

Seismic Qualification of Enclosed Drives and Soft Starters

Retain for future use.

Introduction

This instruction bulletin contains information regarding past requirements for seismic regulatory code compliance, how the International Building Code (IBC) evolved, and techniques for ensuring that facilities and equipment are compliant with current seismic regulatory codes. This bulletin also provides information about the enclosed drives and soft starters seismic qualifications and related supplemental information.

Related Documentation

For additional product information, refer to the latest revision of the instruction bulletins listed in Table 1. These documents ship with the equipment and are available from the Technical Library at www.Schneider-Electric.com.

Table 1: Related Schneider Electric Documentation

Bulletin No.	Title
8638CT0401	Packaged Altistart 48 Soft Starts Catalog
30072-451-51	E-Flex™ Adjustable Speed Drive Controllers Instruction Bulletin
30072-451-52	M-Flex™ Adjustable Speed Drive Controllers Instruction Bulletin
30072-451-53	Altivar® 61/71 PowerGard™ Class 8839 Type CPD 18-Pulse Adjustable Speed Drives Instruction Bulletin
30072-451-83	S-Flex™ Adjustable Speed Enclosed Drive Instruction Bulletin
30072-453-26	Enclosed Altistart™ 22 Instruction Bulletin

International Building Code

Before the year 2000, seismic certification requirements for structures, installed equipment, and related systems in buildings were not very common for states outside the west coast area of the United States. That changed dramatically in March, 2000 when the International Code Council (ICC) published the first IBC. This code was a consolidation of the three existing regional model codes in the U.S.

Critical Facilities

The IBC introduced seismic compliance requirements for critical facilities located in areas with a level of seismicity above a specific threshold. Critical facilities are defined as facilities whose operation is essential for post-event recovery and public safety, health, and welfare. The Federal Emergency Management Association (FEMA), U.S. Geological Survey (USGS), National Institute of Standards and Testing (NIST), and the National Science Foundation (NSF) have all worked closely with the American Society of Civil Engineers (ASCE) to advance seismic mitigation for building codes to maximize the probability that designated critical facilities will be available to support community post-disaster recovery.

Installed Equipment

What is true of a facility is also true of the equipment installed in the facility, including drives and other automation and control equipment. Because the non-structural systems and contents of a facility can exceed the value of the building itself, earthquake mitigation for that equipment and its related systems is critical. It can mean as much as a "\$3 to \$4 payback for every dollar invested in a major construction project."¹

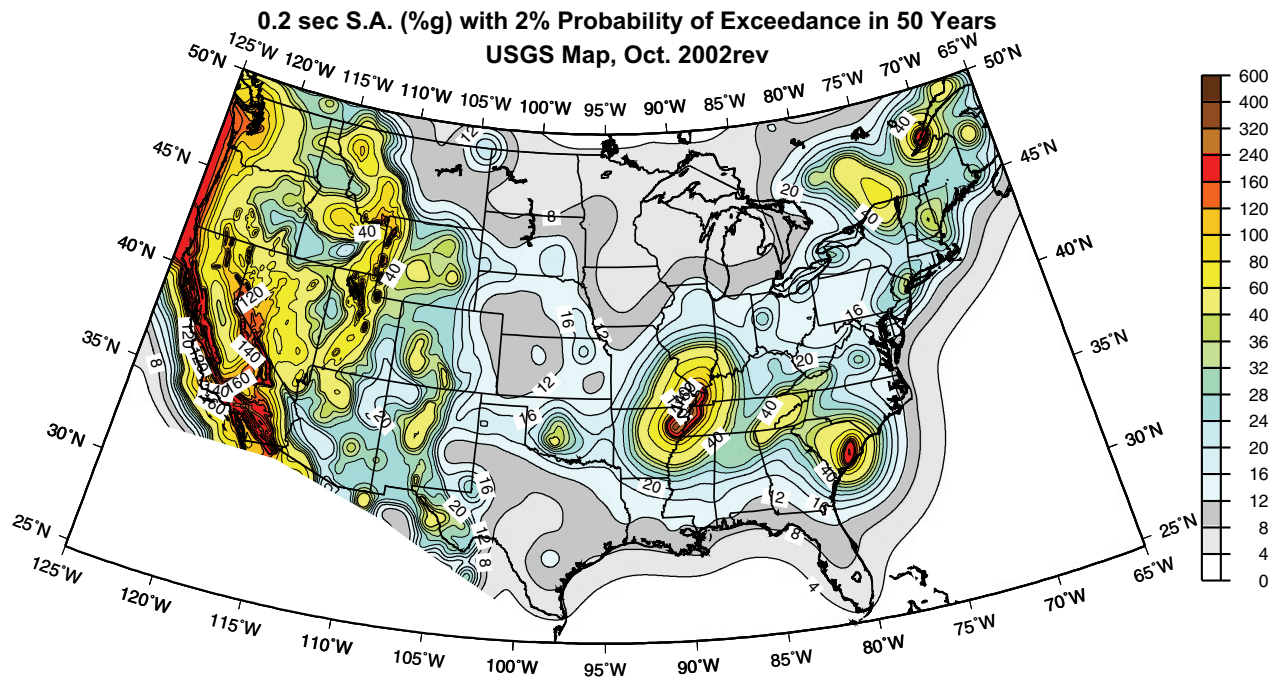
Mandated Code Compliance

For critical facilities, consulting and specifying engineers must now address seismic compliance requirements for the structure as well as the installed equipment and any related systems. The facility location, height, and the critical industrial and institutional applications that occur in the structure all play a role in determining how the seismic code is applied. In the structure, it is the assembled equipment that must be seismically qualified, such as a switchboard or packaged drive, and not the individual components of the equipment.

Seismic Demand vs. Seismic Capacity

The IBC introduces the concept of project specific seismic demand for which the building and its associated equipment must have sufficient seismic capacity to withstand. The design begins when the building design professional obtains the project specific ground motion for the building site, using the code recognized USGS earthquake hazard database (see Figure 1). Ground motions from this database reflect local seismic sources and are used to establish the maximum considered earthquake. The ground motion is then modified to reflect the additional demands that the local site soil conditions and the building structural system can produce in response to the earthquake shaking. This establishes the overall seismic demand that the equipment must have the seismic capacity to absorb. The equipment tested seismic capacity is established by shake table test or other code recognized methods. The code objective is for critical facilities to be capable of being restored to operational status immediately following the design earthquake.

