WITH THE NATIONAL ELECTRIC CODE AND ALL APPLICABLE STATE AND LOCAL CODES.
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1	A1 0-10V	1	A1 4-20mA
2	A2 0-20mA	2	A2 0-20mA
3	A2 10-10V	3	A2 10-10V

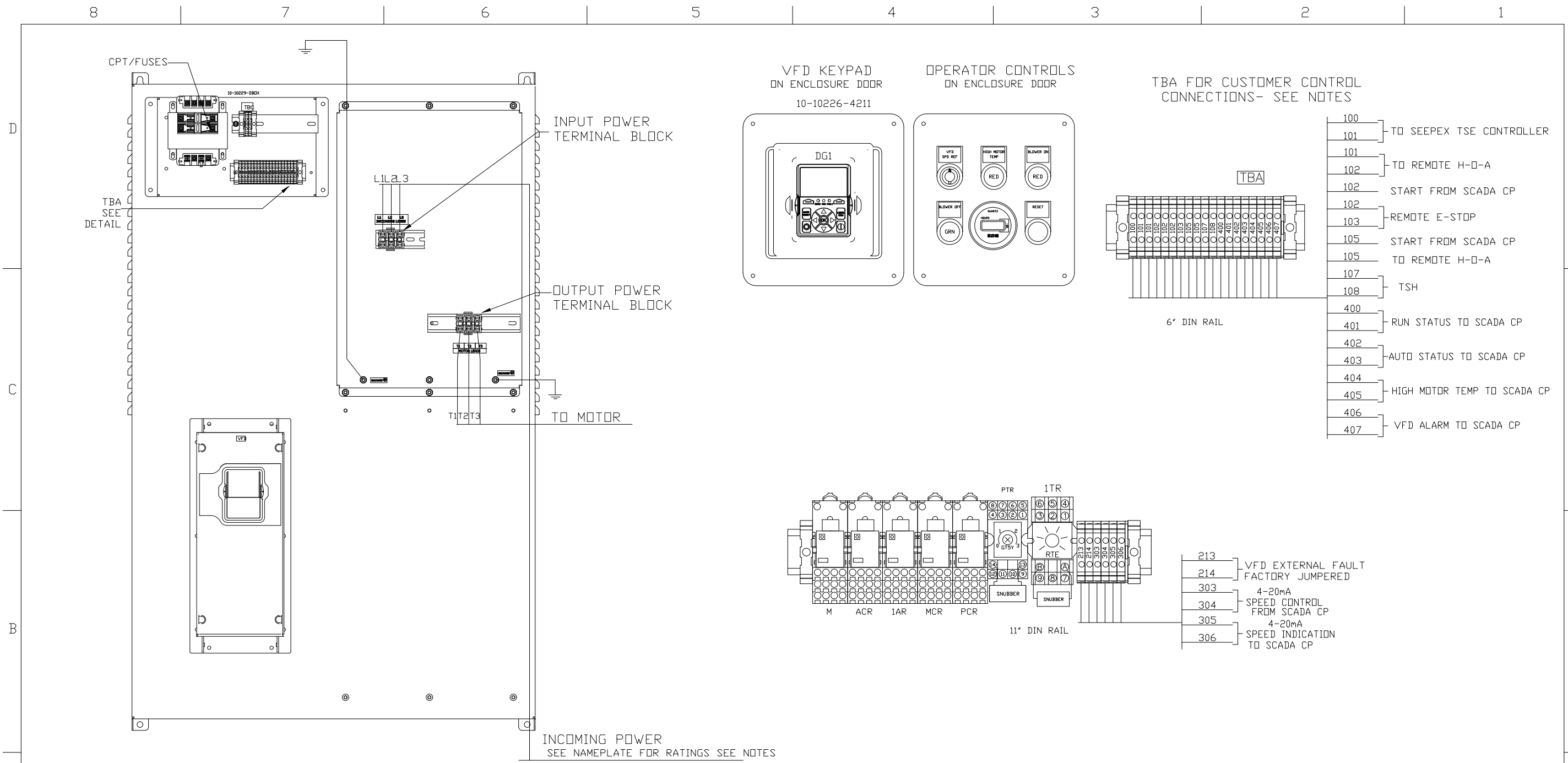
SW2 RS485 MATCHING RESISTOR  
ON  OFF

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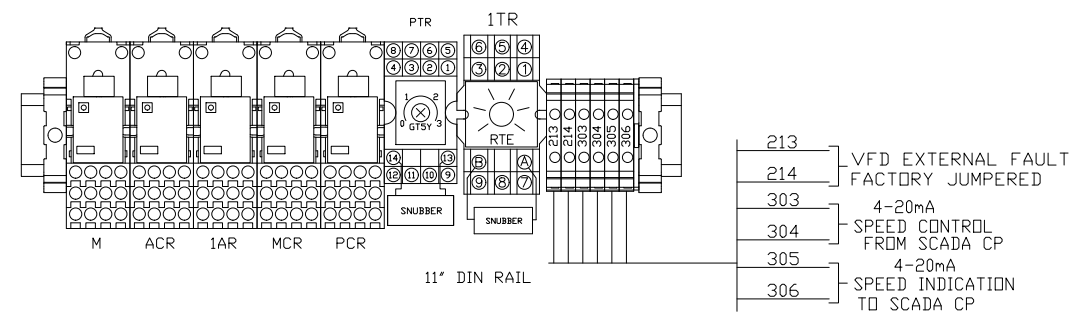
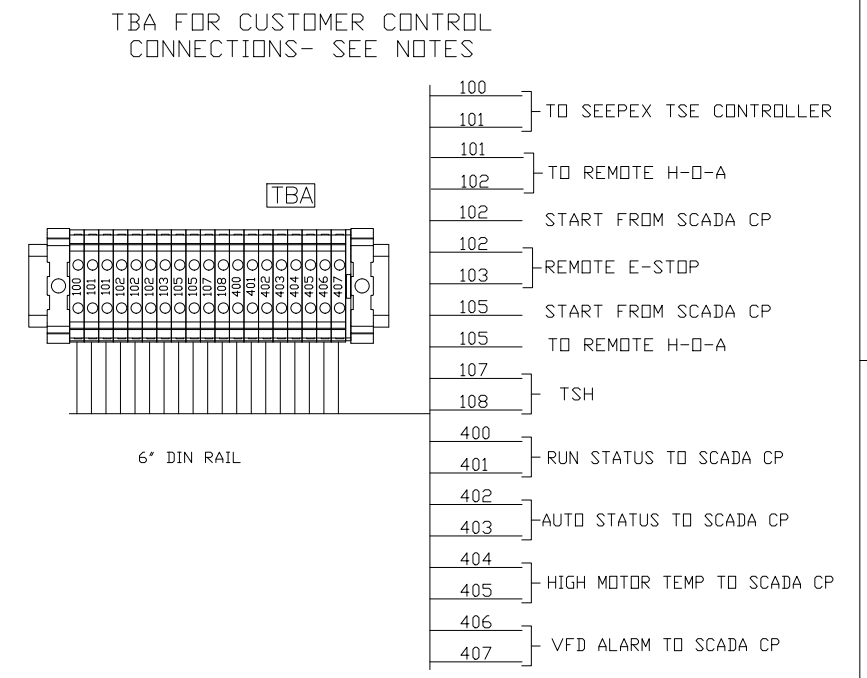
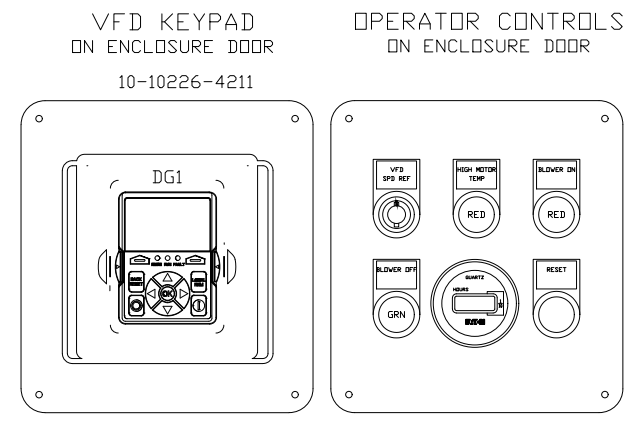
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		DR PDS	DATE 01/28/22	TITLE TAUNTON WWTF SOLIDS				
		CKD JA	DATE 04/12/22	PRODUCT DG1				
THIRD ANGLE PROJECTION	DWG. SIZE B	FILE TYPE AutoCAD	DWG. FILENAME	ECO NUMBER 2200075	REVISION 02	G.O. NUMBER SBS1237854	DWG NO. ENG-090400-12103	SHEET 1 OF 1



**NOTES**

1. SEE SCHEMATIC FOR DETAILS AND CONTROL LOGIC - FACTORY WIRING DETAILS OMITTED.
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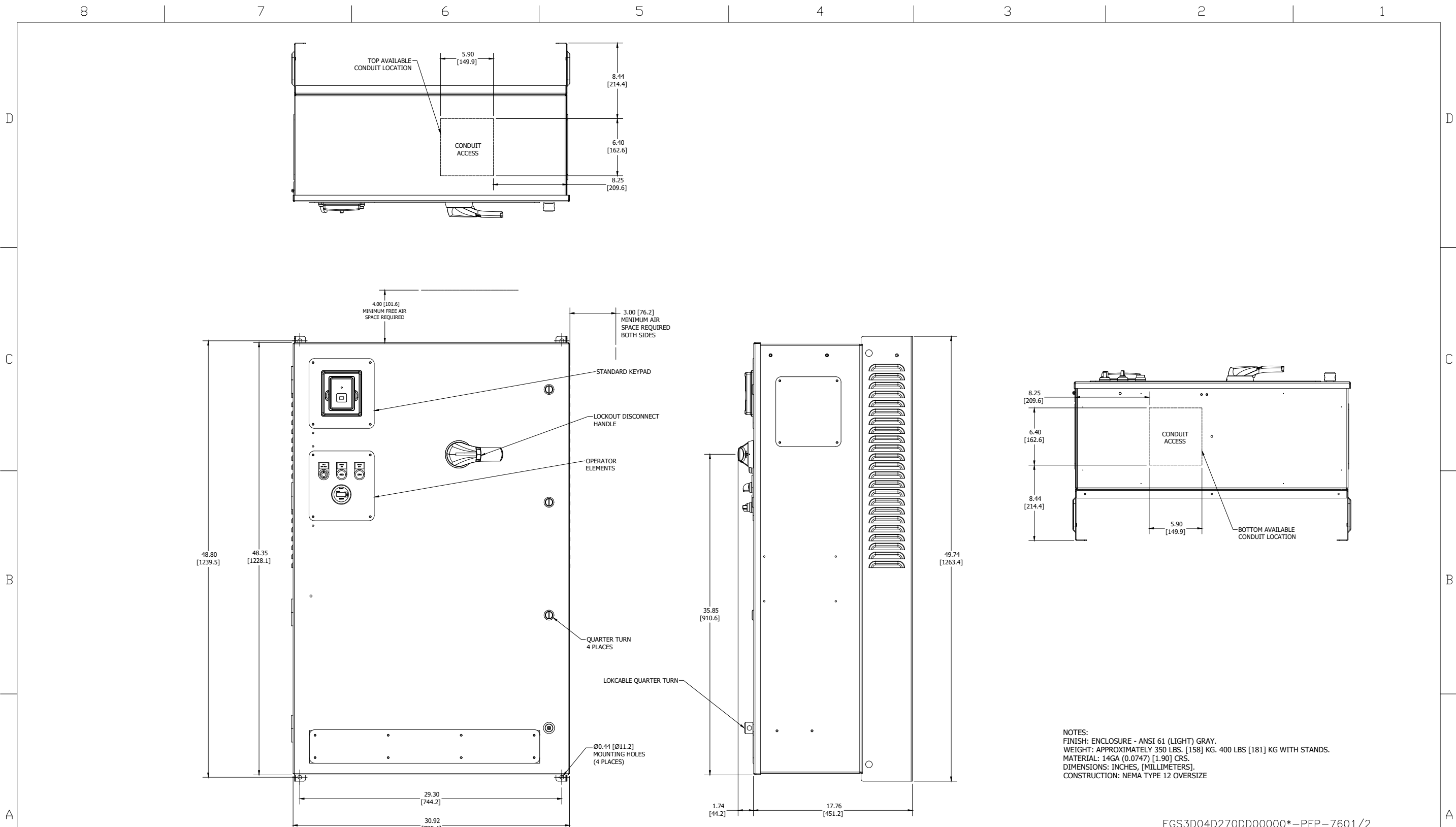
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		PDS	01/31/22					
		CKD	DATE					
		JA	04/12/22					
		APPD	DATE					
				PRODUCT	DWG TYPE			
				DG1	CONNECTION DIAGRAM			
THIRD ANGLE PROJECTION	DWG. SIZE	FILE TYPE	.DWG FILENAME	ECO NUMBER	REVISION	G.O. NUMBER	DWG NO.	SHEET
	B	AutoCAD		2200075	01	SBS1237854	ENG-900500-12064	1 OF 1

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2	SBS1237854 TAUNTON WWTF SOLIDS	ENG-090400-12104.DWG	01
3	SBS1237854 TAUNTON WWTF SOLIDS	ENG-900500-12065.DWG	01

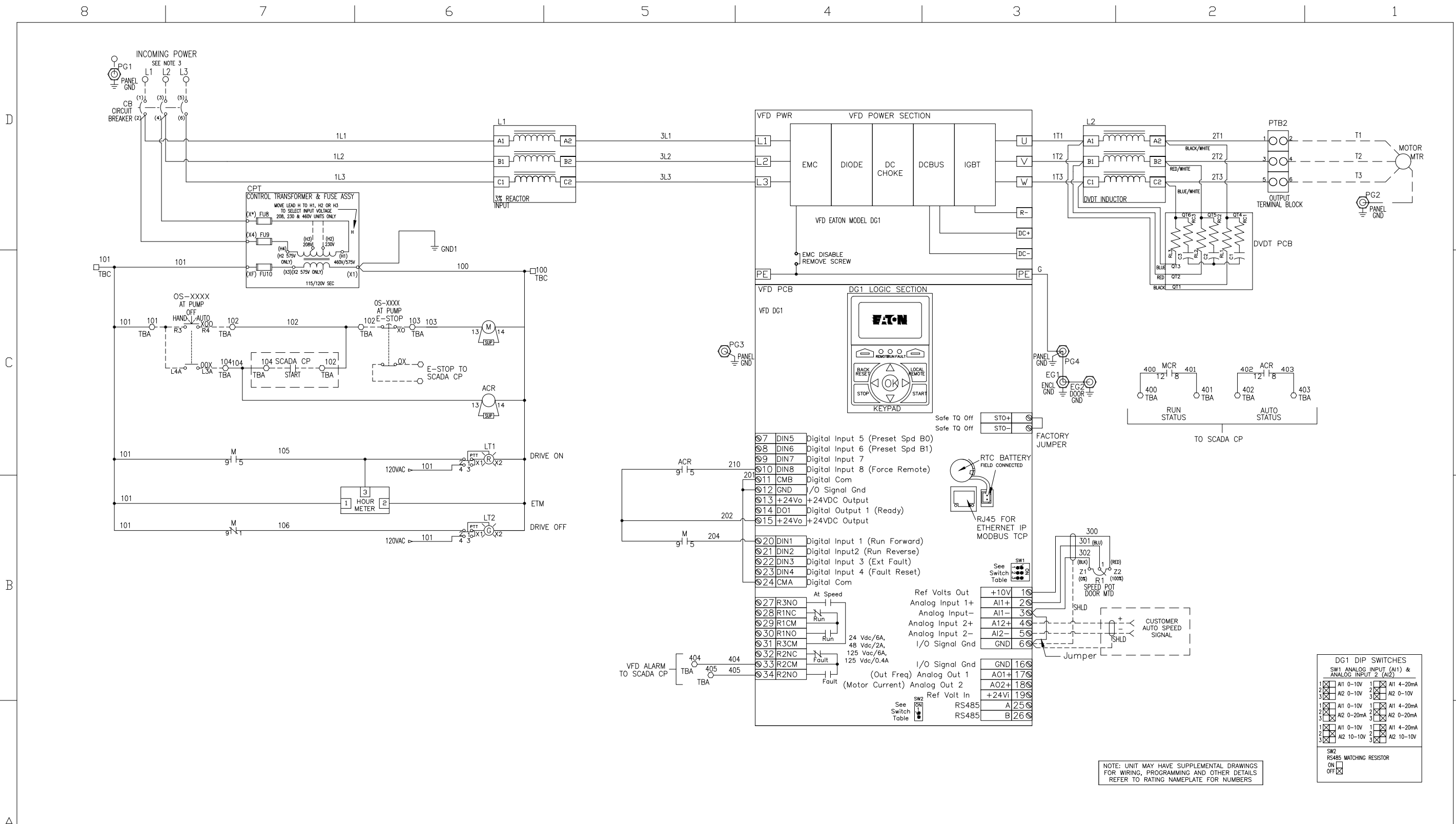
<b>User</b> Jorge Andrade	<b>Date</b> 4/12/2022 4:56:23 PM	THE INFORMATION ON THIS DOCUMENT WAS CREATED BY EATON CORPORATION. IT WAS DISCLOSED IN CONFIDENCE AND IS ONLY TO BE USED FOR THE PURPOSE IN WHICH IT WAS SUPPLIED.	 <small>Powering Business Worldwide</small>
		<b>D7580421X1K1</b>	
		<b>003</b>	<b>Final Drawings</b>
REVISION	DWG SIZE	G.O.	DWG
1	A	<b>SBS1237854-003</b>	<b>D00FRG9M01.DOC</b>
			SHEET 1 of 1



NOTES:  
 FINISH: ENCLOSURE - ANSI 61 (LIGHT) GRAY.  
 WEIGHT: APPROXIMATELY 350 LBS. [158] KG. 400 LBS [181] KG WITH STANDS.  
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 DIMENSIONS: INCHES, [MILLIMETERS].  
 CONSTRUCTION: NEMA TYPE 12 OVERSIZE

EGS3D04D270DD00000\*-PFP-7601/2

NEW RELEASE		DR	DATE	TITLE				
		PDS	01/28/22		TAUNTON WWTF SOLIDS			
		CKD	DATE	PRODUCT				
		JA	04/12/22		DG1			
		APPD	DATE	DWG TYPE				
				OUTLINE DIMENSION				
THIRD ANGLE PROJECTION	DWG. SIZE	FILE TYPE	DWG. FILENAME	ECO NUMBER	REVISION	G.O. NUMBER	DWG. NO.	SHEET
	B	AutoCAD		2200075	01	SBS1237854	ENG-000710-11955	1 OF 1



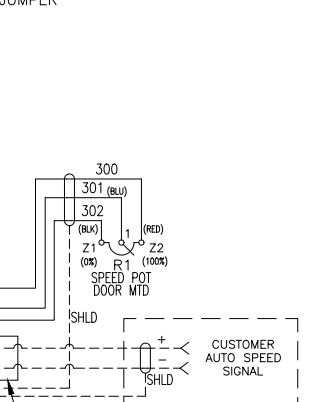
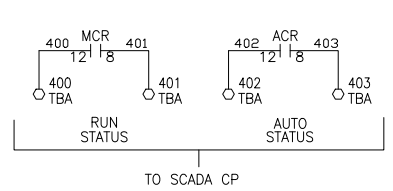
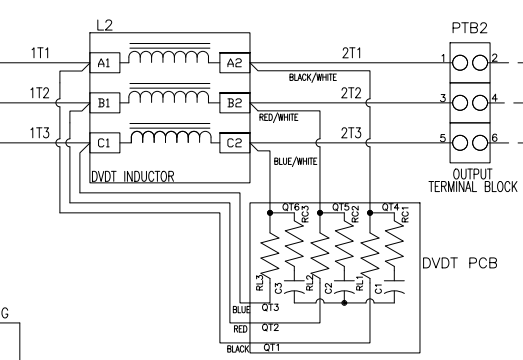
INCOMING POWER  
SEE NOTE 3  
L1 L2 L3  
PG1  
PANEL GND

CPT  
CONTROL TRANSFORMER & FUSE ASSY  
MOVE LEAD H TO H1, H2 OR H3  
TO SELECT INPUT VOLTAGE  
208, 230 & 480V UNITS ONLY  
(X\*) FUB  
(X4) FUS  
(H1) 208V  
(H2) 230V  
(H3) 480V/575V  
(X1)  
(X3) (X2 575V ONLY)  
115/120V SEC  
XF F10

VFD PWR VFD POWER SECTION  
EMC DIODE DC CHOKE DCBUS IGBT  
VFD EATON MODEL DG1  
EMC DISABLE REMOVE SCREW

VFD PCB DG1 LOGIC SECTION  
VFD DG1  
EATON  
KEYPAD  
BACK RESET LOCAL REMOTE STOP START

- ⑦ DIN5 Digital Input 5 (Preset Spd B0)
- ⑧ DIN6 Digital Input 6 (Preset Spd B1)
- ⑨ DIN7 Digital Input 7
- ⑩ DIN8 Digital Input 8 (Force Remote)
- ⑪ CMB Digital Com
- ⑫ GND I/O Signal Gnd
- ⑬ +24Vo +24VDC Output
- ⑭ DO1 Digital Output 1 (Ready)
- ⑮ +24Vo +24VDC Output
- ⑳ DIN1 Digital Input 1 (Run Forward)
- ㉑ DIN2 Digital Input 2 (Run Reverse)
- ㉒ DIN3 Digital Input 3 (Ext Fault)
- ㉓ DIN4 Digital Input 4 (Fault Reset)
- ㉔ CMA Digital Com
- ㉗ R3NO At Speed
- ㉘ R1NC Run
- ㉙ R1CM Run
- ㉚ R1NO Run
- ㉛ R3CM Run
- ㉜ R2NC Fault
- ㉝ R2CM Fault
- ㉞ R2NO Fault
- Ref Volts Out +10V
- Analog Input 1+ A11+ 2
- Analog Input- A11- 3
- Analog Input 2+ A12+ 4
- Analog Input 2- A12- 5
- I/O Signal Gnd GND 6
- (Out Freq) Analog Output 1 A01+ 17
- (Motor Current) Analog Out 2 A02+ 18
- Ref Volt In +24Vi 19
- RS485 A 25
- RS485 B 26



DG1 DIP SWITCHES

SW1 ANALOG INPUT 1 (A1) & ANALOG INPUT 2 (A2)

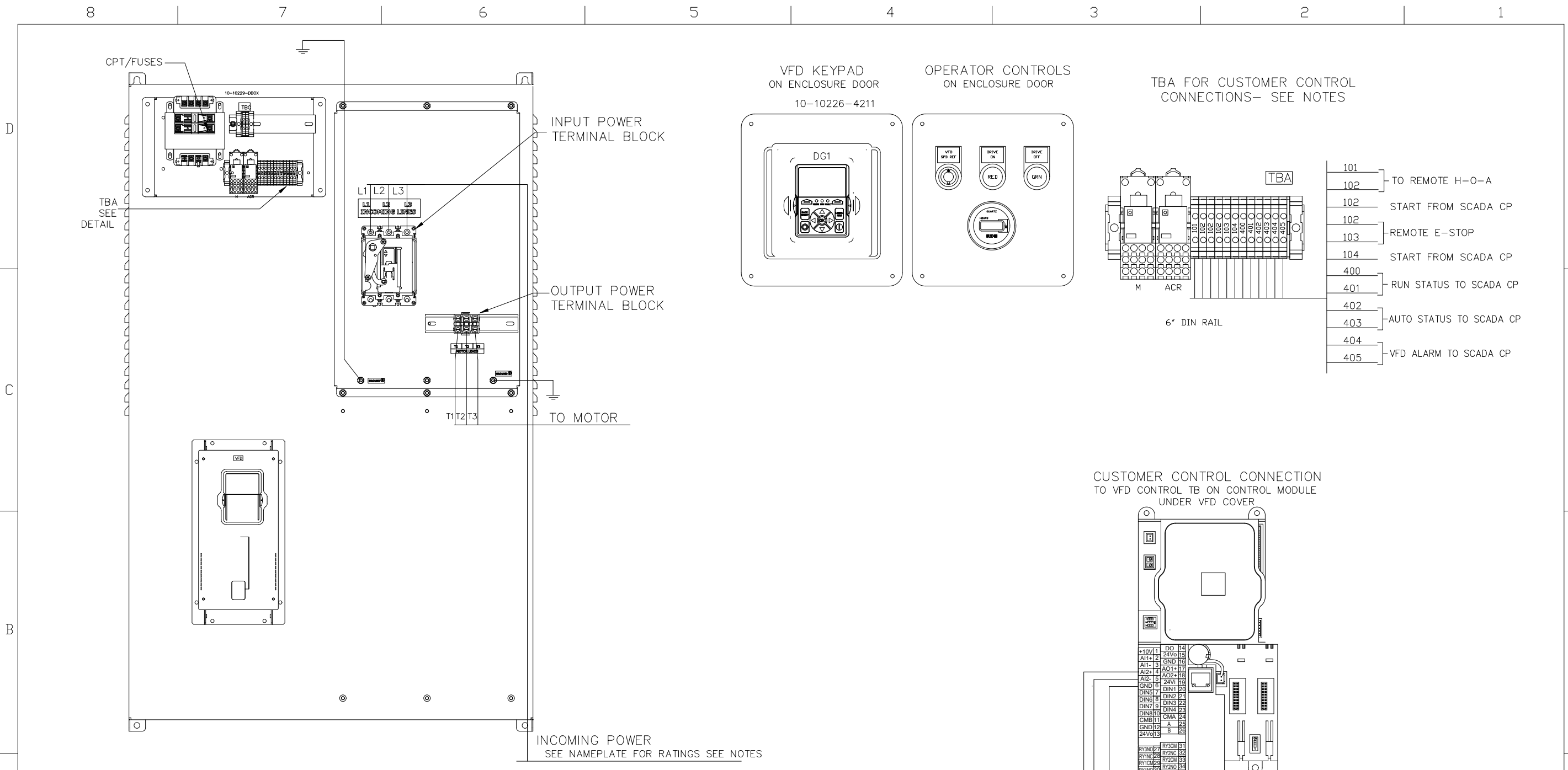
1	A1 0-10V	1	A1 4-20mA
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3	A1 0-10V	3	A1 4-20mA
1	A2 0-20mA	2	A2 0-20mA
2	A1 0-10V	1	A1 4-20mA
3	A2 10-10V	3	A2 10-10V

SW2 RS485 MATCHING RESISTOR  
ON   
OFF

NOTE: UNIT MAY HAVE SUPPLEMENTAL DRAWINGS FOR WIRING, PROGRAMMING AND OTHER DETAILS REFER TO RATING NAMEPLATE FOR NUMBERS

- NOTES
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□ TBC TERMINAL BLOCK FOR FACTORY CONNECTIONS  
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NEW RELEASE	EATON	DR PDS	DATE 01/28/22	EGS3D04D270DD00000*-PFP-7601/2	
		CKD JA	DATE 04/12/22	TITLE TAUNTON WWTF SOLIDS	
THIRD ANGLE PROJECTION	DWG. SIZE B	FILE TYPE AutoCAD	DWG. FILENAME	ECO NUMBER 2200075	REVISION 01
				G.O. NUMBER SBS1237854	DWG NO. ENG-090400-12104
				PRODUCT DG1	DWG TYPE CONTROL SCHEMATIC
			SHEET 1 OF 1		



- NOTES**
- SEE SCHEMATIC FOR DETAILS AND CONTROL LOGIC - FACTORY WIRING DETAILS OMITTED.
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INCOMING POWER  
SEE NAMEPLATE FOR RATINGS SEE NOTES

NEW RELEASE		DR	DATE	TITLE	
		PDS	01/31/22	EGS3D04D270DD00000*-PFP-7601/2 TAUNTON WWTF SOLIDS	
		CKD	DATE		
		JA	04/12/22		
		APPD	DATE	PRODUCT	DWG TYPE
				DG1	CONNECTION DIAGRAM
THIRD ANGLE PROJECTION	DWG. SIZE	FILE TYPE	.DWG FILENAME	ECO NUMBER	REVISION
	B	AutoCAD		2200075	01
				G.O. NUMBER	DWG NO.
				SBS1237854	ENG-900500-12065
					SHEET
					1 OF 1

## General Information: Drives - Enclosed

### Drive Schedule

Item	Qty	Equipment ID	Catalog Number	Output HP	Output Amps	Output Voltage
004	2	TSP-7201/2	EGF0144D2E0DD0 0000+	10.0	14	480VAC Three Phase

### Item Information

Design Series:	Enclosed Passive Filtered DG1 Drive
Output Power:	10 HP (7.5 KW)
Rated Output Current (Amps):	14
Input Voltage:	480VAC Three Phase
Input Frequency:	45 to 66 Hz
Output Voltage:	480VAC Three Phase
Output Frequency:	0 to 320 Hz
Branch Protection:	
Short Circuit Current Rating:	100KAIC
Enclosure NEMA Rating:	NEMA 12
Enclosure Size:	CX
Drive Frame Size:	FR2
Onboard Comms:	BACnet MS/TP, Ethernet/IP, Modbus, & Modbus TCP
Optional Comms:	None

### Enclosure Information

NEMA Rating:	NEMA 12
Height (in):	49.74
Width (in):	30.92
Depth (in):	19.5
Weight (lbs):	400

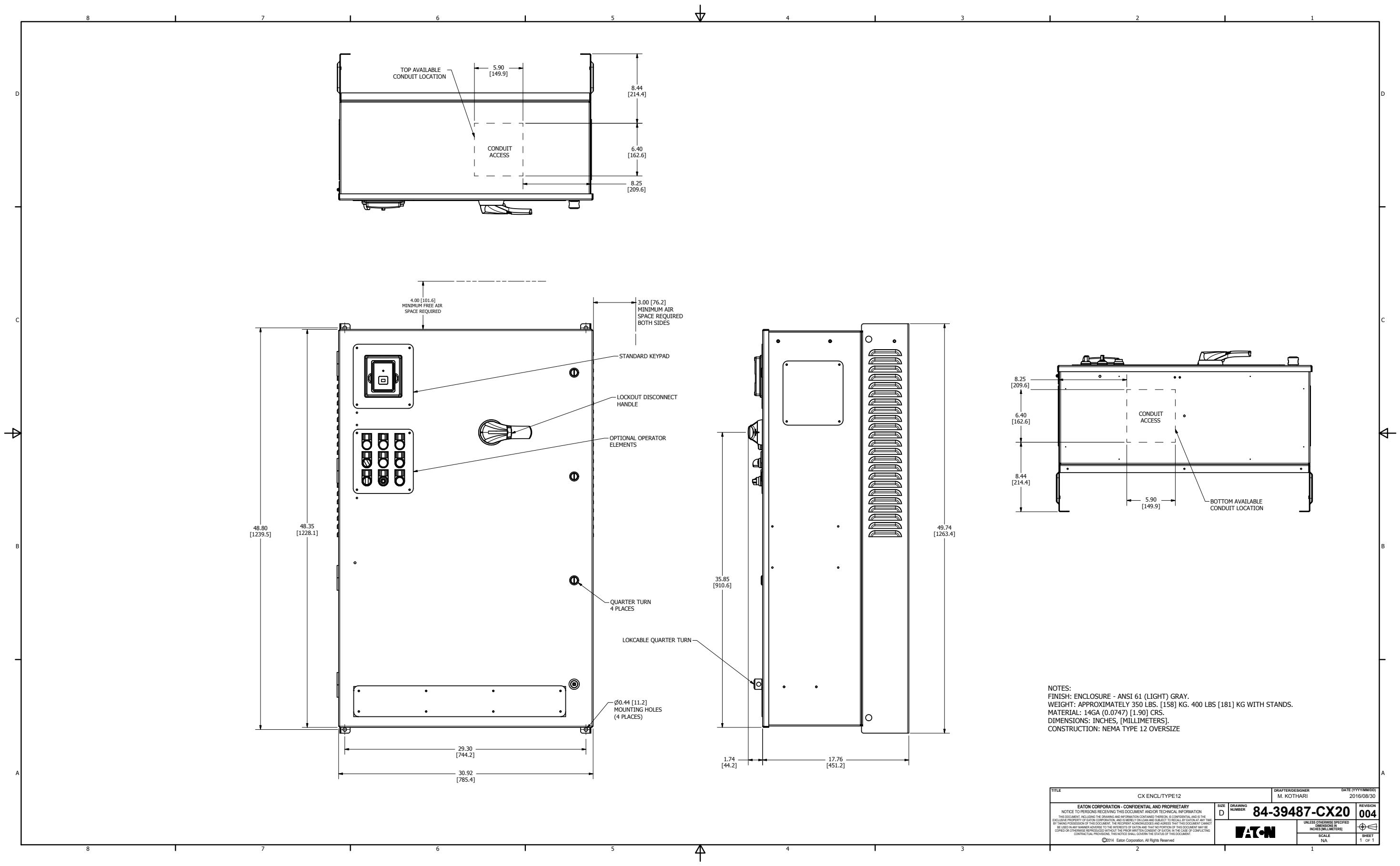
### Circuit Protection

25

### Special Mods

Qty	Description
1	MOUNT MOTOR OVERTEMP SUPPLIED BY OTHERS

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	SCOTT ARNOLD	7/16/2024				
	APPROVED BY	DATE	JOB NAME	Taunton WWTF Solids		
			DESIGNATION	TSP-7201/2		
	VERSION	TYPE		DRAWING TYPE		
	10.0.11.0	Drives - Enclosed		Final		
NEG-ALT Number	REVISION	DWG SIZE	G.O.	ITEM	SHEET	
D7580421X1K1-0004	0	A	SBS1237854	004	1 of 1	

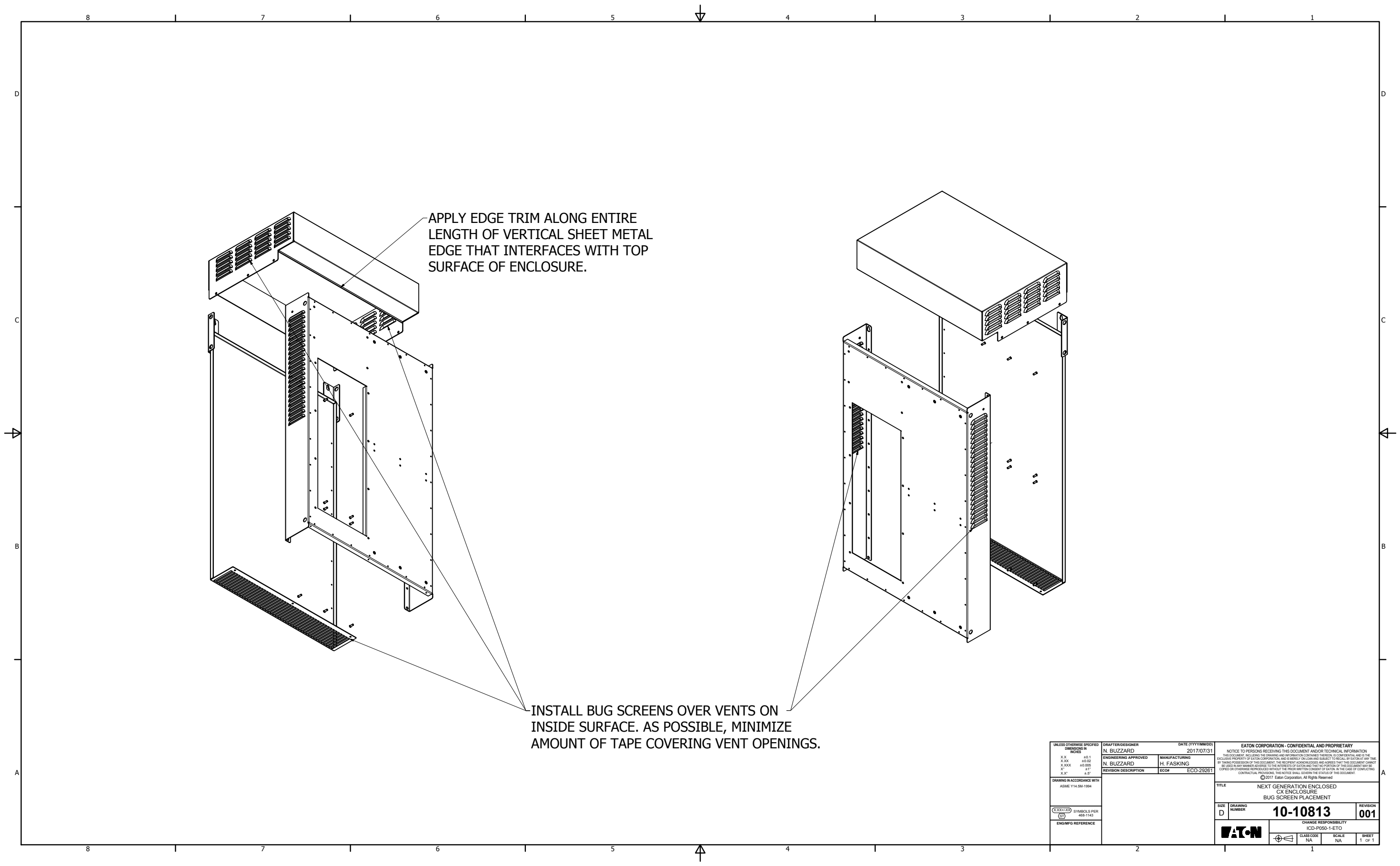


NOTES:  
 FINISH: ENCLOSURE - ANSI 61 (LIGHT) GRAY.  
 WEIGHT: APPROXIMATELY 350 LBS. [158] KG. 400 LBS [181] KG WITH STANDS.  
 MATERIAL: 14GA (0.0747) [1.90] CRS.  
 DIMENSIONS: INCHES, [MILLIMETERS].  
 CONSTRUCTION: NEMA TYPE 12 OVERSIZE

