

This Guide will aid editing of the [Division-22 and -23](#) LANL Master Specification templates ***pertaining to mechanical components<sup>1</sup> that are permanently attached to structures*** (i.e., in International Building Code [IBC] and ASCE 7 scope<sup>2</sup>) in order to create ML-3 and ML-4 Project-specific spec sections that include all applicable/required seismic content. Templates involving ASME B31-series code piping are not addressed herein.<sup>3</sup>

The Guide is generally not applicable to spec templates pertaining to components that aren't permanently attached to structures. Examples of such components include pad-mounted equipment located outside of a building (not positively attached to the building) and for which seismic-induced movement would not block egress/ingress and/or damage an adjacent building/structure. Nevertheless, consider seismically anchoring difficult-to-acquire and/or expensive items, as well as items important to mission.<sup>4</sup>

Construction (vs. performance<sup>5</sup>) specifications: At the time of writing, the only templates in Div. 22 and 23 that have content for which this guide is applicable are construction specs. Thus, what follows is solely based on construction-spec-section templates in Div. 22/23 (e.g., 22 1500, 22 3700).

**Background:** Spec-section templates have seismic content because the LANL Building Code (LBC) is based on the IBC; the 2015 IBC Section 1613.1 requires nonstructural components (and their supports and attachments to structures) to be designed and constructed to resist the effects of earthquake motions in accordance with ASCE 7-2010 Chapter 13, *Seismic Design Requirements for Nonstructural Components*, and that chapter includes design and construction requirements for mechanical components for their supports and attachments.

#### Guide organization

1. First, there is discussion of the three essential/fundamental questions that must be answered (in order to determine what the required Project-specific seismic content must be for a given spec section).
2. Second, based on the responses to these 3 questions, the required Project-specific content is identified for each spec section part (i.e., PART 1 GENERAL, PART 2 PRODUCTS, and PART 3 EXECUTION).

**FLOWCHART:** In order to get the most out the remainder of this Guide, the user/reader is encouraged to refer to the *Seismic Spec-Editing Flowchart for Nonstructural Components* that is webposted with this guide on the LANL Master Specs webpage.

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<sup>1</sup> Per ASCE 7, a mechanical component is simply a part of a mechanical system inside of, or on, a building or "occupiable" (IBC term) structure (e.g., individual pieces of equipment, distribution systems, combinations of equipment, and distribution systems). If the equipment or component is not inside of, or attached to, the building or occupiable structure, then it is not a part of the scope of this document.

<sup>2</sup> Ref. IBC para. 1613.1

<sup>3</sup> B31-related LANL spec section editing is not included herein because current sections differ from the other mechanical sections in their approach to seismic matters (B31 codes even vary one to the next). As such, the designer is responsible for ensuring specifications contain any necessary seismic-related provisions for B31.

<sup>4</sup> Going beyond code minimum increases LANL's resiliency to earthquake.

<sup>5</sup> A construction spec is a complete design product ready for work implementation. A performance spec describes the functionality needed and any design requirements without identifying components to be used, thus deferring/delegating that design to the construction subcontractor; that deferred/delegated design would need to address seismic matters (this Guide might also be useful for that activity).

**Table 1. Guide Summary**

The 3 Questions (Qs)	Resulting Condition/Action
Question 1: If it is in the ASCE 7 scope, is the component seismically exempt (SE)?	<ul style="list-style-type: none"> <li>• If yes (exempt): Condition "SE." Follow guide instructions for same.</li> <li>• If no (not exempt), proceed to Q2 and Q3.</li> </ul>
Question 2: If it is not seismically exempt, who is responsible for compliance with ASCE 7?	There are three possible answers. Follow guide accordingly and also answer Q3.
Question 3: What are the component's seismic performance requirements?	There are two possible answers resulting in one of two conditions: Position Retention <sup>6</sup> or Position Retention + Fully Operational <sup>7</sup> (PR+FO=DSS).

**THE 3 QUESTIONS**

**Question 1:** If the component is within the scope of ASCE 7, is it **seismically exempt (SE)**? This is the case if it meets either the (A) Generic Exemptions or (B) Mechanical-Specific Exemptions.