Figure 1: US Probabilistic Hazard Map²



¹ Multihazard Mitigation Council, "National Institute of Building Sciences", Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities, 2005, http://www.nibs.org/MMC/MitigationSavingsReport/natural_hazard_mitigation_saves.htm
² Citation: Frankel, A., C. Mueller, T. Barnhard, D. Perkins, E. V. Leyendecker, N. Dickman, S. Hanson, and M. Hopper, 1996, National seismic hazard maps., U.S. Geological Survey Open File Report 96-532.

Seismic Design Criteria

This site-specific design criteria must be determined by a structural design professional registered in the location where the project is planned. To do this, the design professional follows a code-defined process to establish the basis of seismic design for the facility. This process includes determining:

- The occupancy, or risk targeted category, which establishes the intended use of the building
- The level of seismicity, which is determined by code-referenced seismic hazard maps and geotechnical soil condition, or by an extensive site specific custom engineering study
- The foundation soil classification, which is determined by site-specific geotechnical reports, or otherwise as described by code
- The code-mandated limitations on building type and structural system
- Increases in the structural force-resisting capability to maximize post-event structural integrity
- The location in the facility where the installed equipment and related systems reside, from grade level to roof top. The information relating to installation location is used to determine increased equipment qualification criteria.
- The classification of the system as a "seismic designated system" if it is essential for post-event recovery and facility operation, or if its failure could have a negative impact on essential systems.

Seismic Testing for Drives and Other Components

Critical Facilities

The installer uses criteria established by the structural design professional to ensure that building components such as packaged drives, motor control centers, switchboards, and even light fixtures are tested and certified to withstand a seismic event. Seismic ratings are particularly important for all of the electronic equipment that is part of a seismic designated system in critical facilities, such as hospitals and water treatment plants, as well as schools and other government buildings designated as essential for post-disaster recovery. These facilities must be operational after a catastrophic event. Therefore, the equipment must be designed to withstand the violent forces of a design earthquake and come back online with only minor repair.

Drives in Critical Facilities

It is especially critical that drives be tested and certified to withstand seismic events, as they are becoming an integral component of critical facilities and lifeline systems. The ever improving cost-to-performance of drives positions them to provide superior system solutions with improved stability in response to system transients and energy efficiency over mechanical dampers and valves.

Seismic Qualification of Drives

Because packaged drives are becoming more integral to post-event system operational reliability, it is essential that they have a proven ability to absorb the unusual physical demands of seismic loads and still have a high probability of operating after a design earthquake. Drives in these applications must therefore be subjected to a rigorous seismic qualification program. The consulting engineer specifying the drives must ensure that they include the IBC-required certificate of compliance with the seismic requirements of the location. It is critically important that the engineers, system integrators, and facility managers know exactly where the equipment is being installed, the possible seismic activity in the location,

and whether or not the drives are qualified for the seismic risk. The potential for equipment to be moved to another facility in a different region should also be considered. Electronic equipment, especially drives, should be clearly documented by the manufacturer to include the level of seismic activity for which the components have been qualified.

Using equipment which does not have the IBC-mandated certificate of compliance burdens all parties with an unnecessary risk. Obtaining qualified service personnel, parts, or replacements can be difficult, if not impossible, during the first few days or weeks after a natural disaster. Therefore, using non-compliant equipment is a risk that should be avoided.

Advantages of Shake Table Qualification

The preferred method to determine seismic qualifications for electrical equipment is by shake table testing. This test is performed by anchoring the equipment at the hard points to a shake table, which moves in three axes simultaneously to replicate worst-case earthquake scenarios. Shake table testing typically uses a 30-second random time history of full motion to envelope a wide range of possible earthquake motions.

Figure 2: 18-Pulse Device Mounted to Test Stand at Wyle Labs



ICC ES AC156 was the first industry qualification protocol developed to translate building code seismic requirements into a shake table test. When shake table tests are conducted in accordance with this protocol the result is earthquake-, building-, and site-independent, which means that it is not specific to any one application. Once the testing is complete, the results indicate the product qualification design issues that the consulting engineer must resolve when the components are installed in the structure. The tri-axial shake table earthquake simulation subjects the equipment to dynamic demand that can be more severe than the code design earthquake for most locations. As long as the qualified equipment is installed, anchored, and restrained in accordance with the manufacturer's guidelines regarding a

seismic restraint system that is code compliant, the test is certified as compliant to the ICC ES AC156 protocol criteria for the applicable code.

Alternatives to Shake Table Test

If the equipment is too large for the shake table test, the only other code recognized option is qualification by experience, but this is also an engineering-intensive process and can be problematic due to the number of conditions that must be satisfied and the lack of an up-to-date equipment database, which is required to validate data relevancy.

The preferred proof of compliance is the shake table test which should be used whenever possible.³

Seismic Qualification Mounting Criteria

⚠ WARNING
TOPPLING AND CRUSHING HAZARD
<ul style="list-style-type: none">• Follow all recommended practices when anchoring and securing seismically rated equipment.• Replace all covers and secure doors before placing equipment into service.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

Figure 3: Seismic Qualification Label



Before installing equipment, review all instructional information provided with the equipment and comply with all requirements of storing, shipping, handling, and methods of securing the equipment during physical installation.

Seismic qualification harmonizes the following standards in compliance with ICC ES AC156 acceptance criteria test protocol, with an importance factor of 1.5:

- IBC (International Building Code)
- NFPA 5000 (Building Code—National Fire Protection Agency)
- CBC (Canadian Building Code)
- ASCE/SEI 7 (American Society of Civil Engineers)

For seismic rating installation compliance:

- Follow the anchorage and mounting guidelines on the seismic qualification labels attached to the controller, either wall-mounted or rigid floor-mounting, with or without supplemental lateral bracing.
- Use SAE grade 5 bolts and washers (Belleville washers were called for in the instruction manual).
- Torque all bolts to applicable SAE standards for grade 5 hardware, considering all plating and lubricant factors.

³ FEMA 450-1, -2, National Earthquake Hazards Reduction Program, Part 2: Commentary, 2003, <http://www.bssconline.org/>

Equipment Outline Detail and Center of Gravity

Center of gravity information is provided for reference in mounting and for consideration in structural analysis. For additional detail, please consult the product literature listed in Table 1 on page 1.

