

## GENERAL EXEMPTIONS AND REQUIREMENTS

### D2.1 – 4.1 Introduction:

The International Building Codes (IBC's) allow certain exemptions to be made for MEP systems and components from the need for seismic restraint. These exemptions are based on the Seismic Design Category, the Component Importance Factor, and the size and weight, of the MEP components.

There are further general provisions in the IBC pertaining to MEP components that must be acknowledged at the outset of a project. These are provisions ranging from the upper bound size for an MEP component in order for it to be considered as a non-structural component to the component certifications and documentation required.

This section will present the general exemptions for MEP systems and components and discuss the general requirements that apply to them.

### D2.1 – 4.2 Exemptions for Seismic Design Categories A and B (Section 9.6.1-1 and 9.6.1-3) [Section 13.1.4-1 and 13.1.4-2]<sup>1</sup>:

MEP systems and their components that are located in or on buildings that have been assigned to Seismic Design Categories A and B are exempt from the requirements for seismic restraints. These two exemptions point out the need for having the correct seismic design information for the project available to all of the design professionals and contractors during the bidding stage of the project. Being able to use these exemptions can save the MEP contractors as much as 10% to 15% in their costs.

<sup>1</sup> References in brackets (Section 9.6.1-1 and 9.6.1-2) [Section 13.1.4-1 and 13.1.4-2] apply to sections, tables, and/or equations in ASCE 7-98/02 and ASCE 7-05 respectively, which forms the basis for the seismic provisions in 2000/2003 IBC and 2006 IBC respectively.

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For example, a critical piece of information required at the outset is the Site Class. If the Site Class has not been determined by a qualified geotechnical engineer, then Site Class D must be assumed. The resulting combination of the mapped acceleration parameters and soil profile of Site Class D may force the project to be assigned to Seismic Design Category C which in turn forces the requirement for seismic restraints. If instead the Site Class had been determined to be Site Class B by a qualified geotechnical engineer, then the project may have been found to fall into Seismic Design Category A or B, thus eliminating the need for seismic restraints for MEP systems and components.

## **D2.1 – 4.3 Exemptions for Seismic Design Category C (Section 9.6.1-4) [Section 13.1.4-3]:**

MEP systems and components that have been assigned to Seismic Design Category C, and that have been assigned a Component Importance Factor of 1.0, are exempt from the requirements for seismic restraints. In this case it is very important that the design professionals responsible for the various MEP systems and components assign the correct Component Importance Factors to those systems and components. If no Component Importance Factor is assigned, the installing contractor should prudently assume that the Component Importance Factor is equal to 1.5, and provide restraints for that system or component. This is particularly true of duct runs where it is very likely that the ventilation components may also be required for smoke control.

It is also critical to know which MEP systems and components have a component Importance Factor of 1.0 and which ones have a Component Importance Factor of 1.5. To the extent possible, those with Component Importance Factors equal to 1.5 should be installed above those with Component Importance Factors equal to 1.0 in order to reduce the over all number of restraints needed for the project.

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## D2.1 – 4.4 Exemptions for Seismic Design Categories D, E, and F (Sections 9.6.1-5 and 9.1.6-6) [Sections 13.1.4-4 and 13.1.4-5]:

There are basically three exemptions that apply here.

1. MEP components that:
  - a. Are in Seismic Design Categories D, E, and F.
  - b. Have a Component Importance Factor equal to 1.0,
  - c. Have flexible connections between the components and all associated duct, piping, conduit.
  - d. Are mounted at 4 ft (1.22 m) or less above a floor level.
  - e. And weigh 400 lbs (1780 N) or less.
2. MEP components that:
  - a. Are in Seismic Design Categories D, E, and F.
  - b. Have a Component Importance Factor equal to 1.0.
  - c. Have flexible connections between the components and all associated duct, piping, conduit.
  - d. And weigh 20 lbs (89 N) or less.
3. MEP distribution systems that:
  - a. Are in Seismic Design Categories D, E, and F.
  - b. Have a Component Importance Factor equal to 1.0.
  - c. Have flexible connections between the components and all associated duct, piping, conduit.
  - d. And weigh 5 lbs/ft (73 N/m) or less.

## D2.1 – 4.5 “Chandelier” Exemption (Section 9.6.3.2) [Section 13.6.1]:

This exemption applies to light fixtures, lighted signs, ceiling fans, and other components that are not connected to ducts or piping and which are supported by chains or other wise suspended from

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the structure by a method that allows the component to swing freely. These components will require no further seismic support provided that all of the following conditions are met.