TITLE CX ENCL/TYPE12		DRAFTER/DESIGNER M. KOTHARI		DATE (YYYYMMDD) 2018/08/30	
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SCALE NA		SHEET 1 OF 1		EATON	

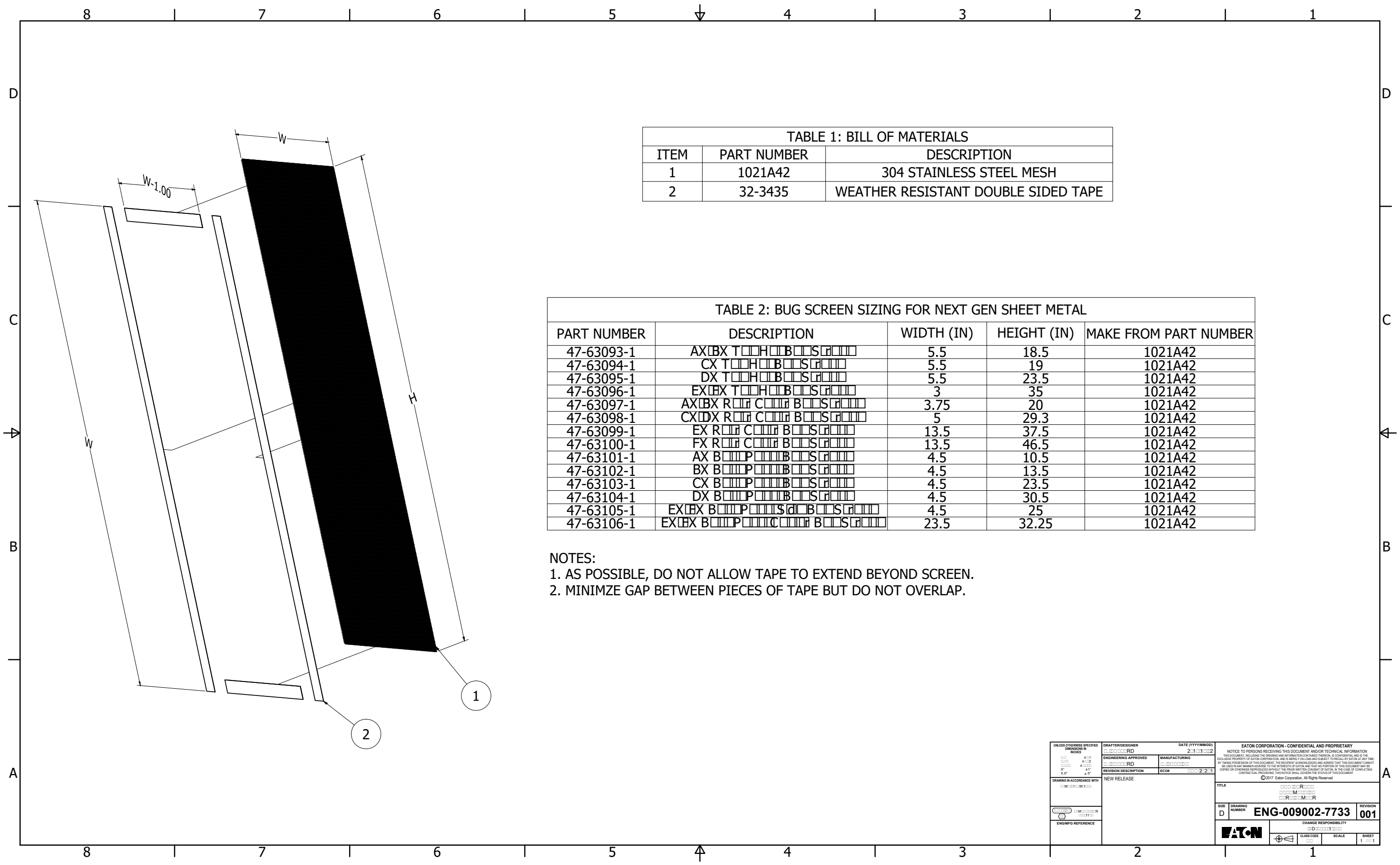
GO/NEG-Alt-Date: SBS1237854-0004-7/16/2024	Job Name: Taunton WWTF Solids
Item Number: 004	Catalog Number: EGF0144D2E0DD00000+
	Designation: TSP-7201/2





UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES X.X .001 X.XX .002 X.XXX .005 X" .1" X.X" .5"	DRAFTER/DESIGNER N. BUZZARD	DATE (YYYYMMDD) 2017/07/31	EATON CORPORATION - CONFIDENTIAL AND PROPRIETARY NOTICE TO PERSONS RECEIVING THIS DOCUMENT AND/OR TECHNICAL INFORMATION THIS DOCUMENT INCLUDING THE DRAWING AND INFORMATION CONTAINED HEREIN IS CONFIDENTIAL AND IS THE EXCLUSIVE PROPERTY OF EATON CORPORATION AND IS HEREBY ON LOAN AND SUBJECT TO RECALL BY EATON AT ANY TIME. BY TAKING POSSESSION OF THIS DOCUMENT THE RECIPIENT ACKNOWLEDGES AND AGREES THAT THIS DOCUMENT CANNOT BE USED IN ANY MANNER ADVERSE TO THE INTERESTS OF EATON AND THAT NO PORTION OF THIS DOCUMENT MAY BE COPIED OR OTHERWISE REPRODUCED WITHOUT THE PRIOR WRITTEN CONSENT OF EATON IN THE CASE OF CONTRACTING CONTRACTUAL PROVISIONS, THIS NOTICE SHALL GOVERN THE STATUS OF THIS DOCUMENT. © 2017 Eaton Corporation. All Rights Reserved.
	ENGINEERING APPROVED N. BUZZARD	MANUFACTURING H. FASKING	
DRAWING IN ACCORDANCE WITH ASME Y14.5M-1994	REVISION DESCRIPTION ECCM ECCO-25261		TITLE NEXT GENERATION ENCLOSED CX ENCLOSURE BUG SCREEN PLACEMENT
SYMBOLS PER 458-1143			SIZE D
ENG/MPG REFERENCE			NUMBER 10-10813
			REVISION 001
			CHANGE RESPONSIBILITY ICD-P050-1-ETG
			CLASS CODE NA
			SCALE NA
			SHEET 1 OF 1

GO/NEG-Alt-Date: SBS1237854-0004-7/16/2024	Job Name: Taunton WWTF Solids
Item Number: 004	Catalog Number: EGF0144D2E0DD00000+
	Designation: TSP-7201/2



**TABLE 1: BILL OF MATERIALS**

ITEM	PART NUMBER	DESCRIPTION
1	1021A42	304 STAINLESS STEEL MESH
2	32-3435	WEATHER RESISTANT DOUBLE SIDED TAPE

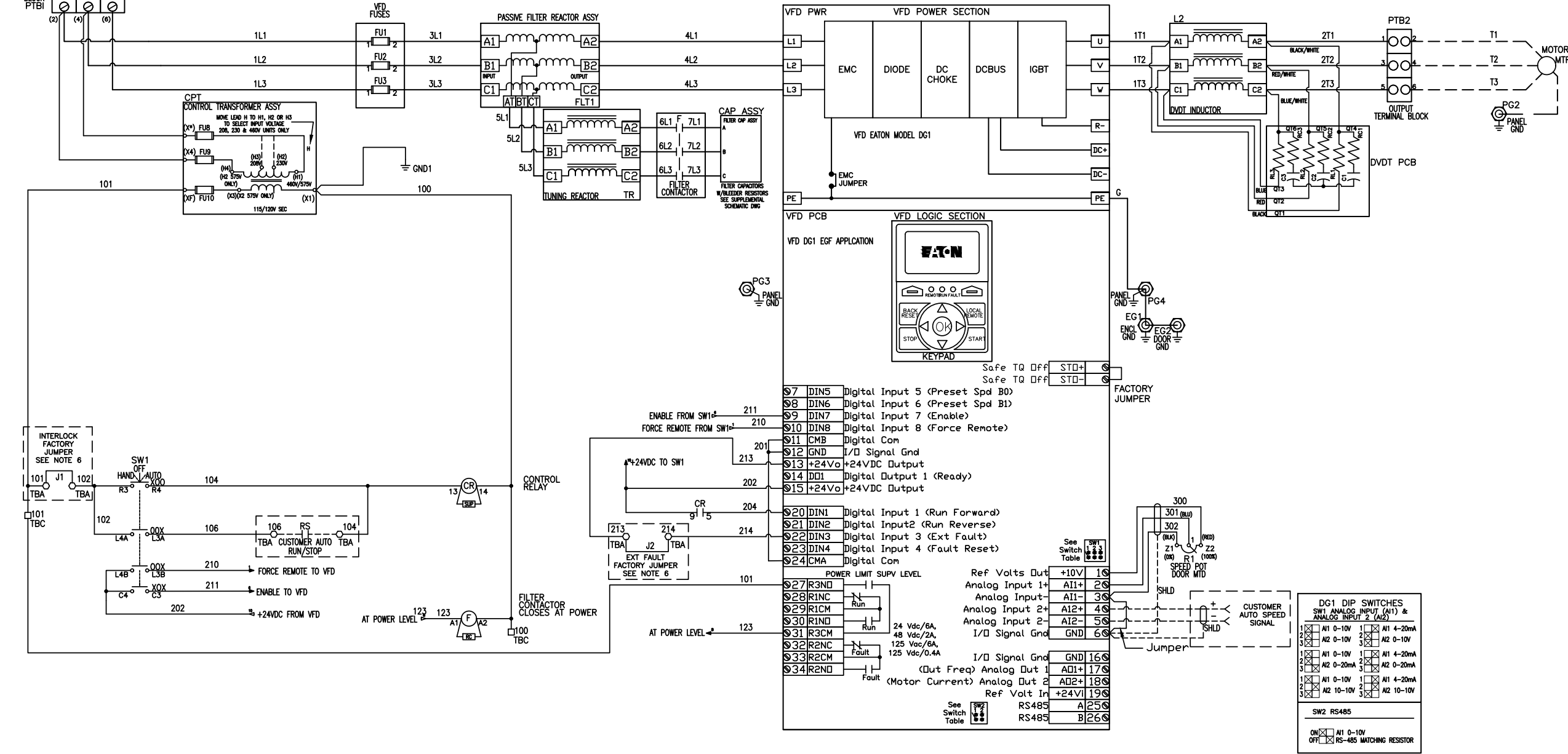
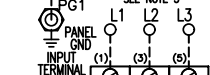
**TABLE 2: BUG SCREEN SIZING FOR NEXT GEN SHEET METAL**

PART NUMBER	DESCRIPTION	WIDTH (IN)	HEIGHT (IN)	MAKE FROM PART NUMBER
47-63093-1	AX BX T H B S	5.5	18.5	1021A42
47-63094-1	CX T H B S	5.5	19	1021A42
47-63095-1	DX T H B S	5.5	23.5	1021A42
47-63096-1	EX BX T H B S	3	35	1021A42
47-63097-1	AX BX R C B S	3.75	20	1021A42
47-63098-1	CX DX R C B S	5	29.3	1021A42
47-63099-1	EX R C B S	13.5	37.5	1021A42
47-63100-1	FX R C B S	13.5	46.5	1021A42
47-63101-1	AX B P B S	4.5	10.5	1021A42
47-63102-1	BX B P B S	4.5	13.5	1021A42
47-63103-1	CX B P B S	4.5	23.5	1021A42
47-63104-1	DX B P B S	4.5	30.5	1021A42
47-63105-1	EX BX B P B S	4.5	25	1021A42
47-63106-1	EX BX B P C B S	23.5	32.25	1021A42

- NOTES:**
1. AS POSSIBLE, DO NOT ALLOW TAPE TO EXTEND BEYOND SCREEN.
  2. MINIMIZE GAP BETWEEN PIECES OF TAPE BUT DO NOT OVERLAP.

UNLESS OTHERWISE SPECIFIED DIMENSIONS 1/8" 1/16" 3/32" 1/4" 1/2" 3/4" 1" 1 1/2" 2" 3" 4" 6" 8" 12"	DRAWN BY: [ ]	DATE (YYYYMMDD): 2-11-22	EATON CORPORATION - CONFIDENTIAL AND PROPRIETARY NOTICE TO PERSONS RECEIVING THIS DOCUMENT AND/OR TECHNICAL INFORMATION: THIS DOCUMENT, INCLUDING THE DRAWINGS AND ANY OTHER INFORMATION THEREON, IS CONFIDENTIAL AND IS THE PROPERTY OF EATON CORPORATION. IT IS TO BE KEPT IN CONFIDENTIALITY AND IS NOT TO BE REPRODUCED, COPIED, OR DISCLOSED TO ANY OTHER PARTY WITHOUT THE WRITTEN CONSENT OF EATON CORPORATION. THIS NOTICE SHALL COVER THE ENTIRETY OF THIS DOCUMENT.
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DRAWING IN ACCORDANCE WITH: [ ]	REVISION DESCRIPTION: [ ]	ECOM: [ ]	TITLE: [ ] DRAWING NUMBER: <b>ENG-009002-7733</b> REVISION: <b>001</b>
ENOMP REFERENCE: [ ]	NEW RELEASE		
EATON		CLASS CODE: [ ]	SCALE: [ ] SHEET: 1 of 1

**INCOMING POWER**



- NOTES
- 1. THIS EQUIPMENT MUST BE INSTALLED IN COMPLIANCE WITH THE NATIONAL ELECTRIC CODE AND ALL APPLICABLE STATE AND LOCAL CODES.
- 2. USE MULTIPLE CONDUITS TO SEPARATE CONTROL WIRES FROM INCOMING LINES AND OTHER POWER WIRING. DO NOT RUN LOGIC WIRING IN SAME CONDUIT AS CONTROL AND POWER WIRING.
- 3. REFER TO ENCLOSURE NAMEPLATE FOR INPUT/OUTPUT VOLTAGE AND CURRENT RATINGS.
- 4. CONNECT MOTOR FOR PROPER OUTPUT VOLTAGE PER MOTOR NAMEPLATE.
- 5. GROUND SYSTEM ON STUDS PROVIDED: PG1 & PG2.
- 6. REMOVAL OF INTERLOCK JUMPERS MAY NOT PREVENT MOTOR OPERATION IN ALL MODES—CONSULT FACTORY FOR PROPER OPERATION.

- TBA TERMINAL BLOCK FOR FIELD CONNECTIONS
- TBC TERMINAL BLOCK FOR FACTORY CONNECTIONS
- ◇ DIRECT COMPONENT TERMINAL FOR FIELD CONNECTIONS

7	DIN5	Digital Input 5 (Preset Spd B0)
8	DIN6	Digital Input 6 (Preset Spd B1)
9	DIN7	Digital Input 7 (Enable)
10	DIN8	Digital Input 8 (Force Remote)
11	CMB	Digital Com
12	GND	I/O Signal Gnd
13	+24Vdc	+24VDC Output
14	DO1	Digital Output 1 (Ready)
15	+24Vdc	+24VDC Output
20	DIN1	Digital Input 1 (Run Forward)
21	DIN2	Digital Input 2 (Run Reverse)
22	DIN3	Digital Input 3 (Ext Fault)
23	DIN4	Digital Input 4 (Fault Reset)
24	CMA	Digital Com
27	R3ND	POWER LIMIT SUPV LEVEL
28	R1NC	Run
29	R1CM	Run
30	R1ND	Run
31	R3CM	Run
32	R2NC	Fault
33	R2CM	Fault
34	R2ND	Fault

Ref Volts Out	+10V	16
Analog Input 1+	A11+	26
Analog Input-	A11-	36
Analog Input 2+	A12+	46
Analog Input 2-	A12-	56
I/O Signal Gnd	GND	66
I/O Signal Gnd	GND	166
(Out Freq) Analog Out 1	A01+	176
(Motor Current) Analog Out 2	A02+	186
Ref Volt In	+24Vdc	196
	RS485	A256
	RS485	B266

DG1 DIP SWITCHES			
SW1 ANALOG INPUT (A11) & ANALOG INPUT 2 (A12)			
1	A1 0-10V	1	A1 4-20mA
2	A2 0-10V	2	A2 0-10V
3	A2 0-20mA	3	A2 0-20mA
1	A1 0-10V	1	A1 4-20mA
2	A2 0-10V	2	A2 0-20mA
3	A2 0-20mA	3	A2 10-10V

SW2 RS485

ON [ ] A1 0-10V

OFF [ ] RS-485 MATCHING RESISTOR

NOTE: UNIT MAY HAVE SUPPLEMENTAL DRAWINGS FOR WIRING, PROGRAMMING AND OTHER DETAILS. REFER TO RATING NAMEPLATE FOR NUMBERS.

UNLESS OTHERWISE SPECIFIED, DIMENSIONS IN INCHES.

ENGINEERING APPROVED: \_\_\_\_\_ DATE: 2-22-13

MANUFACTURING: \_\_\_\_\_

REVISION DESCRIPTION: \_\_\_\_\_

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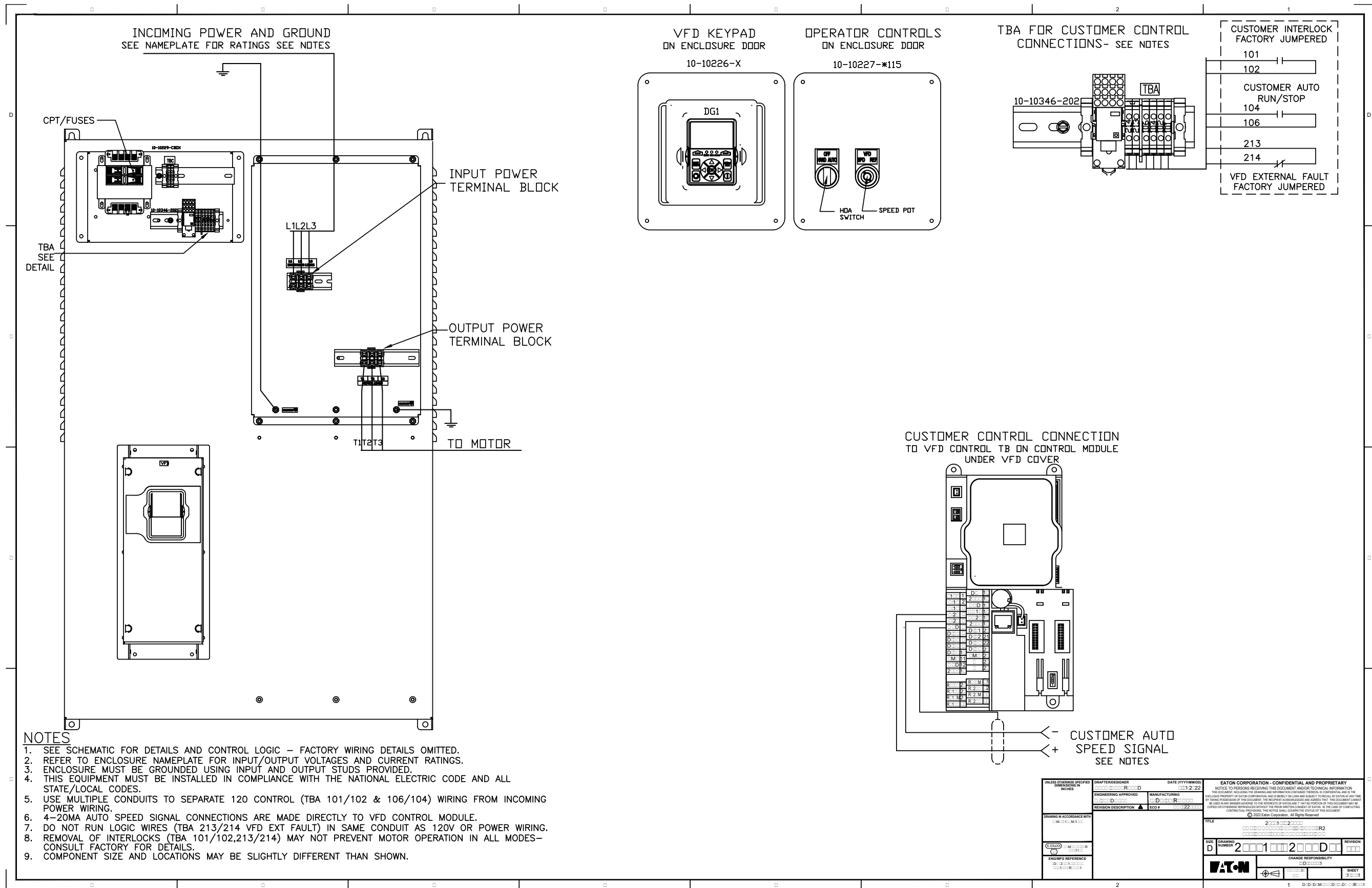
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2-22-13

2011 DD00

CHANGE RESPONSIBILITY

SHEET 3 OF 3



GO/NEG-Alt-Date: SBS1237854-0004-7/16/2024	Job Name: Taunton WWTF Solids
Item Number: 004	Catalog Number: EGF0144D2E0DD00000+
	Designation: TSP-7201/2

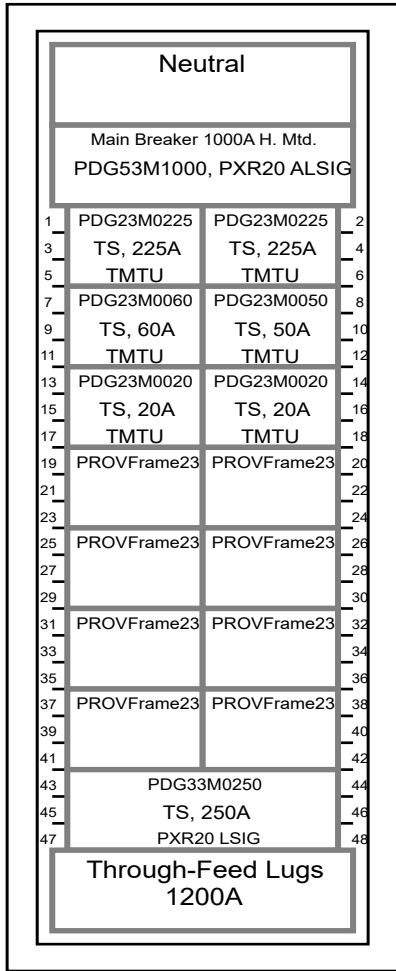
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ENGINO REFERENCE [Blank]	REVISION DESCRIPTION: [Blank]	ECO#: [Blank]	SIZE: [Blank]
			DRAWING NUMBER: 20001002000D
			REVISION: [Blank]
			CHANGE RESPONSIBILITY: [Blank]
			SHEET: 3

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**General Information**

**(Section 1 of 1)**

**Service Voltage:** 480Y/277V 3Ph 4W  
**Bus Rating & Type:** 1200A Copper  
**Ground Bar:** Std. Bolted Aluminum, Al or Cu cable  
**S.C. Rating:** 65k A.I.C. Fully Rated  
**Enclosure:** Type 1  
**Neutral Rating:** 1200A

**Main Device Type:** Main Breaker - Top Cable Entry  
**Main Terminals:** Mechanical - (4) 4/0-500 kcmil (Cu/Al)  
**Neutral Terminals:** Mechanical - (4) #2-500 kcmil (Cu/Al)  
**Through-Feed Lugs:** Mechanical - (4) #2-500 kcmil (Cu/Al)  
**Box Catalog No.:** BX3690P  
**Trim:** Standard Covers  
 Surface Mounted

**Box Dimensions:** 90.00" [2286.0mm]H x 36.00" [914.4mm]W x 10.4" [264.2mm]D  
**Min. Gutter Size:** Top = 10.625" [269.9mm] Bottom = 10.625" [269.9mm]  
 Left = 6" [152.4mm] Right = 8" [203.2mm]

**Panel ID Nameplate:** (1) 7DP1 S1  
**Type:** Plastic, adhesive-backed (2) 480Y/277V 3Ph 4W  
**Color:** White with Black Letters (3)

**UL**

Circuit Directory: Plastic Sleeve with Card  
 Painted Box: ANSI 61  
 Main Circuit Breaker Trip Type: PXR20 Electronic Trip Unit.  
 Seismic Label (IBC/CBC Seismic Qualified).  
 Heat Loss - Watts (Est.) = 816  
 Verify neutral terminal provisions and quantity of branch devices.  
 Wire shall be based on the ampacity of 75°C rated conductors unless otherwise indicated.

**Device Modifications:**

Ref # Description

**Branch Devices**

Qty	Poles	Trip	Frame	Amps	kAIC
1	3	250	Frame 3	400	65
2	3	225	Frame 2	225	65
1	3	60	Frame 2	100	65
1	3	50	Frame 2	100	65
2	3	20	Frame 2	100	65
8	3		PROVFrame23		

**Main Devices**

Qty	Poles	Trip	Frame	Amps	kAIC
1	3	1000	Frame 5	1200	65

**Notes:**

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PREPARED BY SCOTT ARNOLD	DATE 7/16/2024	<b>Eaton</b>	
APPROVED BY	DATE	JOB NAME Taunton WWTF Solids	DESIGNATION 7DP1 S1
VERSION 1.0.0.46	TYPE PRL4X	DRAWING TYPE Final	
NEG-ALT Number D7580421X1K1-0004	REVISION 0	DWG SIZE A	G.O. SBS1237854
		ITEM 005I	SHEET 1 of 3

## Pow-R-Line4X Device Specifications

Ckt #s	Nameplate	Device	Trip	Terminal	Modifications
Main		PDG53M1000	1000	(4) 4/0-500 kcmil (Cu/Al)	PXR20 Electronic Trip Unit w/ LSIG + ARMS Trip Unit Amps, 1200A
Subfeed		1200A-TF-LUGS		(4) #2-500 kcmil (Cu/Al)	
1,3,5		PDG23M0225	225	(1) #4-4/0 (Cu/Al)	
2,4,6		PDG23M0225	225	(1) #4-4/0 (Cu/Al)	
7,9,11		PDG23M0060	60	(1) #4-1/0 (Cu/Al)	
8,10,12		PDG23M0050	50	(1) #4-1/0 (Cu/Al)	
13,15,17		PDG23M0020	20	(1) #14-1/0 (Cu/Al)	
14,16,18		PDG23M0020	20	(1) #14-1/0 (Cu/Al)	
19,21,23		PROVFrame23	225	None Available	
20,22,24		PROVFrame23	225	None Available	
25,27,29		PROVFrame23	225	None Available	
26,28,30		PROVFrame23	225	None Available	
31,33,35		PROVFrame23	225	None Available	
32,34,36		PROVFrame23	225	None Available	

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PREPARED BY SCOTT ARNOLD	DATE 7/16/2024	<b>Eaton</b>	
APPROVED BY	DATE	JOB NAME Taunton WWTF Solids	DESIGNATION 7DP1 S1
VERSION 1.0.0.46	TYPE PRL4X	DRAWING TYPE Final	
NEG-ALT Number D7580421X1K1-0004	REVISION 0	DWG SIZE A	G.O. SBS1237854
		ITEM 005I	SHEET 2 of 3

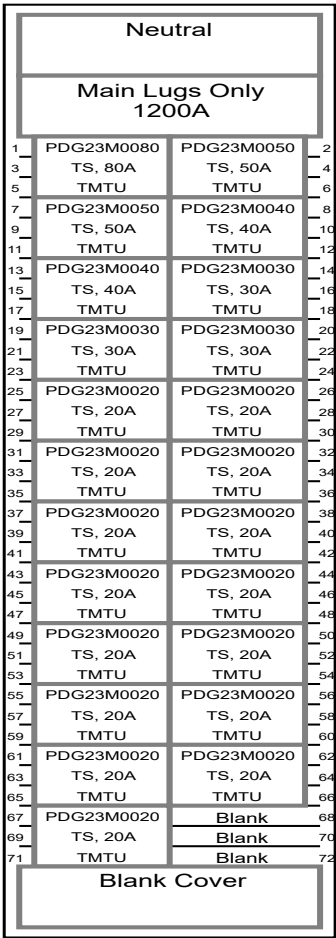


## Pow-R-Line4X Device Specifications

Ckt #s	Nameplate	Device	Trip	Terminal	Modifications
37,39,41		PROVFrame23	225	None Available	
38,40,42		PROVFrame23	225	None Available	
43,44,45 46,47,48		PDG33M0250	250	(1) 2/0-500 kcmil (Cu/Al)	PXR20 Electronic Trip Unit Trip Unit Amps, 400A

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VERSION 1.0.0.46	TYPE PRL4X	DRAWING TYPE Final		
NEG-ALT Number D7580421X1K1-0004	REVISION 0	DWG SIZE A	G.O. SBS1237854	ITEM 005I
				SHEET 3 of 3



**General Information**

**(Section 1 of 1)**

**Service Voltage:** 480Y/277V 3Ph 4W  
**Bus Rating & Type:** 1200A Copper  
**Ground Bar:** Std. Bolted Aluminum, Al or Cu cable  
**S.C. Rating:** 65k A.I.C. Fully Rated

**Enclosure:** Type 1  
**Neutral Rating:** 1200A

**Main Device Type:** Main Lugs Only - Top Cable Entry  
**Main Terminals:** Mechanical - (4) #2-500 kcmil (Cu/Al)  
**Neutral Terminals:** Mechanical - (4) #2-500 kcmil (Cu/Al)  
**Box Catalog No.:** BX3690P  
**Trim:** Standard Covers  
 Surface Mounted

**Box Dimensions:** 90.00" [2286.0mm]H x 36.00" [914.4mm]W x 10.4" [264.2mm]D  
**Min. Gutter Size:** Top = 10.625" [269.9mm] Bottom = 10.625" [269.9mm]  
 Left = 6" [152.4mm] Right = 8" [203.2mm]

**Panel ID Nameplate:** (1) 7DP1 S2  
**Type:** Plastic, adhesive-backed (2) 480Y/277V 3Ph 4W  
**Color:** White with Black Letters (3)

**UL**

Circuit Directory: Plastic Sleeve with Card  
 Painted Box: ANSI 61  
 Seismic Label (IBC/CBC Seismic Qualified).  
 Heat Loss - Watts (Est.) = 816  
 Verify neutral terminal provisions and quantity of branch devices.  
 Wire shall be based on the ampacity of 75°C rated conductors unless otherwise indicated.

**Device Modifications:**

Ref # Description

**Branch Devices**

Qty	Poles	Trip	Frame	Amps	kAIC
15	3	20	Frame 2	100	65
3	3	30	Frame 2	100	65
1	3	80	Frame 2	100	65
2	3	40	Frame 2	100	65
2	3	50	Frame 2	100	65

**Notes:**

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PREPARED BY SCOTT ARNOLD	DATE 7/16/2024	<b>Eaton</b>		
APPROVED BY	DATE	JOB NAME Taunton WWTF Solids	DESIGNATION 7DP1 S2	
VERSION 1.0.0.44	TYPE PRL4X	DRAWING TYPE Final		
NEG-ALT Number D7580421X1K1-0004	REVISION 0	DWG SIZE A	G.O. SBS1237854	ITEM 006I
				SHEET 1 of 3

## Pow-R-Line4X Device Specifications

Ckt #s	Nameplate	Device	Trip	Terminal	Modifications
Main		1200A-MLO		(4) #2-500 kcmil (Cu/Al)	
1,3,5		PDG23M0080	80	(1) #4-1/0 (Cu/Al)	
2,4,6		PDG23M0050	50	(1) #4-1/0 (Cu/Al)	
7,9,11		PDG23M0050	50	(1) #4-1/0 (Cu/Al)	
8,10,12		PDG23M0040	40	(1) #4-1/0 (Cu/Al)	
13,15,17		PDG23M0040	40	(1) #4-1/0 (Cu/Al)	
14,16,18		PDG23M0030	30	(1) #4-1/0 (Cu/Al)	
19,21,23		PDG23M0030	30	(1) #4-1/0 (Cu/Al)	
20,22,24		PDG23M0030	30	(1) #4-1/0 (Cu/Al)	
25,27,29		PDG23M0020	20	(1) #4-1/0 (Cu/Al)	
26,28,30		PDG23M0020	20	(1) #4-1/0 (Cu/Al)	
31,33,35		PDG23M0020	20	(1) #4-1/0 (Cu/Al)	
32,34,36		PDG23M0020	20	(1) #4-1/0 (Cu/Al)	
37,39,41		PDG23M0020	20	(1) #4-1/0 (Cu/Al)	

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VERSION 1.0.0.44	TYPE PRL4X	DRAWING TYPE Final		
NEG-ALT Number D7580421X1K1-0004	REVISION 0	DWG SIZE A	G.O. SBS1237854	ITEM 006I
				SHEET 2 of 3

## Pow-R-Line4X Device Specifications

Ckt #s	Nameplate	Device	Trip	Terminal	Modifications
38,40,42		PDG23M0020	20	(1) #4-1/0 (Cu/Al)	
43,45,47		PDG23M0020	20	(1) #4-1/0 (Cu/Al)	
44,46,48		PDG23M0020	20	(1) #4-1/0 (Cu/Al)	
49,51,53		PDG23M0020	20	(1) #4-1/0 (Cu/Al)	
50,52,54		PDG23M0020	20	(1) #4-1/0 (Cu/Al)	
55,57,59		PDG23M0020	20	(1) #4-1/0 (Cu/Al)	
56,58,60		PDG23M0020	20	(1) #4-1/0 (Cu/Al)	
61,63,65		PDG23M0020	20	(1) #4-1/0 (Cu/Al)	
62,64,66		PDG23M0020	20	(1) #4-1/0 (Cu/Al)	
67,69,71		PDG23M0020	20	(1) #4-1/0 (Cu/Al)	

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APPROVED BY	DATE	JOB NAME Taunton WWTF Solids	DESIGNATION 7DP1 S2
VERSION 1.0.0.44	TYPE PRL4X	DRAWING TYPE Final	
NEG-ALT Number D7580421X1K1-0004	REVISION 0	DWG SIZE A	G.O. SBS1237854
		ITEM 006I	SHEET 3 of 3

Main Breaker 150A V. Mtd.  
PDD23F0150, TMTU

1	BAB3050H	BAB1020	2
3		BAB1020	4
5		BAB1020	6
7	BAB1020	BAB1020	8
9	BAB1020	BAB1020	10
11	BAB1020	BAB1020	12
13	BAB1020	BAB1020	14
15	BAB1020	BAB1020	16
17	BAB1020	BAB1020	18
19	BAB1020	BAB1020	20
21	BAB1020	BAB1020	22
23	BAB1020	BAB1020	24
25	BAB1020	BAB1020	26
27	BAB1020	BAB1020	28
29	BAB1020	BAB1020	30

**Bus Support**

31	BAB1020	BAB1020	32
33	BAB1020	BAB1020	34
35	BAB1020	BAB1020	36
37	BAB1020	BAB1020	38
39	BAB1020	BAB1020	40
41	BAB1020	BAB1020	42
43	BAB1020	BAB1020	44
45	BAB1020	BAB1020	46
47	BAB1020	BAB1020	48
49	BAB1020	BAB1020	50
51	BAB1020	BAB1020	52
53	BAB1020	BAB2020	54
55	QBGFT1020		56
57	QBGFT1020	QBGFT1020	58
59	BAB1020	BAB1020	60

Blank Cover  
4 inches

**General Information**

**(Section 1 of 1)**

**Service Voltage:** 208Y/120V 3Ph 4W  
**Enclosure:** Type 12  
**Bus Rating & Type:** 225A Copper  
**Neutral Rating:** 225A  
**Ground Bar:** Std. Bolted Aluminum, Al or Cu cable  
**S.C. Rating:** 10k A.I.C. Fully Rated

**Main Device Type:** Main Breaker - Top Cable Entry  
**Main Terminals:** Mechanical - (1) #14-4/0 (Cu/Al)  
**Neutral Terminals:** Mechanical - (1) #6-300 kcmil (Cu/Al)  
**Box Catalog No.:** LWPQ2060  
**Trim:** Standard Trim (Includes Trim)  
  
Surface Mounted

**Box Dimensions:** 60.00" [1524.0mm]H x 20.00" [508.0mm]W x 6.5" [165.1mm]D  
**Min. Gutter Size:** Top = 5.5" [139.7mm] Bottom = 5.5" [139.7mm]  
Left = 6.0" [152.4mm] Right = 6.0" [152.4mm]

**Panel ID Nameplate:** (1) 7LP1  
**Type:** Plastic, adhesive-backed (2) 208Y/120V 3Ph 4W  
**Color:** White with Black Letters (3)

**UL** \*\*\*Non-Interchangeable Main Device\*\*\*

Trim Lock: T-Handle Lock Assembly  
Circuit Directory: Plastic Sleeve with Card  
Painted Box: ANSI 61  
Main Circuit Breaker Trip Type: Thermal-Magnetic.  
Seismic Label (IBC/CBC Seismic Qualified).  
Heat Loss - Watts (Est.) = 117  
Weight - lbs (Est.) = 230  
Wire shall be based on the ampacity of 75°C rated conductors unless otherwise indicated.