S-Flex Wall-Mounted Drives

Figure 4: S-Flex Wall-Mounted Drives

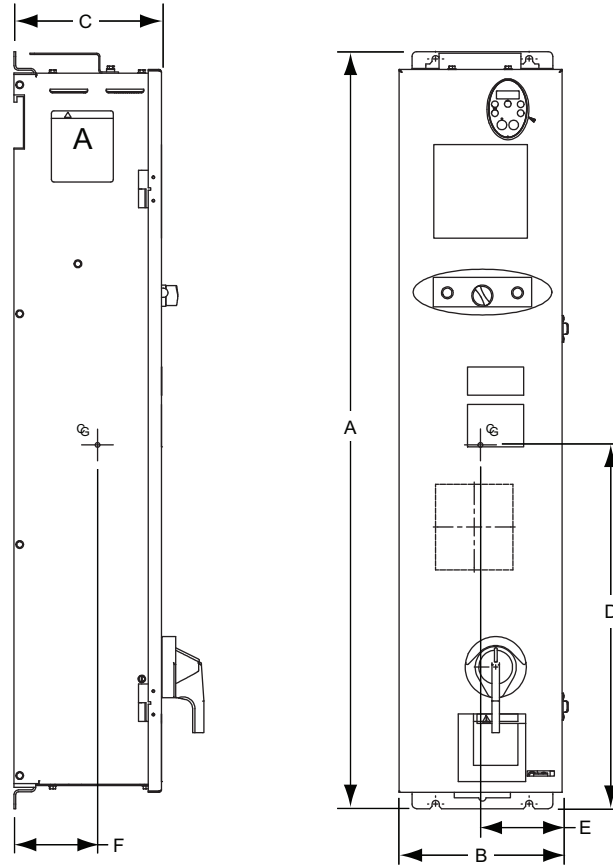


Table 2: S-Flex Wall-Mounted Drives Outline and Center of Gravity Dimensions ¹

Enclosure	Dimensions (see Figure 4)					
	A	B	C	D	E	F
Size A	40	9	8	19	5	4
Size B	45	13	9	23	6	5
Size C	62	13	11	35	6	6
Size D	65	15	12	38	7	5

¹ All values are given in inches, +/- 1 inch tolerance.

**E-Flex and M-Flex
Wall-Mounted Drives**

Figure 5: E-Flex and M-Flex Wall-Mounted Drives

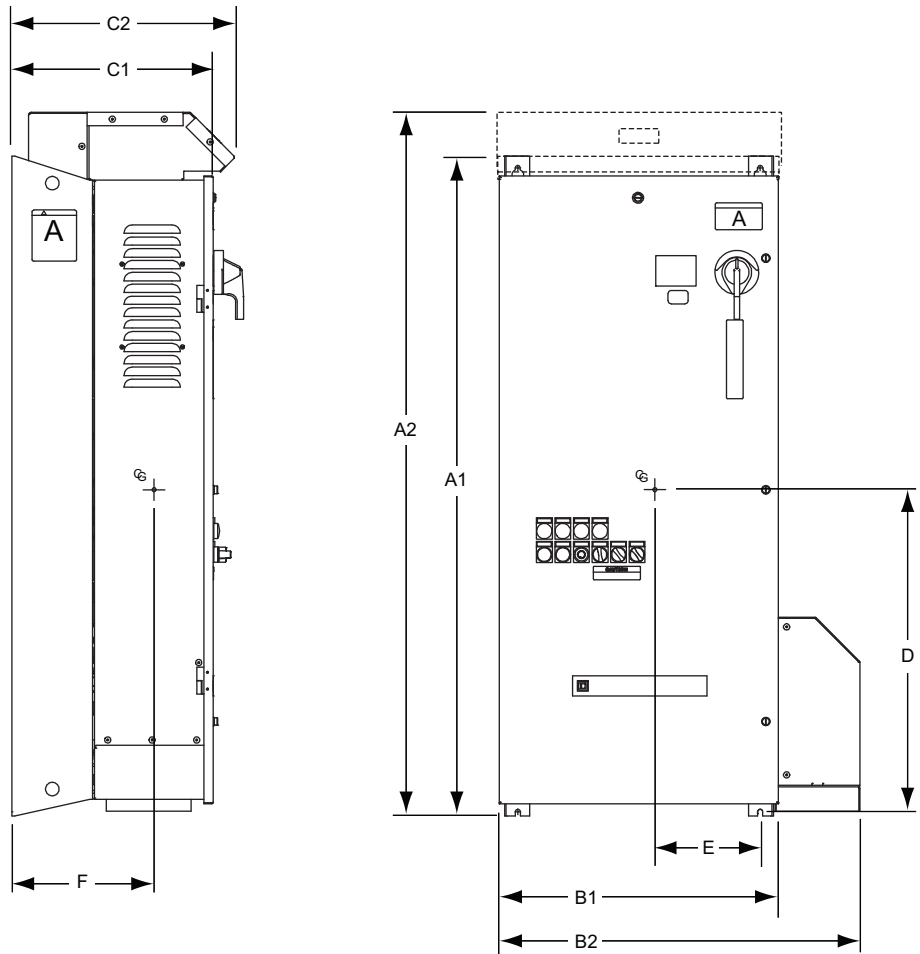


Table 3: E-Flex/M-Flex Wall-Mounted Drives Outline and Center of Gravity Dimensions ¹

Enclosure	Dimensions (see Figure 5)								
	A1	A2 ²	B1	B2 ²	C1	C2 ²	D	E	F
Size A	35	38	15	21	12	14	21	6	6
Size B	41	44	21	27	13	15	22	9	6
Size C	49	52	21	27	15	17	24	8	1
Size D	63	66	26	33	15	17	34	11	11

¹ All values are given in inches, +/- 1 inch tolerance.

² Dimension applies for E-Flex Type 3R enclosure only.

