



THE VMC GROUP
The Power of Together™

SEISMIC DESIGN OF NON-STRUCTURAL COMPONENTS AND SYSTEMS



**Power
Generation**

CERTIFICATE OF COMPLIANCE

Cummins Power Generation has qualified the listed standard engine generator set packages as CERTIFIED¹ for seismic application.

The basis of qualification is by shake table testing and analysis, in accordance with the following International Building Code² (IBC) releases.

IBC 2000, IBC 2003, IBC 2006

The following model designations and bulleted options are included in this certification. A complete list of certified models, options, and installation methods are detailed in report number VMA-44026-RS as issued by The VMC Group.

Model Designation	Rating (kW)	Basic Open Generator Set	Steel Enclosure Options			Aluminum Enclosure Options			Fuel Tank Options
			Standard Weather	Standard Level 1	Standard Level 2	Standard Weather	Standard Level 1	Standard Level 2	Standard Sub-base
DSHAD, DSHAC, DSHAB	230/200/175	•	•	•	•	•	N/A	•	•
DGHE, DGHCA, DGHCB, DGHCC	50/30/35/40	•	•	•	•	•	N/A	•	•
DSKCA, DSKBA, DSKAB, DSKAA	25/20/15/10	•	•	•	•	•	N/A	•	•
DSFAE, DSFAD, DSFAC, DSFAB, DSFAA	80/60/50/40/35	•	N/A	N/A	N/A	N/A	N/A	N/A	•
GGLB, GGLA	150/140/125/115	•	•	•	•	•	N/A	•	N/A
GGMC, GGMB, GGMA	30/29/25/20	•	N/A	N/A	N/A	•	N/A	•	N/A
GGHH, GGHG, GGHF, GGHE	100/85/75/70/60	•	•	•	•	•	N/A	•	N/A
GGPA, GGPB, GGPC	50/45/40/35	•	•	•	•	•	N/A	•	N/A

This certification includes the open generator set and the enclosed generator set when installed with or without the sub-base tank. This certification also includes the sub-base tank as a stand-alone accessory. The generator set and included options MUST be a catalogue design and factory supplied. The generator set and applicable options MUST be installed and attached to the building structure per the manufacturer supplied seismic installation instructions. This certification excludes all non-factory supplied accessories, including but not limited to mufflers, isolation/restraint devices, and electrical components.

The above referenced equipment is APPROVED for seismic application when properly installed,³ used as intended, and located in the United States. Lookup the interpolated project specific Design Spectral Response Acceleration at Short Periods, S_{DS} , value in the table below as it pertains to the applicable building code and Importance Factor, I_p , and compare to the allowed value. As limited by the tabulated values, below grade, grade, and roof-level installations, as well as installations in essential facilities and for life safety applications, both requiring post event functionality, were $I_p=1.5$ are permitted and included in this certification.

The basis of this certification is through successful tri-axis shake testing at nationally recognized Clark Dynamic / ANDI Test Laboratory under the witness of and analytical evaluation by an independent approval agency, The VMC Group. Seismic shake table testing was conducted in accordance with ICC-ES AC-156 to envelope the required response spectrum (RRS) to maximum flexible region acceleration (A_{FLEX}) of 3.64g and a zero period acceleration (A_{RIG}) of 2.73g.

For calculations and analysis, the Seismic Design Acceleration, F_p/W_p ,⁴ was calculated as 5.13g for Load Resistance Factored Design (LRFD) methods, equivalent to 3.59g for Allowable Stress Design (ASD) methods. All calculations were conducted using the ASD analysis method. This included but was not limited to the skid anchoring requirements tank anchoring requirements, tank to skid attachment, enclosure to skid attachment, tank structural comparison, enclosure structural comparison, internal isolation ratings, and various component stress analyses. The Seismic Design Acceleration, F_p/W_p , used for calculations and analysis, is defined per the building code (or respective design standard) for the section titled Seismic Design Requirements for Non-structural (architectural, mechanical, and electrical) Components. The seismic design level is based on the LRFD calculation shown below.

$$\text{IBC 2006} \quad F_p/W_p = 0.4 \times 2/3(S_s=3.42) \times (F_A=1.0) \times (I_p=1.5) \times (a_p/R_p=1.25) \times (1+2(z/h=1.0)) = 5.13g$$

$$\text{IBC 2003 / 2000} \quad F_p/W_p = 0.4 \times 2/3(S_s=3.69) \times (F_A=1.0) \times (I_p=1.5) \times (a_p/R_p=1.00) \times (1+2(z/h=1.0)) = 4.43g < 5.13g$$

This certification covers all applications that fall below the limitations in the chart below.