**Device Modifications:**  
Ref # Description

<b>Branch Devices</b>						
Qty	Poles	Trip	Frame	Amps	kAIC	
52	1	20	BAB	100	10	
1	3	50	BAB-H	100	10	
1	2	20	BAB	100	10	
3	1	20	QBGFT	100	10	
<b>Main Devices</b>						
Qty	Poles	Trip	Frame	Amps	kAIC	
1	3	150	Frame 2	225	10	

**Notes:**

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PREPARED BY	DATE	<b>Eaton</b>			
SCOTT ARNOLD	7/16/2024	JOB NAME	Taunton WWTF Solids		
APPROVED BY	DATE	DESIGNATION	7LP1		
VERSION	TYPE	DRAWING TYPE			
1.0.0.46	PRL1X	Final			
NEG-ALT Number	REVISION	DWG SIZE	G.O.	ITEM	SHEET
D7580421X1K1-0004	0	A	SBS1237854	007I	1 of 1

**EATON**

*Powering Business Worldwide*

# Panelboard seismic application guidelines

Equipment representing the products listed below were subjected to seismic testing in accordance with the 2012 International Building Code (IBC) and the 2013 California Building Code (CBC). The results of these tests exceeded the requirements as stated within the IBC and CBC and demonstrated the ability to function after the test. All installation guidelines covered in this document as well as the instruction and operations literature provided with the equipment must be followed to ensure installation suitable for a seismic application.

Certificates for various types of distribution and control equipment along with an application paper, *“Earthquake Requirements and Seismic Capabilities for Eaton’s Electrical Distribution and Control Equipment”* can be found at [www.eaton.com/seismic](http://www.eaton.com/seismic).

## Mounting surface and mounting requirements

Proper mounting of the equipment is the single most important factor in withstanding a seismic event. The mounting surface must be designed to withstand the reaction loads imposed on it by the equipment during a seismic event. The mounting bolts, quantity and torque values contained in **Table 1** represent the mounting characteristics for the specimens tested. The anchoring system should be put in place prior to equipment installation to reduce effort associated with anchoring. Wall plan drawings provided for the specific product should be utilized to identify anchoring locations.

**Table 1. Equipment hardware and floor plan information (as tested)**

Panelboard type	Enclosure type	Bolt type and size	Torque	Bolt quantity	Wall plan drawing #
PRL1a, 1aF, 2a, 2aF, 3a, 3E and F-16	NEMA® 1	SAE grade 5, ½-13	60 lb ft	4	1A32158
PRL1a, 1aF, 2a, 2aF, 3a, 3E and F-16	NEMA 12/3R	SAE grade 5, ½-13	60 lb ft	4	1A84756
PRL1a-LX and 2a-LX	NEMA 1	SAE grade 5, ½-13	60 lb ft	4	1A32472
PRL4	NEMA 1	SAE grade 5, ½-13	60 lb ft	4	1A32157
PRL4	NEMA 12/3R	SAE grade 5, ½-13	60 lb ft	4	6589C50
PRL5P	NEMA 1	SAE grade 5, ½-13	60 lb ft	4	47-35168
PRL5P	NEMA 12/3R	SAE grade 5, ½-13	60 lb ft	4	CE24213



Powering Business Worldwide

## Displacement

Not applicable for wall-mounted equipment.

## Center of gravity

For seismic calculations, the following dimensions should be used to locate the center of gravity for the equipment.

**Table 2. Equipment center of gravity**

Axis	PRL1a, 1aF, 1a-LX, 2a, 2aF, 2a-LX, 3a, 3E and F-16	PRL 4 and 5P
Vertical	67 percent of overall enclosure height as taken from the bottom of the enclosure	67 percent of overall enclosure height as taken from the bottom of the enclosure
Left to right	Centerline of product	Centerline of product
Front to back	3 inches from rear mounting plane of enclosure	7 inches from rear mounting plane of enclosure

## Equipment weight

The maximum weight of the products is given below. For job-specific weights, see order-specific drawings.

**Table 3. Equipment weight**

Panelboard type	Panelboard height <=48" width <=20"	Panelboard height <=48" width >20"	Panelboard height >48" width <=20"	Panelboard height >48" width >20"
PRL1a, 2a and F-16	187 lbs.	218 lbs.	392 lbs.	424 lbs.
PRL1aF and 2aF	NA	252 lbs.	NA	457 lbs.
PRL1a-LX and 2a-LX	NA	NA	213 lbs.	NA
PRL3a and 3E	240 lbs.	271 lbs.	504 lbs.	535 lbs.
PRL4	NA	NA	NA	904 lbs.
PRL5P	NA	NA	NA	1,000 lbs.

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 United States  
 Eaton.com

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**ANSI/NEMA PB 1.1-2013**

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Panelboards Rated 600 Volts or Less*

*Published by*

**National Electrical Manufacturers Association**

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Rosslyn, Virginia 22209

[www.nema.org](http://www.nema.org)

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## Foreword

This publication is a guide of practical information containing instructions for the proper installation, operation, and maintenance of panelboards rated 600 volts or less.

These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency regarding installation, operation, or maintenance.

It is recommended that work described in this set of instructions be performed only by qualified personnel familiar with the construction and operation of panelboards and that such work be performed only after reading this complete set of instructions. For specific information not covered by these instructions, you are urged to contact the manufacturer of the panelboard directly.

In the preparation of this standards publication input of users and other interested parties has been sought and evaluated. Inquiries, comments, and proposed or recommended revisions should be submitted to the concerned NEMA product section by contacting the following: These recommendations will be reviewed periodically and updated as necessary.

Senior Technical Director, Operations  
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Rosslyn, Virginia 22209

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This standards publication was developed by the Panelboard and Distribution Board Product Group of the LVDE Section. Product Group approval of the standard does not necessarily imply that all Product Group members voted for its approval or participated in its development. At the time it was approved, the Product Group was composed of the following members:

Eaton Corporation.—Pittsburgh, PA  
GE Industrial Solutions—Plainville, CT  
Hubbell, Inc.—Orange, CT  
Milbank Manufacturing Company—Kansas City, MO  
Penn Panel & Box Company—Collingdale, PA  
Reliance Controls Corporation—Racine, WI  
Siemens Industry, Inc.—Norcross, GA  
Schneider Electric —Palatine, IL

## **Section 1**

### **SCOPE**

This publication covers single panelboards or groups of panel units suitable for assembly in the form of single panelboards, including buses, and with or without switches or automatic overload protective devices (fuses or circuit breakers), or both. These units are used in the distribution of electricity at 600 volts and less with:

- 1600—ampere mains or less
- 1200—ampere branch circuits or less

Specifically excluded are live-front panelboards, panelboards employing cast enclosures for special service conditions, and panelboards designed primarily for residential and light commercial service equipment.



## Section 2 REFERENCES

**National Fire Protection Association (NFPA)**  
Batterymarch Park  
Quincy, MA 02269

NFPA 70                      *National Electrical Code®*  
NFPA 70E                  *Standard for Electrical Safety in the Workplace*

**National Electrical Manufacturers Association (NEMA)**  
1300 North 17th Street, Suite 900  
Rosslyn, Virginia 22209

AB 4                      *Guidelines for Inspection and Preventative Maintenance of Molded Case Circuit  
Breakers Used in Commercial and Industrial Applications*

PB 2.2                    *Application Guide for Ground Fault Protective Devices for Equipment*

*Guidelines for Handling Water Damaged Electrical Products*





## Section 3 GENERAL

**WARNING—HAZARDOUS VOLTAGES IN ELECTRICAL EQUIPMENT CAN CAUSE SEVERE PERSONAL INJURY OR DEATH. UNLESS OTHERWISE SPECIFIED, INSPECTION AND MAINTENANCE SHOULD ONLY BE PERFORMED ON PANELBOARDS AND EQUIPMENT TO WHICH POWER HAS BEEN TURNED OFF, DISCONNECTED AND ELECTRICALLY ISOLATED SO THAT NO ACCIDENTAL CONTACT CAN BE MADE WITH ENERGIZED PARTS. FOLLOW ALL MANUFACTURER'S WARNINGS AND INSTRUCTIONS.**

Safety-related work practices, as described in NFPA 70E, should be followed at all times. All requirements of the *National Electrical Code®* NFPA 70 should be followed.

**CAUTION—HYDROCARBON SPRAY PROPELLANTS AND HYDROCARBON BASED SPRAYS OR COMPOUNDS WILL CAUSE DEGRADATION OF CERTAIN PLASTICS. CONTACT THE PANELBOARD MANUFACTURER BEFORE USING THESE PRODUCTS TO CLEAN, DRY, OR LUBRICATE COMPONENTS DURING INSTALLATION OR MAINTENANCE.**

### 3.1 SUCCESSFUL OPERATION OF PANELBOARDS

The successful operation of panelboards is dependent upon proper installation, operation, and maintenance. Neglecting fundamental installation and maintenance requirements may lead to personal injury, death, or damage to electrical equipment or other property.

### 3.2 QUALIFIED PERSONNEL

Installation, operation, and maintenance of panelboards should be conducted only by qualified personnel.

### 3.3 DEFINITION OF QUALIFIED PERSONNEL

For purposes of these guidelines, a qualified person is one who is familiar with the installation, construction, and operation of the equipment and the hazards involved. In addition, the person is:

#### 3.3.1 Requirements

Knowledgeable of the requirements of the *National Electrical Code®* and of all other applicable codes, laws, and standards.

#### 3.3.2 Established Safety Practices

Trained and authorized to test, energize, clear, ground, tag, and lockout circuits and equipment in accordance with established safety practices.

#### 3.3.3 Protective Equipment

Trained in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, and flash resistant clothing in accordance with established safety practices.

#### 3.3.4 First Aid

Trained in rendering first aid.

### **3.4 SUITABLE RATINGS**

Verify that all equipment being installed has ratings suitable for the installation.



## Section 4 INSTALLATION OF PANELBOARD CABINETS (BOXES)

### 4.1 INSTALLATION INSTRUCTIONS

Installation of the cabinet in a neat and workmanlike manner. Follow the manufacturer's installation instructions.

### 4.2 LOCATION IN BUILDING

Locate the cabinet so that it is readily accessible and not exposed to physical damage.

### 4.3 FLAMMABLE MATERIAL

Locate the cabinet well away from flammable material.

### 4.4 UNUSUAL SERVICE CONDITIONS

Do not locate the cabinet where it will be exposed to ambient temperatures above 40°C (104°F), corrosive or explosive fumes, dust, vapors, dripping or standing water, abnormal vibration, mechanical shock, high humidity, tilting, or unusual operating conditions, unless the cabinet/panelboard combination has been designed and so identified by the manufacturer for these conditions.

### 4.5 INDOOR DAMP LOCATIONS

Locate or shield the cabinet so as to prevent moisture and water from entering and accumulating therein. Mount the cabinet so that there is at least 1/4 inch of air space between the cabinet and the wall or other supporting surface.

### 4.6 WET LOCATIONS

Cabinets should be specifically approved for wet locations. Mount the cabinet so that there is at least 1/4 inch of air space between the cabinet and the wall or other supporting surface.

### 4.7 CLEARANCE FROM CEILING

Do not locate the cabinet against a non-fireproof ceiling; allow a space of 3 feet between the ceiling and cabinet unless an adequate fireproof shield is provided.

### 4.8 SPACE AROUND THE CABINET

When selecting a location, provide sufficient access and working space around the cabinet (see Section 110.26 of the *National Electrical Code*®). The width of the working space in front of the panelboard should be at least 30 inches, or the width of the cabinet, whichever is greater, and this space should not be used as storage. The working space should have adequate lighting and a minimum head room of 6 feet 6 inches.

### 4.9 MOUNTING OF CABINET

The cabinet should be reliably secured to the mounting surface. Do not depend on wooden plugs driven into holes in masonry, concrete, plaster, or similar materials. (See Section 110.13 of the *National Electrical Code*®.)

#### **4.10 FLUSH MOUNTING IN WALL**

In walls of concrete, tile, or other noncombustible material, install the cabinet so that its front edge will not set back more than 1/4 inch from the finished surface. In walls of wood or other combustible material, cabinets should be flush with or project beyond the finished surface. (See Section 312.3 of the *National Electrical Code*®.)

#### **4.11 UNUSED OPENINGS IN CABINET**

Effectively close unused openings in the cabinet to provide protection which is substantially equivalent to that afforded by the wall of the cabinet.

#### **4.12 GROUNDING OF PANELBOARD CABINETS**

Ground the cabinet as specified in Article 250 of the *National Electrical Code*®. When the cabinet contains service equipment, it is necessary to bond the cabinet to the grounded (neutral) service conductor.



## Section 5 INSTALLATION OF CONDUIT AND CONDUCTORS

### 5.1 CONDUITS INSTALLATION

Conduits should be installed so as to prevent moisture or water from entering and accumulating within the enclosure. Provision should be made to protect conductors from abrasion in accordance with Article 312 of the *National Electrical Code*®.

### 5.2 KNOCKOUTS REMOVAL

Knockouts should be removed as follows:

**IMPORTANT—Remove knockouts, ONE AT A TIME, alternating INWARD and OUTWARD.**

#### 5.2.1 First Step—Remove Center Knockout

Remove center knockout INWARD.

##### 5.2.1.1 Screwdriver Blade

Place screwdriver blade against point farthest from tie and strike INWARD (Figure 1). Bend back and forth to break tie.

#### 5.2.2 Next Step—Remove Rings

Remove rings ONE AT A TIME without straining remaining rings.

##### 5.2.2.1 Pry First Ring

Pry first ring OUTWARD with screwdriver midway between ties, using pliers flat against box under screwdriver (Figure 2). Bend ring sections OUTWARD with pliers, then back and forth to break ties (Figure 5-3).

##### 5.2.2.2 Second Ring

Remove second ring INWARD by striking screwdriver (with blade against point midway between ties) then breaking ring sections inward and back and forth to break ties.

### 5.3 NATIONAL ELECTRICAL CODE®, ARTICLE 300

Refer to the *National Electrical Code*®, Article 300 for proper wiring methods. See 6.7 for making proper connections.

### 5.4 CONDUCTOR LENGTH

Keep conductor length to a minimum within the wiring gutter. Excessive conductor length will result in additional heating and may result in overheating. However, conductors should be long enough to reach the terminal location in a manner that avoids strain on the terminal.

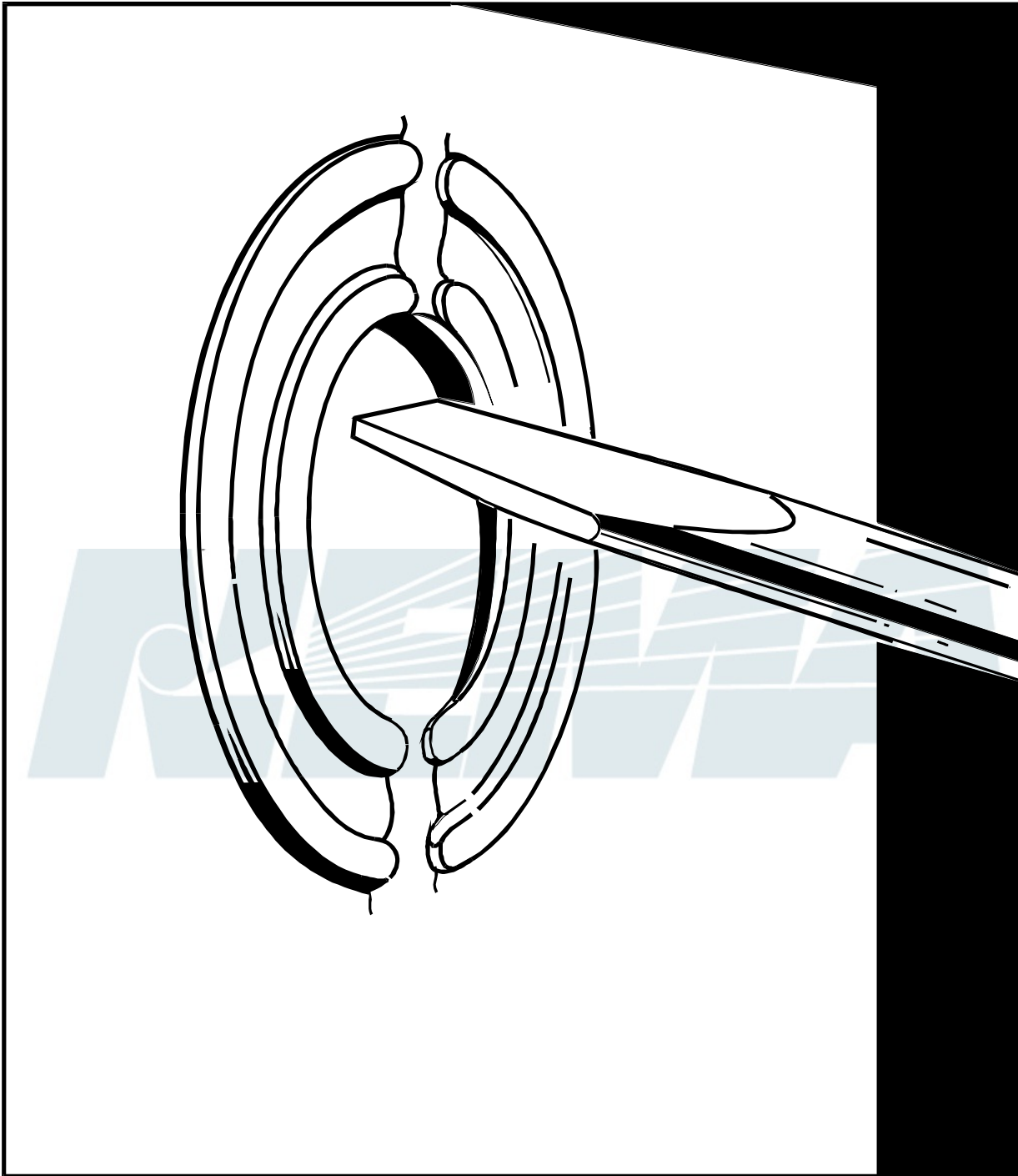
### 5.5 EXERCISE CARE

Exercise care to maintain the largest practical bending radius of conductors; otherwise the insulation may be damaged and terminal connections may become loosened. Deflection of conductors shall comply with *NEC*® Section 312.6.

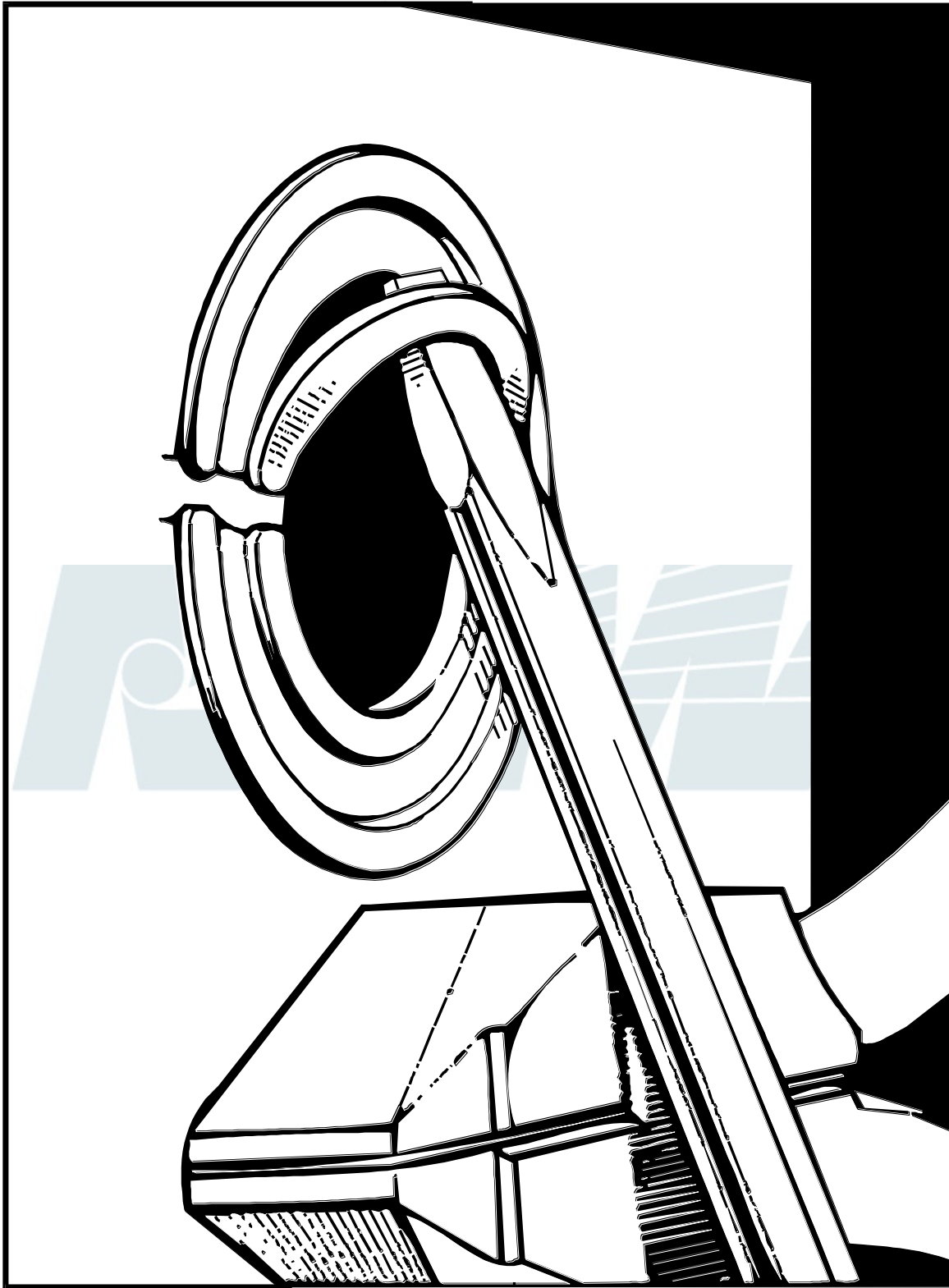
**5.6 NATIONAL ELECTRICAL CODE®, SECTION 725.136**

Refer to the *National Electrical Code®*, Section 725.136 for the separation requirements for conductors of Class 2 and Class 3 remote-control, signaling and power-limited circuits.



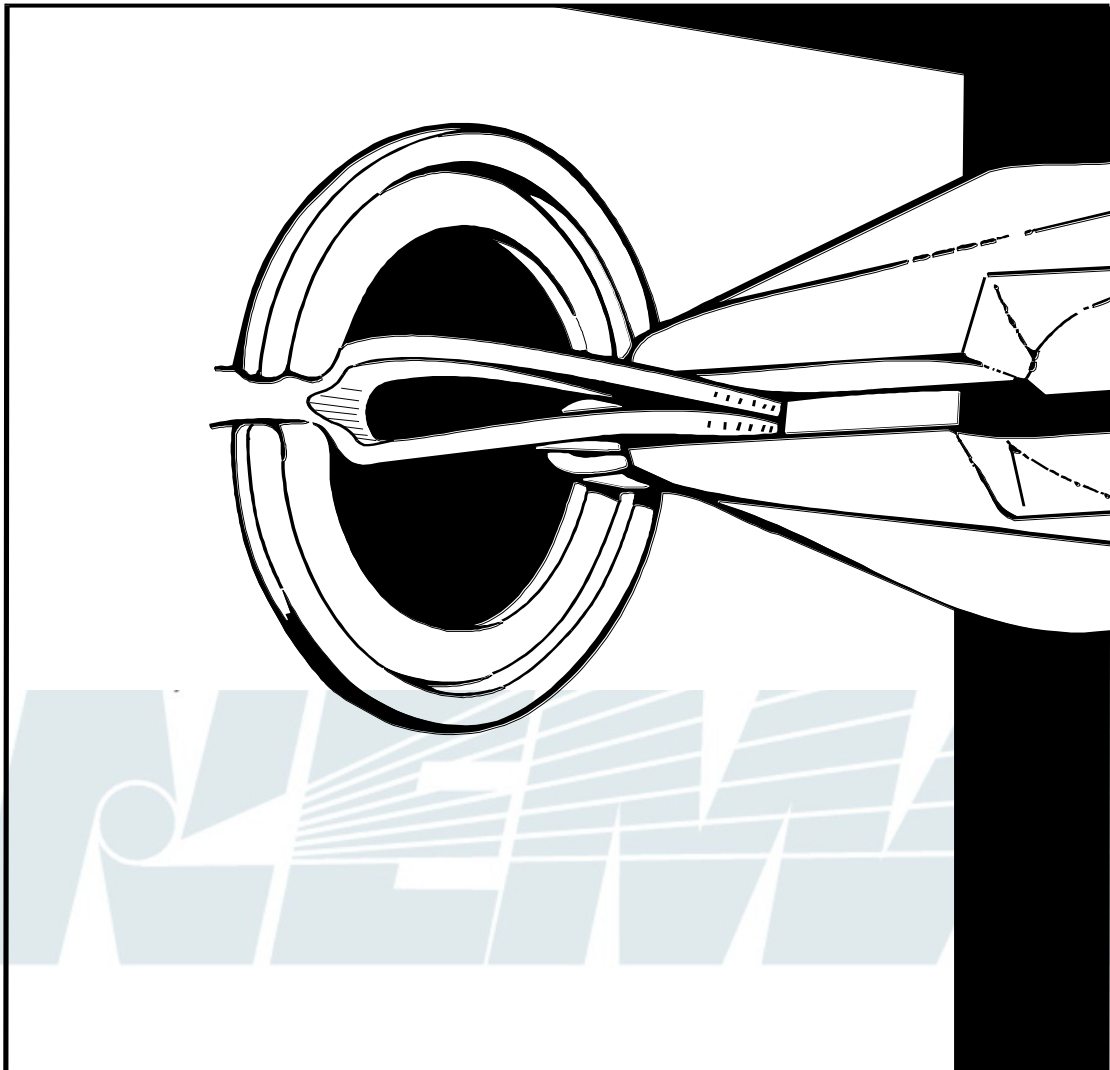


**Figure 5-1**  
**KNOCKOUT REMOVAL—STEP 1**



**Figure 5-2**  
**KNOCKOUT REMOVAL—STEP 2**





**Figure 5-3**  
**KNOCKOUT REMOVAL—STEP 3**

## Section 6 INSTALLATION OF PANELBOARD

### 6.1 PROPER STORAGE

Store the panelboard in a clean, dry place located so that mechanical damage from work personnel in the area is not likely to happen.

### 6.2 UNPACKING

Care should be exercised in unpacking the panelboard to prevent damage and loss of instruction materials and loose parts.

### 6.3 INSPECTION

Check for shipping damage and check to make sure that the panelboard is the correct one for installation in the cabinet.

### 6.4 CARE

Care should be taken to protect the panelboard internal parts from contamination during the installation process.

#### 6.4.1 Cleaning

Clean the cabinet of all foreign materials. If parts at connection points are spattered with cement, plaster, paint, or other foreign material, remove the foreign materials with great care to avoid damage to the plating.

**CAUTION—HYDROCARBON SPRAY PROPELLANTS AND HYDROCARBON BASED SPRAYS OR COMPOUNDS WILL CAUSE DEGRADATION OF CERTAIN PLASTICS. CONTACT THE PANELBOARD MANUFACTURER BEFORE USING THESE PRODUCTS TO CLEAN, DRY, OR LUBRICATE PANELBOARD COMPONENTS DURING INSTALLATION OR MAINTENANCE.**

### 6.5 MANUFACTURER'S INSTRUCTIONS

Carefully follow the manufacturer's instructions and labels.

### 6.6 INSTALLATION

#### 6.6.1 Alignment Devices

Adjust the alignment devices where provided.

#### 6.6.2 Panelboard

Install the panelboard, finalize its alignment, and tighten it securely in the cabinet.

#### 6.6.3 Flange of Deadfront Shield

Unless otherwise instructed by the manufacturer, adjust the panelboard so that the flange of the deadfront shield is no more than 3/16 inch from (1) the front of the cabinet for surface mounting or (2) the surrounding wall surfaces for flush mounting.

## **6.7 LINE AND BRANCH CONDUCTORS**

Connect Line and Branch Conductors

### **6.7.1 Conductors**

Use care in stripping insulation from conductors so as not to nick or ring the conductor. For aluminum, clean all oxide from the stripped portion and apply an antioxidant compound.

#### **6.7.1.1 Wiring Gutters**

Distribute and arrange conductors neatly in the wiring gutters. (See Section 5.)

#### **6.7.1.2 Types and Temperature Ratings**

Care should be exercised to ensure that the types and temperature ratings of conductors being installed in the panelboard are suitable for use with the terminals, which have been provided.

#### **6.7.1.3 Tighten All Terminals**

Use the manufacturer's torque values. (See 7.1).

## **6.8 PANELBOARD GROUNDING AND BONDING**

Ground the panelboard cabinet in accordance with 4.12. (See Section 408.40 of the *National Electrical Code*®.)

### **6.8.1 Equipment Grounding Conductors**

Where separate equipment grounding conductors are used, prepare equipment grounding conductors in accordance with 6.7.1 and connect them to the equipment grounding terminal bar. Check to be sure that the terminal bar is securely bonded to the cabinet or panelboard frame and that it is not connected to the neutral bar except at service equipment (as permitted in Section 250.28 of the *National Electrical Code*®) or at separately derived systems (as permitted in Section 250.30 of the *National Electrical Code*®).

NOTE—An equipment grounding terminal bar is not always required. For example, when a properly installed metallic raceway is used as the equipment grounding path or when the grounded conductor terminals (neutral bar) complies with the conditions of the last sentence of Section 408.40 of the *National Electrical Code*®.

## **6.9 PROPER TYPE OR CLASS AND RATING**

When installing circuit breakers or fuses, ensure that they are of the proper type or class and rating.

## **6.10 DEBRIS**

Clean the cabinet of all debris, which has accumulated during the panelboard installation. Ensure that all foreign materials, including cement, plaster and paint (overspray) are cleaned and removed. Remove all such materials with great care to avoid damage to conductors, plating, etc. (see 6.4.1).

## **6.11 STEPS IN SECTION 7**

If the job is complete, perform the steps in Section 7 and then install the cabinet front (see Section 8).

## **Section 7**

### **STEPS TO BE TAKEN BEFORE ENERGIZING**

#### **7.1 ACCESSIBLE ELECTRICAL CONNECTIONS**

Tighten all accessible electrical connections to the manufacturer's torque specifications. If such information is not provided with the equipment, consult the manufacturer.

#### **7.2 BLOCKS AND PACKING MATERIALS**

Make certain that all blocks and packing materials used for shipment have been removed from all component devices and the panelboard.

#### **7.3 SWITCHES, CIRCUIT BREAKERS, AND OTHER OPERATING MECHANISMS**

Manually exercise all switches, circuit breakers, and other operating mechanisms to make certain they operate freely. If devices with self-test function are installed, perform test and verify proper operation per the manufacturer's instructions.

Check the integrity of all electrical and mechanical interlocks and padlocking mechanisms. For key interlocked systems, assure that only the required number of keys are accessible to the operator.

#### **7.4 SHORT CIRCUITS AND GROUND FAULTS**

To make sure that the system is free from short circuits and ground faults, conduct an insulation resistance test phase to ground and phase to phase with the switches or circuit breakers in both the open and closed positions. If the resistance reads less than 1 megohm while testing with the branch circuit devices in the open position, the system may be unsafe and should be investigated. If after investigation and possible correction, low readings are still observed, the manufacturer should be contacted. Some electronic equipment (metering, SPD, etc.) may be damaged by this testing. Refer to the manufacturer's equipment markings for guidelines.

#### **7.5 GROUND FAULT PROTECTION SYSTEM**

Test the ground fault protection system (if furnished) in accordance with the manufacturer's instructions. See Section 230.95 of the *National Electrical Code*® and NEMA PB 2.2, *Application Guide for Ground Fault Protective Devices for Equipment*.

#### **7.6 ADJUSTABLE TIME CURRENT TRIP DEVICE SETTINGS**

Set any adjustable time current trip device settings to the proper values.

NOTE—Experience has indicated that damage from overcurrent can be reduced if the devices used for overload and short-circuit protection are set to operate instantaneously (that is, without intentional time delay) at 115 percent of the highest value of phase current which is likely to occur as the result of any anticipated motor starting or welding currents.

#### **7.7 GROUNDING CONNECTIONS**

Check to determine that all grounding connections are properly made. If the panelboard is used as service equipment, make certain that the neutral, if present, is properly bonded to the cabinet.

## 7.8 FOREIGN MATERIAL

Remove all foreign material from the panelboard and cabinet before installing the cabinet front. Make certain that all deadfront shields are properly aligned and tightened. Install the cabinet front in accordance with Section 8.



## **Section 8 INSTALLATION OF CABINET FRONT**

### **8.1 CABINET FRONT OR TRIM PACKAGE**

The cabinet front or trim package is designed to prevent damage to the front during shipment and handling.

### **8.2 UNPACKING**

Care should be used when unpacking and handling the cabinet front.

### **8.3 COVERS AND DOORS**

Install covers, close doors, and make certain that no conductors are pinched and that all enclosure parts are properly aligned and tightened. Hinged covers or doors must open a minimum of 90 degrees when installed.

### **8.4 TOUCH-UP**

A suitable paint or other corrosion-resistant finish should be applied to those places where the finish is damaged.

### **8.5 FRONT ALIGNMENT**

The cabinet front may be provided with an adjusting means to align it squarely with the building even though the cabinet may be slightly out of plumb with the building.

## **Section 9 ENERGIZING EQUIPMENT**

**WARNING—HAZARDOUS VOLTAGES IN ELECTRICAL EQUIPMENT CAN CAUSE SEVERE PERSONAL INJURY OR DEATH. ENERGIZING A PANELBOARD FOR THE FIRST TIME AFTER INITIAL INSTALLATION OR MAINTENANCE IS POTENTIALLY DANGEROUS.**

### **9.1 QUALIFIED PERSONNEL**

Only qualified personnel should energize equipment for the first time. If short circuit conditions caused by damage or poor installation practices have not been detected in the procedures specified in Section 7, serious personal injury and damage can occur when the power is turned on.

### **9.2 LOAD ON THE PANELBOARD**

There should be no load on the panelboard when it is energized. Turn off all of the downstream loads.

### **9.3 ENERGIZED IN SEQUENCE**

The equipment should be energized in sequence by starting at the source end of the system and working towards the load end. In other words, energize the main devices, then the feeder devices, and then the branch-circuit devices. Turn the devices on with a firm positive motion.

### **9.4 LOADS SUCH AS LIGHTING CIRCUITS, CONTACTORS, HEATERS, AND MOTORS**

After all main, feeder, and branch circuit devices have been closed, loads such as lighting circuits, contactors, heaters, and motors may be turned on.

## **Section 10 MAINTENANCE**

### **10.1 MAINTENANCE PROGRAM**

A maintenance program for panelboards should be conducted on a regularly scheduled basis in accordance with the following:

### **10.2 PANELBOARD WHICH HAS BEEN CARRYING ITS REGULAR LOAD FOR AT LEAST 3 HOURS**

A panelboard which has been carrying its regular load for at least 3 hours just prior to inspection should be field tested by feeling the deadfront surfaces of circuit breakers, switches, interior trims, doors, and enclosure sides with the palm of the hand. If the temperature of these surfaces does not permit you to maintain contact for at least 3 seconds, this may be an indication of trouble and investigation is necessary. Thermographic (infrared) scanning has become a useful method of investigating thermal performance.

**WARNING—HAZARDOUS VOLTAGES IN ELECTRICAL EQUIPMENT CAN CAUSE SEVERE PERSONAL INJURY OR DEATH. UNLESS OTHERWISE SPECIFIED, INSPECTION AND MAINTENANCE SHOULD ONLY BE PERFORMED ON PANELBOARDS TO WHICH POWER HAS BEEN TURNED OFF, DISCONNECTED AND ELECTRICALLY ISOLATED SO THAT NO ACCIDENTAL CONTACT CAN BE MADE WITH ENERGIZED PARTS. FOLLOW ALL MANUFACTURER'S WARNINGS AND INSTRUCTIONS.**

Safety related work practices, as described in NFPA 70E, should be followed at all times.

**CAUTION—HYDROCARBON SPRAY PROPELLANTS AND HYDROCARBON BASED SPRAYS OR COMPOUNDS WILL CAUSE DEGRADATION OF CERTAIN PLASTICS. CONTACT THE PANELBOARD MANUFACTURER BEFORE USING THESE PRODUCTS TO CLEAN, DRY, OR LUBRICATE PANELBOARD COMPONENTS DURING INSTALLATION OR MAINTENANCE.**

### **10.3 INSPECT PANELBOARD ONCE EACH YEAR**

Inspect the panelboard once each year or after any severe short circuit.

### **10.4 ACCUMULATION OF DUST AND DIRT**

If there is an accumulation of dust and dirt, clean out the panelboard by using a brush, vacuum cleaner, or clean lint-free rags. Avoid blowing dust into circuit breakers or other components. Do not use a blower or compressed air.

#### **10.4.1 Visible Electrical Joints and Terminals**

Carefully inspect all visible electrical joints and terminals in the bus and wiring system.