1. The design load for these components shall be equal to:
  - a. 3.0 times the operating load, applied as a gravity design load, for 2000/2003 IBC.
  - b. 1.4 times the operating weight of the component acting downward with a simultaneous horizontal load that is also equal to 1.4 times the operating weight for 2006 IBC. The horizontal load is to be applied in the direction that results in the most critical loading and thus the most conservative result.
2. The component shall not impact other components, systems, or structures as it swings through its projected range of motion.
3. The connection to the structure shall allow a 360° range of motion in the horizontal plane. In other words, this must be a “free swinging” connection.

## **D2.1 – 4.6 Component Size Relative to the Building Structure (Section 9.6.1) [Section 13.1.5]:**

For the most part MEP components will be treated as nonstructural components by the code. However, if the MEP component is very large relative to the building it must be treated as a nonbuilding structure, which has a completely different set of design issues. For 2000/2006 IBC, if the weight of the MEP component is greater than or equal to 25% of the combined weight of the MEP Component and the supporting structure, the MEP component must be treated as a nonbuilding structure per Section 9.14 of ASCE 7-98/02. For 2006 IBC, if the weight of the nonstructural component is greater than or equal to 25% of the effective seismic weight of the building as defined in Section 12.7.2 of ASCE 7-05, then that component must be classified as a nonbuilding structure and designed accordingly.

When might this apply? This applies to very large pieces of MEP equipment such as large cooling towers, and the very large air handling units that are placed on the roofs of buildings employing

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lightweight design techniques. The structural engineer of record will have a value for the effective seismic weight of the building. This must be compared to the operating weight of the MEP component in question.

## **D2.1 – 4.7 Reference and Accepted Standards (Sections 9.6.1.1 and 9.6.1.2) and Reference Documents [Section 13.1.6]:**

Typically reference standards, acceptance standards, and reference documents are other publications that will provide a basis for earthquake resistant design. Examples of reference documents currently in existence would be the SMACNA Seismic Restraint Manual, listed in Section 1.0 Introduction of the guide, and NFPA 13. These documents may be used with the approval of the jurisdiction having authority as long as the following conditions are met.

1. The design earthquake forces used for the design and selection of the seismic restraints shall not be less than those specified in Section 9.6.1.3 of ASCE 7-98/02 and Section 13.3.1 of ASCE 7-05, which is also covered in Section 8.0 of this guide.
2. The seismic interaction of each MEP component with all other components and building structures shall be accounted for in the design of the supports and restraints.
3. The MEP component must be able to accommodate drifts, deflections, and relative displacements that are defined in ASCE 7-05. This means that flexible connections for pipe, duct, and electrical cables for MEP components are in general, a good idea to prevent damage if the MEP component, and/or the pipe, duct, and electrical cables that are attached to it are unrestrained.

## **D2.1 – 4.8 Allowable Stress Design (Sections 2.3 and 2.4) [Sections 2.3, 2.4, and 13.1.7]:**

Reference documents that use allowable stress design may be used as a basis for the design and selection of seismic restraints. However, the design earthquake loads determined in accordance with Section 9.6.1.3 of ASCE 7-98/02 and Section 13.3.1 of ASCE 7-05 must be multiplied by 0.7.

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## D2.1 – 4.9 Submittals and Construction Documents (Sections 9.6.3.6, 9.6.3.15 and A.9.3.4.5) [Sections 13.2.1, 13.2.5, 13.2.6, and 13.2.7]:

Projects that require seismic restraints for MEP systems and components will require project specific certification that the design of the seismic restraints selected for the MEP systems and their components will meet the code, specification, or details which ever is most stringent. This certification is to be provided both in the submittals and in the construction documents.

For the submittal of seismic restraints and supports, the certification may be satisfied by one of the following means.

1. Project and site specific designs and documentation that are prepared and submitted by a registered design professional. Please note that a specific discipline is not mentioned regarding the registered design professional that is responsible for the design and signing and sealing of the documentation.
2. Manufacturer's certification accompanying the submittal the restraints are seismically qualified for the project and site. The certification may be made in any one of three ways as detailed below.
  - a. Analysis – this is typical for the seismic restraints used for MEP systems and components. Manufacturers of these seismic restraint devices will normally have families of the various types of restraint devices that have different seismic force capacity ranges. The manufacturer will perform an analysis to determine the project and site specific seismic design loads, and then analyze the MEP system and/or components to determine the required restraint capacities at the restraint attachment points to the system and/or components. The proper restraint will be selected from the manufacturer's standard product offering, or a special restraint may be designed and built for the application. The manufacturer's certification will include a statement signed and seal by a registered design professional that the restraint devices will meet the appropriate code, specification, and/or details.