A. **Generic Exemptions:** A component is seismically exempt if it meets these four criteria:<sup>8</sup>

1. Importance Factor,  $I_p = 1.0$ .
  - What happens to the component as a result of the design-basis earthquake (DBE)<sup>9</sup> doesn't matter as long as it doesn't result in someone getting hurt (or worse) as a result of the component collapsing, sliding, overturning, blocking egress, and so forth.

AND

2. Positive attachment<sup>10</sup> to structure.
  - The component is attached to the structure, and that attachment consists of more than just the frictional resistance produced by the effects of gravity (in other words, the component must be attached with bolts, welds, cast-in-place anchor rods, post-installed anchors, screws, or the like).
  - Since this is a criterion for a component to be exempt, positive attachment of the exempt component must be included in the component-specific Project Spec section.

<sup>6</sup> **Position Retention means** that the component must remain in place after a design event and must contain all internal components.

<sup>7</sup> **Fully Operational means** that, in addition to the requirements of Position Retention, the component must function after a design event. This requirement makes the component a "Designated Seismic System" (DSS).

<sup>8</sup> From the ASCE 7 Chapter 13 paragraph 13.1.4.6 "generic exemptions" for seismic design category D.

<sup>9</sup> The DBE is the "worst-case earthquake" for which the IBC requires design. Design for DBE forces is intended to prevent collapse in a "once-in-several-thousand-year event." LANL ESM Ch. 5, via an amendment to the IBC, defines the LANL DBE.

<sup>10</sup> "Positive Attachment" has no definition in either ASCE7 or the IBC. It is defined in this paragraph for LANL.

AND

3. Flexible connections between the component and associated piping or ductwork.<sup>11</sup>
  - Flexible connections are those connections between components that permit rotational and/or translational movement without degradation of performance. Examples include universal joints, bellows expansion joints, flexible metal hose, and some types of small-diameter conduit and tubing.
  - Since this is a criterion for a component to be exempt, flexible connection(s) of/to the exempt component must be included in the component-specific Project Spec section.
  - For additional information on flexible connections, see **PART 3** (below).

AND

4. Weight: Either of the following exist:
  - 4.1 The component weighs  $\leq 400$  lb and has a center of mass located  $\leq 4$  ft above the adjacent floor level,

OR

- 4.2 The component weighs  $\leq 20$  lb or is part a distribution system weighing  $\leq 5$  pounds per linear foot (plf).

**B. Mechanical-Specific Exemptions:** In addition to the aforementioned "generic exemption," there are other exemptions that are specific to mechanical components mechanical distribution-type components (e.g., ductwork and piping).

1. Ductwork is SE if it meets **any** of the following criteria, which are based on ASCE 7 para. 13.6.7:
  - Supported by trapeze assemblies, total supported weight  $\leq 10$  plf, and  $I_p = 1.0$ .
  - Supported by hangars<sup>12</sup>, each hangar in the run is  $\leq 12$  inches (i.e., 12") from the support point to the supporting structure, and  $I_p = 1.0$ .
  - Provisions are made to preclude impact with other ducts or mechanical components or to protect the ducts in the event of such impact, cross-sectional area  $< 6$  square feet or weight  $\leq 17$  plf, and  $I_p = 1.0$ .
2. Piping<sup>13</sup> is SE if it meets **any** of the following criteria, which are based on ASCE 7 para. 13.6.8.3<sup>14</sup>:
  - Supported by trapeze assemblies,  $I_p = 1.0$ , no single pipe  $> 3$ " nominal size, and total supported weight  $< 10$  plf.

<sup>11</sup> The thought process is as follows: Since neither the component nor its "positive attachment" are designed to resist seismic forces, if the component does collapse, slide, or overturn in the design-basis earthquake, flexible connection(s) between the component and whatever's running to/from it will (likely/hopefully) prevent a cascading failure ("domino effect").

<sup>12</sup> If rod hangars are used, they must have a swivel at the connection between the end of the rod and the structure.