#### **10.4.2 Conductors and Connections**

Visually check all conductors and connections to be certain that they are clean and secure. Loose and/or contaminated connections increase electrical resistance which can cause overheating. Such overheating is indicated by discoloration or flaking of insulation and/or metal parts. Pitting or melting of connecting surfaces is a sign of arcing due to a loose or otherwise poor connection. Parts which show evidence of overheating or looseness should be cleaned and re-torqued or replaced if damaged. Tighten bolts and nuts at bus joints to manufacturer's torque specifications.



**CAUTION—DO NOT REMOVE PLATING FROM ALUMINUM PARTS IN JOINTS OR TERMINATIONS. DAMAGE TO PLATING CAN RESULT IN OVERHEATING. REPLACE DAMAGED ALUMINUM PARTS.**

#### **10.4.3 Fuse Clip Contact Pressure and Contact Means**

Examine fuse clip contact pressure and contact means. If there is any sign of overheating or looseness, follow the manufacturer's maintenance instructions or replace the fuse clips. Loose fuse clips can result in overheating.

#### **10.4.4 Plug Fuses**

Re-tighten plug fuses.

#### **10.4.5 Conditions Which Caused Overheating**

Be sure that all conditions which caused the overheating have been corrected.

### **10.5 PROPER AMPERE, VOLTAGE, AND INTERRUPTING RATINGS**

Check circuit breakers, switches, and fuses to ensure they have the proper ampere, voltage, and interrupting ratings. Ensure that non-current-limiting devices are not used as replacements for current-limiting devices. Never attempt to defeat rejection mechanisms which are provided to prevent the installation of the incorrect class of fuse.

#### **10.5.1 Mechanisms Free and in Proper Working Order**

Operate each switch or circuit breaker several times to ensure that all mechanisms are free and in proper working order. Replace as required. See NEMA AB-4 for maintenance of molded case circuit breakers.

### **10.6 OPERATION OF ALL MECHANICAL COMPONENTS**

Check the operation of all mechanical components. Replace as required.

#### **10.6.1 Switch Operating Mechanisms**

Exercise switch operating mechanisms and external operators for circuit breakers to determine that they operate freely to their full on and off positions.

#### **10.6.2 Integrity of Electrical and Mechanical Interlocks**

Check the integrity of all electrical and mechanical interlocks and padlocking mechanisms. For key interlocked systems, assure that only the required number of keys are accessible to the operator.

#### **10.6.3 Missing or Broken Parts**

Whenever practical, check all devices for missing or broken parts, proper spring tension, free movement, corrosion, dirt, and excessive wear.

#### **10.6.4 Manufacturer's Instructions**

Adjust, clean, and lubricate or replace parts according to the manufacturer's instructions.

##### **10.6.4.1 Clean Nonmetallic Light Grease or Oil**

Use *clean* nonmetallic light grease or oil as instructed.

##### **10.6.4.2 Molded Case Circuit Breakers**

Do *not* oil or grease parts of molded case circuit breakers.

#### **10.6.4.3 Clean, Light Grease**

If no instructions are given on the devices, sliding copper contacts, operating mechanisms, and interlocks may be lubricated with clean, light grease.

#### **10.6.4.4 Excess Lubrication**

Wipe off excess lubrication to avoid contamination.

**CAUTION—HYDROCARBON SPRAY PROPELLANTS AND HYDROCARBON BASED SPRAYS OR COMPOUNDS WILL CAUSE DEGRADATION OF CERTAIN PLASTICS. CONTACT THE PANELBOARD MANUFACTURER BEFORE USING THESE PRODUCTS TO CLEAN, DRY, OR LUBRICATE PANELBOARD COMPONENTS DURING INSTALLATION OR MAINTENANCE.**

#### **10.6.5 Accessible Copper Electrical Contacts, Blades, and Jaws**

Clean and dress readily accessible copper electrical contacts, blades, and jaws according to the manufacturer's instructions when inspection indicates the need.

### **10.7 DAMAGED INSULATING MATERIAL AND ASSEMBLIES**

Look for and replace damaged insulating material and assemblies where sealing compounds have deteriorated.

### **10.8 MOISTURE OR SIGNS OF PREVIOUS WETNESS OR DRIPPING**

Look for any moisture or signs of previous wetness or dripping inside the cabinet.

NOTE—Condensation in conduits or dripping from outside sources is one known cause of panelboard malfunction.

#### **10.8.1 Conduits Which Have Dripped Condensate**

Seal off any conduits which have dripped condensate, and provide means for further condensate to drain away from the panelboard.

#### **10.8.2 Cracks or Openings**

Seal off any cracks or openings which have allowed moisture to enter the enclosure. Eliminate the source of any dripping on the enclosure and any other source of moisture.

#### **10.8.3 Insulating Material Which is Damp or Wet**

Replace or thoroughly dry and clean any insulating material, which is damp or wet or shows an accumulation of deposited material from previous wettings.

#### **10.8.4 Component Devices Which Show Evidence of Moisture Damage**

Inspect all component devices. Replace any component device which shows evidence of moisture damage or has been subjected to water damage or flooding. Additional information may be found in the NEMA document "Guidelines for Handling Water Damaged Electrical Products."

### **10.9 BEFORE CLEANUP AND CORRECTIVE ACTION IS ATTEMPTED**

In the event of water damage, e.g., flooding or sprinkler discharge, the manufacturer should be consulted before clean up and corrective action is attempted.

## **10.10 SEVERE ELECTRICAL SHORT CIRCUIT**

If a severe electrical short circuit has occurred, the excessive currents may have resulted in structural component and/or bus and conductor damage due to mechanical distortion, thermal damage, metal deposits, or smoke. Examine all devices and bus supports for cracks or breakage. The manufacturer should be consulted before cleanup and correction is attempted.

## **10.11 GROUND FAULT PROTECTION SYSTEM**

Test the ground fault protection system (if furnished) in accordance with the manufacturer's instructions. See Section 230.95 of the *National Electrical Code®* and NEMA PB 2.2 *Application Guide for Ground Fault Protective Devices for Equipment*.

## **10.12 INSULATION RESISTANCE**

Check insulation resistance (see 7.4) under any of the following conditions:

### **10.12.1 Severe Short Circuit**

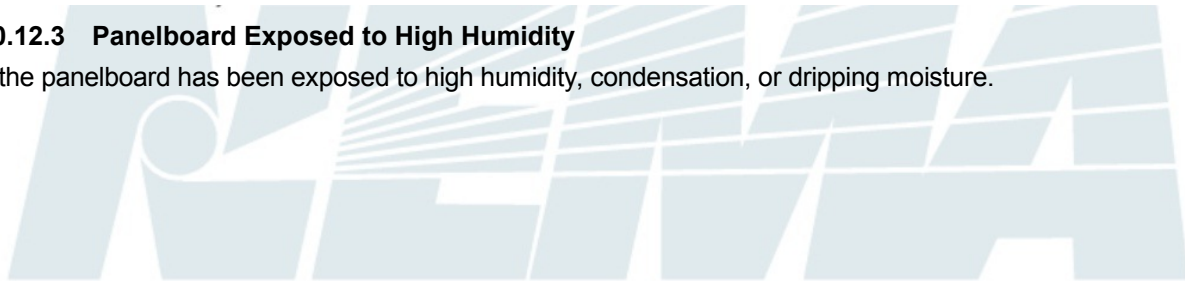
If a severe short circuit has occurred (see 10.10);

### **10.12.2 Parts Replaced**

If it has been necessary to replace parts or clean insulating surfaces;

### **10.12.3 Panelboard Exposed to High Humidity**

If the panelboard has been exposed to high humidity, condensation, or dripping moisture.



## **Section 11** **PERMISSIBLE LOADING OF PANELBOARDS**

### **11.1 NATIONAL ELECTRICAL CODE®**

In compliance with the *National Electrical Code®*, the normal continuous loads (3 hours or more) of panelboard circuits should be not more than 80 percent of the rating of the overcurrent protective device, unless the marking of the device indicates that it is suitable for continuous duty at 100 percent of its rating.

### **11.2 HARMONICS IN ELECTRICAL SYSTEM**

Some types of electrical equipment cause harmonics in the electrical system, which may result in overheating. This condition should be considered when determining panelboard loading.

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## Product Selection

QUICKLAG Type BAB  
Single-Pole

## QUICKLAG Type: BA 10,000A Interrupting Capacity Thermal-Magnetic Breakers

Continuous Ampere Rating at 40°C	Single-Pole 120/240 Vac Catalog Number	Two-Pole 120/240 Vac Catalog Number	Two-Pole 240 Vac Catalog Number	Three-Pole 240 Vac Catalog Number
10	BAB1010	BAB2010	BAB2010H ③	BAB3010H ③
15	BAB1015 ①②	BAB2015	BAB2015H	BAB3015H
20	BAB1020 ①②	BAB2020	BAB2020H	BAB3020H
25	BAB1025	BAB2025	BAB2025H	BAB3025H
30	BAB1030	BAB2030	BAB2030H	BAB3030H
35	BAB1035	BAB2035	BAB2035H	BAB3035H
40	BAB1040	BAB2040	BAB2040H	BAB3040H
45	BAB1045	BAB2045	BAB2045H	BAB3045H
50	BAB1050	BAB2050	BAB2050H	BAB3050H
55	BAB1055	BAB2055	BAB2055H	BAB3055H
60	BAB1060	BAB2060	BAB2060H	BAB3060H
70	BAB1070	BAB2070	BAB2070H	BAB3070H
80	—	BAB2080	BAB2080H	BAB3080H
90	—	BAB2090	BAB2090H	BAB3090H
100	BAB1100	BAB2100	BAB2100H	BAB3100H
110	—	BAB2110	—	—
125	—	BAB2125	—	—

## QUICKLAG Type: BA Non-Automatic Switches

Continuous Ampere Rating at 40°C	Single-Pole 120/240 Vac Catalog Number	Two-Pole 120/240 Vac Catalog Number	Two-Pole 240 Vac Catalog Number	Three-Pole 240 Vac Catalog Number
50	BAB1050N	—	BAB2050N	BAB3050N
60	BAB1060N	—	BAB2060N	BAB3060N
100	BAB1100N	—	BAB2100N	BAB3100N

## QUICKLAG Type: QBHW 22,000A Interrupting Capacity Thermal-Magnetic Breakers

Continuous Ampere Rating at 40°C	Single-Pole 120/240 Vac Catalog Number	Two-Pole 120/240 Vac Catalog Number	Two-Pole 240 Vac Catalog Number	Three-Pole 240 Vac Catalog Number
15	QBHW1015 ①	QBHW2015	QBHW2015H	QBHW3015H
20	QBHW1020 ①	QBHW2020	QBHW2020H	QBHW3020H
25	QBHW1025	QBHW2025	QBHW2025H	QBHW3025H
30	QBHW1030	QBHW2030	QBHW2030H	QBHW3030H
35	QBHW1035	QBHW2035	QBHW2035H	QBHW3035H
40	QBHW1040	QBHW2040	QBHW2040H	QBHW3040H
45	QBHW1045	QBHW2045	QBHW2045H	QBHW3045H
50	QBHW1050	QBHW2050	QBHW2050H	QBHW3050H
55	QBHW1055	QBHW2055	QBHW2055H	QBHW3055H
60	QBHW1060	QBHW2060	QBHW2060H	QBHW3060H
70	QBHW1070	QBHW2070	QBHW2070H	QBHW3070H
80	—	QBHW2080	QBHW2080H	QBHW3080H
90	—	QBHW2090	QBHW2090H	QBHW3090H
100	—	QBHW2100	QBHW2100H	QBHW3100H
110	—	QBHW2110	—	—
125	—	QBHW2125	—	—

**Notes**

- ① Switching duty rated for 120 Vac fluorescent light applications.
- ② For special low-magnetic breaker, order **BAB1015L1** or **BAB1020L1**.
- ③ Not UL listed.

### QUICKLAG Type: HBAX 42,000A Interrupting Capacity Thermal-Magnetic Breakers

Continuous Ampere Rating at 40°C	Single-Pole 120/240 Vac Catalog Number	Two-Pole 120/240 Vac Catalog Number	Two-Pole 240 Vac Catalog Number	Three-Pole 240 Vac Catalog Number
15	HBAX1015 <sup>①</sup>	HBAX2015	—	HBAX3015H
20	HBAX1020 <sup>①</sup>	HBAX2020	—	HBAX3020H
25	HBAX1025	HBAX2025	—	HBAX3025H
30	HBAX1030	HBAX2030	—	HBAX3030H
35	HBAX1035	HBAX2035	—	HBAX3035H
40	HBAX1040	HBAX2040	—	HBAX3040H
45	HBAX1045	HBAX2045	—	HBAX3045H
50	HBAX1050	HBAX2050	—	HBAX3050H
55	HBAX1055	HBAX2055	—	HBAX3055H
60	HBAX1060	HBAX2060	—	HBAX3060H
70	HBAX1070	HBAX2070	—	HBAX3070H
80	—	HBAX2080	—	HBAX3080H
80	—	HBAX2080	—	HBAX3080H
90	—	HBAX2090	—	HBAX3090H
100	—	HBAX2100	—	HBAX3100H

### QUICKLAG Type: HBAW 65,000A Interrupting Capacity Thermal-Magnetic Breakers

Continuous Ampere Rating at 40°C	Single-Pole 120/240 Vac Catalog Number	Two-Pole 120/240 Vac Catalog Number	Two-Pole 240 Vac Catalog Number	Three-Pole 240 Vac Catalog Number
15	HBAW1015 <sup>①</sup>	HBAW2015	—	HBAW3015H
20	HBAW1020 <sup>①</sup>	HBAW2020	—	HBAW3020H
25	HBAW1025	HBAW2025	—	—
30	HBAW1030	HBAW2030	—	—

### Dimensions

Approximate Dimensions in Inches (mm)

### Shipping Data

Number of Poles	Carton Quantity	Approximate Weight Lbs (kg)	Dimensions
1	24	9.00 (4.1)	12.50 x 7.50 x 5.00 (317.5 x 190.5 x 127.0)
2	12	9.00 (4.1)	12.50 x 7.50 x 5.00 (317.5 x 190.5 x 127.0)
3	8	9.00 (4.1)	12.50 x 7.50 x 5.00 (317.5 x 190.5 x 127.0)

### Note

<sup>①</sup> Switching duty rated for 120 Vac fluorescent light applications.



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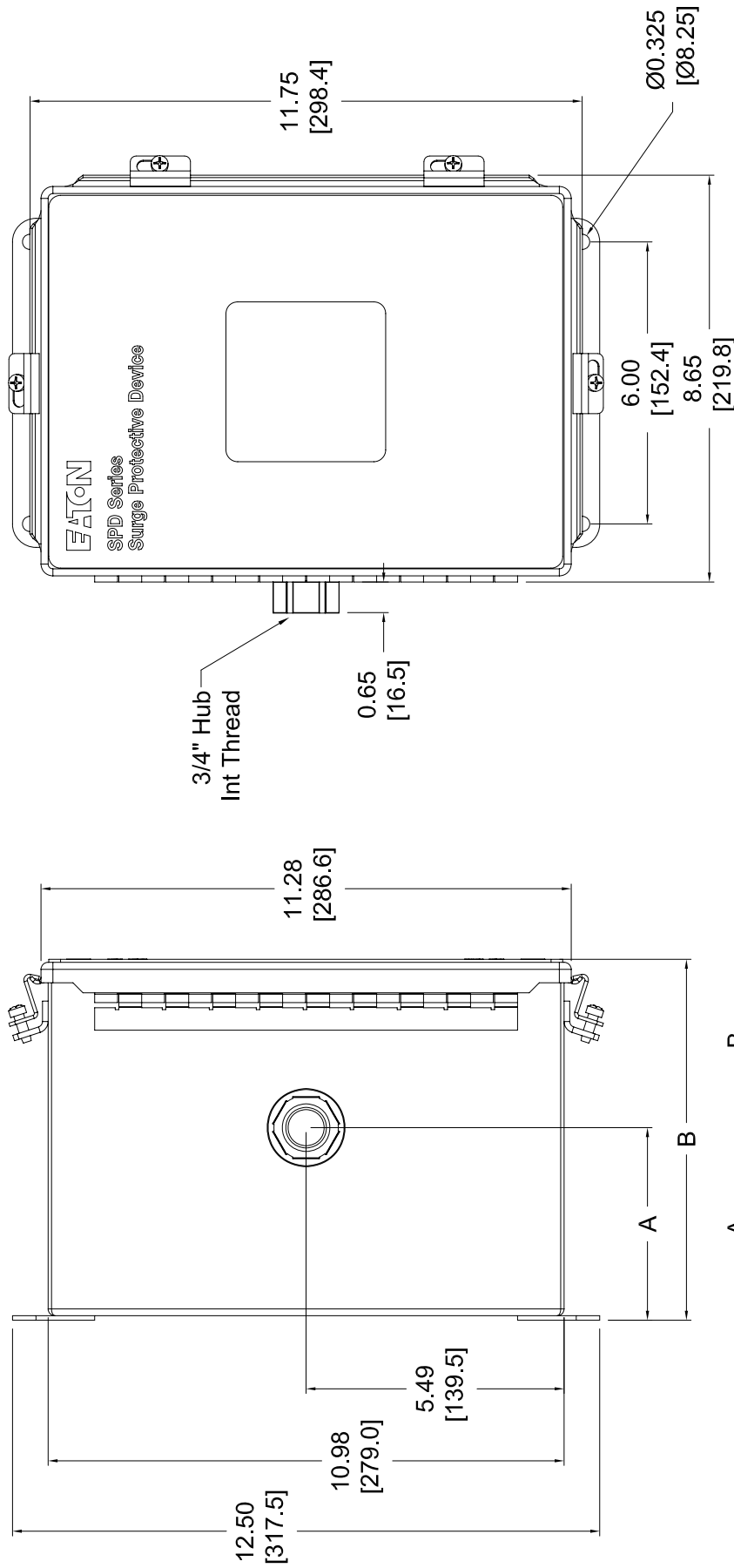
## General Information: Surge Protection Device

CATALOG NUMBER:	SPD200480Y3P
DEVICE:	SPD Series
SURGE RATING:	200 kA
PER MODE SURGE RATING:	480 VAC
VOLTAGE:	(4W+G)
WIRING:	NEMA 4X
ENCLOSURE:	10 Modes
PROTECTION MODES:	

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	PREPARED BY SCOTT ARNOLD	DATE 7/16/2024	<b>Eaton</b>		
	APPROVED BY	DATE	JOB NAME		
			DESIGNATION SPD		
	VERSION 1.0.0.0	TYPE Surge Protection Device	DRAWING TYPE Final		
NEG-ALT Number D7580421X1K1-0004	REVISION 0	DWG SIZE A	G.O. SBS1237854	ITEM 008	SHEET 1 of 1

GO/NEG-Alt-Date: SBS1237854-0004-7/16/2024		Job Name: Taunton WWTF Solids
Item Number: 008	Catalog Number: SPD200480Y3P	Designation: SPD



50-200 KA	A	2.60 / [66.0]	B	5.39 / [137.0]	Weight - 14.6 lb / 6.6 kg
250-400 KA	A	4.10 / [104.1]	B	7.68 / [195.0]	Weight - 21.0 lb / 9.5 kg

SPD SIDEMT SGL/DBL NEMA 4/4X  
MKT-DL-10-003

**EATON**

*Powering Business Worldwide*

# Eaton SPD Series

## Table of Contents

- 1.0 Introduction
- 2.0 Installation
- 3.0 Operating Features
- 4.0 Troubleshooting
- 5.0 Specifications
- 6.0 Ordering Guidelines
- 7.0 Warranty



*Powering Business Worldwide*

## 1.0 Introduction

### 1.1 Manual Organization

This Installation Manual describes the safe installation, testing and operation of the Eaton® SPD Series Surge Protective Device (SPD).

This manual is organized into seven sections, as follows:

- 1.0 Introduction
- 2.0 Installation
- 3.0 Operating Features
- 4.0 Troubleshooting
- 5.0 Specifications
- 6.0 Ordering Guidelines
- 7.0 Warranty

### 1.2 Product Overview

The Eaton SPD Series protects critical electrical and electronic equipment from damage by power surges. This is done by shunting high energy lightning surges (and other transient disturbances) away from the equipment being protected. It does this in nanoseconds by providing a low impedance surge path to ground while supporting power frequency voltage.

The Eaton SPD Series is designed to mount on the wall (or other vertical surface) as close as possible to the electrical cabinet. The SPD Series is available in AC, surge current capacity ratings from 50kA to 400kA, NEMA 1 enclosures.

The Eaton SPD Series is available in three feature packages (Basic, Standard, and Standard with Surge Counter), as described in Section 3, "Operating Features." Each model is available in Delta, Wye, and Split Phase wiring configurations.

All Eaton SPD Series models have been tested and certified by Canadian Standards Association to comply with ANSI/UL Standard 1449, 3rd Edition.

### 1.3 Safety Precautions

A licensed/qualified electrician must complete all instructions in this manual in accordance with the National Electric Code (NEC®), state, and local codes, or other applicable country codes. All applicable local electrical codes supersede these instructions.

#### ⚠WARNING

**IMPROPER INSTALLATION COULD CAUSE DEATH, INJURY AND EQUIPMENT DAMAGE. FOLLOW ALL WARNINGS AND CAUTIONS. COMPLETELY READ AND UNDERSTAND THE INFORMATION IN THIS INSTRUCTION MANUAL BEFORE ATTEMPTING TO INSTALL OR OPERATE THIS EQUIPMENT.**

**IMPROPER WIRING COULD CAUSE DEATH, INJURY AND/OR EQUIPMENT DAMAGE. ONLY LICENSED/QUALIFIED ELECTRICIANS WHO ARE TRAINED IN THE INSTALLATION AND SERVICE OF ELECTRICAL SERVICES ARE TO INSTALL AND SERVICE THIS EQUIPMENT.**

**HAZARDOUS VOLTAGES ARE PRESENT INSIDE THE SPD DURING NORMAL OPERATION. FOLLOW ALL SAFE WORK PRACTICES TO AVOID ELECTRICAL SHOCK.**

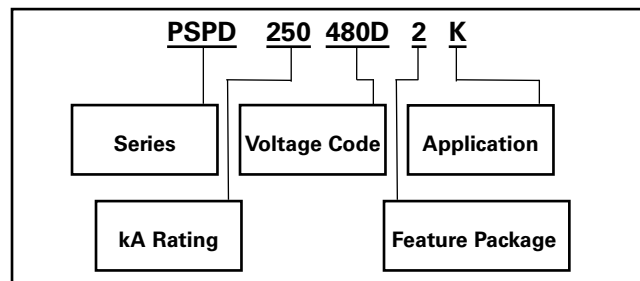
#### ⚠WARNING

**ARC FLASH DURING INSTALLATION COULD CAUSE INJURY. USE APPROPRIATE SAFETY PRECAUTIONS AND EQUIPMENT FOR ARC FLASH PROTECTION.**

### 1.4 Catalog Numbering System

Each Eaton SPD Series unit has a name plate that identifies the parameters used for manufacture. These parameters are expressed in letters and numbers, to reflect the Series, kA Rating, Voltage Code, Feature Package, and Application as shown in Table 1.

**Table 1. Catalog Numbering System**



For example, a 480 volt Delta (3-wire plus Ground) for use in an NEMA 1 application requires an SPD model SPD 250480D2K, where:

SPD = \_\_SPD model,

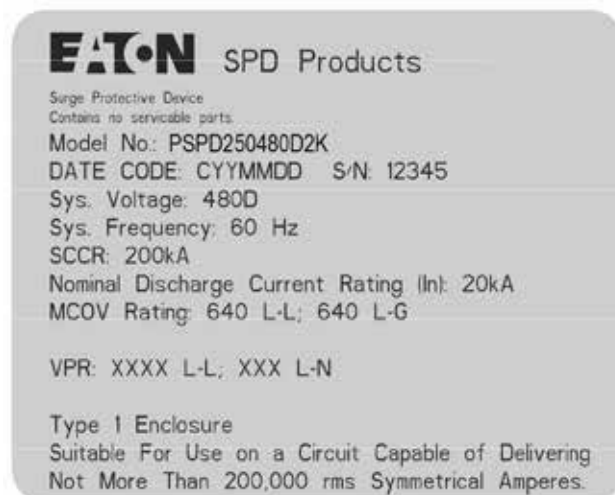
250 = the kA rating (50 – 400 kA),

480D = the voltage,

2 = the feature package (Basic, Standard, Standard With Surge Counter), and,

K = the Application Suffix (NEMA 1 with or without an internal disconnect).

These numbers appear as part of the product label attached to the front left side of the SPD. See Figure 1.



**Figure 1. Product Label**

## 1.5 Equipment Testing

### **⚠WARNING**

**CONDUCTING DIELECTRIC, MEGGER, OR HI-POTENTIAL TESTING WITH THE SPD INSTALLED WILL CAUSE INTERNAL DAMAGE TO THE SPD. THE SPD WILL ALSO CAUSE THE TEST TO FAIL.**

Every Eaton SPD Series unit is tested at the factory for dielectric breakdown. No further SPD testing is required for installation.

If you desire to test distribution equipment by performing dielectric, megger, or hi-potential tests, any installed SPD **must** be disconnected from the power distribution system to prevent damage to the unit.

Follow this procedure to safely disconnect the SPD:

1. For SPDs connected to a circuit breaker or fuse:
  - a. 3-wire delta SPDs: Turn off the circuit breaker or remove the fuses from the fuse holder to isolate the SPD.
  - b. Wye and Split phase SPDs: Turn off the circuit breaker or remove the fuses from the fuse holder to isolate the SPD and remove the Neutral connection on Wye connected SPDs.

## 2.0 Installation

### **⚠WARNING**

**INSTALLING AN SPD THAT IS IMPROPERLY RATED FOR THE ELECTRICAL SYSTEM VOLTAGE COULD CREATE A POTENTIALLY HAZARDOUS CONDITION, RESULTING IN INJURY OR EQUIPMENT DAMAGE.**

### 2.1 Preparation for Installation

### **⚠CAUTION**

**EATON SPD SERIES PRODUCTS MUST BE INSTALLED OR REPLACED BY A QUALIFIED ELECTRICIAN TO AVOID INJURY OR EQUIPMENT DAMAGE.**

Before installing an Eaton SPD Series unit, do the following:

- Verify that the area is clear of any dirt, debris or clutter that may hamper the installation process.
- Verify that there is enough space to install the SPD. See Section 2.3, "Installation Procedures" for dimensions.
- Confirm that all tools and equipment needed for the installation are available.
- Confirm that the system voltage and wiring configuration is the same as the SPD you are installing. Check the voltage rating label on the side of the SPD.

### **⚠WARNING**

**TURN OFF THE POWER SUPPLY BEFORE WORKING IN ANY ELECTRICAL CABINET OR ON ANY CIRCUIT BREAKER PANEL. FAILURE TO DO SO COULD RESULT IN INJURY OR DEATH FROM ELECTRICAL SHOCK.**

## **NOTICE**

**A POOR GROUND, OR GROUNDING/BONDING VIOLATIONS, COULD PREVENT THE SPD FROM PERFORMING AS SPECIFIED.**

**DO NOT USE THE SPD TO CARRY OR PASS THROUGH GROUND TO OTHER DEVICES OR LEADS. DAMAGE TO THE EQUIPMENT MAY RESULT.**

- Check the facility grounding system. All grounding, bonding, and earthing must meet the NEC and any other national, state and local electrical codes.

### 2.2 Installation Locations

Eaton's SPD Series can be installed next to, above, or below any existing electrical enclosure.

The ideal mounting location for the Eaton SPD Series is as close as possible to the electrical enclosure. The Eaton SPD Series should be mounted in such a way as to minimize any sharp bends in the wiring conduit.

### 2.3 Installation Procedures

1. Before mounting the SPD first determine the ideal location and ensure that the mounting surface is sufficient to support the weight of the SPD (See Figures 2 and 3 on page 4 for model weights). The SPD should be mounted as close as possible to the electrical enclosure and as close as possible to the wiring connection point within the enclosure. This will ensure a minimum wire length and maximum SPD performance.
2. Lay out the four enclosure mounting holes using the enclosure dimensions provided in Figures 2 and 3 on page 4. Drill the appropriate holes per the product dimensions. Note: NEMA 1 enclosures require a #10 fastener.
3. Determine the correct length and install metal conduit onto the SPD. NEMA 1 SPDs have a 3/4 inch trade size chase nipple. Route all Phase, Neutral (where applicable), Ground and Form C (where applicable) wires through the conduit.
4. Determine the hole location on the receiving electrical enclosure and either remove the knock-out provided or drill the appropriate size hole at this location. Route the SPD wires through the enclosure hole and mount the SPD enclosure.
5. Select the correct wiring diagram for the SPD you are installing. You must refer to this diagram while wiring the SPD. See Figures 5, 6, and 7 on page 5.
6. Determine the wire length required to make the SPD Phase connections and cut the wires to the appropriate length. (To maximize SPD performance, wire length should be as short as possible). Connect the Phase wires.
 

**Note:** For wire lengths longer than 4 inches, Phase wires should be twisted once for each 4 inches of wire length to maximize SPD performance.
7. Determine the wire length for the Ground and Neutral (where applicable) wires and cut these wires as needed. Again, keep these wires as short as possible to maximize SPD performance.
8. Standard and Standard with Surge Counter SPDs also provide wiring for Form C relay contacts. This connection can be used for remote monitoring of the SPD. The Form C contacts are rated at 150V AC or 125V DC at 1A. Make the remote monitoring connections per the Form C wiring diagram in Figure 4. Follow all national, state and local electrical codes when making these connections.



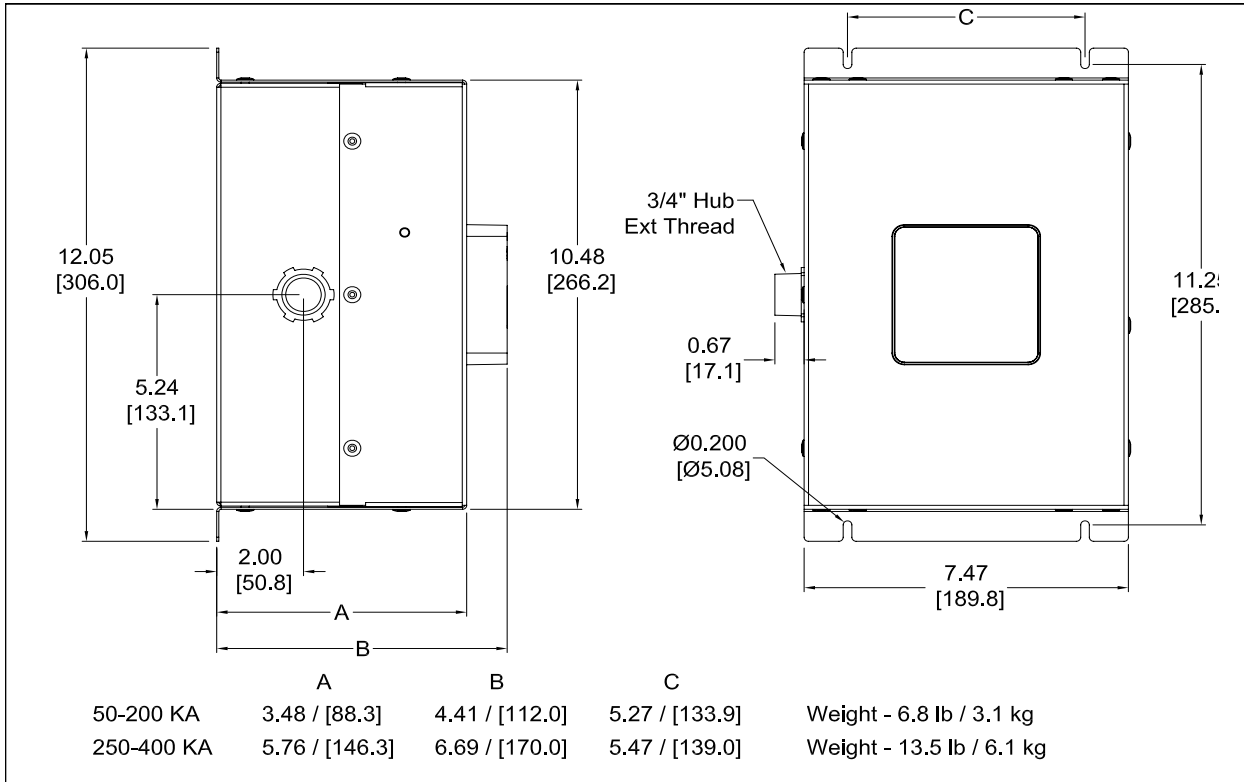


Figure 2. NEMA 1 (Suffix K)

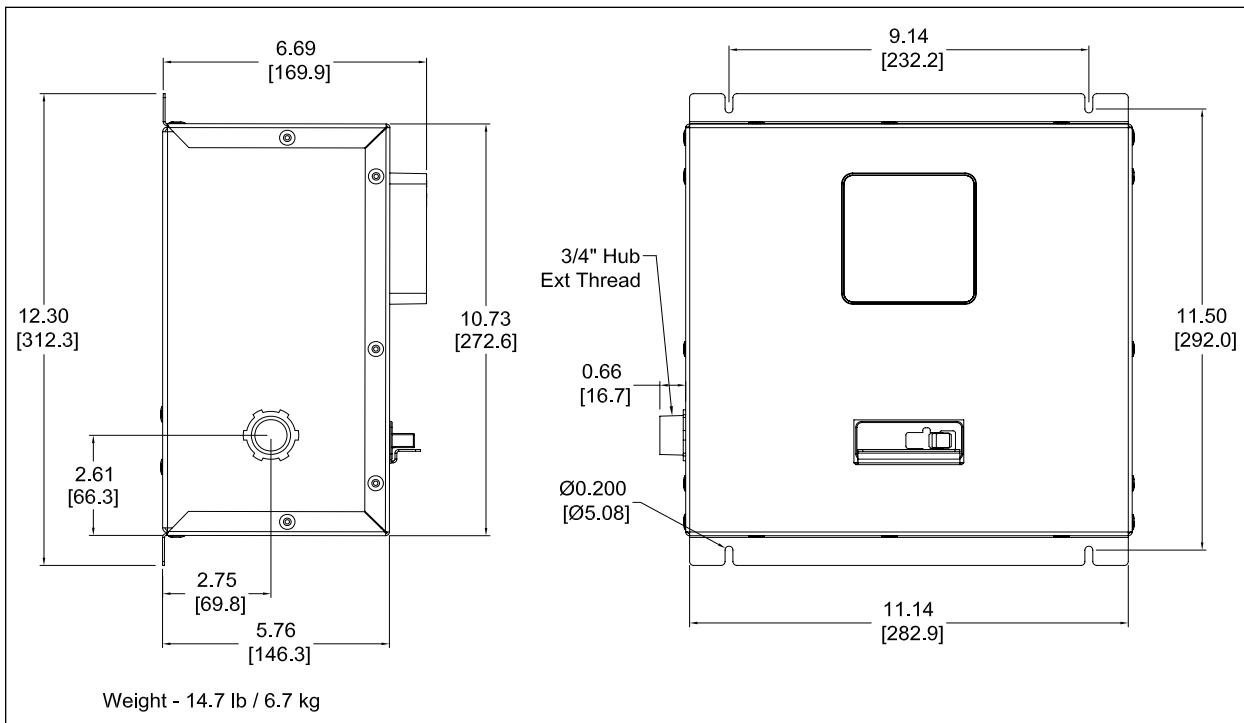


Figure 3. NEMA 1 (With Disconnect) (Suffix M)

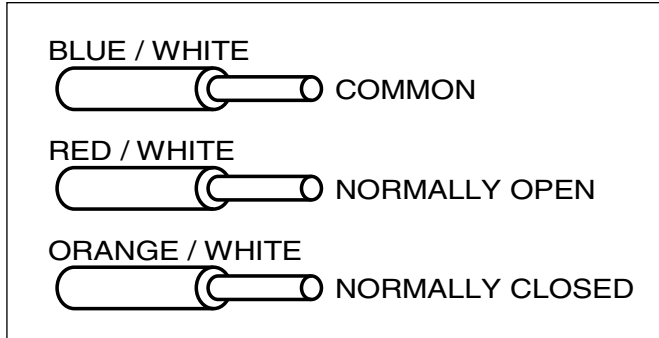


Figure 4. Sidemount Form C Wires

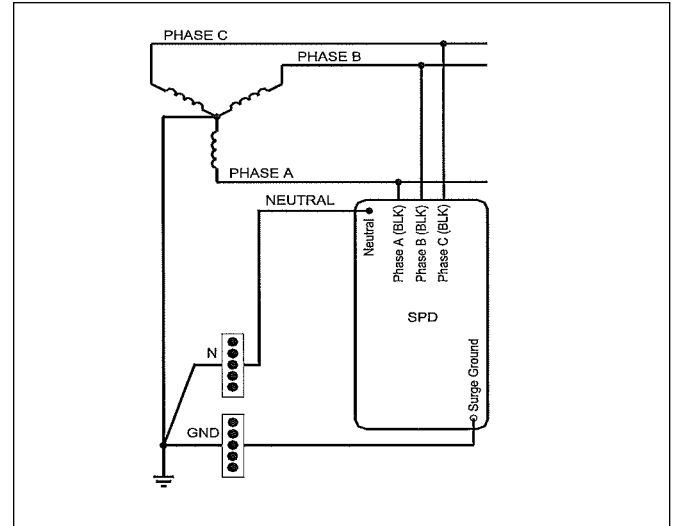


Figure 7. 3-Phase Wye Units

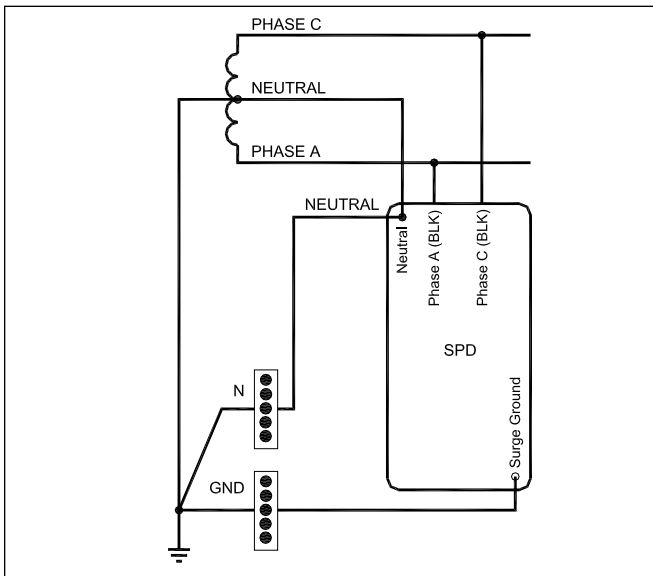


Figure 5. Split Phase Units

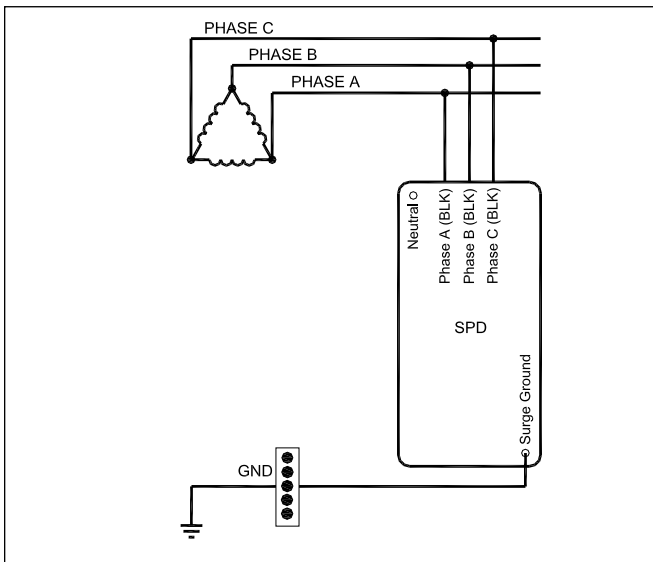


Figure 6. 3-Phase Delta

### 3.0 Operating Features

#### 3.1 General

The Eaton SPD Series comes in three feature packages: Basic, Standard, and Standard with Surge Counter. The operating specifics of each feature package are described below.