IBC 2006	IBC 2003	IBC 2000
$S_{DS} \leq 2.28$	$S_{DS} \leq 2.46$	$S_{DS} \leq 2.46$
$I_p \leq 1.5$	$I_p \leq 1.5$	$I_p \leq 1.5$
$a_p/R_p \leq 1.25$	$a_p/R_p \leq 1.0$	$a_p/R_p \leq 1.0$
$z/h \leq 1.0$	$z/h \leq 1.0$	$z/h \leq 1.0$

Soil Classes A, B, C, D, E, Seismic Use groups I, II, III, IV, and Seismic Design Categories A, B, C, D, E, and F are all covered under this certification, limited by the S_{DS} value stated above.



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IBC 2000, IBC 2003, IBC 2006

The following model designations and bulleted options are included in this certification. A complete list of certified models, options, and installation methods are detailed in report number VMA-44026-RS as issued by The VMC Group.

Model Designation	Rating (kW)	Basic Open Generator Set	Steel Enclosure Options			Aluminum Enclosure Options			Fuel Tank Options
			Standard Weather	Standard Level 1	Standard Level 2	Standard Weather	Standard Level 1	Standard Level 2	Standard Sub-base
DSFAE, DSFAD, DSFAC, DSFAB, DSFAA	80/60/50/40/35	•	•	•	•	•	N/A	•	•

This certification includes the open generator set and the enclosed generator set when installed with or without the sub-base tank. This certification also includes the sub-base tank as a stand-alone accessory. The generator set and included options MUST be a catalogue design and factory supplied. The generator set and applicable options MUST be installed and attached to the building structure per the manufacturer supplied seismic installation instructions. This certification excludes all non-factory supplied accessories, including but not limited to mufflers, isolation/restraint devices, and electrical components.

The above referenced equipment is APPROVED for seismic application when properly installed,³ used as intended, and located in the United States. Lookup the interpolated project specific Design Spectral Response Acceleration at Short Periods, S_{DS} , value in the table below as it pertains to the applicable building code and Importance Factor, I_p , and compare to the allowed value. As limited by the tabulated values, below grade, grade, and roof-level installations, as well as installations in essential facilities and for life safety applications, both requiring post event functionality, were $I_p=1.5$ are permitted and included in this certification.

The basis of this certification is through successful tri-axis shake testing at nationally recognized Clark Dynamic / ANDI Test Laboratory under the witness of and analytical evaluation by an independent approval agency, The VMC Group. Seismic shake table testing was conducted in accordance with ICC-ES AC-156 to envelope the required response spectrum (RRS) to maximum flexible region acceleration (A_{FLEX}) of 3.64g and a zero period acceleration (A_{RIG}) of 2.73g. The enclosure options listed above have been analyzed to the design levels specified below due to their unique design characteristics, different from the representative unit shake tested. The limiting factors expressed on page 1 have been de-rated to the values shown below due to the results of the enclosure analysis. The above listed gensets and corresponding enclosure options are CERTIFIED, limited to the values in the table below.

For calculations and analysis, the Seismic Design Acceleration, F_p/W_p ,⁴ was calculated as 4.35g for Load Resistance Factored Design (LRFD) methods, equivalent to 3.04g for Allowable Stress Design (ASD) methods. All calculations were conducted using ASD analysis methods. This included but was not limited to the skid anchoring requirements tank anchoring requirements, tank to skid attachment, enclosure to skid attachment, tank structural comparison, enclosure structural comparison, internal isolation ratings, and various component stress analyses. The Seismic Design Acceleration, F_p/W_p , used for calculations and analysis, is defined per the building code (or respective design standard) for the section titled Seismic Design Requirements for Non-structural (architectural, mechanical, and electrical) Components. The seismic design level is based on the LRFD calculation shown below.