<sup>13</sup> Not applicable to fire protection sprinkler piping per ASCE 7 para. 13.6.8.2, or to ASME Pressure Piping despite ASCE 7 paras. 13.6.8.1 and 13.6.8.3.

<sup>14</sup> At the time of writing, ASCE 7-10 was in effect (at LANL), and portions of its para. 13.6.8.3 are unclear; thus, it was necessary to use some of the corresponding para. in ASCE 7-16 (i.e., 13.6.7.3).

- Supported by trapeze assemblies,  $I_p = 1.5$ , no single pipe > 1" nominal size, and total supported weight < 10 plf.
- Component response modification factor ( $R_p$ )  $\geq 4.5$ ; supported by hangars<sup>15</sup> and provisions are made to preclude impact with other structural or nonstructural components or to protect the piping in the event of such impact,  $I_p = 1.0$ , and nominal pipe size  $\leq 3$ ".
- $R_p \geq 4.5$ , supported by hangars<sup>5</sup> and provisions are made to preclude impact with other structural or nonstructural components or to protect the piping in the event of such impact,  $I_p = 1.5$ , and nominal pipe size  $\leq 1$ ".

**Question 2:** If the component is in the scope of ASCE 7 and isn't seismically exempt, **who is responsible** for compliance with ASCE 7 Ch. 13?

1. ASCE 7 Ch. 13 paragraph 13.2.1 stipulates two methods for demonstrating compliance with Ch. 13: (1) Project-specific design and documentation, which can be achieved during "Title II (by the Project's structural engineer of record)" or "Title III (by the construction Subcontractor via delegated design)" or (2) Manufacturer's certification that the component in question is seismically qualified, which is very rare at LANL.
2. Thus, there are three potential answers to this question:
  - Project structural engineer of record is responsible.
  - Project Construction Subcontractor is responsible.
  - Component manufacturer is responsible.

**Question 3:** If the component is in the scope of ASCE 7 and isn't seismically exempt, what are the component's **seismic performance requirements**?

1. Structural integrity/position retention (PR)
  - PR is applicable if  $I_p = 1.0$
  - $I_p = 1.0$  applies if PR is the only seismic performance requirement (the component does not need to function after the DBE)

OR

2. PR and functional/operable (PR+FO), which means the component is a Designated Seismic System (DSS). In the IBC/ASCE 7, if a component must function after the Design Basis Earthquake, it is assigned an  $I_p$  of 1.5, which makes it a Designated Seismic System (per ASCE 7 paragraph 13.1.3).
  - Designated Seismic System is applicable if  $I_p = 1.5$  (and  $I_p = 1.5$  applies if the component is a DSS).
  - Does the Designated Seismic System include active parts, energized components, and/or contain hazardous substances?
    - If it does, Special Certification is required (IBC defines this concept).

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<sup>15</sup> If rod hangars are used, they must have swivels, eye nuts, or other devices to prevent bending of the rod at the connection between the end of the rod and the structure.

**ACTIONS BASED ON QUESTION RESPONSES**

The remainder of the Guide includes the details on how to edit each part (i.e., PART 1 – PART 3) of an applicable Div-22/23 template based on the potential responses to Questions 1–3.

**NOTE: Boxed text below is typical of seismic content in the Div.-22/23 sections. Editing guidance may precede or follow the box.**

**PART 1**

- Q1: Is the component seismically exempt (SE)?
  - If no (not SE), proceed to Part 1 Q2 below. If yes (SE):
    - delete every reference to seismic, and seismic-related content, in Related Sections (i.e., 01 8734, 22 0548.23) and in Action Submittals,
    - ignore submittals in Action Submittals that appear here but not in the template being edited, and
    - proceed to **PART 2**.

**RELATED SECTIONS**

Section 01 8734, *Seismic Qualification of Nonstructural Components (IBC)*, for requirements **pertaining to [manufacturer's certification] [and] [special certification]**<sup>16</sup>.