The Eaton SPD Series requires no operator involvement, other than to monitor the display panel to determine status of the SPD.

After system power is applied, the SPD automatically begins protecting downstream electrical equipment from voltage transients.

Some SPD units have a Form C relay contact that allows for the remote indication of SPD status. Form C contact wires are permanently connected to the SPD.

#### 3.2 Displays and Indicators

All Eaton SPD Series units (Basic, Standard, and Standard With Surge Counter) use a display panel to indicate system status. The display panel is slightly different for each feature package.

Each display has both green and red light emitting diodes (LEDs) to indicate the status of the protection on each phase. Green indicates the phase is fully protected. Red indicates a loss of protection. Wye, Split Phase and High-Leg Delta units have an additional set of green/red LEDs to indicate status of Neutral/Ground protection.

When the LEDs turn red, an audible alarm will also sound on units equipped with an audible alarm.

Specific operating conditions displayed for each Eaton SPD Series Feature Package are described below.

##### 3.2.1 Basic Feature Package

The Eaton SPD Basic Feature Package display is shown in Figure 8.



Figure 8. Basic Feature Package Display

The Basic Feature Package has the following features:

- Green LEDs: Illumination indicates the phase is fully protected, and operating normally, with all protection active and available. Green LEDs also indicate Neutral to Ground protection on units with a Neutral wire. Green LEDs do not indicate on/off status of power.
- Red LEDs: Illumination indicates a loss of protection, and that one or more protective devices are now inactive and unavailable for that Phase. Red LEDs also indicate Neutral to Ground protection on units with a Neutral wire. Red LEDs do not indicate on/off status of power.

##### 3.2.2 Standard Feature Package

The Eaton SPD Series Standard Feature Package display is shown in Figure 9.



Figure 9. Standard Feature Package Display

The Standard Feature Package has the following features:

- All features of the Basic Feature Package.
- One Form C relay contact rated at 150Vac or 125Vdc @1A.
  - Normal operating conditions. N.O. = OPEN. N.C = CLOSED.
  - Loss of protection on any phase or loss of power. N.O. = CLOSED. N.C. = OPEN.
- Audible alarm with Reset push button.
- EMI/RFI filtering.

##### 3.2.3 Standard With Surge Counter Feature Package

The Eaton SPD Series Standard With Surge Counter Feature Package display is shown in Figure 10.



Figure 10. Standard With Surge Counter Feature Package Display

The Standard With Surge Counter Feature Package has the following features:

- All features of the Standard Feature Package.
- LCD screen that displays surge count.
- Reset button to RESET the surge counter to zero.

### 3.2.4 SPD Display Rotation

The SPD display can be rotated on the SPD enclosure, up to 360 degrees. This allows you to position the display for the best visibility regardless of the position in which the SPD is installed.

Rotations are at 90, 180, and 270 degrees.

Reposition the SPD display as follows:

1. Remove power from the unit.
2. Remove and discard the perforated overlay material at the two opposite corners of the display.
3. Remove the two phillips head screws that hold the display.
4. Rotate the display to the desired position. Be careful not to overstress the display ribbon cable.
5. Place the display back onto the SPD enclosure. Again, be careful not to overstress or crimp the ribbon cable.
6. Replace the two phillips head screws. Tighten screws to 1.35 Nm (12 in-lbs).
7. Restore power to the unit.

## 4.0 Troubleshooting

Many SPD failures result from improper installation. Once the SPD is installed properly, it is a highly reliable unit.

If the SPD does not function properly, first confirm that it is installed properly. See Section 2, "*Installation.*"

If the SPD malfunctions after it has been operating routinely, refer to Table 2, *Troubleshooting Chart*. This Troubleshooting Chart identifies possible causes and solutions to the malfunction. Further assistance may be obtained by calling Eaton's Applications Engineers, at 1-800-809-2772, option 4, sub-option 2, including being directed to the warranty process if applicable.

**Table 2. Troubleshooting Chart**

Condition	Probable Cause	Solution
Green LEDs ON (1 per phase) and one Green LED ON for Neu/Gnd Protection	Normal operation	N/A.
Audible Alarm OFF, Form C (N.C.) contact in the CLOSED state	Normal operation	N/A.
Phase Green LED is OFF, same Phase Red LED is ON, Audible Alarm is ON	Phase protection compromised or lost	Replace SPD
	Extended Temporary Overvoltage (TOV)	Check electrical system for TOV sources, correct, replace SPD
	Significant surge event	Replace SPD
Neu/Gnd Green LED is OFF, Neu/Gnd Red LED is ON, Audible Alarm is ON (for models with Neutral connections)	Neu/Gnd protection is compromised or lost	Replace SPD
	Significant surge event	Replace SPD
All phase Green LEDs OFF, all phase RED LEDs ON, Audible Alarm is ON	All phase protection is compromised or lost	Replace SPD
	SPD <u>rated</u> voltage is less than <u>system</u> voltage	Replace SPD with correct voltage model
	Extended Temporary Overvoltage (TOV)	Check electrical system for TOV sources, correct, replace SPD
	Significant surge event	Replace SPD
One of the display Red LEDs is ON. Audible Alarm is OFF	Audible Alarm Silence button has been depressed and Alarm is silenced	Normal operation  If power is cycled and a fault condition still exists, the Audible Alarm will reactivate
All Green and Red LEDs are OFF, LCD display (on Surge Counter models) is OFF	SPD is not connected to a power source	Check system voltage at SPD connection  Check SPD connections

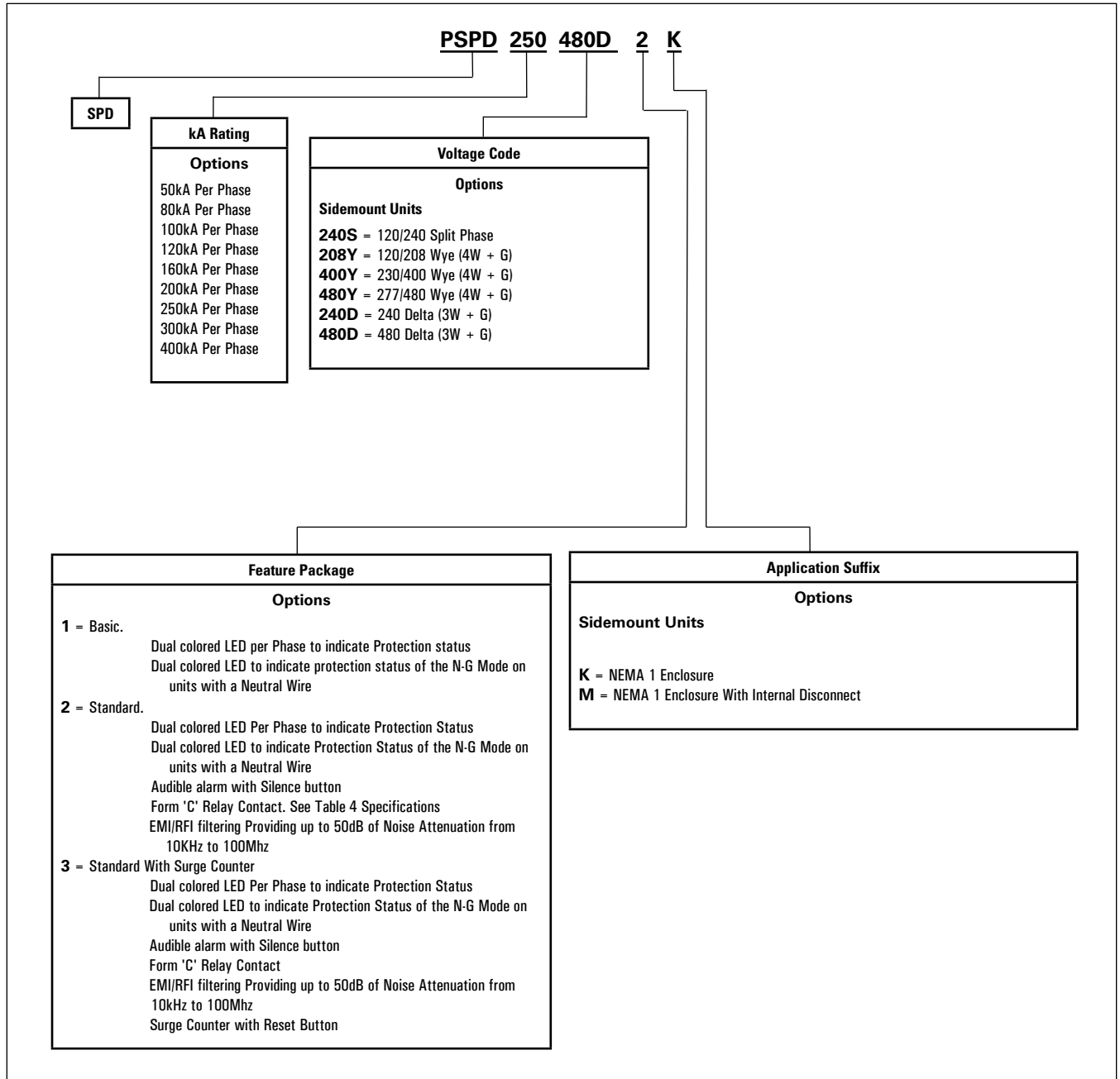
## 5.0 Specifications

**Table 3. Specifications**

Description	Specification
Surge current capacity per phase	50, 80, 100, 120, 160, 200, 250, 300, 400 kA ratings available
Nominal discharge current ( $I_n$ )	20kA
Short circuit current rating (SCCR)	200kA
SPD Type	Basic feature package = Type 1 (can also be used in Type 2 applications) Standard and Standard with Surge Counter feature packages = Type 2
Enclosure Types	NEMA 1
Standard split phase voltages available	120/240
Three phase wye system voltages available	120/208, 230/400, 277/480,
Three phase delta system voltages	240, 480
Phase wire length	48" of 10AWG extend beyond the conduit hub
Relay wire length (optional)	48" of 14AWG extend beyond the conduit hub
RoHS Compliant	Yes
Internal Disconnect (optional)	Eaton 30 Amp FDC Circuit Breaker, Type MCCB
Input Power Frequency	50/60 Hz
Power consumption (Basic units) 208Y, 240S, 240D, voltage codes	0.5W
400Y, 480Y and 480D voltage codes	1.1W
Power consumption (Standard and Standard with Surge Counter units) 208Y, 240S, 240D, voltage codes	0.6W
400Y, 480Y, and 480D Basic voltage codes	1.7W
Protection modes	Single split phase ...L-N, L-G, N-G, L-L Three phase delta...L-G, L-L Three phase Wye.....L-N, L-G, N-G, L-L
Maximum continuous operating voltage (MCOV) 208Y, 240S voltage codes	150 L-N, 150 L-G, 150 N-G, 300 L-L
400Y and 480Y voltage codes	320 L-N, 320 L-G, 320 N-G, 640 L-L
240 D voltage code	320 L-G, 320 L-L
480 D voltage code	640L- L-G, 640 L-L
Ports	1
Operating temperature	-20 through 50C (-4 through 122F)
Operating humidity	5% through 95%, non-condensing
Weight	Reference Figures 2 and 3 on page 4
Form C relay contact ratings	150 Vac or 125 Vdc, 1A maximum
Form C relay contact logic	Power on, normal state - NO contact = OPEN, NC contact = CLOSED Power off, fault state, - NO contact = CLOSED, NC contact = OPEN
EMI/RFI filtering attenuation (Standard and Standard With Surge Counter)	Up to 50 dB from 10 kHz to 100 MHz
Agency certifications and approvals	CSA Listed to ANSI/UL1449 3rd Edition CSA Std. C22.2 No. 8-M1986.
Warranty	10 Years, 15 Years if the product is properly registered with Eaton at <a href="http://www.eaton.com/spd">www.eaton.com/spd</a>

### 6.0 Ordering Guidelines

Table 4. Eaton SPD Series



Example: PSPD250480D2K = SPD Series, 250kA Per Phase, 480D Voltage, Standard Feature Package, NEMA 1 Sidemount Application.

## 7.0 Warranty

Eaton warrants these products for a period of 10 years from the date of delivery to the purchaser, 15 years if the product is properly registered with Eaton, to be free from defects in both workmanship and materials. Eaton assumes no risk or liability for results of the use of the products purchased from it, including but without limiting the generality of the foregoing: (1) The use in combination with any electrical or electronic components, circuits, systems, assemblies, or any other materials or substances; (2) Unsuitability of any product for use in any circuit or assembly.

Purchaser's rights under the warranty shall consist solely of requiring Eaton to repair, or at Eaton's sole discretion, replace, free of charge, F.O.B. factory, and defective items received at said factory within said term determined by Eaton to be defective. The giving of or failure to give any advice or recommendations by Eaton shall not constitute any warranty by or impose any liability upon Eaton. The foregoing constitutes the sole and exclusive liability of Eaton AND IS IN LIEU OF ANY AND ALL OTHER WARRANTIES EXPRESSED, IMPLIED OR STATUTORY AS TO THE MERCHANTABILITY, FITNESS FOR PURPOSE SOLD, DESCRIPTION, QUALITY, PRODUCTIVENESS OR ANY OTHER MATTER.

In no event shall Eaton be liable for special or consequential damages or for delay in performance of the warranty.

This warranty does not apply if the product has been misused, abused, altered, tampered with, or used in applications other than specified on the nameplate. At the end of the warranty period, Eaton shall be under no further warranty obligation expressed or implied.

The product covered by this warranty certificate can only be repaired or replaced by the factory. For help on troubleshooting the SPD, or for warranty information, call 1-800-809-2772, Option 4, sub-option 2. Repair or replacement units will be returned collect. If Eaton finds the return to be a manufacturer's defect, the product will be returned prepaid.





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**EATON**

*Powering Business Worldwide*

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### Dry-Type Transformers General Information

- Standard Transformer Catalog Number: V48M28T4516CU
- Transformer Type: General Purpose Vented
- Phase: 3
- kVA: 45
- Primary Volts: 480
- Secondary Volts: 208Y/120
- Temperature Rise: 150C with 220C Insulation System
- Winding Material: Copper
- Enclosure Type: NEMA 2 (for N3R, select Weather Shield in Mods tab)
- Frequency (Hz): 60
- Frame: 940
- Wiring Diagram: 280B
- Weight (lbs.): 476
- Impedance (%): 3.44
- UL Listed: Y
- Max Practical Inrush (Amps): 181
- X/R: 0.85
- No Load Losses (Watts): 123
- Total Losses (Watts): 1289

### Standard Values

- K-Factor: 1
- TAPS: 2@+2.5%, 4@-2.5%
- Sound Reduction (dB): 0
- NEMA ST20 Sound Level (dB): 45
- DOE 10 CFR Part 431 (2016) Efficient: Y
- Infrared Viewing Window: None

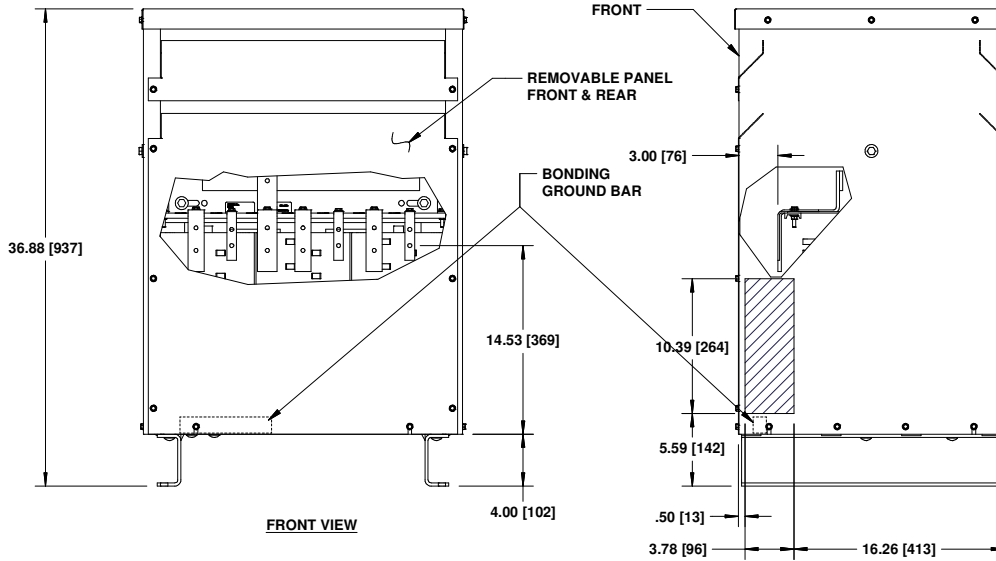
### Field-Installed Accessories Included

- Lug Kit: Not Included

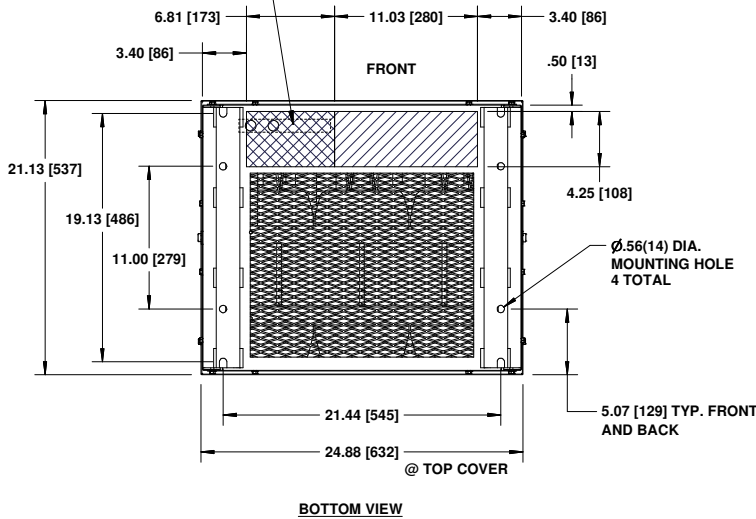
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	APPROVED BY	DATE	JOB NAME Taunton WWTF Solids	DESIGNATION 45kVA	
	VERSION 1.0.0.4	TYPE Dry-Type Transformer	DRAWING TYPE Final		
NEG-ALT Number D7580421X1K1-0004	REVISION 0	DWG SIZE A	G.O. SBS1237854	ITEM 009	SHEET 1 of 1

**NOTE:**

1. ALL UNITS ARE DESIGNED IN ACCORDANCE WITH APPLICABLE NEMA, UL, ANSI, AND IEEE STANDARDS.
2. DRY-TYPE VENTILATED, CLASS AA, NEMA TYPE 2 ENCLOSURE.
3. FOR NEMA 3R OUTDOOR APPLICATION, USE WEATHERSHIELD # WS58.
4. TRANSFORMERS ARE FLOOR-MOUNTED. USE WALL-MOUNT BRACKET WMB05 FOR WALL-MOUNTING.
5. 220°C CLASS INSULATION SYSTEM.
6. PAINT COLOR IS ANSI #61.
7. ALUMINUM UNITS HAVE ALUMINUM WINDINGS AND TERMINATIONS. COPPER UNITS HAVE COPPER WINDINGS AND TERMINATIONS.
8. TRANSFORMER CAN BE INSTALLED AT A MIN. DISTANCE TO BACK AND SIDE WALLS OF 2 INCHES AND TO A 6 INCHES MIN. DISTANCE TO BACK WALLS WHEN WEATHERSHIELDS ARE NEEDED. WALLMOUNT BRACKETS CANNOT BE USED IN COMBINATION WITH WEATHERSHIELDS.
9. DIMENSIONS IN INCHES[mm].




IF CABLE ENTRY IS REQUIRED IN THIS AREA BONDING GROUND BAR MAY NEED TO BE RELOCATED BY INSTALLER.



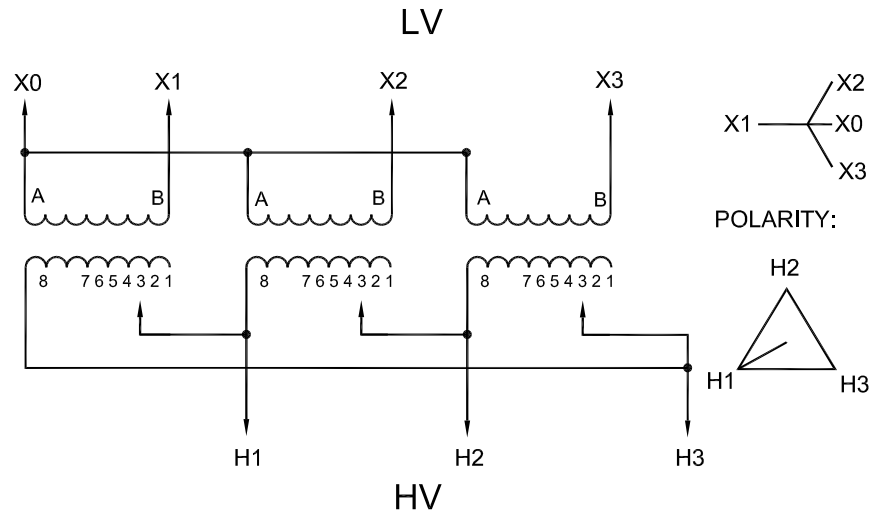
USE 10.39[264] x 3.78[96] BOTH SIDES, AND (11.03[280]+6.81[173]) x 4.25[108] ON BOTTOM AS RECOMMENDED CABLE ENTRY LOCATIONS.

THIS DIMENSION DRAWING IS FOR REFERENCE ONLY. IT IS NOT BE REGARDED AS INDICATING THE EXACT DETAILS OF CONSTRUCTION.

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7	ECO-164756	J.C.S.	D.G.	3/31/2021	APPD	DATE				
6	ECO-133517	J.G.	C.B.	5/7/2019	D.G.	10/30/2015	TYPE		OUTLINE	
REVISION					8	G.O.		DWG	FR940	SHEET
REVISIONS					8				FR940	1 OF 1

GO/NEG-Alt-Date: SBS1237854-0004-7/16/2024		Job Name: Taunton WWTF Solids	
Item Number: 009	Catalog Number: V48M28T4516CU	Designation: 45kVA	

VOLTS	TAP
504	1
492	2
480	3
468	4
456	5
444	6
432	7



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				HEG	12/01/01	TITLE		DRY TYPE TRANSFORMER WIRING SCHEMATIC	
				APPD	DATE	TYPE		DRY TYPE TRANSFORMER	
				EER	12/01/01	WIRING		WIRING	
				S.O.		G.O.		DWG	
4		UPDATE FORMAT EATON & CHANGE DESC. TO HW/LV		J.C.S.	C.B.	10/JUN/14		280B	
REVISIONS		REVISION		04		SHEET		1 OF 01	

GO/NEG-Alt-Date: SBS1237854-0004-7/16/2024		Job Name: Taunton WWTF Solids	
Item Number: 009	Catalog Number: V48M28T4516CU	Designation: 45kVA	

**EATON**

*Powering Business Worldwide*

# Low-Voltage Dry-Type Distribution Transformers.



Eaton's Family of Dry-Type Distribution Transformers.



Powering Business Worldwide

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Indicates a hazardous situation that, if not avoided, will result in death or serious injury.



Indicates a hazardous situation that, if not avoided, could result in death or serious injury.



Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

## Instructions for Installation, Operation, and Maintenance of Dry-Type Distribution Transformers.



Turn off the power supplying this equipment before servicing.

Lockout power before servicing.

Burn hazard. Allow for a cool-down period before servicing equipment.

### 1. INTRODUCTION

Transformers should be installed and serviced only by competent personnel familiar with good safety practices. These instructions are written for such personnel and are not intended as a substitute for adequate training and experience in the use of transformers. Refer to Standards NEMA ST-20 and IEEE C57.94 for more information on general application requirements.

### 2. RECEIVING

All dry-type distribution transformers are completely assembled and carefully tested at the factory before being shipped.

Upon receipt of the transformer:

- Inspect for possible shipping damage.
- Check the bill of lading for possible shortages.



Indica una situación de riesgo que de no ser evitada resultara en muerte o heridas severas.



Indica una situación de riesgo que de no ser evitada podría resultar en muerte o heridas severas.



Indica una situación de riesgo que de no ser evitada podría resultar en heridas menores o moderadas.

## Instrucciones para la Instalación, Operación y Mantenimiento de los Transformadores de Distribución Tipo Seco.



Apague el equipo antes de realizar cualquier trabajo en él.

Bloquee las fuentes de energía antes de realizar cualquier trabajo.

Riesgo de quemaduras. Permita que el equipo se enfríe antes de realizar cualquier trabajo.

### 1. INTRODUCCION

La instalación y mantenimiento de los transformadores deben estar a cargo de personal calificado que conozca las prácticas de seguridad recomendadas. Estas instrucciones van dirigidas a este sin intención de sustituir la adecuada capacitación y experiencia en transformadores. Consulte el estándar NEMA (National Electrical Manufacturers Association E.U.A.) ST-20 y IEEE C57.94 para más información.

### 2. ARRIBO

Todos los transformadores de distribución tipo seco son completamente ensamblados y cuidadosamente probados en la fábrica antes de ser enviados.

Al recibir el transformador:

- Inspeccione por posibles daños durante el transporte.
- Verifique la guía de carga por posibles faltantes.

If shipping damage occurs, a claim should immediately be filed with the carrier. Notify the local sales office with the carrier's name and the extent of the damage.

En caso de existir daño durante el transporte, inmediatamente levante un reporte con el transportista. Notifíquelo a la oficina local de ventas el nombre del transportista y el alcance del daño.

**3. LIFTING AND HANDLING**

Carefully follow the lifting instructions below.



Use appropriate material handling equipment.

Move the transformer in an upright position only.

**Ventilated transformers:**

- Remove the top cover to access the lifting holes in the core frame. Use spreaders with lifting chains or slings to lift the transformer.

OR

- Lift the unit with a fork lift.
- For further information see Figure 1 and 2.

**Encapsulated transformers (above 2 kVA):**

- Lift the transformer by its lifting brackets.

OR

- Lift the unit with a fork lift when a pallet is provided.
- For further information see Figure 3.

**3. LEVANTAMIENTO Y MANEJO**

Siga cuidadosamente las instrucciones de levantamiento indicadas más abajo.



Utilice equipo adecuado para el manejo del material.

Mueva el transformador en posición vertical solamente.

**Transformadores ventilados:**

- Remueva la tapa superior para acceder a los orificios de izado en el marco del núcleo. Use correas o cadenas con separadores para levantar el transformador

O

- Use montacargas.
- Para referencia vea las Figuras 1 y 2.

**Transformadores Encapsulados (mayores de 2 kVA):**

- Levante la unidad por las ménsulas.

O

- Levante la unidad con montacargas si el transformador está sobre una tarima.
- Para referencia, vea la Figura 3.

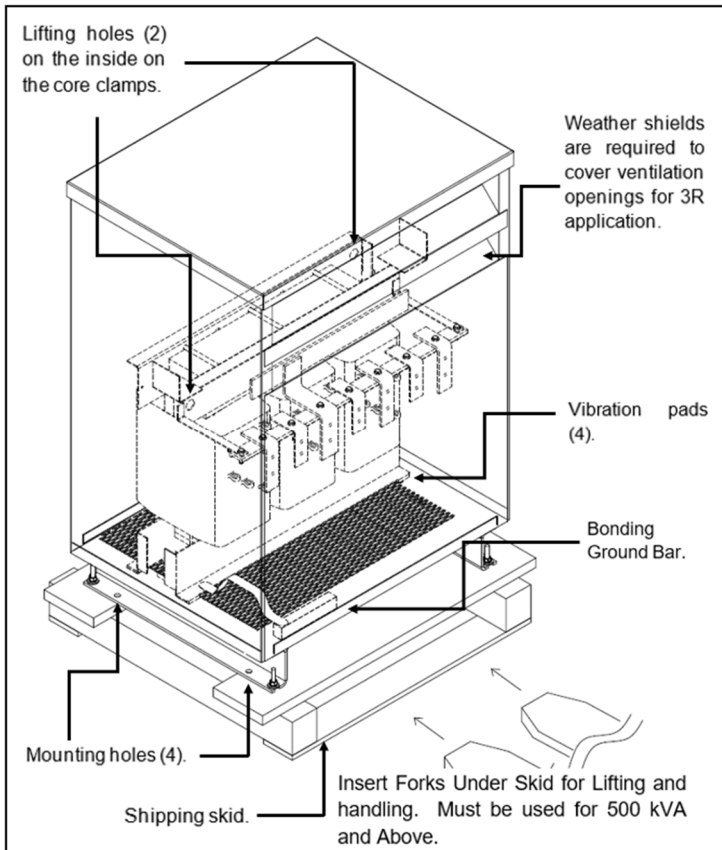


Figure 1: Typical Ventilated Transformer.

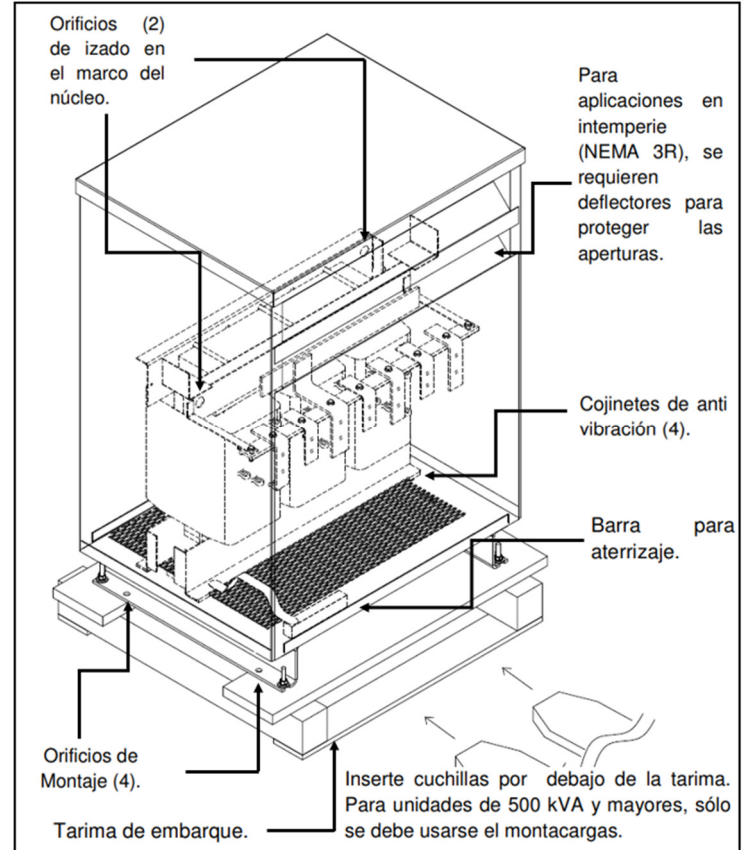


Figura 1: Transformador Ventilado Típico.

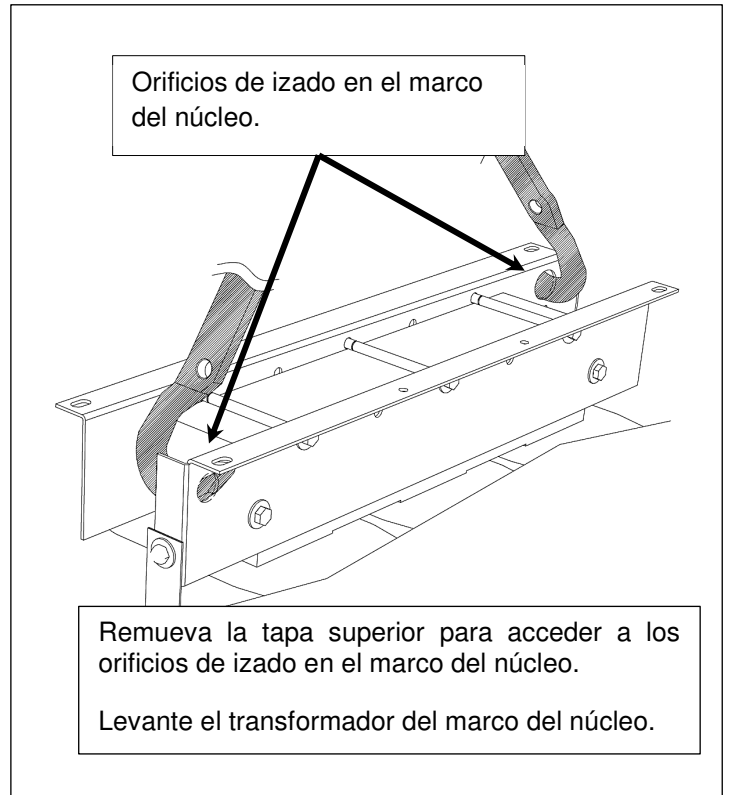
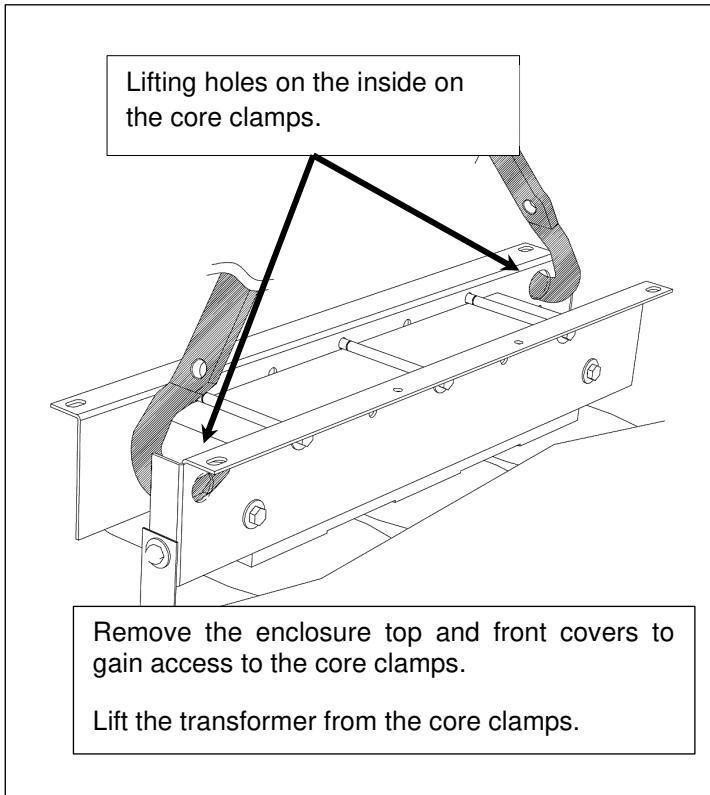


Figure 2: Typical location of the lifting holes for a ventilated transformer.

Figura 2: Ubicación típica de los orificios de izado para un transformador ventilado.