M-Flex Floor-Mounted Drives

Figure 6: M-Flex Floor-Mounted Drives

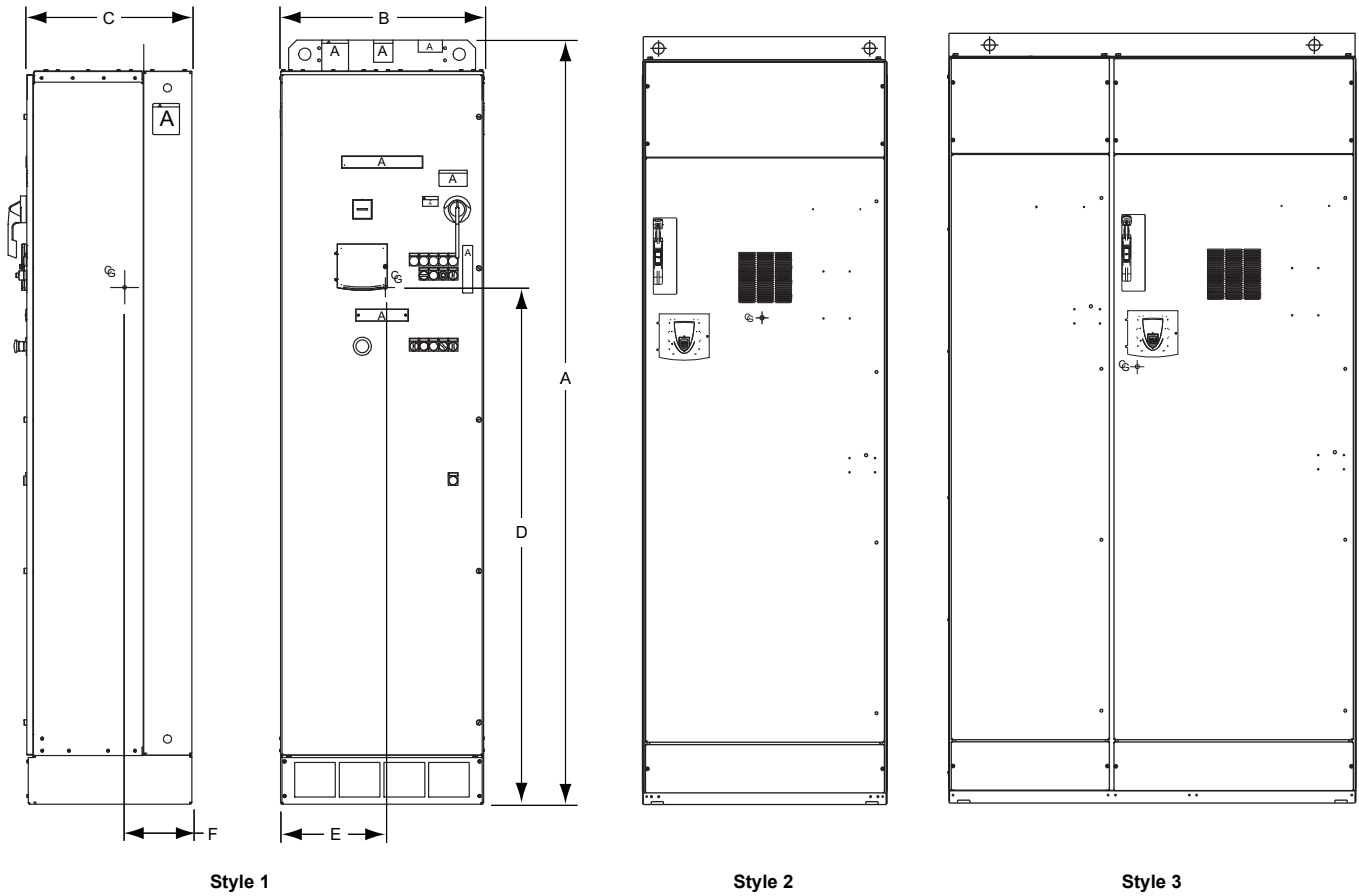


Table 4: M-Flex Floor-Mounted Drives Outline and Center of Gravity Dimensions ¹

Enclosure	Style	Dimensions (see Figure 6)					
		A	B	C	D	E	F
Size E	1	94	20	20	61	10	8
Size F	1	94	25	20	63	13	8
Size C/D BB ²	1	94	20	20	63	10	8
Size E BB ²	1	94	25	20	60	13	8
Size F BB ²	1	94	30	20	60	16	8
Size H	2	95	25	20	60	12	8
Size H with INT BYP ³	3	95	45	20	60	24	9
Size H BB ²	3	95	50	20	61	24	9
Size I	2	95	30	20	60	15	10
Size I with INT BYP ³	3	95	50	20	60	28	10
Size I with BB ²	3	95	55	20	60	25	9
Size J	2	95	35	20	57	15	10

¹ All values are given in inches, +/- 1 inch tolerance.

² BB is an abbreviation for barriered bypass power circuit.

³ INT BYP is an abbreviation for Internal Bypass.