IBC 2006	$F_p/W_p = 0.4 \times 2/3(S_s=2.90) \times (F_A=1.0) \times (I_p=1.5) \times (a_p/R_p=1.25) \times (1+2(z/h=1.00)) = 4.35g$
IBC 2006	$F_p/W_p = 0.4 \times 2/3(S_s=3.42) \times (F_A=1.0) \times (I_p=1.5) \times (a_p/R_p=1.25) \times (1+2(z/h=0.77)) = 4.35g$
IBC 2003 / 2000	$F_p/W_p = 0.4 \times 2/3(S_s=3.62) \times (F_A=1.0) \times (I_p=1.5) \times (a_p/R_p=1.00) \times (1+2(z/h=1.00)) = 4.35g$
IBC 2003 / 2000	$F_p/W_p = 0.4 \times 2/3(S_s=3.69) \times (F_A=1.0) \times (I_p=1.5) \times (a_p/R_p=1.00) \times (1+2(z/h=0.97)) = 4.35g$

This certification covers all applications that fall below the limitations in the charts below.

IBC 2006	IBC 2006	IBC 2003 / 2000	IBC 2003 / 2000
$S_{DS} \leq 1.93$	$1.93 < S_{DS} \leq 2.28$	$S_{DS} \leq 2.41$	$S_{DS} \leq 2.46$
$I_p \leq 1.5$	$I_p \leq 1.5$	$I_p \leq 1.5$	$I_p \leq 1.5$
$a_p/R_p \leq 1.25$	$a_p/R_p \leq 1.25$	$a_p/R_p \leq 1.0$	$a_p/R_p \leq 1.0$
$z/h \leq 1.0$	$z/h \leq 0.77$	$z/h \leq 1.0$	$z/h \leq 0.97$

Soil Classes A, B, C, D, E, Seismic Use groups I, II, III, IV, and Seismic Design Categories A, B, C, D, E, and F are all covered under this certification, limited by the S_{DS} value stated above.



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Notes and Comments:

1. All equipment listed herein successfully passed the seismic acceptance criteria for shake testing non-structural components and systems as set forth in the ICC AC-156 (2007). The test response spectrum (TRS) enveloped the design response spectrum (DRS) for all units tested. The units cited in this certification were representative samples of a contingent of models and all remained captive and structurally sound after the seismic shake simulation. The units also remained functionally operational after the simulation testing as functional testing was completed by the equipment manufacturer before and after the seismic simulations. Although a seismic qualified unit inherently contains some wind resisting capacity, that capacity is undetermined and is excluded from this certification. Snow/Ice loads have been neglected and thus limit the unit to be installed both indoors (covered by an independent protective structure) and out of doors (exposed to accumulating snow/ice) for snow/ice loads no greater than 30 psf for all applications.
2. The following building codes are addressed under this certification:
 - IBC 2000 – referencing ASCE 7-98 and ICC AC-156
 - IBC 2003 – referencing ASCE 7-02 and ICC AC-156
 - IBC 2006 – referencing ASCE 7-05 and ICC AC-156
3. Refer to the manufacturer supplied installation drawings for anchor requirements and mounting considerations for seismic applications. Required anchor locations, size, style, and load capacities (tension and shear) are specified on the installation drawings. Mounting requirement details such as anchor brand, type, embedment depth, edge spacing, anchor-to-anchor spacing, concrete strength, special inspection, wall design, and attachment to non-building structures must be outlined and approved by the Engineer of Record for the project or building. Structural walls, structural floors, and housekeeping pads must also be seismically designed and approved by the project or building Structural Engineer of Record to withstand the seismic anchor loads as defined on the installation drawings. The installing contractor is responsible for observing the installation requirements detailed in the seismic installation drawings and the proper installation of all anchors and mounting hardware.
4. When the site soil properties or final equipment installation location are not known, the soil site coefficient, F_A , defaults to the Soil Site Class D coefficient. Soil Classes A, B, C, D, E, Seismic Use groups I, II, III, IV, and Seismic Design Categories A, B, C, D, E, and F are all covered under this certification, limited by the S_{DS} values on page 1, respective to the applicable building code, Importance factor, and z/h ratio. A seismic importance factor, $I_p=1.5$, applies to this certification to include essential facility requirements and life safety applications for post event functionality.

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