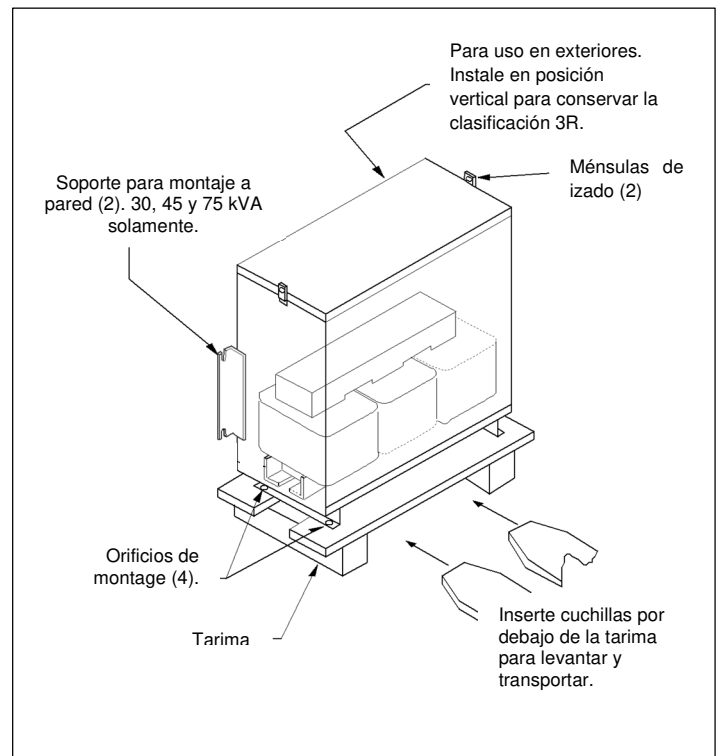
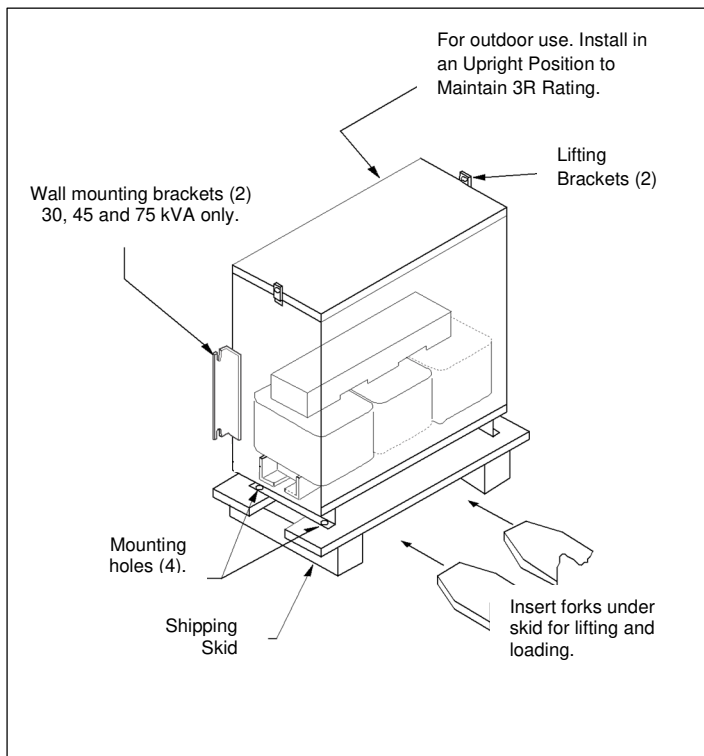


Figure 3: Typical Encapsulated Transformer.

Figura 3: Transformador Encapsulado Típico.

#### 4. STORAGE PRIOR TO ENERGIZATION

Store Low-Voltage Dry-Type Distribution Transformers in their original shipping cartons indoors in a clean, dry, temperature stable environment.

#### 5. LOCATION AND MOUNTING

All dry-type transformers:

- Locate the transformer in an area where the transformer is easily accessible and serviceable by qualified personnel.
- Install the transformer in accordance with the requirements of Article 450 of the National Electrical Code and other appropriate local codes.
- Install the transformer in a protected electrical circuit. Do not subject the transformer to voltage surges unless it is properly protected.
- Transformers are not tamper proof and should be installed in secured locations away from all unauthorized personnel.
- Locate transformer in a well-ventilated area free from excessive moisture, dust, dirt, or explosive/corrosive gases or vapors.
- Locate the transformer at least the minimum distance marked on the nameplate to assure proper air circulation. Avoid any obstruction to the bottom and top panel ventilation openings.
- Install transformer on a surface strong enough to support the weight of the transformer.
- Install ventilated transformers in an upright position only.
- Encapsulated transformers for indoor use may be mounted in any position. To maintain their Type 3R, Type 12, Type 4, or Type 4X enclosure rating, the transformer must be installed in an upright position with the top point upward.

Wall mount installation:

- For wall mounted ventilated transformers see Instruction Leaflet IL009002EN (Wall-mounting bracket kits WMB04 and WMB05 assembly instructions).
- WMB04 maximum weight capacity 1400 Lb.
- WMB05 maximum weight capacity 810 Lb.
- Do not install wall-mounted transformers over flammable materials, and do not store flammable materials under a wall-mounted transformer

#### 6. HOW TO REDUCE SOUND TRANSMISSION

All transformers produce sound due to the vibration generated in its core by alternating flux. NEMA ST-20 defines the sound levels for dry-type distribution transformers.

All general purpose dry-type distribution transformers are designed to meet NEMA ST-20 established sound levels. However, to minimize the potential for sound transmission to surrounding structures and sound reflection, follow these instructions:

1. Mount the transformer away from corners, walls or ceilings. For installations which must be near a corner, use

#### 4. ALMACENAJE PREVIO A CONEXION

Mantenga los transformadores en su empaque original, en interiores secos, limpios y a temperatura estable.

#### 5. LOCALIZACION Y MONTAJE

Para todos los transformadores de tipo seco:

- Coloque el transformador en un lugar que facilite el acceso y servicio del personal calificado.
- Instale el transformador de acuerdo a lo provisto en el artículo 450 del NEC (Código Nacional Eléctrico EUA) y/o los códigos o normas locales aplicables.
- Instale el transformador en un circuito eléctrico protegido. No exponga el transformador a sobre voltajes a menos que esté adecuadamente protegido.
- Los transformadores no son a prueba de manipulación y deben ser instalados en localidades seguras lejos de personal no autorizado.
- Ubique el transformador en un área ventilada, libre de humedad excesiva, polvo, suciedad, vapores y gases explosivos y/o corrosivos.
- Instale el transformador con una separación de al menos la distancia mínima indicada en la placa de datos para asegurar la apropiada circulación de aire. Evite obstrucciones en las ventilaciones de los paneles superior e inferior.
- Instale el transformador sobre una superficie suficientemente rígida para soportar el peso de la unidad.
- Instale los transformadores ventilados solamente en posición vertical.
- Los transformadores encapsulados para uso en interiores pueden ser montados en cualquier posición. Para mantener la clasificación en el gabinete 3R, 12, 4 o 4X, el transformador debe ser instalado en posición vertical.

Instalación montada a pared:

- Para transformadores ventilados montados a pared refiera las instrucciones IL009002EN (instrucciones de ensamble para kits de montaje a pared WMB04 y WMB05).
- Peso máximo para WMB04; 1400 Lb. [635 Kg].
- Peso máximo para WMB05; 810 Lb. [367 Kg].
- Transformadores montados a pared no deben instalarse sobre materiales inflamables. No almacene materiales inflamables debajo del transformador.

#### 6. COMO REDUCIR LA TRANSMISION DE SONIDO

Todos los transformadores producen sonido debido a la vibración generada en el núcleo por el flujo magnético alternante. NEMA ST-20 define los niveles promedio máximos de sonido para transformadores de distribución tipo seco. Todos los transformadores de distribución tipo seco son diseñados para cumplir con los niveles de sonido establecidos por NEMA, norma ST-20. Sin embargo, para minimizar la potencial transmisión y reflexión de sonido siga estas instrucciones:

1. Instale el transformador alejado de esquinas, paredes y techos. En instalaciones donde sea necesario estar cerca de

- sound absorbing materials on the adjacent walls and ceiling.
2. Use flexible conduit to make the connections to the transformers.
  3. Locate the transformers as far away as possible from areas where noise is of concern.
  4. Install the transformer over vibration isolators; for better results use Eaton B-Line's vibration isolation products.

## 7. CONNECTING CABLES TO TRANSFORMER TERMINATIONS.

Any standard cable of the conductor size specified in NEC Section 310 can be used. Recommended external cable should be rated 90°C and sized at 75% ampacity for encapsulated transformers and sized at 75°C for ventilated. Connectors should be selected on the basis of the type of cable and cable size used to wire the specific transformer, proper torque should be applied based on the connector's manufacturer recommendations.

- Remove access panels to access the wiring compartment.
- Top entry of cable should be avoided.
- Clean all electrical joints.
- Connect primary wiring first to correct terminal as shown on the transformer nameplate.

- Transformers labeled as "Bi-directional" are suitable for reverse-feeding (back-feeding). Transformers are designed to have the incoming cables connected to the primary terminals. Transformers marked as bi-directional are suited to have the incoming cables connected to the secondary terminals. When the secondary connection is a Y (208Y/120 for example), The neutral terminal (X0 or H0) should not be connected. If the secondary is a delta connection with a center tap (aka lighting tap or convenience tap), the center tap (normally X4) cannot be connected.

When reverse-feeding a transformer the circuit breakers and fuses should be the time-delay type.

Make sure to follow NEC 250 system grounding.



Reverse-feeding a transformer may result in higher than normal inrush currents.

Reverse-feeding a transformer may cause nuisance tripping of overcurrent protective devices.

- una esquina, use materiales que absorban el sonido en paredes adyacentes y techo.
2. Use conducto flexible para hacer las conexiones al transformador.
  3. Instale el transformador lo más alejado posible de áreas donde el ruido sea motivo de preocupación.
  4. Utilice aisladores de vibración en la instalación del transformador, para mejores resultados use aisladores de vibración Eaton B-Line.

## 7. CONEXION DE CABLES A LAS TERMINALES DEL TRANSFORMADOR

Cualquier conductor estándar del calibre especificado por NEC sección 310 puede ser usado. El cable recomendado debe de estar clasificado para 90°C calculado al 75% de ampacidad en transformadores encapsulados, y calculado para 75°C en ventilados. Los conectores deberán seleccionarse específicamente de acuerdo al tipo y al calibre del conductor utilizado en la conexión al transformador, el torque correcto deberá ser aplicado de acuerdo a las recomendaciones del fabricante del conector.

- Remueva los paneles de acceso al compartimiento de alambrado.
- Evite el acceso de cable por la parte superior del gabinete.
- Limpie todas las uniones eléctricas.
- Conecte el devanado primario a la terminal correcta según se muestre en la placa de datos.

- Transformadores etiquetados como "Bidireccional" pueden ser alimentados en reversa (back-feeding). Los transformadores están diseñados para conectar los cables de alimentación a las terminales del primario. Los transformadores marcados como bidireccional pueden recibir cables de alimentación a las terminales del secundario. Cuando la conexión del secundario está en estrella (por ejemplo 208Y/120), La terminal neutral (X0 o H0) no debe ser conectada. Si el secundario es un configuración delta con derivación central (derivación de alumbrado), la derivación central (normalmente X4) no puede ser conectada.

Cuando se alimente un transformador en reversa, las protecciones deben de ser con retardo.

Siga NEC 250 para el Sistema de tierra física.



Alimentar en reversa un transformador puede resultar en corrientes de arranque mayores a lo normal.

Alimentar en reversa un transformador puede causar falsos disparos de las protecciones.



- Insulate any unused tap leads and verify tap connections are tight.
- It is not necessary to loosen or remove any components or hardware for proper operation of this transformer.
- Energize transformer and measure secondary voltage to verify correct voltage.
- De-energize primary circuit and connect secondary wiring to terminations in accordance with nameplate wiring diagram.
- Make sure all connections are tight.
- Re-install access panels.

#### Grounding

As required by the National Electrical Code, connect a ground cable to the transformer enclosure. The transformer core is grounded to enclosure.

### 8. ENERGIZATION AND OPERATION GUIDELINES



Follow the guidelines set forth below. Failure to do so could result in personal injury, death, property damage, or reduced transformer life.

For ventilated transformers only, if moisture is evident, the unit should be dried out by placing it in an oven or by blowing heated air over it. The temperature should not exceed 110° C (230°F) to prevent damage to transformer's insulation.

When the tests and connections are complete, the transformer may be energized.

Do not make any connections other than those shown on the nameplate or diagram. Do not change connections or taps while the unit is energized.

This dry-type transformer was built and tested in accordance with applicable standards of American National Standards Institute and National Electrical Manufacturers Association.

The following operations guides are excerpts from these standards.

The maximum allowed overvoltage is 5% above rated secondary voltage at rated kVA load with load power factor at least 80%. If the transformer is energized while the secondary is not connected to a load, then the voltage applied to the primary must not result in a voltage exceeding 110% of the rated secondary voltage.

Continuous overload capability is not intentionally designed into general purpose transformers. For short term overload capability, See ANSI C57.96-01.250 for guidelines and limitations.

Transformers depend entirely on the surrounding air for adequate ventilation. The ambient should not exceed 40°C

- Aisle las derivaciones sin usar y verifique que conexiones en las derivaciones en uso este apretadas.
- No es necesario el aflojar o remover ningún componente o tornillería para la correcta operación del transformador.
- Energice el transformador y mida el voltaje en la sección secundaria, verifique que el voltaje sea correcto.
- Des energice el circuito primario y conecte las terminales del devanado secundario según la placa de datos.
- Asegúrese que todas las conexiones han sido apretadas.
- Reinstale todos los paneles del transformador.

#### Conexión a tierra (potencial cero)

Por requerimiento del NEC (Código Nacional Eléctrico EUA), conecte el cable de tierra física al gabinete del transformador. El núcleo del transformador esta aterrizado al gabinete.

### 8. GUIA DE ENERGIZADO Y OPERACION



La omisión en el seguimiento de las recomendaciones debajo puede resultar en lesiones severas, muerte o daño en propiedad o reducción de la vida útil del transformador.

Para transformadores ventilados solamente: si existiera humedad evidente, la unidad debe de secarse ya sea dentro de un horno o soplando aire caliente a través de la ella. La temperatura no debe exceder 110° C (230° F) para prevenir daños al aislamiento del transformador.

Una vez probado el transformador y terminadas las conexiones, el transformador puede ser energizado.

No intente realizar conexiones diferentes a las mostradas en la placa de datos. No intente modificaciones o cambio de derivaciones (taps) con el transformador energizado.

Este transformador tipo seco fue construido y probado de acuerdo a normas aplicables ANSI (American National Standards Institute, EUA) y NEMA (National Electrical Manufacturers Association, EUA).

Las siguientes instrucciones de operación son extractos de esas normas.

El sobre voltaje máximo permitido es 5% sobre el voltaje nominal secundario, a carga (kVA) nominal, con un factor de potencia de al menos 80%. Si el transformador se energiza sin que el secundario esté conectado a una carga, entonces el voltaje aplicado al primario no debe provocar un voltaje secundario mayor al 110% del nominal.

Los transformadores de uso general no están diseñados para soportar sobrecargas continuas. Para información acerca de capacidad de sobre carga durante periodos cortos de tiempo, consulte ANSI C57.96-01.250.

(104°F) and the average temperature of the air for any 24 hour period should not exceed 30°C (86°F). For operation at higher ambient, the transformer kVA load needs to be reduced. Refer to NEMA ST-20 for detailed de-rating guidelines.

The transformer may be connected in parallel with other transformers if the phase angle shift is the same; phase rotation is the same; transformers' turn ratios and voltage ratings are within a 0.5% range; and the percent impedance on the same kVA base is within a 7.5% range.

Transformers are normally designed for operation at altitudes below 1000 meters (3300 feet). To operate a transformer above 1000 meters, it is necessary to reduce the kVA load and to increase the electrical insulation clearances between energized terminals. Refer to NEMA ST-20 for detailed guidelines.

## 9. MAINTENANCE AND REPAIR

Follow the instructions set forth below before attempting repairs.

Electrical hazard. Turn off power before servicing.



Immediately replace cover after repair or adjustment.

Lockout power supply before servicing equipment.

Use proper personal protection equipment with qualified personnel only.

It is the responsibility of the owner to inspect, maintain and keep the transformer in good repair.

Report all failures during the warranty period to your local sales office prior to repairs. All warranty repairs must be made or approved by the manufacturer.

A minimal amount of maintenance is required on a dry-type transformers, however, periodic inspection should be performed as indicated below:

- De-energize transformer.
- Make sure the unit is cool before servicing.
- Check for any accumulation of dust or dirt on the terminations or vents. If necessary, remove by vacuuming, brushing, or blowing dry air. Special care should be taken when blowing with dry air to prevent further damage to the product or injury to maintenance personnel from flying particles.
- Inspect insulators, terminals, terminal boards, for tracking (discharge), breaks, cracks, or burns. Clean or repair if necessary.

Los transformadores ventilados dependen completamente del aire circundante para su adecuada ventilación. El ambiente no debe exceder los 40°C (104°F) y el promedio de temperatura del aire no debe exceder los 30°C (86°F) en un periodo de 24 horas. Para operación a temperaturas mayores, la carga del transformador necesita ser reducida. Consulte NEMA ST-20 para una guía detallada de como reajustar la capacidad del transformador.

El transformador puede conectarse en paralelo con otros transformadores solo si: el ángulo de fase es el mismo, la rotación de fase es igual, la relación de vueltas y los voltajes nominales están dentro de un 0.5% del rango, y el porcentaje de impedancia, basado en el mismo KVA, está dentro del rango de 7.5%.

Los transformadores normalmente se diseñan para operar a altitudes por debajo de 1000 metros (3300 Ft.). Para operaciones sobre 1000m es necesario reducir la carga en kVA e incrementar los claros entre terminales energizadas. Consulte NEMA ST-20 para más información.

## 9. MANTENIMIENTO Y REPARACION

Antes de dar mantenimiento siga las instrucciones debajo.

Riesgo eléctrico. Des energice antes de dar mantenimiento.



Coloque de nuevo los paneles después de reparaciones o ajustes.

Bloquee las fuentes de poder antes de dar mantenimiento al equipo.

Use equipo de protección personal adecuado y personal calificado solamente.

Es responsabilidad del propietario la inspección, mantenimiento y reparación del transformador.

Durante la vigencia de la garantía, notifique las fallas a su oficina de ventas antes de intentar reparar el transformador. Toda reparación bajo garantía debe ser hecha o aprobada por el fabricante.

Un transformador tipo seco requiere una cantidad mínima de mantenimiento, sin embargo se requiere de inspecciones periódicas según las indicaciones debajo:

- Des energice el transformador.
- Deje enfriar la unidad antes de darle servicio.
- Busque polvo y suciedad acumulados en terminales y ventilaciones. De ser necesario, remueva con aspiradora, cepillando o soplando aire seco. Se debe tener cuidado al soplar aire seco para prevenir posibles daños al producto o al personal debido a las partículas sueltas.
- Inspeccione por quebraduras, quemaduras y fisuras en aislantes, terminales y soportes de terminales. Limpie o repare según sea necesario.


- Check terminal quality and connections, including taps, for tightness. Replace or tighten as necessary.
- Inspect ground connections and ground contact surfaces. Tighten or repair if needed.
- For ventilated transformers only, if moisture is evident, the unit should be dried out by placing it in an oven or by blowing heated air over it. The temperature should not exceed 110°C (230°F) to prevent damage to installation wiring.
- Inspect the paint finish for scratches or wear. Repair the finish if necessary.

## 10. SAFETY

The installation, operation and maintenance of a transformer present numerous potential unsafe conditions, including, but not limited to the following:

- Improper tap changing operation
- Arc Flash exposure
- Lethal voltages
- Moving machinery
- Heavy components
- High temperature components

All applicable safety procedures as OSHA requirements, regional and local safety requirements, safe working practices, NFPA 70 and good judgment must be used by personnel when installing, operating, and/or maintaining such equipment.

	Failure to adhere to the following could result in severe bodily damage, injury, death, or property damage.
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Refer to appropriate areas of this instruction book for further instructions.

1. When the transformer is energized, the electrical terminations are at high voltages. Close exposure to these parts could result in death by electrocution.
2. Do not remove enclosure panels and/or doors when the transformer is energized. Do not energize transformer for operation until the panels are properly installed.
3. Improper or inadequate maintenance could result in reduced transformer life, cause personal injury, death, or property damage.

## 11. DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITY

There are no understandings, agreements, representations or warranties, express or implied, including warranties of merchantability or fitness for a particular purpose, other than those specifically set out by any existing contract between the

- Revise la calidad y firmeza de terminales y contactos, incluyendo las derivaciones (taps). Apriete o reemplace según sea necesario.

- Revise conexiones y superficies de contacto a tierra (potencial cero). Limpie, apriete o repare según sea necesario.

- Para Transformadores ventilados solamente: si existiera humedad evidente, la unidad debe de secarse ya sea dentro de un horno o soplando aire caliente a través de la ella. La temperatura no debe exceder 110° C (230° F) para prevenir daños al aislamiento del transformador.


- Inspeccione raspaduras o deterioro en el acabado de la pintura exterior del gabinete. Retoque de ser necesario.

## 10. SEGURIDAD

La instalación, operación y mantenimiento de un transformador presenta numerosas condiciones inseguras, incluyendo entre otras:

- Modificar arreglo de derivaciones (taps) inapropiadamente.
- Exposición a arco eléctrico.
- Voltajes mortales
- Equipo en movimiento
- Partes y componentes pesados
- Componentes a altas temperaturas.

Todos los procedimientos de seguridad como los requeridos por OSHA (Occupational Safety & Health Administration, EUA), instituciones como CFE, IMSS y STPS (MEX) u otros aplicables, requerimientos locales y regionales deben ser usados por el personal durante la instalación y mantenimiento del transformador, así como también seguir prácticas de seguridad y buen juicio.

	El no apegarse a las siguientes recomendaciones puede resultar en lesiones severas, muerte o daño en propiedad.
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Para más información refiera las secciones apropiadas de este manual.

1. Cuando el transformador está energizado las terminales eléctricas mantienen un alto potencial (voltaje). El exponerse a estas partes puede causar muerte por electrocución.
2. No remueva los paneles y/o tapas cuando el transformador esté energizado. No energice el transformador sin haber reinstalado dichos elementos.
3. El mantenimiento inapropiado reduce la vida útil de la unidad y puede causar lesiones personales, muerte o daño a la propiedad.

## 11. LIMITES EN RESPONSABILIDAD Y GARANTIA

No hay entendimientos, acuerdos, representaciones o garantías, expresas o implícitas, incluyendo garantías de mercadeo o adecuación a un propósito particular, más que aquellas estipuladas en un contrato existente entre las partes.



parties. Any such contract states the entire obligation of seller, the contents of this document shall not become part of or modify any prior or existing agreement, commitment or relationship.

The information, recommendations, descriptions and safety notations in this document are based on industry experience and judgment with respect to transformers. This information should not be considered to be all inclusive or covering all contingencies. If further information is required the local sales office should be consulted. No warranties express or implied, including warranties of fitness for a particular purpose or merchantability, or warranties arising from course of dealing or usage of trade, are made regarding the information, recommendations, descriptions, and safety notations contained herein. In no event will the manufacturer be responsible to the user in contract, in tort (including negligence), strict liability or otherwise for any special, indirect, incidental or consequential damage or loss whatsoever, including but not limited to damage or loss of use of equipment, plant or power system, cost of capital, loss of profits, or revenues, cost of replacement power, additional expenses in the use of existing power facilities, or claims against the user by its customers resulting from the use of the information, recommendations, descriptions and safety notations contained herein.

Tal contrato establece toda la obligación del vendedor. El contenido de este instructivo no será parte ni modificará cualquier acuerdo, compromiso o relación previa o existente. La información, recomendaciones, descripciones y notas de seguridad se basan en la experiencia y el juicio del fabricante en la industria de transformadores. Este instructivo no cubre ni incluye todas las contingencias posibles. Si requiere más información consulte la oficina local de ventas. Ninguna garantía, expresa o implícita, incluyendo garantías de adecuación a un propósito particular o mercadeo, o garantías surgidas de negociaciones o tratos comerciales, se hace concerniente a la información, recomendaciones, descripciones y notas de seguridad contenidas aquí. En ningún caso el fabricante será responsable ante el usuario en contrato, por agravio, responsabilidad a terceros o de otra forma, por ningún daño o pérdida especial, indirecta, incidental o consecuente, incluyendo pero no limitado a daño o pérdida en el uso de equipo, sistemas de planta o potencia, costo de capital, pérdida de utilidades o ingresos, costo de reemplazo de potencia, gastos adicionales en el uso de instalaciones de potencia existentes, o reclamos contra el usuario de parte de sus clientes por el uso de la información, recomendaciones, descripciones y notas de seguridad contenidas aquí.

**When you need more than 'off the shelf'**

**Eaton's Dry-Type Distribution Transformer Flex Center can help.**

- Customer-driven specs**
  - Custom-painted enclosures
  - Special labeling
  - Tailor-made dimensions and configurations
  - Custom efficiency, sound, altitude, operating ambient, impedance and temperature rise
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## Safety Switch General Information

### Global Specifications

System Voltage	600 VAC
Switch Type	Single Throw - Heavy Duty
Poles/Blades	3-Pole
Amperage	30
Protection	Non-Fusible with No Neutral
Enclosure Type	NEMA 4X (304 Stainless)
Special Paint	No Paint
Fuse Clips	"H" Fuse Clips
Switch Lugs	(1) 14-2
Fungus Proof Treatment	None
Lock-On Provision	None
Fuse Pullers	None
Control Pole	None
Ground Lugs	(1) 14-4
Stainless Mechanism	None
Mill Duty	None

### Cover Controls

QUANTITY	DESCRIPTION
----------	-------------

### Nameplate

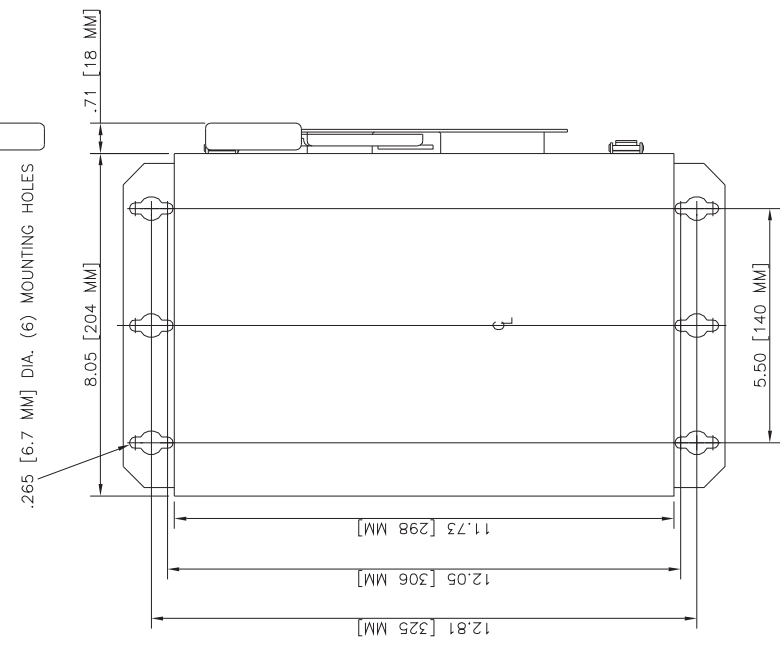
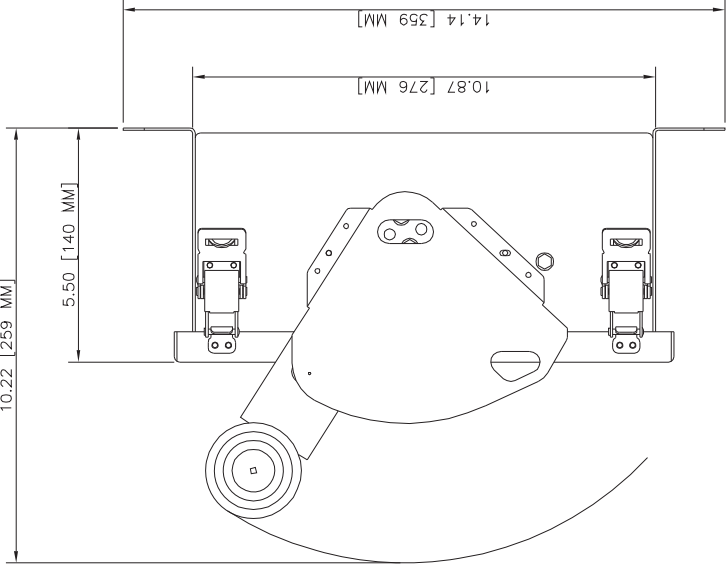
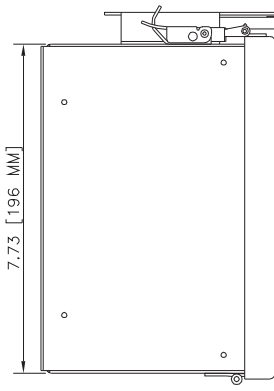
### Field Installed Kits

QUANTITY	DESCRIPTION
1	Ground Lug Kit : DS100GK (Field Installed)
1	Neutral / Ground Kit : DH030NK (Field Installed)

### Safety Switch Catalog No.

DH361UWK

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	SCOTT ARNOLD	7/16/2024				
	APPROVED BY	DATE	JOB NAME	Taunton WWTF Solids		
			DESIGNATION	30A N4X NF		
	VERSION	TYPE		DRAWING TYPE		
	1.0.1.3	Safety Switch General Information		Final		
NEG-ALT Number	REVISION	DWG SIZE	G.O.	ITEM	SHEET	
D7580421X1K1-0004	0	A	SBS1237854	010	1 of 1	



TITLE DIMENSIONS FOR 30 AND 60 AMP 3 POLE NON-FUSIBLE TYPES 4X AND 12

A	WS	RP	DS02331/13/01D	APP. F. BLSCHOF	DATE
B				PARREN SIFE	
C				FIRST ASSY. WHERE LISTED	

**Eaton** Cutler-Hammer **C** 95-1371



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GO/NEG-Alt-Date: SBS1237854-0004-7/16/2024		Job Name: Taunton WWTF Solids
Item Number: 010	Catalog Number: DH361UWK	Designation: 30A N4X NF

## Safety Switch General Information

### Global Specifications

System Voltage	600 VAC
Switch Type	Single Throw - Heavy Duty
Poles/Blades	3-Pole
Amperage	60
Protection	Non-Fusible with No Neutral
Enclosure Type	NEMA 4X (304 Stainless)
Special Paint	No Paint
Fuse Clips	"H" Fuse Clips
Switch Lugs	(1) 14-2
Fungus Proof Treatment	None
Lock-On Provision	None
Fuse Pullers	None
Control Pole	None
Ground Lugs	(1) 14-4
Stainless Mechanism	None
Mill Duty	None

### Cover Controls

QUANTITY	DESCRIPTION
----------	-------------

### Nameplate

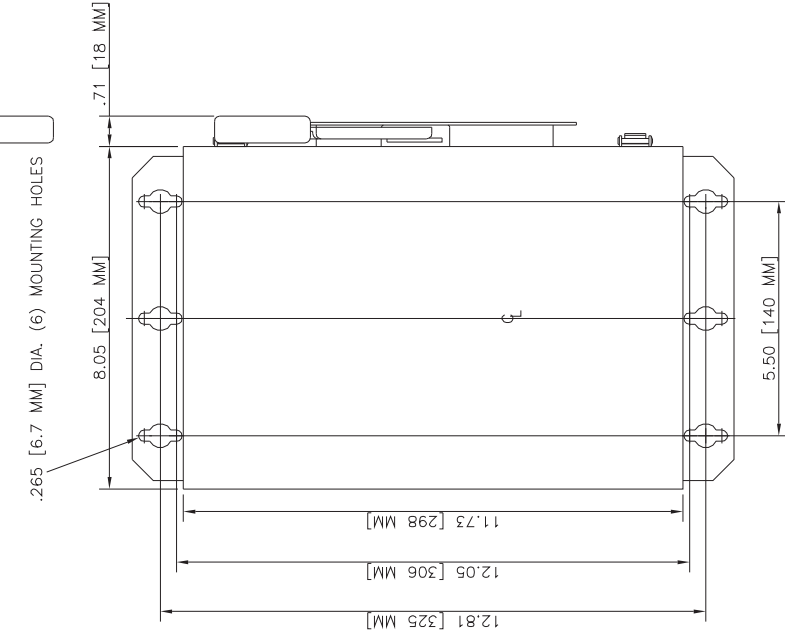
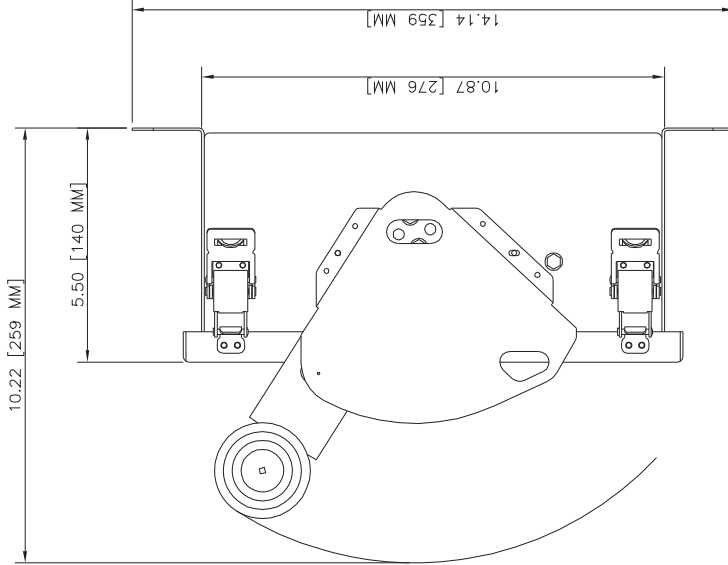
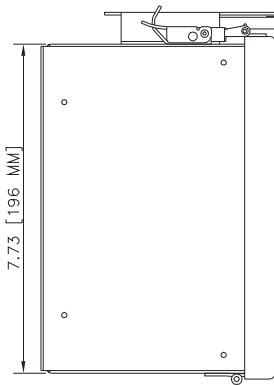
### Field Installed Kits

QUANTITY	DESCRIPTION
1	Ground Lug Kit : DS100GK (Field Installed)
1	Neutral / Ground Kit : DH030NK (Field Installed)

### Safety Switch Catalog No.

DH362UWK

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	APPROVED BY	DATE	JOB NAME Taunton WWTF Solids	DESIGNATION 60A N4X NF	
	VERSION 1.0.1.3	TYPE Safety Switch General Information	DRAWING TYPE Final		
NEG-ALT Number D7580421X1K1-0004	REVISION 0	DWG SIZE A	G.O. SBS1237854	ITEM 013	SHEET 1 of 1



TITLE DIMENSIONS FOR 30 AND 60 AMP 3 POLE NON-FUSIBLE TYPES 4X AND 12

A	WS	RP	DS9331/1/10/1D	APP. F. B.SCHOF. (M)	BY	DATE
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C						

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GO/NEG-Alt-Date: SBS1237854-0004-7/16/2024		Job Name: Taunton WWTF Solids
Item Number: 013	Catalog Number: DH362UWK	Designation: 60A N4X NF

## Safety Switch General Information

### Global Specifications

System Voltage	600 VAC
Switch Type	Single Throw - Heavy Duty
Poles/Blades	3-Pole
Amperage	200
Protection	Non-Fusible with No Neutral
Enclosure Type	NEMA 4X (304 Stainless)
Special Paint	No Paint
Fuse Clips	"H" Fuse Clips
Switch Lugs	(1) 6-300
Fungus Proof Treatment	None
Lock-On Provision	None
Fuse Pullers	None
Control Pole	None
Ground Lugs	(1) 14-4
Stainless Mechanism	None
Mill Duty	None

### Cover Controls

QUANTITY	DESCRIPTION
----------	-------------

### Nameplate

### Field Installed Kits

QUANTITY	DESCRIPTION
1	Ground Lug Kit : DS200GK (Field Installed)
1	Neutral / Ground Kit : DH200NK (Field Installed)

### Safety Switch Catalog No.

DH364UWK

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	SCOTT ARNOLD	7/16/2024				
	APPROVED BY	DATE	JOB NAME	Taunton WWTF Solids		
			DESIGNATION	200A N4X NF		
	VERSION	TYPE		DRAWING TYPE		
	1.0.1.3	Safety Switch General Information		Final		
NEG-ALT Number	REVISION	DWG SIZE	G.O.	ITEM	SHEET	
D7580421X1K1-0004	0	A	SBS1237854	016	1 of 1	







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# **NEMA KS 3**

**GUIDELINES FOR  
INSPECTION AND  
PREVENTIVE MAINTENANCE  
OF SWITCHES USED IN  
COMMERCIAL AND  
INDUSTRIAL APPLICATIONS**



**NEMA Standards Publication KS 3-2010**

*Guidelines for Inspection and Preventive Maintenance  
of Switches Used in Commercial and Industrial Applications*

*Published by:*

**National Electrical Manufacturers Association**

1300 North 17th Street, Suite 1752  
Rosslyn, Virginia 22209

[www.nema.org](http://www.nema.org)

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## Foreword

This is the first edition of NEMA Standards Publication KS 3. To ensure that a meaningful publication was developed, draft copies were sent to a number of individuals and organizations in the public sector having an interest in or responsibility for the purchase, testing, application, use, and preventive maintenance of these products. Their resulting comments and suggestions provided a vital user and general interest input prior to final NEMA approval and resulted in a number of substantive changes to this publication. This publication will be periodically reviewed by the Switches Voting Classification of NEMA for any revisions necessary to keep it up to date with advancing technology. Proposed or recommended revisions should be submitted to:

Vice President, Technical Services  
National Electrical Manufacturers Association  
1300 North 17th Street  
Rosslyn, Virginia 22209

This Standards Publication was developed by the Switches Voting Classification of the National Electrical Manufacturers Association. Approval of this standard does not necessarily imply that all voting classification members voted for its approval or participated in its development. At the time it was approved, the Switches Voting Classification had the following members:

ABB Control, Inc.—Wichita Falls, TX  
Boltswitch, Inc.—Crystal Lake, IL  
Cooper Bussmann—St. Louis, MO  
Eaton Corporation—Pittsburgh, PA  
GE Industrial Solutions—Plainville, CT  
Hubbell Inc.—Bridgeport, CT  
Mersen USA—Newburyport, MA  
Siemens Industry, Inc.—Alpharetta, GA  
Schneider Electric—Palatine, IL

## Introduction

NEMA KS 3 deals with guidelines for inspection and preventive maintenance of switches used in commercial and industrial applications. These guidelines are to be used to identify switches requiring maintenance or replacement. Good practice includes periodic switch maintenance during plant shutdown or during a regular maintenance period as specified, for example, in NFPA 70B. When a switch operates automatically, good practice dictates that the source of the overcurrent should be located, and if it is suspected that the operation was at or near the interrupting rating, the switch condition should be checked prior to circuit re-energization.