Clean Power Drives

Figure 7: Clean Power Drives

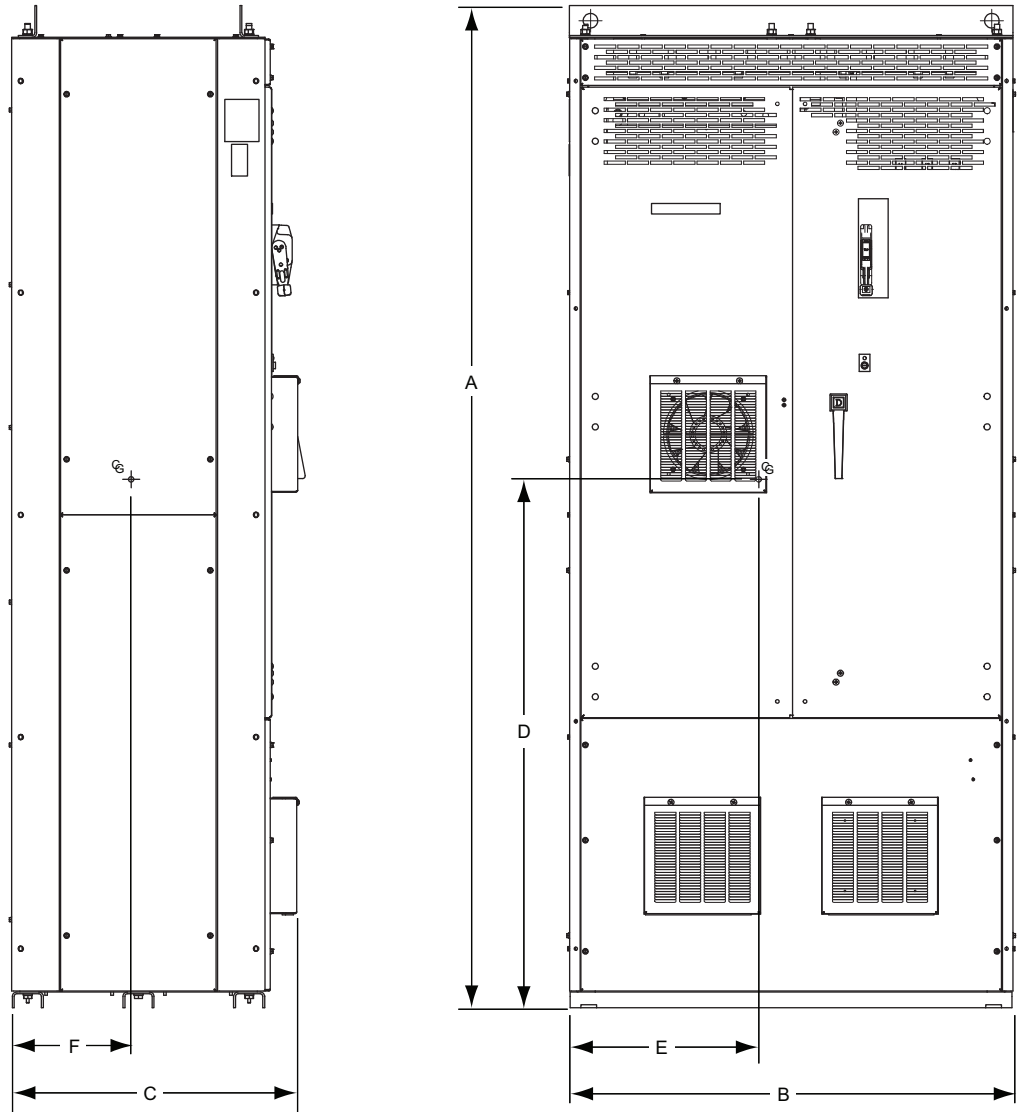


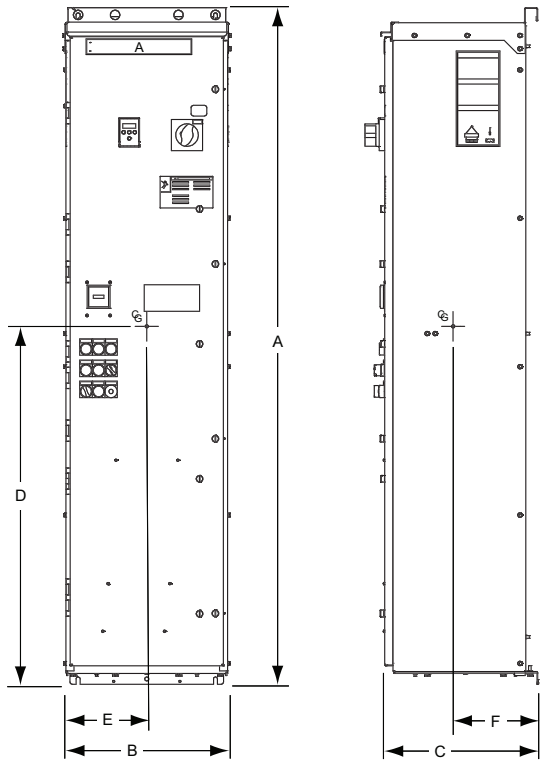
Table 5: Clean Power Drives Outline and Center of Gravity Dimensions ¹

Enclosure	Dimensions (see Figure 7)					
	A	B	C	D	E	F
36W	95	36	29	52	15	11
42W	95	42	29	50	18	11
48W	95	48	29	53	21	11
54W	95	54	29	53	23	11

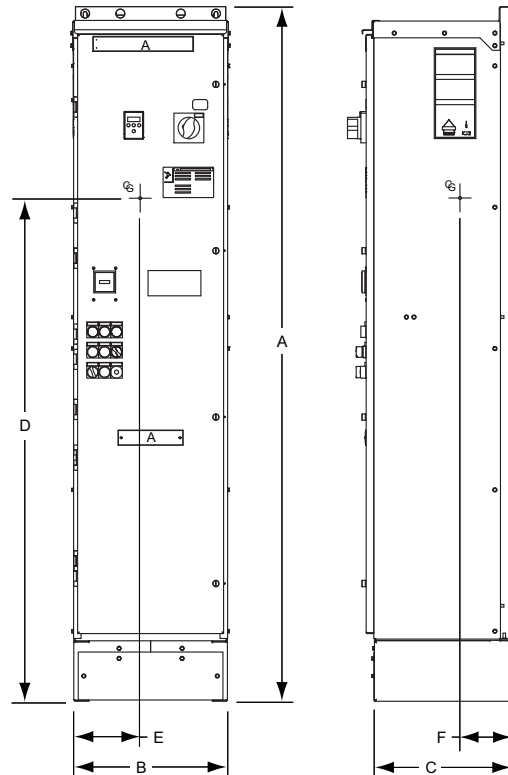
¹ All values are given in inches, +/- 1 inch tolerance.