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- b. The manufacturer of the restraint devices may have them tested in accordance with ICC-ES AC 156 as outlined in Sections 9.6.3.6 and A.9.3.4.5 of ASCE 7-98/02 and Section 13.2.5 of ASCE 7-05. They will then provide a signed and sealed certification document stating that the restraint devices will provide adequate protection for the MEP system and components.
- c. Experience data per the requirements in Sections 9.6.3.6 and A.9.3.4.5 of ASCE 7-98/02 and Section 13.2.6 of ASCE 7-05. This is not a normal avenue for a manufacturer of seismic restraint devices to use to certify their products as being fit for a specific project. In using this method, the manufacturers would incur a great deal of liability.

Section A.9.3.4.5 of ASCE 7-98/02 and Section 13.2.7 of ASCE 7-05 indicates that seismic restraints for MEP systems and components will require construction documents that are prepared and, signed and sealed by a registered design professional. Frequently, the submittal package provided by the manufacturer of the seismic restraints will also have enough information to fulfill this requirement.

The registered design professional mentioned above needs to be one with knowledge and experience in force analysis, stress and analysis, and the proper use of steel, aluminum, elastomers, and other engineering materials in the design of force resisting systems. There are several disciplines that may fulfill these requirements such as, structural engineers, civil engineers, and mechanical engineers involved in the area of machine design.

## **D2.1 – 4.10 Equipment Certification for Essential Facilities (Sections 9.6.3.6, 9.6.6.15, and A9.3.4.5) [Sections 13.2.2, 13.2.5, and 13.2.6]:**

For buildings that have been assigned to Seismic Design Categories C, D, E, and F designated seismic systems will require certification. Designated seismic systems are those whose failure has the potential to cause loss of life or loss of function for buildings that were deemed essential for recovery following an earthquake. Typically essential facilities are those that have been assigned

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to Occupancy Category IV, see Section 2.2 of this guide. For these types of systems, certification shall be provided as follows.

1. For active MEP systems and components that must remain functional after an earthquake shall be certified by the supplier or manufacturer as being operable after the design level earthquake for the project site based on:
  - a. Shake table testing such as that specified in ICC-ES AC 156 as described in Section A.9.3.4.5 of ASCE 7-98/02 and Section 13.2.5 of ASCE 7-05. Evidence of compliance is to be submitted to the jurisdiction having authority and the design professional of record for approval.
  - b. Experience or historical data as outlined in Sections 9.6.3.6, 9.6.3.15 and A.9.3.4.5 of ASCE 7-98/02 and Section 13.2.6 of ASCE 7-05. This experience data is to come from a nationally recognized procedures and data base that is acceptable to the authority having jurisdiction. The substantiated seismic capacities from the experience data must meet or exceed the specific seismic requirements for the project. As in a. above evidence of compliance will need to be submitted to the design professional of record, and the jurisdiction having authority for approval.
2. MEP systems and components that contain hazardous materials must be certified as maintaining containment of the hazardous materials following an earth quake. Evidence of compliance must be submitted to the design professional of record and the jurisdiction having authority for approval. This certification may be made through:
  - a. Analysis.
  - b. Approved shake table testing specified in Section 9.6.3.6 of ASCE 7-98/02 and Section 13.2.5 of ASCE 7-05.
  - c. Experience data as described in Section 9.6.3.6 of ASCE 7-98/02 and Section 13.2.6 of ASCE 7-05.

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## D2.1 – 4.11 Consequential or Collateral Damage (Section 9.6.1) [Section 13.2.3]:

The potential interaction of the MEP systems and components with surrounding systems, components or building structures must be considered when locating and restraining the MEP systems and components. The failure of an MEP system or component that has been assigned a Component Importance Factor equal to 1.0 must not cause the failure of an MEP system or component that has been assigned a Component Importance Factor equal to 1.5. This goes back to the issue of assigning a Component Importance Factor of 1.5 to MEP systems or components with a Component Importance Factor of 1.0 whose failure would cause the failure of a system or component with a Component Importance Factor of 1.5.

## D2.1 – 4.12 Flexibility of Components and their Supports and Restraints (Sections 9.6.1 and 9.6.1.2) [Section 13.2.4]:

All MEP systems and components that are constructed of normal engineering materials will have a certain amount of flexibility, or springiness. So how these systems and components behave during an earthquake will greatly affect their performance and survivability. The system or component could have a flexibility that would put it to resonance with the building and/or the earthquake, in which case the displacements and stresses in the system would be much larger than expected. Conversely the flexibility of the system or component could be such that it was not in resonance with either the building or the earthquake. In this case, the displacements and stresses may be much lower than a code based analysis would indicate. Therefore, the code indicates that the flexibility of the components and their supports be considered as well as the strength of the parts to ensure that the worst cases are considered.

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## D2.1 – 4.13 Summary:

The exemptions and requirements outlined in this section are intended to assist the MEP design professionals and contractors in planning their project contribution efficiently. Also, they help define the limits of responsibility for each MEP design profession and trade.

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