When appropriately maintained, switches provide reliable protection for many years. The exact lifetime of the switch, however, is determined by the switch's operational duty and by its environment.

With respect to operational duty, for some circuits there will be occasional overload conditions or low-current fault conditions. Here the operating life will be tens of years. In other circuits, there may be high short-circuit-current faults but it should be noted that bolted faults at the switch interrupting rating are rarely encountered. Short circuit events can significantly reduce the operating life of the switch and may necessitate replacement of the switch. Switches in this Guideline are evaluated to three different UL Standards: UL 98 *Enclosed and Dead-Front Switches*, UL 977 *Fused Power-Circuit Devices*, and UL 1429 *Pullout Switches*. They are subjected to thousands of endurance test operations; overload test operations; and two interrupting tests at maximum short-circuit-current rating. Thus switches have an extensive but finite interrupting capability, and switches that experience multiple high short-circuit-current faults should receive a thorough inspection and be replaced if necessary.

With respect to environmental effects, switches are sometimes exposed to high ambient temperatures, high humidity, and other ambient conditions that are hostile to long term performance. For example, industries may have corrosive environments or could be associated with dusty environments that could affect operating parts.

It is not intended that switches be disassembled for inspection. Rather, NEMA KS 3 should be referenced during periodic maintenance or during specific inspection following a high short-circuit-current fault. This document is intended to ensure that switches are well maintained, and provides guidelines for switch replacement.

This document is divided into separate sections as follows:

**Section 1** presents the scope and referenced standards.

**Section 2** details the safety procedures to be followed.

**Section 3** deals with general guidance.

**Section 4** deals with inspection procedures and describes thermal checks (4.2) and visual checks (4.3) of the enclosure and switch condition. Overheating of the switch would necessitate further investigation, and cracks in the insulation systems would certainly necessitate switch replacement.

**Section 5** deals with preventive maintenance and ensures that the switch's life is not compromised by external conditions. The objectives are that the switch operates in a clean environment and that the terminals are in good condition (5.2), that fuses (if required) are connected properly (5.3), and that wire connectors are in good condition and are correctly torqued (5.4).

**Section 6** deals with non-destructive test procedures that can be used to verify specific operating characteristics of switches. These include the Mechanical Operation Test (6.2), the Insulation Resistance Test (6.3), and the Individual Pole Resistance Test (millivolt drop test) (6.4). Non-compliance to one or more of these tests could necessitate switch replacement.

**Section 7** deals with the operation of accessory devices. Failure of an accessory would lead to replacement of that accessory, or switch replacement if accessories are not removable.

In summary, following an automatic overcurrent interruption at or near its interrupting rating, the condition of any protective device should be checked prior to circuit re-energization. Switches that have experienced multiple high short-circuit-current faults, as evidenced by conditions at the source of the faults, should receive a thorough inspection per the guidelines of NEMA KS 3. This document should also be used for recommended, periodic, preventive maintenance.

## Section 1 GENERAL

### 1.1 Scope

NEMA Standards Publication KS 3 sets forth, for use by qualified personnel<sup>1</sup>, a number of basic procedures that may be used for the inspection and preventive maintenance of switches used in industrial and commercial applications rated up to and including 600 V 50/60 Hz ac or ac/dc.

**NOTE**—Consult the manufacturer for other manufacturer-specific ratings.

The *National Electrical Code*<sup>®</sup> defines several switch types: General Use Switch, Isolating Switch, Motor-Circuit Switch, and Double-Throw Switch. In most cases, a switch is capable of interrupting/disconnecting its rated current at its rated voltage. An Isolating Switch does not have an interrupting rating and is actuated after the circuit has been opened by some other means. A Motor-Circuit Switch is rated in horsepower and is capable of interrupting the maximum overload current of a motor with the same horsepower rating.

The methods outlined may be used to verify specific characteristics of a switch that was originally built and tested in compliance with the requirements of NEMA Standards Publication KS 1. These methods are intended for field application and are, therefore, non-destructive in nature. Accordingly, these methods cannot be used to verify all performance capabilities of a switch since verification of some capabilities requires tests of a destructive nature.

Many tests, including those of a destructive nature, as defined in KS 1, are performed on representative samples of switches by the manufacturer, as part of a routine program of factory inspection.

The KS 3 Standards Publication is not intended, nor is it adequate, to verify proper electrical performance of a switch that has been disassembled, modified, rebuilt, refurbished, or handled in any manner not intended or authorized by the original manufacturer. Such switches should be removed from service.

### 1.2 Referenced Standards

In this publication, reference is made to the latest edition of the standards listed below. Copies are available from the indicated sources.

**National Fire Protection Association**  
1 Batterymarch Park  
Quincy, MA 02169

NFPA 70    *National Electrical Code*<sup>®</sup>  
NFPA 70B   *Recommended Practice for Electrical Equipment Maintenance*  
NFPA 70E   *Standard for Electrical Safety in the Workplace*

---

<sup>1</sup> For purposes of these guidelines, a qualified person is one who has skills and knowledge related to the construction and operation of the electrical equipment and installation and has received training to recognize and avoid the hazards involved. In addition, the person is trained:

- and authorized to test, energize, clear, ground, tag, and lockout circuits and equipment in accordance with established safety practices.
- in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, and flash resistant clothing, in accordance with established safety practices.
- in first aid.

**National Electrical Manufacturers Association**

1300 North 17th Street  
Suite 1752  
Rosslyn, Virginia 22209

*Evaluating Water-Damaged Electrical Equipment*

- NEMA KS 1 *Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)*  
NEMA KS 2 *Distribution Equipment Switch Application and Maintenance Guide, A User's Reference*  
NEMA 250 *Enclosures for Electrical Equipment (1000 Volts Maximum)*

**Underwriters Laboratories, Inc.**

333 Pfingsten Road  
Northbrook, IL 60062

- UL 98 *Enclosed and Dead-Front Switches*  
UL 977 *Fused Power-Circuit Devices*  
UL 1429 *Pullout Switches*

## Section 2 SAFETY PROCEDURES

The inspection and preventive maintenance of switches in service require the user to take all necessary precautions to avoid being injured.

### 2.1 Warning

#### 2.1.1 Switch Testing

**WARNING—Hazardous voltages in electrical equipment can cause death or severe personal injury. Turn off and lock out the power supplying this equipment before performing any of the following operations.**

Unless otherwise specified in this publication, inspection, preventive maintenance, and testing must always be performed on equipment that is de-energized (note that certain tests require control power to conduct the test). Verify that there is no voltage present on incoming line and load terminals (and on control power terminals, if present) and between these terminals and ground to positively ascertain that the equipment is totally de-energized. The disconnecting or isolating means on the line side of the devices being checked and/or tested must be locked in the OFF position to ensure that the equipment will remain de-energized during these procedures.

Safety related work practices described in NFPA 70E must be followed at all times.

#### 2.1.2 Test Equipment

**WARNING—High voltages involved with some test equipment can cause death or serious injury. Do not touch or permit anyone else to touch the switch or the test leads when voltage is applied. Strict adherence to the safety procedures recommended by the manufacturers of the test equipment is required.**

### 2.2 Safety Procedure

In all the following clauses, where removal of the enclosure cover is necessary, the following safety steps must be taken in the sequence shown.

- 2.2.1 Operate the switch to the OFF position. Turn OFF all power supplying the switch to electrically isolate it from all other circuits.
- 2.2.2 Open the enclosure and verify that there is no voltage on the incoming and load conductors (including control power conductors, if present) and between these conductors and ground to positively ascertain that the equipment is de-energized.
- 2.2.3 If disconnection of power and accessory leads, cables, or bus bars is required, be sure to properly identify all connections to ensure safe and accurate reconnection.
- 2.2.4 Before any functional tests are performed, be sure to connect the test switch with properly rated cable torqued to the recommended values marked on the rating label of the switch.

### 2.3 Reinstallation Safety Procedure

- 2.3.1 Do not re-energize equipment until all connections (power and control) are thoroughly checked for accuracy and tightness (torqued to value listed on the rating label), internal areas of enclosure are cleaned of any conductive loose parts or debris, all switches are turned off, and all enclosure covers are reinstalled.

- 2.3.2** If it is necessary to replace the switch, make sure the new switch is properly rated for the application.

### **Section 3 GUIDELINES**

#### **3.1 To Avoid Damaged or Otherwise Inoperable Switches Being Inadvertently Returned to Service**

To avoid damaged or otherwise inoperable switches being inadvertently returned to service, it is suggested that such switches be destroyed.

#### **3.2 Guidance Regarding Inspection and Preventive Maintenance Procedures**

Industrial users have requested guidance regarding inspection and preventive maintenance procedures that could be carried out on a regularly scheduled basis. Sections 4 through 7 of this publication set forth guidelines for inspection, preventive maintenance, and testing. These clauses may be applied independently or in combination to establish such a program. For additional assistance, consult the manufacturer's published instructions or NFPA 70B.

#### **3.3 For Information Regarding Switch Performance and Application**

For information regarding switch performance and application refer to NEMA Standards Publications KS 1 and KS 2, respectively.

#### **3.4 Water-Damaged Switches**

Switches that are known to have been subjected to water damage should be replaced. For additional information, refer to the NEMA document *Evaluating Water-Damaged Electrical Equipment*.

#### **3.5 Switch Inspection Once Each Year**

It is recommended to inspect switches once each year or after any short circuit event.



## Section 4 INSPECTION PROCEDURES

### 4.1 General

The following inspection practices are recommended.

### 4.2 Exposed Surfaces Temperature Check

#### 4.2.1 Purpose

To determine if there is excessive temperature on the external cover of a switch.

**CAUTION**—Severe burns can result from high temperatures. Do not hold hand or fingers in contact with surfaces if excessive heat is felt.

#### 4.2.2 Procedure

A switch that has been carrying its regular load for at least 3 hours just prior to inspection should be tested by feeling the external deadfront surfaces with the palm of the hand.

#### 4.2.3 Results

If the temperature of these surfaces does not permit you to maintain contact for at least 3 seconds, this may be an indication of trouble and investigation is necessary. Thermographic (infrared) scanning has become a useful method of investigating thermal performance. Further investigation may be necessary. Proceed to 4.3.

### 4.3 Inspection of Enclosure Interior

#### 4.3.1 Purpose

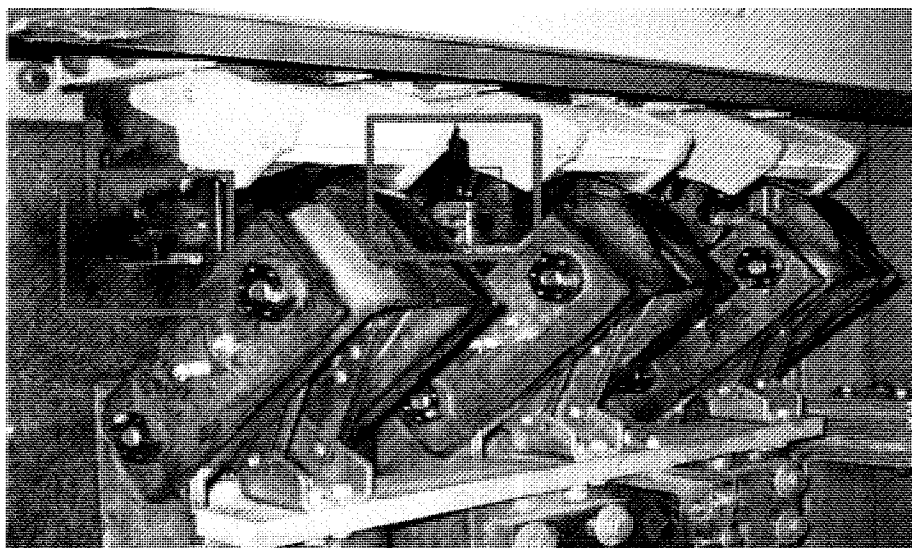
To evaluate the operating environment, the apparent condition of the switch, that proper conductors have been used, and if there is any visual indication that overheating has occurred.

#### 4.3.2 Procedure

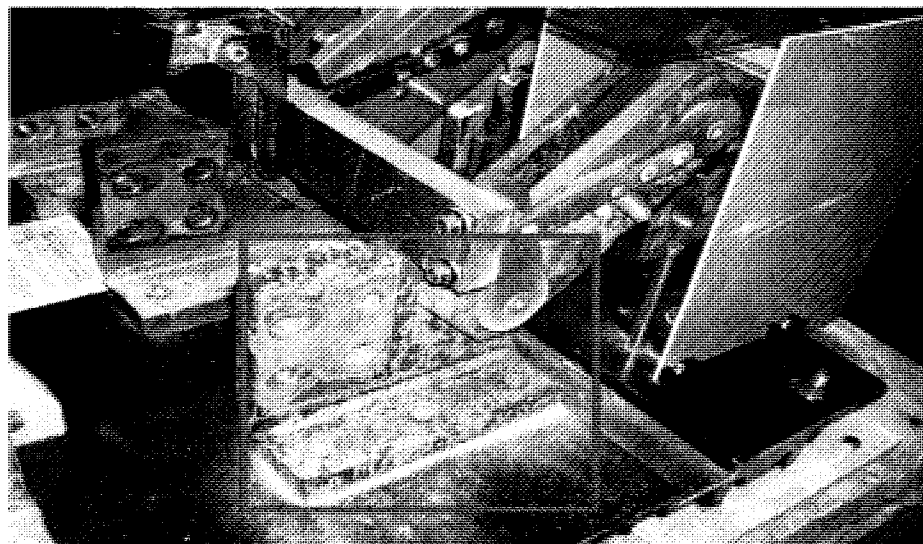
**WARNING**—Follow all safety procedures described in Section 2.

- 4.3.2.1 After being properly isolated, verify that the switch has been properly applied within its marked ratings. If the switch has not been applied within its ratings, it should be replaced with a switch suitable for the application.
- 4.3.2.2 Examine the switch surfaces for the presence of dust, dirt, soot, grease, or moisture. If such contamination is found, the surfaces should be cleaned. Refer to 5.2.2.1 for cleaning and precautionary instructions.
- 4.3.2.3 Examine the switch bases for cracks. The integrity of the base is important in withstanding the stresses imposed during operation. Switches should be replaced if cracks are found.
- 4.3.2.4 Verify that the conductors are of the correct size and type for the application. Visually check all electrical connections to the switch to be certain that such connections are clean and secure. Loose or contaminated connections increase electrical resistance, which can damage insulation and conductors and interfere with proper switch operation. Increased electrical resistance causes overheating of a connection. Such overheating is indicated by discoloration or cracks of the switch bases, discoloration or flaking of external metal parts, or melting or blistering of adjacent wire insulation. Pitting or melting of connection surfaces is a sign of arcing due to a loose or otherwise poor connection. (See Figures 1 and 2.)

- a. If there is no evidence of looseness, e.g., overheating, do not disturb or tighten the connections.
- b. If there is evidence of overheating (as noted in 4.2) or arcing, an investigation of the cause should be made and corrective steps taken. (See Section 5.)



**Figure 1**  
**Pitting**



**Figure 2**  
**Heat Damage**

**4.3.2.5** Examine the switch for evidence of a high short circuit closing operation. Any of the following observations will warrant performing the Section 6 Test Procedures or the replacement of the switch. In some cases, switch interior renewal parts can be obtained from the manufacturer to bring the assembly back to a serviceable condition.

Evidence of excessive high current switch closing operation includes:

- Bright metal or metallic deposits on insulating surfaces or the enclosure interior
- An excessive number of small, bright metal balls resting on the enclosure bottom end wall
- Excessive black film on insulating surfaces or the enclosure interior adjacent to the contact air gap or arc chute exhaust
- Enclosure shape distortion caused by excessive internal pressure
- Contacts not fully engaging or closing
- Rough mechanism operation

#### **4.3.2.6 Reinstallation Procedure**

For reinstallation or replacement of the switch and/or accessories, follow the installation safety procedures given in 2.3 in conjunction with any installation instructions provided by the manufacturer.

## Section 5 PREVENTIVE MAINTENANCE

### 5.1 General

Under normal conditions, properly applied switches require maintenance only for verification of environmental conditions and that the correct enclosure type for those conditions is being used. However, when inspections determine an abnormal condition and indicate the possibility of damage, it may be necessary to perform certain maintenance steps. This clause is intended to assist the user in performing these steps.

These steps cover the only maintenance that should be performed on switches unless specifically authorized by the switch manufacturer.

### 5.2 Environmental Evaluation

#### 5.2.1 Purpose

To examine the operating environment and the switch's physical condition. Preventive maintenance and corrective actions are included as appropriate.

#### 5.2.2 Procedure

**WARNING—Follow all safety procedures described in Section 2.**

The switch enclosure must be opened to perform the following steps and, in some cases, it will be necessary to remove the switch from the enclosure.

**5.2.2.1** After being properly isolated, examine the switch surfaces for dust, dirt, soot, or moisture. If evidence of contaminants or moisture is found, or more than a thin film of dust, dirt, or soot is seen, the switch should be cleaned as suggested below.

The insulating surfaces of the switch should be cleaned using a lint free dry cloth, brush, or vacuum cleaner. Avoid blowing material into the switch or into surrounding equipment.

**CAUTION—**Commercial cleaners and lubricants may attack and damage the plastic insulating materials of the switch. Therefore, such cleaners should not be used. Only the methods described in 5.2.2.1 should be used. Follow manufacturer's recommendations for the use of grease.

Steps should be taken to eliminate the source of the contamination or to provide an appropriate enclosure that will protect against the future entry of contaminants. With respect to the prevention of moisture, the switch should be housed in an enclosure appropriate for the environment.

**5.2.2.2** Examine the switch and terminations for signs of overheating as described in 4.3.2.4. If such evidence is found, the following maintenance steps should be performed.

**5.2.2.2.1** Copper switch terminals and connecting straps (wire connectors and bus bars) can normally be cleaned. They should be carefully disassembled, cleaned, and dressed, following the manufacturer's instructions. All metal and abrasive particles should be removed before reassembling. Care should be taken to ensure that the switch terminals and connecting straps are properly torqued during re-installation.

**CAUTION—**When performing this procedure, extreme care should be exercised to prevent any damage to plated connections or mechanical disturbance to the switch and to prevent any particles from entering the switch mechanism, contacts, or arc suppression areas.

If the damage is extensive, or cannot be corrected by dressing the surfaces, the damaged parts should be replaced if they are intended by the manufacturer to be replaceable. If the damaged parts are not intended to be replaceable, the complete switch and/or bus connections should be replaced.

**5.2.2.2.2** Aluminum wire connectors and bus bars cannot be cleaned or repaired; therefore, they must be replaced.

**5.2.2.2.3** If wire conductors are damaged, the damaged lengths of the conductors should be cut off before reinstalling the conductors. (See 5.4.)

### **5.3 Fuse Provisions**

**5.3.1** If the switch has fuses and a fuse base, visually check the fuse connections to the switch for evidence of looseness, overheating, or arcing on the fuse clips or mounting arrangements for the fuse. (See 4.3.2.4.)

**5.3.2** If the connecting surfaces show evidence of overheating, the switch and fuses should be replaced.

**5.3.3** If there is no evidence of overheating or looseness, do not disturb or tighten the connections.

### **5.4 Wire Connectors**

**5.4.1** If conductors are removed from the wiring connectors, the following steps should be performed.

**5.4.1.1** Examine wire connectors. If the wire connectors appear to be in good condition, they may be reused. If the connectors, screws, or their plating appear worn or damaged, or there is evidence of cross threading or binding, the connector assembly should be replaced.

**5.4.1.2** If the wire conductors are damaged, the damaged wires should be repaired or replaced.

**5.4.1.3** When required, an oxide inhibiting compound should be applied.

**5.4.1.4** All wire connectors should be torqued in accordance with the nameplate marking or the switch manufacturer's instructions.

### **5.5 Reinstallation Procedure**

If the switch needs to be reinstalled or replaced, follow the safety installation procedures given in 2.3.

## Section 6 TEST PROCEDURES

### 6.1 General

The KS 3 Standards Publication is not intended, nor is it adequate, to verify proper electrical performance of a switch that has been disassembled, modified, rebuilt, refurbished, or handled in any manner not intended or authorized by the original switch manufacturer. The following non-destructive tests may be used to verify specific operational characteristics of switches: mechanical operation test, insulation resistance test, and individual pole resistance test (millivolt drop test).

### 6.2 Mechanical Operation Test

#### 6.2.1 Purpose

To verify that the switch mechanism is operating freely.

#### 6.2.2 Equipment

Appropriately rated continuity indicating device.

#### 6.2.3 Procedure

**WARNING—Follow all safety procedures described in Section 2.**

**6.2.3.1** After disconnecting and locking out all power, operate the switch ON and OFF 2 or 3 times. The switch handle should operate smoothly without binding.

**6.2.3.2** Using an ohmmeter or other indicating device, verify that all switch contacts are open when the handle is in the OFF position and closed when the handle is in the ON position.

**6.2.3.3** For switches that are provided with mechanical trip provisions (generally indicated by a test button), operate the tripping means according to the manufacturer's instructions. With the switch in the tripped position, verify that the contacts are open using an ohmmeter (or other indicating device). Reset the switch according to the manufacturer's instructions and operate the switch to the ON and OFF positions. Use an ohmmeter (or other indicating device) to verify that all the contacts are closing and opening respectively.

#### 6.2.4 Results

The switch must be repaired or replaced if:

- a. The contacts are not open with the switch in the OFF position
- b. The contacts are not closed with the switch in the ON position
- c. The switch does not reset
- d. The mechanical trip provisions (if provided) do not trip the switch

#### 6.2.5 Reinstallation Procedure

For reinstallation or replacement of the switch and/or accessories, follow the safety installation procedures given in 2.3.

### 6.3 Insulation Resistance Test

**CAUTION**—If applied incorrectly, the voltages utilized in the insulation resistance tests may damage electronic or other accessory components. Refer to the manufacturer's instructions for guidelines.

**NOTE**—Where the switch can be safely isolated as installed, the test may be performed with the switch in its equipment.

See Figure 3 for typical test set-up.

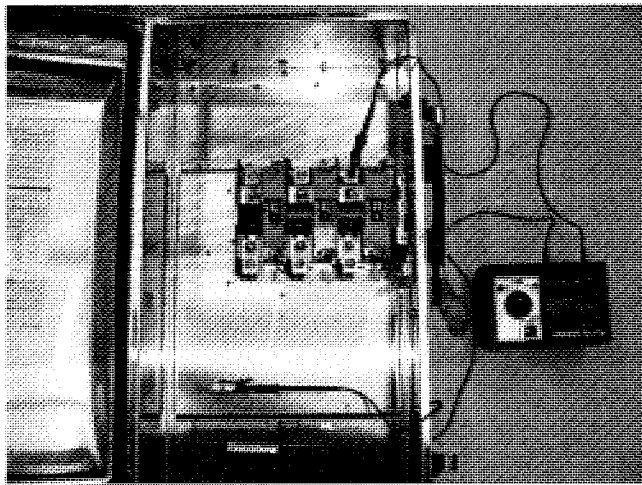
#### 6.3.1 Purpose

To determine the adequacy of the insulation between line and load terminals, between poles, and between each pole and ground.

#### 6.3.2 Equipment

Perform dielectric tests in accordance with the manufacturer's instructions.

This test requires an insulation resistance tester capable of applying a voltage of at least 500 volts. It should also be noted that more in-depth information can be obtained when 1000 volt testers are used since they are more likely to detect deteriorated insulation systems. (See Figure 3.)



**Figure 3**  
**Typical Insulation Resistance Test Set-Up**

#### 6.3.3 Procedure

**WARNING**—Follow all safety procedures described in Section 2.

**CAUTION**—If applied incorrectly, the voltages utilized in the insulation resistance test may damage electronic or other accessory components. To avoid such damage, the following procedure should be adhered to closely. Do not apply test voltages to accessory terminals.

**6.3.3.1** After disconnecting and locking out all power supplying the device to be tested, remove the switch from the electrical system. In cases where the switch can be safely isolated/disconnected from line and load connections as installed, the test may be performed with the switch in its equipment.

#### **6.3.4 Test**

- 6.3.4.1** All exposed metal parts except line, load, and accessory terminals should be electrically connected together.
- 6.3.4.2** Using an insulation resistance tester, apply a voltage of at least 500 volts to determine the resistance. Voltage is to be applied as follows.

**WARNING—High Voltage—Do not touch switch or leads.** See 2.1.2 for proper safety procedure.

- 6.3.4.2.1** Between line and load terminals of each individual pole with the switch in the OFF position and tripped position if possible.
- 6.3.4.2.2** Between terminals of adjacent poles with the switch in the ON position.
- 6.3.4.2.3** From line terminals to the metal enclosure with the switch in the ON position.

#### **6.3.5 Results**

All resistance readings should be one megohm or greater for each measurement. If any reading is less than one megohm, the switch should be replaced or the manufacturer should be consulted before restoring the switch to service. Any reading less than one megohm may indicate contaminated, unsound, or cracked insulating material.

#### **6.3.6 Reinstall Switch**

If applicable, reinstall the switch following the manufacturer's instructions. Also refer to 5.4 for information on reinstalling wire connectors and/or conductors.

#### **6.3.7 Reinstallation Procedure**

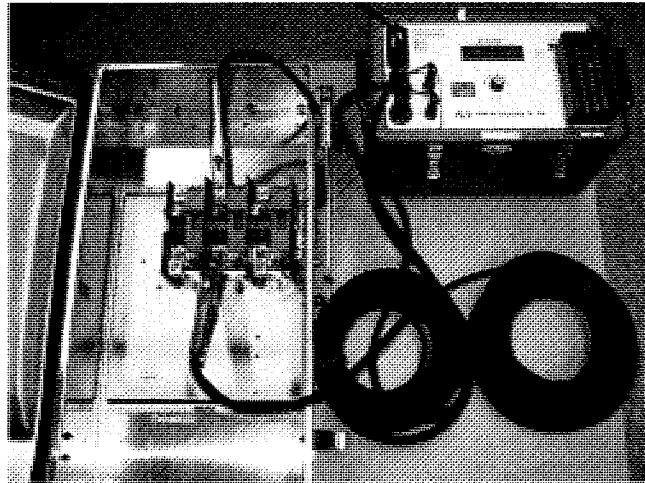
For reinstallation or replacement of the switch and/or accessories, follow the safety installation procedures given in 2.3.

#### **6.4 Individual Pole Resistance Test (Millivolt Drop)**

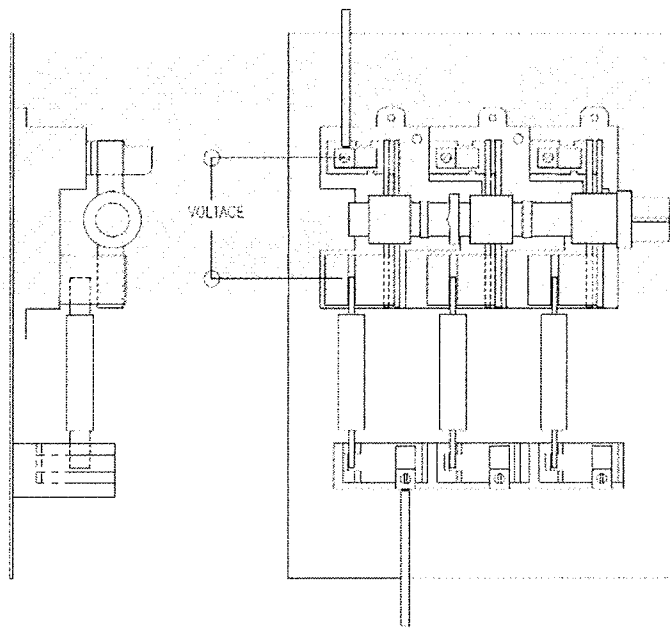
See Figure 4, Figure 5, and Figure 6 for typical test set up.

**NOTE**—The switch should be removed from the equipment for this test. In cases where the switch can be safely isolated as installed, the test may be performed with the switch in its equipment.

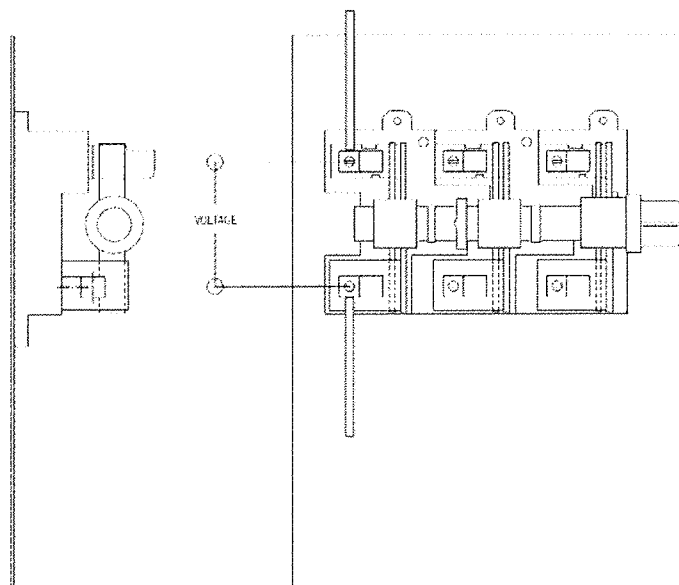




**Figure 4**  
**Individual Pole Resistance Test Set-Up**



**Figure 5**  
**Fused Switch Individual Pole Resistance Test Set-Up**



**Figure 6**  
**Non-Fused Switch Individual Pole Resistance Test Set-Up**

#### 6.4.1 Purpose

To assess the electrical integrity of internal connections and contacts in a switch. This can be done by conducting a millivolt drop test across the line and load terminals of each pole with the switch contacts closed.

The millivolt drop (resistance) of a switch pole can vary significantly because of inherent variability in the extremely low resistance of the electrical contacts and connectors. Such variations do not necessarily predict unacceptable performance and should not be used as the sole criteria for determination of acceptability.

#### 6.4.2 Equipment

**6.4.2.1** This test should be conducted using a 24 volt, or less, direct current power supply capable of supplying the rated current of the switch. For switch rated higher than 500 amperes, the power supply should be capable of delivering no less than 500 amperes.

**6.4.2.2** If the above equipment is not available for field tests, a Digital Low Resistance Ohmmeter (DLRO), or 4-point tester, capable of 10 to 100 amperes (dc) may be used.

**NOTE**—Use of a multimeter or low current ohmmeter in place of the power supply will not provide an accurate or reliable measurement of millivolt drop and should not be used.

**CAUTION**—Do not exceed the current rating of the fuse where the fuse cannot be isolated from the test circuit.

#### 6.4.3 Procedure

**WARNING**—Follow all safety procedures described in Section 2.

**6.4.3.1** After being properly isolated, remove the switch from the enclosure. In cases where the switch can be safely isolated/disconnected as installed, the test may be performed with the switch in its equipment.

#### **6.4.4 Test**

**NOTE**—If the switch is equipped with an under-voltage trip release, energize the trip release to allow proper operation of the switch.

**6.4.4.1** The test is performed as follows.

**6.4.4.1.1** Apply test current across a pole equal to the switch rating (or 500 Amperes minimum for switch rated in excess of 500 Amperes). Record the millivolt drop and the test current. Do not maintain current for more than 1 minute. If this equipment is not available, use the following test.

**6.4.4.1.2** Apply test current across a pole of 10 Amperes, or the Ampere rating of the switch, for switch rated less than 100 Amperes. For switch rated more than 100 Amperes, apply a test current across a pole of 100 Amperes. Record the millivolt drop and the test current, or resistance. Do not maintain current for more than 1 minute.

**6.4.4.1.3** De-energize the test circuit. Manually operate the switch to the OFF and then ON positions.

**6.4.4.1.4** Repeat steps 6.4.4.1.1 and 6.4.4.1.2 for a total of three readings on the pole being tested.

**6.4.4.1.5** Repeat steps 6.4.4.1.1 through 6.4.4.1.3 for each of the remaining poles of the switch.

#### **6.4.5 Results**

Test results will vary according to the switch ampere rating and manufacturer. The manufacturer should be consulted to determine the maximum allowable voltage drop. If the average test values of any pole of the switch exceed the maximum allowable drop, the switch may have reached the end of life and additional tests may have to be conducted.

**NOTE**—Inconsistent readings could be the result of oxide films or foreign material on the contact surfaces, depending on the service history of the switch. If high millivolt or high resistance readings are detected, refer to the manufacturer's recommendations, and if necessary, clean and/or lubricate the contact surfaces, then repeat tests in this section. If results are still out of acceptable range, the switch should not be returned to service.

#### **6.4.6 Reinstall Switch**

If applicable, reinstall the switch following manufacturer's instructions. Also refer to 5.4 for information on reinstalling wire connectors and/or conductors.

#### **6.4.7 Reinstallation Procedure**

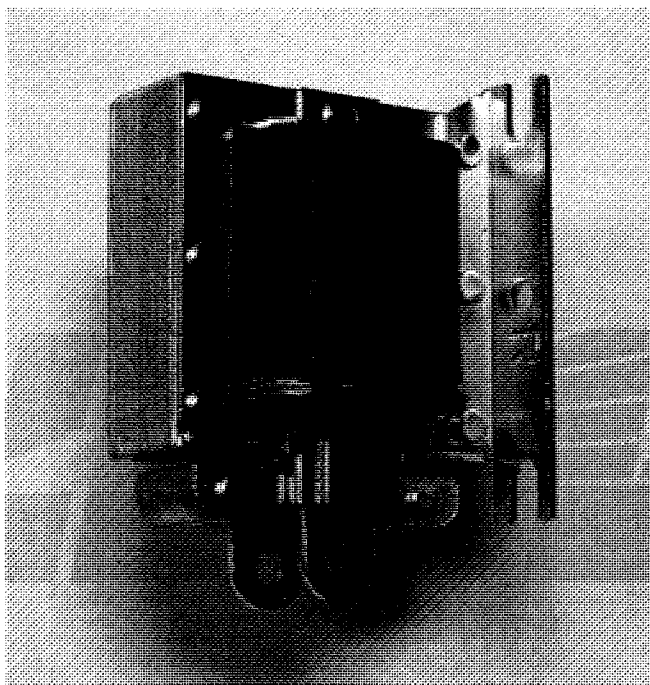
For reinstallation or replacement of the switch and/or accessories, follow the safety installation procedures given in 2.3.

## Section 7 ACCESSORY DEVICE TEST PROCEDURES

### 7.1 General

If testing instructions for the specific accessory being tested are available from the manufacturer, those instructions should be followed to verify the operation of the accessory. If the manufacturer's instructions are not available, the tests described below may be used to verify the basic operation of the accessory.

### 7.2 Shunt Trip Release Tests



**Figure 7**  
**Sample Shunt Trip Release**

#### 7.2.1 Purpose

To verify that the shunt trip release device (Figure 7) will trip the switch when energized.

#### 7.2.2 Equipment

This test requires a power supply capable of maintaining the rated voltage.

#### 7.2.3 Procedure

**WARNING—Follow all safety procedures described in Section 2.**

**CAUTION—**Switches and accessory devices can be damaged if power is applied to the wrong terminals. The specific lead wires or terminals for each accessory must be properly identified before conducting any of the following tests.

**7.2.3.1** After disconnecting and locking out all power, isolate the shunt trip solenoid leads from the control circuit for testing.

**7.2.3.2** Connect a test power supply to the terminals (or leads) of the shunt trip release device.

**WARNING—High Voltage. Do not touch switch or test leads while voltage is applied.**

**7.2.3.3** Operate the switch to the ON position.

**7.2.3.4** Set the power supply voltage to 75% of the rated voltage of the shunt trip and energize. The switch should open. If the switch with shunt trip release is used in a ground fault relay system, use 55% of the rated voltage instead of 75% of the rated voltage.