Enclosed 22 Soft Starters

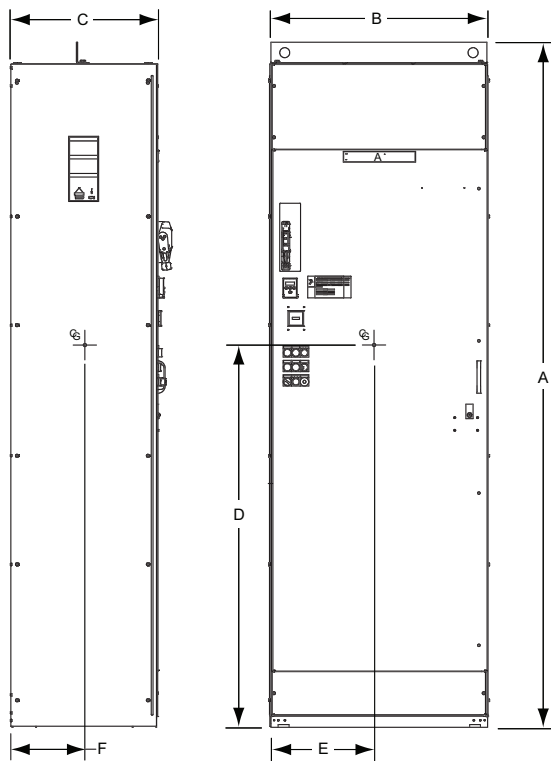
Figure 8: Enclosed 22 Soft Starters



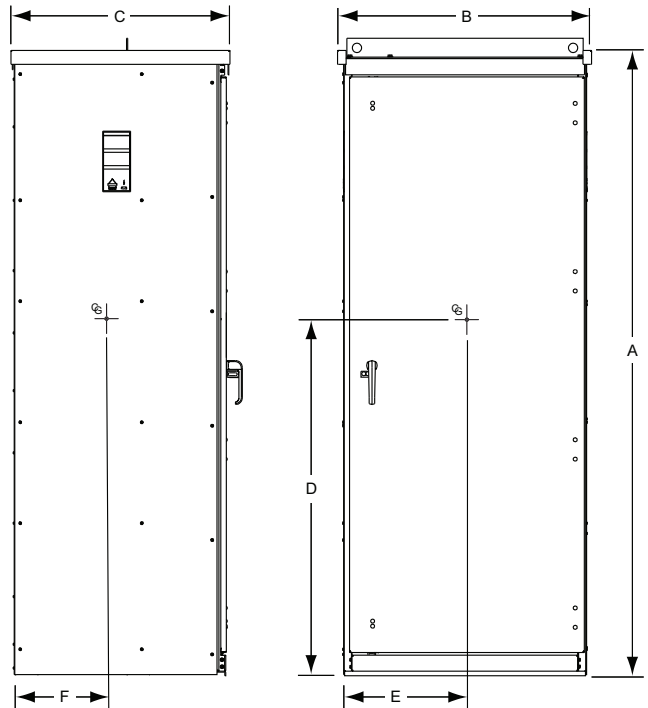
Style 1 — Wall Mounted



Style 2 — Wall Mounted with Floor Mounting Adapter



Style 3 — Floor Mounted Type 1/12



Style 2 — Floor Mounted Type 3R

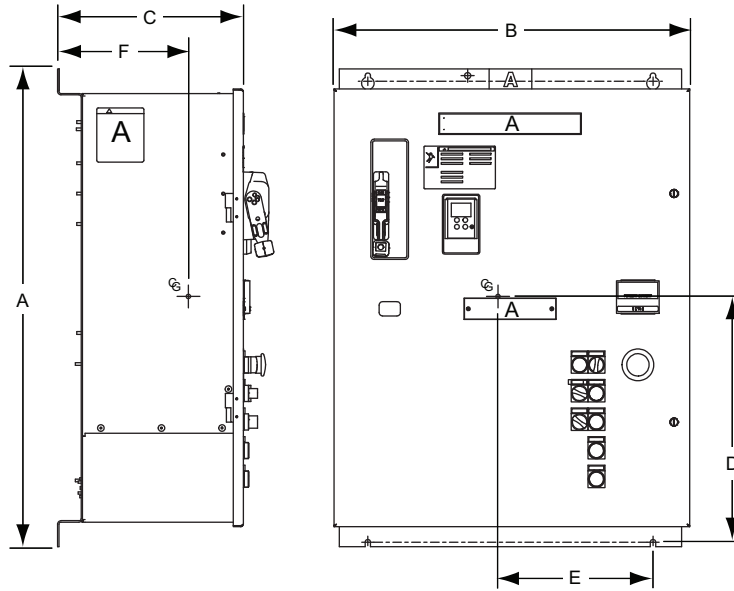
Table 6: Enclosed 22 Soft Starters Outline and Center of Gravity Dimensions¹

Enclosure	Style	Dimensions (see Figure 8)					
		A	B	C	D	E	F
Size A	1	32	11	11	15	5	7
Size B	1	48	13	12	25	6	8
Size C	1	52	14	12	27	6	7
Size D	1	64	15	14	33	7	8
Size D with Floor Mounting Adapter	2	69	15	14	50	7	5
Size E	3	95	20	20	55	9	10
	4	95	28	33	56	13	14
Size F	3	95	25	20	54	12	10
	4	95	33	33	56	16	13
Size G	3	95	30	20	53	14	10
	4	95	38	33	53	18	14

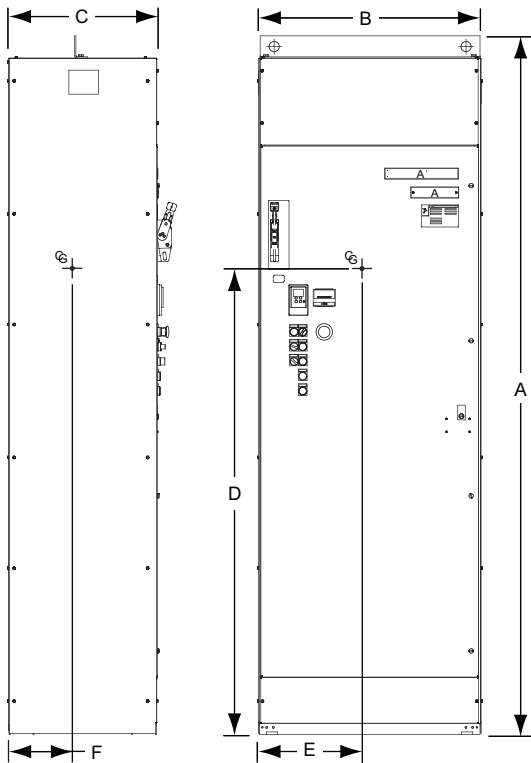
¹ All values are given in inches, +/- 1 inch tolerance.

Enclosed 48 Soft Starters

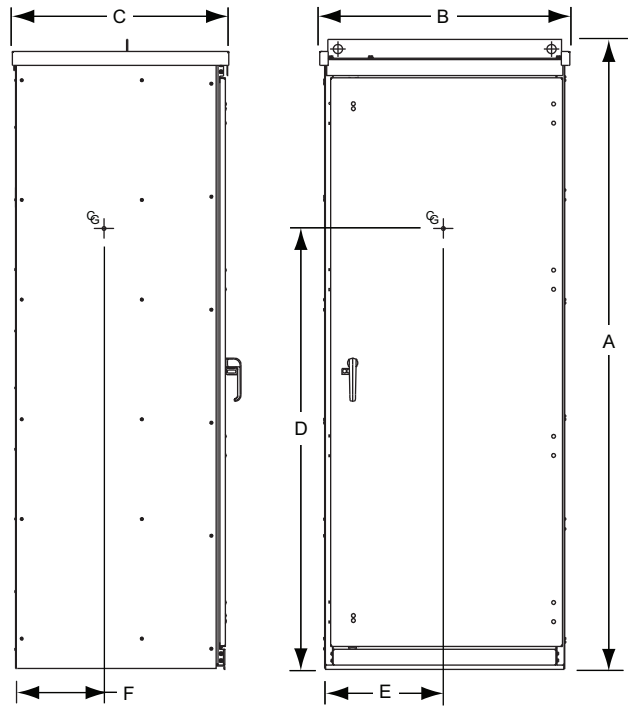
Figure 9: Enclosed 48 Soft Starters



Style 1 — Wall Mounted



Style 2 — Floor Mounted Type 1/12



Style 3 — Floor Mounted Type 3R

Table 7: Enclosed 48 Soft Starters Outline and Center of Gravity Dimensions¹

Enclosure	Style	Dimensions (see Figure 9)					
		A	B	C	D	E	F
Size A	1	33	25	13	17	11	10
Size B	1	46	19	13	23	7	9
Size C	1	62	19	13	30	7	9
Size D	2	95	20	20	62	10	9
	3	95	28	33	67	13	14
Size E	2	95	30	20	63	14	9
	3	95	38	33	66	18	13

¹ All values are given in inches, +/- 1 inch tolerance.