**CAUTION**—If the switch does not open within 1 to 2 seconds, turn off the test power supply to prevent possible damage to the shunt trip release coil.

**7.2.3.5** When the test is completed, turn off the test power supply, disconnect it from the shunt trip release device terminals (or leads), and reconnect the control circuit wires to the shunt trip release device terminals (or leads). If an under-voltage trip release device was connected during the test, turn off the test power supply, disconnect the test power supply wires, and reconnect the control circuit wires to the under-voltage release device.

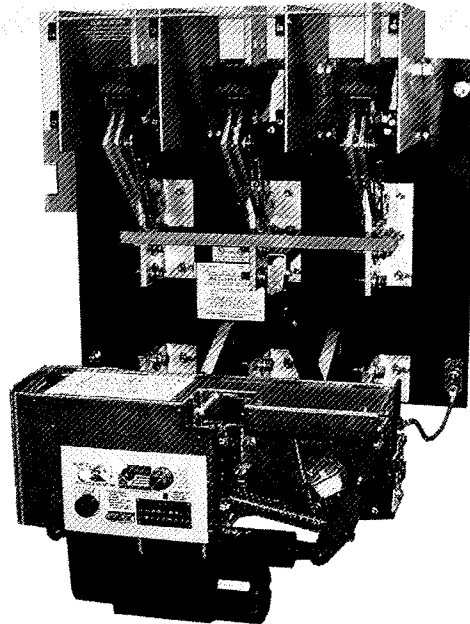
#### **7.2.4 Results**

The switch should open when the power supply to the shunt trip release is turned on. If the switch does not open, check the connections and repeat the test. If the switch still does not open, replace the shunt trip release, if replaceable. If it is not possible to replace the shunt trip release, the switch should be replaced.

#### **7.2.5 Reinstallation Procedure**

If the switch needs to be reinstalled or replaced, follow the safety installation procedures given in 2.3 and the manufacturer's instructions.

### **7.3 Electrical Operator Tests**



**Figure 8**  
**Sample Electrical Operator / Switch Assembly**

### 7.3.1 Purpose

To verify that the electrical operator (Figure 8) will operate the switch to the ON and OFF positions.

### 7.3.2 Equipment

This test requires a power supply capable of maintaining the rated voltage.

### 7.3.3 Procedure

**WARNING—Follow all safety procedures described in Section 2.**

**CAUTION—**Switches and accessory devices can be damaged if power is applied to the wrong terminals. The specific lead wires or terminals for each accessory must be properly identified before conducting any of the following tests.

**7.3.3.1** After disconnecting and locking out all power, remove the control circuit wires from the terminals of the electrical operator.

**7.3.3.2** Set test power supply to the rated voltage of the electrical operator and connect to the terminals of the electrical operator marked "common" and "close" or "on."

**7.3.3.3** With the switch in the OFF position, turn on the test power supply. The switch contacts should close.

**WARNING—High Voltage. Do not touch switch or test leads while voltage is applied.**

**7.3.3.4** Turn the test power supply off. Disconnect its leads to the electrical operator.

**7.3.3.5** Connect the test power supply leads to the terminals of the electrical operator marked "common" and "open" or "off."

**7.3.3.6** With the switch in the ON position, turn on the test power supply. The switch contacts should open.

**7.3.3.7** When the test is completed, turn off the test power supply, disconnect it from the electrical operator terminals, and reconnect the control circuit wires to the electrical operator terminals.

**NOTE—**It may also be possible to test the operation of the electrical operator by leaving the control circuit wiring in place and energized and pushing the "open" and "close" buttons on the operator. Follow step 7.3.3 to ensure that the main power to the switch is disconnected, but the power to the control circuits would be left in place.

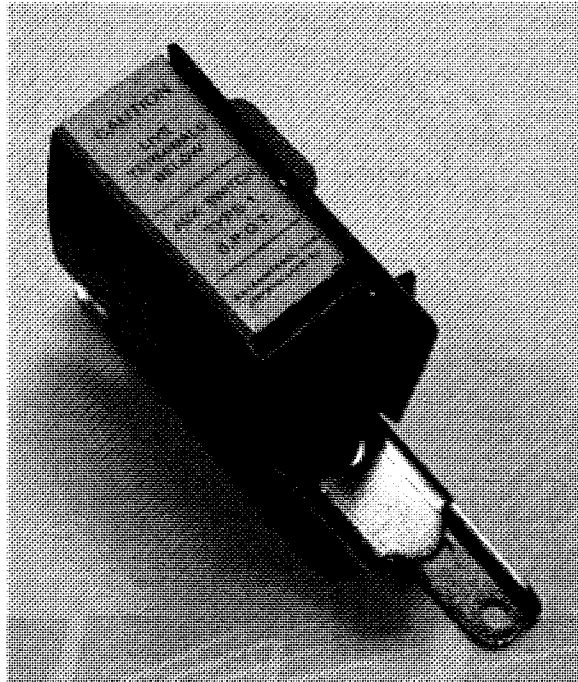
### 7.3.4 Results

The switch should operate to the ON and OFF positions when the above steps are followed. If the switch does not operate properly, check the connections and ensure that there is no obvious obstruction of the operating mechanism and repeat the test. If the electrical operator still does not operate properly, it should be replaced.

### 7.3.5 Reinstallation Procedure

For reinstallation or replacement of the switch and/or accessories, follow the safety installation procedures given in 2.3.

## 7.4 Auxiliary Switch Tests



**Figure 9**  
**Sample Auxiliary Switch**

### 7.4.1 Purpose

To verify that the contacts of the auxiliary switch(es) (see Figure 9) change status when the main switch contacts are opened and closed.

### 7.4.2 Equipment

This test requires an ohmmeter or low voltage continuity tester.

### 7.4.3 Procedure

**WARNING—Follow all safety procedures described in Section 2.**

- 7.4.3.1 Remove the control circuit wires from the terminals (or leads) of the auxiliary switch(es).
- 7.4.3.2 Starting with the main switch in the OFF position, use an ohmmeter or continuity tester connected to the terminals (or leads) of each auxiliary switch, to verify that its contact position (open or closed) is in agreement with the wiring diagram provided by the manufacturer.
- 7.4.3.3 Connect the ohmmeter or low voltage continuity tester to the terminals (or leads) of one auxiliary switch to monitor the contact.
- 7.4.3.4 Operate the main switch to the ON position. The auxiliary switch contact should change position.
- 7.4.3.5 Repeat steps 7.4.3.2 through 7.4.3.4 for each auxiliary switch.

**7.4.3.6** When the test is completed, reconnect the control circuit wires to the terminals (or leads) of the auxiliary switch(es). If an under-voltage trip release device was connected, refer to 7.2.3.5 for instructions.

#### **7.4.4 Results**

Each auxiliary contact should change position (move from open to closed or vice versa) as the main switch is operated from the OFF to ON or ON to OFF positions. If the auxiliary switches do not perform correctly, check the connections and repeat the test. If performance is still incorrect, the auxiliary switches should be replaced; or if the auxiliary switch is not replaceable, replace the complete switch.

#### **7.4.5 Reinstallation Procedure**

For reinstallation or replacement of the switch and/or accessories, follow the safety installation procedures given in 2.3.

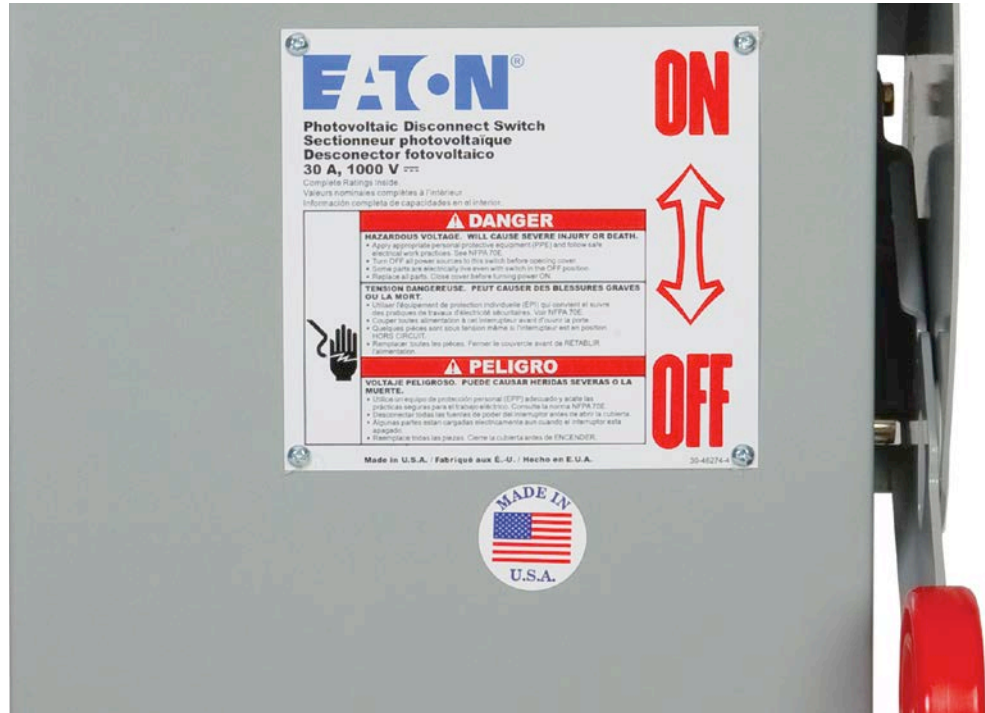
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**EATON**

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# Safety switch renewal parts



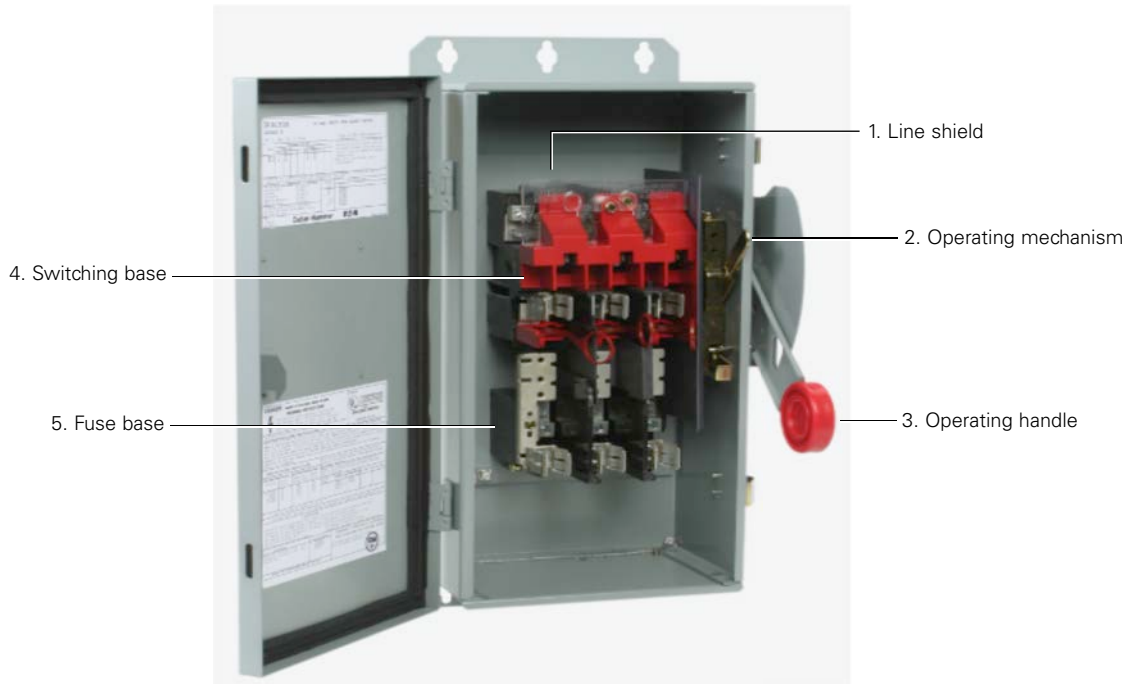
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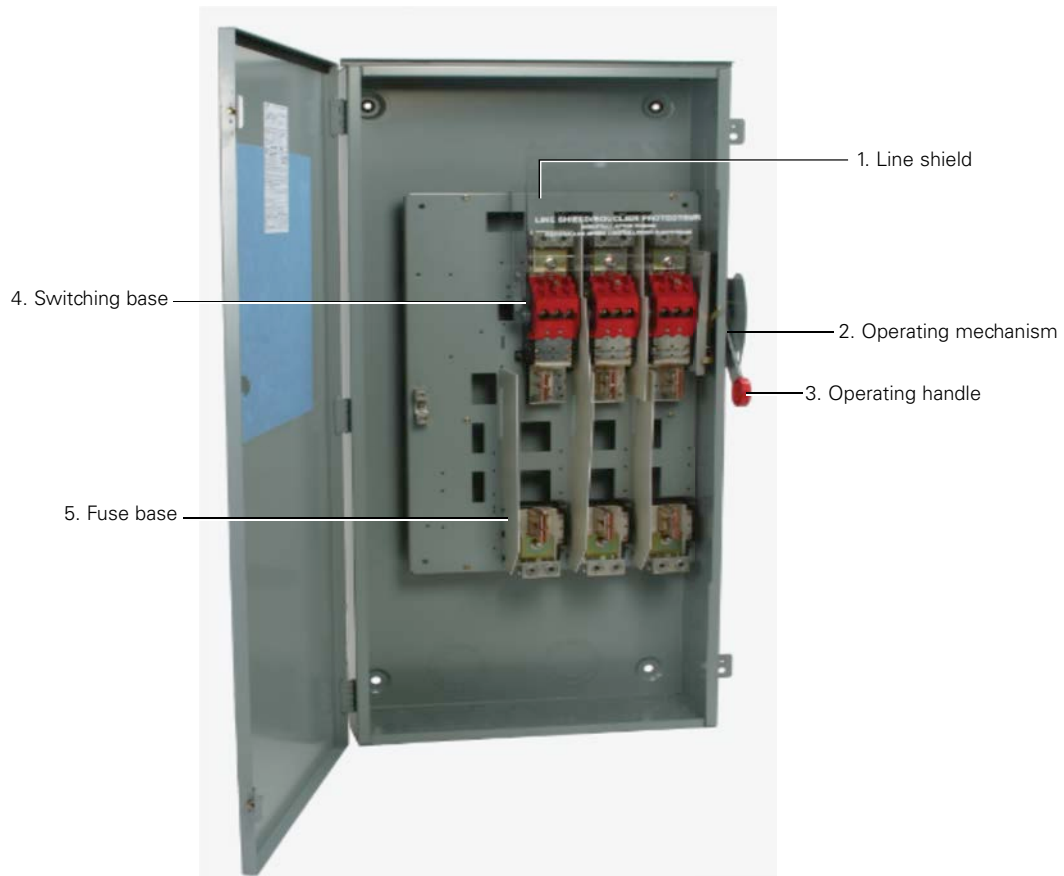


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## Heavy-duty switch



30/60/100 A heavy-duty switch



200-1200 A heavy-duty safety switch

**Table 1. Line shield**

Switch ampere rating	Part number
<b>General-duty two- and three-pole</b>	
400	70-8063-8
600	70-8064-8
<b>Heavy-duty two- and three-pole ①</b>	
30–60	70-7758-34
100	70-7758-35
200	70-7759-11
400	70-8063-8
600–800	70-8064-8
1200	70-8453-4
<b>Double-throw two- and three-pole ②</b>	
30–100	70-7758-35
200	70-7759-11
400	70-8063-8
600	70-8064-8

① Two used for four- and six-pole configurations.

② Two used per switch.

**Note:** 30–200 A general-duty switches do not have line shields installed as standard from the factory.



30–100 A line shield



200–1200 A line shield

**Table 2. Operating mechanism**

Switch ampere rating	NEMA rating	Part number
<b>Heavy-duty switches</b>		
30–100 ①	NEMA® 1/3R/12/4X	70-7813
200	NEMA 1/3R/12/4X	70-7833-4
400	NEMA 1/3R/12/4X	70-7833-5
600–800	NEMA 1/3R/12/4X	70-7833-6
<b>Stainless steel mechanism</b>		
30–100 ①	NEMA 4X EnviroLine	70-8304
200	NEMA 4X EnviroLine	70-8305
400	NEMA 4X EnviroLine	70-8305-2

① For internal window replacement mechanisms, see **Table 6**.

**Note:** Replacement mechanisms are not available for general-duty or double-throw switches.



30–100 A operating mechanism



200–1200 A operating mechanism

**Table 3. Operating handle**

Switch ampere rating	NEMA rating	Part number
<b>General-duty switches</b>		
200–600	NEMA 1 and 3R	70-7833-2
<b>Heavy-duty switches</b>		
30–100 ①	NEMA 1/3R/12	70-7813-2
30–100	NEMA 4X	70-7813-3
200–800	NEMA 1/3R/12	70-7833-2
200–800	NEMA 4X	70-7833-3
1200 ②	Consult factory	

① For internal window replacement handles, see **Table 6**.

② No replacement handles available for the flange style handle on 1200 A switches manufactured prior to 2015.

**Note:** Replacement handles are not available for general-duty or double-throw switches.



30–100 A operating handle



200–1200 A operating handle



30-100 A switching base



200-1200 A switching base



30-100 A fuse base



200-1200 A fuse base

**Table 4. Heavy-duty fusible switches**

Amperes	NEMA rating	4. Switching base	5. Fuse base
<b>Two-pole 240 V</b>			
30	All	70-7758-16	70-7758-29
60	All	70-7758-36	70-7997-4
100	All	70-7758-7	70-7758-23
200	NEMA 1 and 3R	70-8266-3	70-7820-4 ①
200	NEMA 4X and 12	70-7759-7	70-7759-4 ①
400	All	70-8063-3	70-8063-7 ①
600	All	70-8064-3	70-8064-7 ①
800	All	70-8065-3	70-8065-7 ①
<b>Three-pole 240 V</b>			
30	All	70-7758-14	70-7758-26
60	All	70-7997	70-7997-5
100	All	70-7758-3	70-7758-21
200	NEMA 1 and 3R	70-8266	70-7820-4 ①
200	NEMA 4X and 12	70-7759	70-7759-4 ①
400	All	70-8063-4	70-8063-7 ①
600	All	70-8064-4	70-8064-7 ①
800	All	70-8065-4	70-8065-7 ①
1200	All	70-8821	70-8453-3 ①
<b>Two-pole 600 V</b>			
30	All	70-7758-17	70-7758-30
60	All	70-7997-3	70-7997-6
100	All	70-7558-9	70-7558-25
200	NEMA 1 and 3R	Consult factory	70-7820-4 ①
200	NEMA 4X and 12	Consult factory	70-7759-5 ①
400	All	70-8063-5	70-8063-7 ①
600	All	70-8064-5	70-8064-7 ①
800	All	70-8065-5	70-8065-7 ①
<b>Three-pole 600 V</b>			
30	All	70-7758-12	70-7758-27
60	All	70-7997-2	70-7997-7
100	All	70-7758-3	70-7758-21
200	NEMA 1 and 3R	70-8266	70-7820-4 ①
200	NEMA 4X and 12	70-7759	70-7759-5 ①
400	All	70-8063-6	70-8063-7 ①
600	All	70-8064-6	70-8064-7 ①
800	All	70-8065-6	70-8065-7 ①
1200	All	70-8821	70-8453-3 ①

**Table 4. Heavy-duty fusible switches, continued**

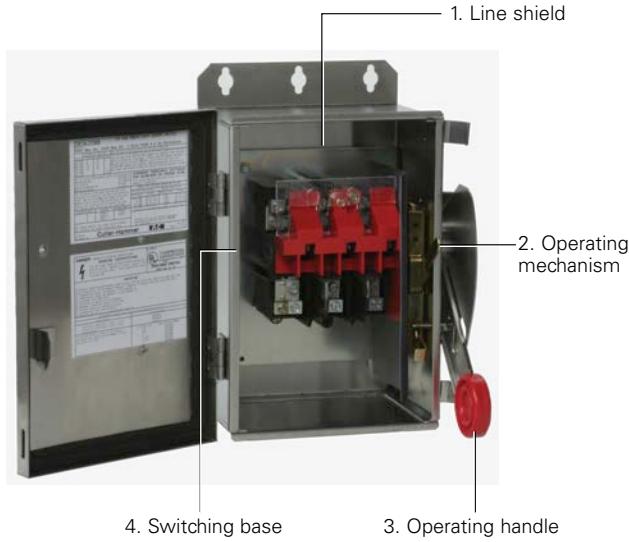
Amperes	NEMA rating	4. Switching base	5. Fuse base
<b>Four-pole 240 V</b>			
30	All	70-7758-16 ②	70-7758-29 ②
60	All	70-7758-36 ②	70-7997-4 ②
100	All	70-7758-7 ②	70-7758-23 ②
200	NEMA 1 and 3R	Consult factory	70-7820-4 ①
200	NEMA 4X and 12	70-7759-9	70-7759-4 ①
400	All	70-8270	70-8063-7 ①
600	All	70-8271	70-8064-7 ①
800	All	Consult factory	70-8065-7 ①
<b>Four-pole 600 V</b>			
30	All	70-7758-36 ②	70-7758-38 ②
60	All	70-7997-2 ②	70-7758-39 ②
100	All	70-7758-7 ②	70-7758-23 ②
200	NEMA 1 and 3R	Consult factory	70-7820-4 ①
200	NEMA 4X and 12	70-7759-9	70-7759-5 ①
400	All	70-8270-2	70-8063-7 ①
600	All	70-8271-2	70-8064-7 ①
800	All	Consult factory	70-8065-7 ①
<b>Six-pole 600 V</b>			
30	All	70-7758-12 ②	70-7758-27 ②
60	All	70-7758-2 ②	70-7758-20 ②
100	All	70-7758-3 ②	70-7758-21 ②
200	NEMA 1 and 3R	Consult factory	Consult factory
200	NEMA 4X and 12	Consult factory	70-7759-5 ①
400	All	Consult factory	70-8063-7 ①
600	All	Consult factory	70-8064-7 ①
800	All	Consult factory	70-8065-7 ①

① Order one per pole.

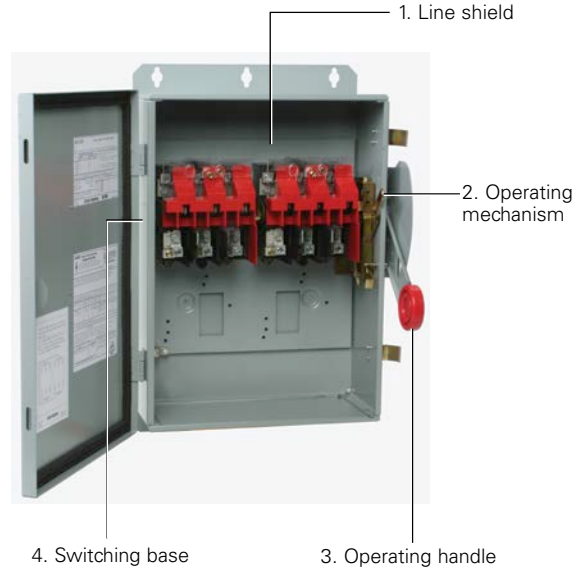
② Order two.

**Note:** General-duty replacement bases are not available.

**Note:** Please contact the TRC for technical questions concerning replacement parts at 1-877-386-2273, option 2 (Technical).



30-100 A heavy-duty non-fusible switch



30-100 A heavy-duty six-pole non-fusible switch

**Table 5. Heavy-duty non-fusible switches**

Amperes	NEMA rating	4. Switching base	5. Lower base ①
<b>Two-pole 600 V</b>			
30	All	70-7758-18	
60	All	70-7758-18	
100	All	70-7758-11	
200	NEMA 1 and 3R	70-8266-2	
200	NEMA 4X and 12	70-7759-2	70-7759-6 ②
400	All	70-8063	
600	All	70-8064	
800	All	70-8065	
<b>Three-pole 600 V</b>			
30	All	70-7758-13	
60	All	70-7758-13	
100	All	70-7758-5	
200	NEMA 1 and 3R	70-8266-2	
200	NEMA 4X and 12	70-7759-2	70-7759-6 ②
400	All	70-8063-2	
600	All	70-8064-2	
800	All	70-8065-2	
1200	All	70-8820	

**Table 5. Heavy-duty non-fusible switches, continued**

Amperes	NEMA rating	4. Switching base	5. Lower base ①
<b>Four-pole 600 V</b>			
30	All	70-7758-40	
60	All	70-7758-41	
100	All	70-7758-42	
200	NEMA 1 and 3R	Consult factory	
200	NEMA 4X and 12	70-7759-10	70-7759-6 ②
400	All	70-8270-3	
600	All	70-8271-3	
<b>Six-pole 600 V</b>			
30	All	70-7758-13 ③	
60	All	70-7758-13 ③	
100	All	70-7758-5 ③	
200	NEMA 1 and 3R	Consult factory	
200	NEMA 4X and 12	70-7759-13	70-7759-6 ②

① Only used in 200 A, NEMA 4X and NEMA 12 switch combinations.

② Order one per pole as needed.

③ Order two.

**Note:** Please contact the TRC for technical questions concerning replacement parts at 1-877-386-2273, option 2 (Technical).

**Internal window replacement parts for safety switches with windows produced prior to May 2015**



30-60 A internal window

**External window replacement parts**



30-60 A external window

**Table 6. Internal window replacement parts**

Switch ampere rating	NEMA rating	Part number
<b>Operating mechanism</b>		
30-100	NEMA 12 and 4X	70-7813-4
30-100	NEMA 4X Enviroline	70-8305
<b>Operating handle</b>		
30-100	NEMA 12	70-7833-2
30-100	NEMA 4X	70-7833-3

**Table 8. External replacement window kits**

Switch ampere rating	NEMA rating	Part number
30-60	NEMA 12	70-8889
30-60	NEMA 4X and 4X Enviroline	70-8889-2
100-1200	NEMA 12	70-8889-3
100-1200	NEMA 4X and 4X Enviroline	70-8889-4

**Table 7. Internal replacement window kits**

Switch ampere rating	NEMA rating	Part number
30-60	NEMA 12 and 4X	70-8564
30-60	NEMA 4X Enviroline	70-8564-2
100	NEMA 12 and 4X	70-8564-3
100	NEMA 4X Enviroline	70-8564-4

**Note:** For internal window switches, use the replacement fuse bases listed on pages 4 and 5. Replacement bases are NOT interchangeable between standard switches and visible blade/exterior window switches.

**Note:** For Internal window replacement parts, use standard replacement parts unless otherwise specified in the table above.

**Note:** Please contact the TRC for technical questions concerning replacement parts at 1-877-386-2273, option 2 (Technical).



**Enhanced visible blade and exterior window replacement bases**

Replacement bases shown below can ONLY replace bases in existing enhanced visible blade/exterior window style switches.



30-60 A exterior window switch



100-1200 A exterior window switch



30-100 A replacement switching base



200-1200 A replacement switching base

**Table 9. Heavy-duty fusible switches**

Amperes	NEMA rating	4. Switching base	5. Fuse base
<b>Two-pole 240 V</b>			
30	All	70-8835	70-7758-29
60	All	70-8838	70-7997-4
100	NEMA 4X and 12	70-8829	70-7758-23
200	NEMA 1 and 3R	70-8856	70-7820-4 ①
200	NEMA 4X and 12	70-8845	70-7759-4 ①
400	All	70-8864	70-8063-7 ①
600	All	70-8870	70-8064-7 ①
800	All	70-8876	70-8064-8 ①
<b>Three-pole 240 V</b>			
30	NEMA 4X and 12	70-8834	70-7758-26
60	All	70-8851	70-7997-5
100	All	70-8825	70-7758-21
200	NEMA 1 and 3R	70-8854	70-7820-4 ①
200	NEMA 4X and 12	70-8843	70-7759-4 ①
400	All	70-8865	70-8063-4 ①
600	All	70-8871	70-8064-7 ①
800	All	70-8877	70-8065-7 ①
1200	All	70-8887	70-8453-3 ①
<b>Two-pole 600 V</b>			
30	All	70-8836	70-7758-30
60	All	70-8853	70-7997-6
100	All	70-8830	70-7558-25
200	NEMA 1 and 3R	Consult factory	70-7820-4 ①
200	NEMA 4X and 12	Consult factory	70-7759-5 ①
400	All	70-8866	70-8063-7 ①
600	All	70-8872	70-8064-7 ①
800	All	70-8878	70-8065-7 ①
<b>Three-pole 600 V</b>			
30	All	70-8832	70-7758-27
60	All	70-8852	70-7997-7
100	All	70-8825	70-7758-21
200	NEMA 1 and 3R	70-8854	70-7820-4 ①
200	NEMA 4X and 12	70-8843	70-7759-5 ①
400	All	70-8867	70-8063-7 ①
600	All	70-8873	70-8064-7 ①
800	All	70-8879	70-8065-7 ①
1200	All	70-8887	70-8453-3 ①

**Table 9. Heavy-duty fusible switches, continued**

Amperes	NEMA rating	4. Switching base	5. Fuse base
<b>Four-pole 240 V</b>			
30	All	70-8835 ②	70-7758-29 ②
60	All	70-8838 ②	70-7997-4 ②
100	All	70-8829 ②	70-7758-23 ②
200	NEMA 1 and 3R	70-8856	70-7820-4 ①
200	NEMA 4X and 12	70-8846	70-7759-4 ①
400	All	70-8880	70-8063-7 ①
600	All	70-8883	70-8064-7 ①
800	All	Consult factory	70-8065-7 ①
<b>Four-pole 600 V</b>			
30	All	70-8838 ②	70-7758-38 ②
60	All	70-8839 ②	70-7758-39 ②
100	All	70-8829 ②	70-7758-23 ②
200	NEMA 1 and 3R	70-8857	70-7820-4 ③
200	NEMA 4X and 12	70-8846	70-7759-5 ③
400	All	70-8881	70-8063-7 ③
600	All	70-8884	70-8064-7 ③
800	All	Consult factory	70-8065-7 ③
<b>Six-pole 600 V</b>			
30	All	70-8832 ②	70-7758-27 ②
60	All	70-8824 ②	70-7758-20 ②
100	All	70-8825 ②	70-7758-21 ②
200	NEMA 1 and 3R	Consult factory	Consult factory
200	NEMA 4X and 12	Consult factory	70-7759-5 ③
400	All	Consult factory	70-8063-7 ③
600	All	Consult factory	70-8064-7 ③
800	All	Consult factory	70-8065-7 ③

① Order one per pole.

② Order two.

③ Order one per pole as needed.

**Note:** The replacement bases listed on pages 7 and 8 CANNOT be used as replacement bases in standard or interior window style safety switches. If the existing switch has a red colored arc shield, then the standard replacement base must be used. If the existing switch has a yellow colored arc shield, then a replacement base must be selected from the tables on pages 7 and 8.

**Note:** Please contact the TRC for technical questions concerning replacement parts at 1-877-386-2273, option 2 (Technical).



## Enhanced visible blade and exterior window replacement bases

Replacement bases shown below can ONLY replace bases in existing enhanced visible blade/exterior window style switches.

**Table 10. Heavy-duty non-fusible switches**

Amperes	NEMA rating	4. Switching base	5. Lower base ①
<b>Two-pole 600 V</b>			
30	All	70-8837	
60	All	70-8837	
100	All	70-8831	
200	NEMA 1 and 3R	70-8855	
200	NEMA 4X and 12	70-8844	70-7759-6 ②
400	All	70-8862	
600	All	70-8868	
800	All	70-8874	
<b>Three-pole 600 V</b>			
30	All	70-8833	
60	All	70-8833	
100	All	70-8827	
200	NEMA 1 and 3R	70-8855	
200	NEMA 4X and 12	70-8844	70-7759-6 ②
400	All	70-8863	
600	All	70-8869	
800	All	70-8875	
1200	All	70-8886	
<b>Four-pole 600 V</b>			
30	All	70-8840 ③	
60	All	70-8841 ③	
100	All	70-8842 ③	
200	NEMA 1 and 3R	Consult factory	
200	NEMA 4X and 12	70-8847	70-7759-6 ②
400	All	70-8882	
600	All	70-8885	
800	All	Consult factory	
<b>Six-pole 600 V</b>			
30	All	70-8833 ③	
60	All	70-8833 ③	
100	All	70-8827 ③	
200	NEMA 1 and 3R	Consult factory	
200	NEMA 4X and 12	70-8848	70-7759-6 ②
400	All	Consult factory	
600	All	Consult factory	
800	All	Consult factory	

① Only used in 200 A, NEMA 4X and NEMA 12 switch combinations.

② Order one per pole.

③ Order two.

**Note:** Please contact the TRC for technical questions concerning replacement parts at 1-877-386-2273, option 2 (Technical).

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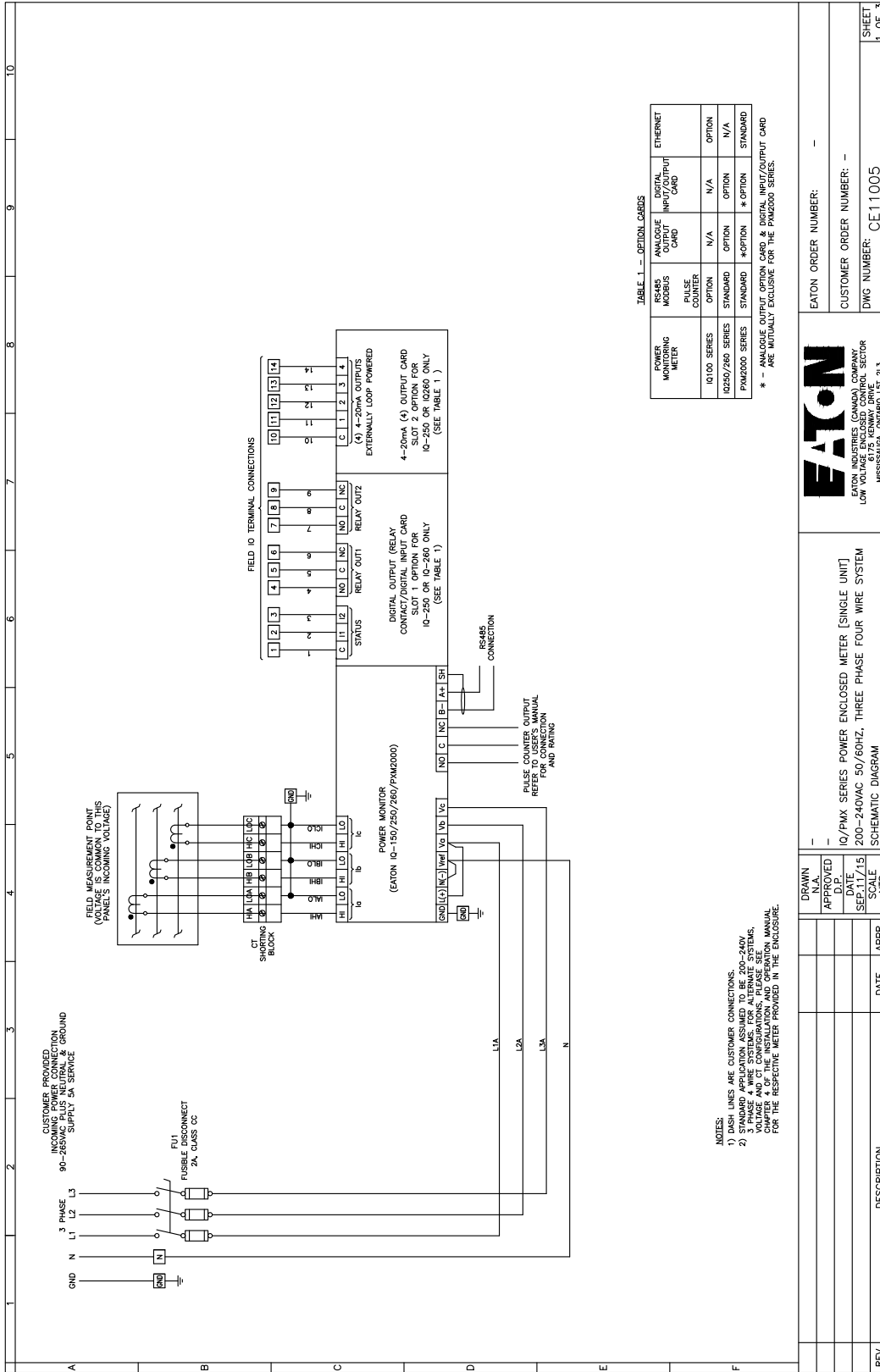
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NOTES:  
 1) DASH LINES ARE CUSTOMER CONNECTIONS.  
 2) STANDARD APPLICATION ASSUMED TO BE 200-240V 50/60HZ, 3PHASE, 4WIRE SYSTEMS. VOLTAGE AND CT CONFIGURATIONS, PLEASE SEE CHAPTER 4 OF THE INSTALLATION AND OPERATION MANUAL FOR THE RESPECTIVE METER PROVIDED IN THE ENCLOSURE.

REV	DESCRIPTION	DATE	APPR.	DESIGN N/A	APPROVED	EATON ORDER NUMBER: -
						CUSTOMER ORDER NUMBER: -
						DWG NUMBER: CE11005
						SHEET 1 OF 3



GO/NEG-AIt-Date: SBS1237854-0004-7/16/2024		Job Name: Taunton WWTF Solids	
Item Number: 020	Catalog Number: PXM2280MA65145-3A	Designation: Enclosed Meter	