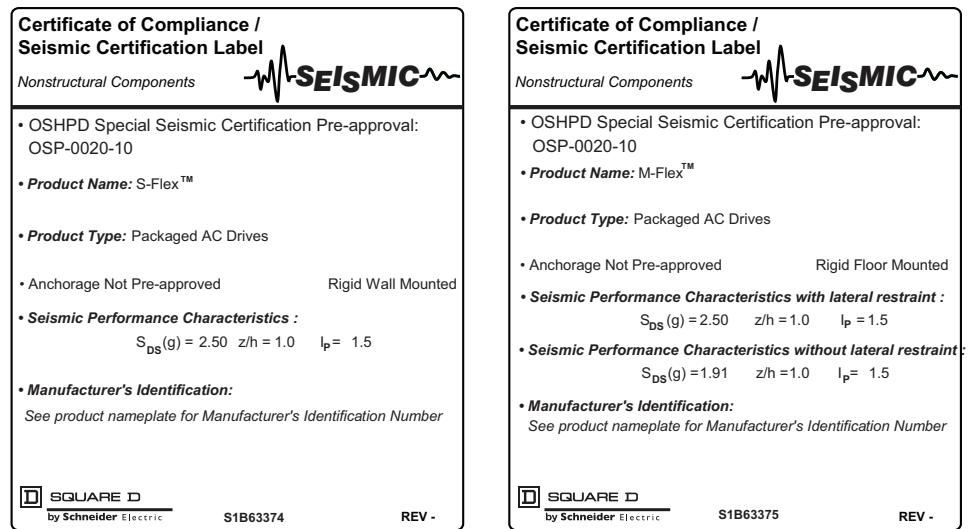
OSHPD Special Seismic Certification Preapproval

Enclosed drives and soft starters manufactured by Schneider Electric have undergone additional review for compliance with the California Building Code and ASCE/SEI 7, as adopted by the state of California's Office of Statewide Health Planning and Development (OSHPD).

The current version of OSHPD Special Seismic Certification Preapproval (OSP) can be found at:
<http://www.oshpd.ca.gov/fdd/Pre-Approval/OSP-0020-10.pdf>.

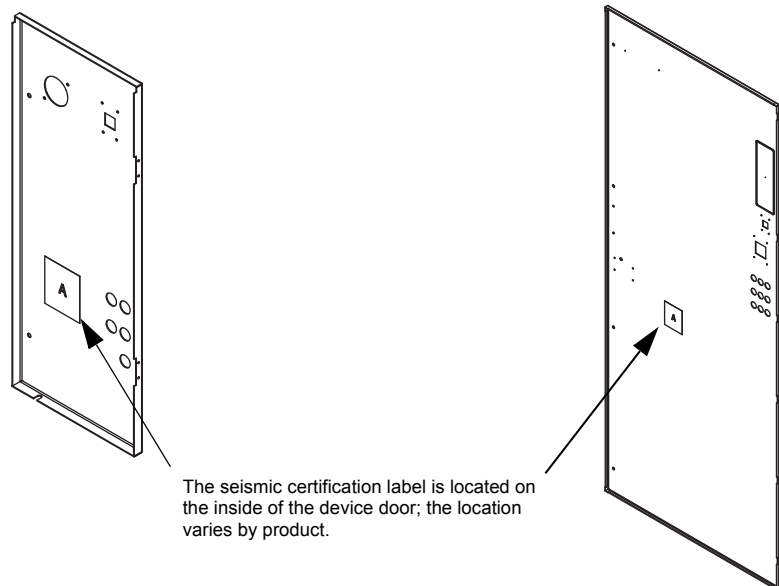
When OSHPD preapproval has been selected, one of the following labels will replace the seismic certification label shown in Figure 3 on page 5.

Figure 10: OSHPD Special Seismic Certification Pre-Approval Label



When selected, the seismic certification labels are placed on the inside surface of the device door as shown in Figure 11.

Figure 11: Seismic Certification Label Location



OSHPD Certificates of Compliance

The certificates of compliance for enclosed drives and soft starters shown in Figures 12 through 19 are applicable only when the OSHPD Special Seismic Certification Pre-Approval Label (Figure 10 on page 14) is affixed to the inside surface of the device door. Select the certificate appropriate for the product and mounting condition applicable to the installation. Other certificates may be discarded or ignored.

Figure 12: Enclosed Altistart 22 Certificate of Compliance




Certificate of Compliance / Seismic Certification Nonstructural Components			
OSHPD Special Seismic Certification preapproval: OSP-0020-10			
Product Name: Enclosed Altistart™ 22			
Product Type: Packaged Soft Starts			
Anchorage Not Pre-approved		Rigid Floor Mounted	
<u>Seismic Performance Characteristics with lateral restraint</u>			
$S_{DS}(g) = 2.50 \quad z/h = 1.0 \quad I_p = 1.5$			
<u>Seismic Performance Characteristics without lateral restraint</u>			
$S_{DS}(g) = 1.91 \quad z/h = 1.0 \quad I_p = 1.5$			
Manufacturer's Identification Number:			
Enclosure Size D 15" w x 15" d x 65" h 186 lbs Service Weight		Enclosure Size G 38" w x 33" d x 95" h 976 lbs Service Weight	
The following NEMA type enclosures are included in this certification:			
<u>Mild Steel Sheet Metal Construction</u> NEMA 1, NEMA 12 and NEMA 3R			
 	Scale: N/A	Tolerance standard: N/A	Units of measure: INCHES
		Packaged AC Drives and Soft Starts	
Number:		S1B69368	Revision: 00
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Figure 13: Enclosed Altistart 22 Certificate of Compliance


Certificate of Compliance / Seismic Certification Nonstructural Components			
OSHPD Special Seismic Certification preapproval: OSP-0020-10			
Product Name: Enclosed Altistart™ 22			
Product Type: Packaged Soft Starts			
Anchorage Not Pre-approved		Rigid Wall Mounted	
<u>Seismic Performance Characteristics</u>			
$S_{Ds}(g) = 2.50$ $z/h = 1.0$ $I_p = 1.5$			
Manufacturer's Identification Number:			
Enclosure Size A 11" w x 11" d x 33" h 63 lbs Service Weight		Enclosure Size D 15" w x 15" d x 65" h 205 lbs Service Weight	
The following NEMA type enclosures are included in this certification:			
<u>Mild Steel Sheet Metal Construction</u> NEMA 1, NEMA 12 and NEMA 3R			
 	Scale: N/A	Tolerance standard: N/A	Units of measure: INCHES
		Packaged AC Drives and Soft Starts	
Number:		S1B69369	Revision: 00
Sheet: 1/1		State: Released for Manufacturing Printed on 2012/05/02	
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Figure 14: Enclosed Altistart 48 Certificate of Compliance



Certificate of Compliance / Seismic Certification Nonstructural Components			
OSHPD Special Seismic Certification preapproval: OSP-0020-10			
Product Name: Enclosed Altistart™ 48			
Product Type: Packaged Soft Starts			
Anchorage Not Pre-approved		Rigid Floor Mounted	
<u>Seismic Performance Characteristics with lateral restraint</u>			
$S_{DS}(g) = 2.50$ $z/h = 1.0$ $I_p = 1.5$			
<u>Seismic Performance Characteristics without lateral restraint</u>			
$S_{DS}(g) = 1.91$ $z/h = 1.0$ $I_p = 1.5$			
Manufacturer's Identification Number:			
Enclosure Size D 20" w x 20" d x 95" h 200 lbs Service Weight		Enclosure Size E 63" w x 33" d x 95" h 1050 lbs Service Weight	
The following NEMA type enclosures are included in this certification:			
<u>Mild Steel Sheet Metal Construction</u> NEMA 1, NEMA 12 and NEMA 3R			
 	Scale: N/A	Tolerance standard: N/A	Units of measure: INCHES
		Packaged AC Drives and Soft Starts	
		Number: S1B69370	Revision: 00 Sheet: 1/1
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Figure 15: Enclosed Altistart 48 Certificate of Compliance

Certificate of Compliance / Seismic Certification Nonstructural Components			
OSHPD Special Seismic Certification preapproval: OSP-0020-10			
Product Name: Enclosed Altistart™ 48			
Product Type: Packaged Soft Starts			
Anchorage Not Pre-approved		Rigid Wall Mounted	
<u>Seismic Performance Characteristics</u>			
$S_{DS}(g) = 2.50$ $z/h = 1.0$ $I_p = 1.5$			
Manufacturer's Identification Number:			
Enclosure Size D 18" w x 14" d x 33" h 110 lbs Service Weight		Enclosure Size E 25" w x 14" d x 63" h 200 lbs Service Weight	
The following NEMA type enclosures are included in this certification:			
<u>Mild Steel Sheet Metal Construction</u> NEMA 1, NEMA 12 and NEMA 3R			
 	Scale: N/A	Tolerance standard: N/A	Units of measure: INCHES
		Packaged AC Drives and Soft Starts	
Number:		S1B69371	Revision: 00
Sheet: 1/1		State: Released for Manufacturing Printed on 2012/05/02	
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Figure 16: E-Flex Certificate of Compliance

Certificate of Compliance / Seismic Certification Nonstructural Components			
OSHPD Special Seismic Certification preapproval: OSP-0020-10			
Product Name: E-Flex™			
Product Type: Packaged AC Drives			
Anchorage Not Pre-approved		Rigid Wall Mounted	
<u>Seismic Performance Characteristics</u>			
$S_{DS}(g) = 2.50$ $z/h = 1.0$ $I_p = 1.5$			
Manufacturer's Identification Number:			
Enclosure Size A 14" w x 13" d x 35" h 83 lbs Service Weight		Enclosure Size D 36" w x 17" d x 67" h 247 lbs Service Weight	
The following NEMA type enclosures are included in this certification:			
<u>Mild Steel Sheet Metal Construction</u> NEMA 1, NEMA 12 and NEMA 3R			
 	Scale: N/A	Tolerance standard: N/A	Units of measure: INCHES
		Packaged AC Drives and Soft Starts	
		Number: S1B69372	Revision: 00 Sheet: 1/1
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Figure 17: M-Flex Certificate of Compliance

Certificate of Compliance / Seismic Certification Nonstructural Components			
OSHPD Special Seismic Certification preapproval: OSP-0020-10			
Product Name: M-Flex™			
Product Type: Packaged AC Drives			
Anchorage Not Pre-approved		Rigid Floor Mounted	
<u>Seismic Performance Characteristics with lateral restraint</u>			
$S_{DS}(g) = 2.50$ $z/h = 1.0$ $I_p = 1.5$			
<u>Seismic Performance Characteristics without lateral restraint</u>			
$S_{DS}(g) = 1.91$ $z/h = 1.0$ $I_p = 1.5$			
Manufacturer's Identification Number:			
Enclosure Size E 20" w x 21" d x 95" h 170 lbs Service Weight		Enclosure Size J 35" w x 21" d x 95" h 969 lbs Service Weight	
The following NEMA type enclosures are included in this certification:			
<u>Mild Steel Sheet Metal Construction</u> NEMA 1 and NEMA 1A			
	Scale: N/A	Tolerance standard: N/A	Units of measure: INCHES
		Packaged AC Drives and Soft Starts	
Number:		S1B69373	Revision: 00
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Figure 18: M-Flex Certificate of Compliance


Certificate of Compliance / Seismic Certification Nonstructural Components			
OSHPD Special Seismic Certification preapproval: OSP-0020-10			
Product Name: M-Flex™			
Product Type: Packaged AC Drives			
Anchorage Not Pre-approved		Rigid Wall Mounted	
<u>Seismic Performance Characteristics</u>			
$S_{DS}(g) = 2.50$ $z/h = 1.0$ $I_p = 1.5$			
Manufacturer's Identification Number:			
Enclosure Size C 20" w x 15" d x 49" h 175 lbs Service Weight		Enclosure Size D 25" w x 15" d x 63" h 243 lbs Service Weight	
The following NEMA type enclosures are included in this certification:			
<u>Mild Steel Sheet Metal Construction</u> NEMA 1 and NEMA 12			
 	Scale: N/A	Tolerance standard: N/A	Units of measure: INCHES
		Packaged AC Drives and Soft Starts	
		Number: S1B69374	Revision: 00 Sheet: 1/1
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Figure 19: PowerGard Certificate of Compliance

Certificate of Compliance / Seismic Certification Nonstructural Components			
OSHPD Special Seismic Certification preapproval: OSP-0020-10			
Product Name: PowerGard™			
Product Type: Packaged AC Drives			
Anchorage Not Pre-approved		Rigid Floor Mounted	
<u>Seismic Performance Characteristics without lateral restraint</u>			
$S_{DS}(g) = 1.91$ $z/h = 1.0$ $I_p = 1.5$			
Manufacturer's Identification Number:			
Enclosure Size 36" w x 25" d x 95" h 1603 lbs Service Weight		Enclosure Size 54" w x 25" d x 95" h 3148 lbs Service Weight	
The following NEMA type enclosures are included in this certification:			
<u>Mild Steel Sheet Metal Construction</u> NEMA 1 and NEMA 1A			
 	Scale: N/A	Tolerance standard: N/A	Units of measure: INCHES
		Packaged AC Drives and Soft Starts	
Number:		S1B69375	Revision: 00
Sheet: 1/1		State: Released for Manufacturing Printed on 2012/05/02	
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