- Q2: Will the component be qualified by the manufacturer's certification? If so, then Section 01 8734 will be applicable and the 1<sup>st</sup> option—manufacturer's certification—must be retained.
- Q3: Does the component require special certification? If so, Section 01 8734 will still be applicable and the 2<sup>nd</sup> option—special certification—must be retained.

Section 22 0548.23, *Vibration and Seismic Controls for Mechanical Systems*, for [seismic-design criteria,] submittal requirements, devices for seismic restraint, and installation requirements for these devices.

- If seismic design and detailing is to be accomplished by the Structural Eng or Record (SEOR), only the content of Section 22 0548.23 that's unrelated to seismic-design criteria and delegated design might be applicable. In other words, if the 22 0548.23 content related to "devices"<sup>17</sup> is needed/desired<sup>18</sup> then 22 0548.23 will be applicable and the 1<sup>st</sup> option—seismic-design criteria—must be deleted.
 

If seismic design and detailing is to be accomplished by the construction Subcontractor, then Section 22 0548.23 will be applicable and the 1<sup>st</sup> option must be retained. And, when editing 22 0548.23 for the Project, in addition to retaining the design criteria (in PART 2), the delegated-design portions of PART 1 of the template must also be retained.
- If 01 8734 is applicable (i.e., included as Related Section), then 22 0548.23 isn't applicable.

<sup>16</sup> At the time of writing, the specificity associated with the bold text wasn't included in some Div.-22/23 sections; however, it will be added as these sections are revised.

<sup>17</sup> Seismic control/restraint is achieved by devices (e.g., supports and attachments) that provide restraint against excessive movement during an earthquake (without compromising the effectiveness of vibration controls, if applicable). Such devices are included 22 0548.23.

<sup>18</sup> Whether "devices-related content" from 22 0548.23 is needed depends on what's included/not included in the component-specific spec section with regard to supports, restraints, control devices, attachments, and anchorage.

**ACTION SUBMITTALS**

Shop Drawings: For [each type of] [\_\_\_\_\_].<sup>19</sup>

1. Include dimensioned representations or plans and elevations that identify the weight and the location of the center of gravity.
2. Indicate field anchorage or mounting provisions to hold the component in place and resist forces derived from the criteria specified in [Section 01 8734] [Section 22 0548.23].
3. Identify anchors and other mounting devices.
4. Include information on the size, type, and spacing of factory-installed mounting brackets, holes, and other mounting provisions.

Q2: Shop drawings must be required if (a) seismic design and detailing is to be accomplished by either the Project structural engineer of record or construction Subcontractor, and (b) the component is other than distributed/distribution systems. The reasons for this are:

- o Whoever performs the seismic design and detailing has to have the requisite component-specific data/info to do such, and
- o The installation of the component has to be consistent with the seismic design and detailing.

Q3: If 01 8734 is applicable, then Shop Drawings aren't applicable (from a seismic standpoint).

**PART 2**

- Q1: Is the component seismically exempt? If so, delete SEISMIC PERFORMANCE REQUIREMENTS article and proceed to PART 3.

If a Project Spec includes 22 0548.23, and the component-specific Div-22/23 section includes devices that differ from those in 22 0548.23, then these products (i.e., the "devices that differ") must be included in PART 2 of the component-specific Div-22/23 section. And, if/when what has been described is applicable, use the same terminology for these devices in PART 3 in order to identify the type of devices required for each application.

**SEISMIC PERFORMANCE REQUIREMENTS<sup>20</sup>**

A. The [\_\_\_\_\_] shall remain in place without separation of any parts<sup>21</sup> when subjected to the design-basis earthquake **[(1)]** per Section 01 8734, *Seismic Qualification of Nonstructural Components (IBC)* **[(2)]** as represented by the seismic forces derived from the criteria indicated **[(3)]** on the drawings **[(4)]** in Section 22 0548.23, *Vibration and Seismic Controls for Mechanical Systems*.

<sup>19</sup> This shop-drawing text/verbiage, to include the four subparagraphs that follow, doesn't appear in Div.-22/23 sections for distribution systems (since it's not applicable to them).

<sup>20</sup> At the time of writing, the verbiage in subparagraphs A and B may differ from that in several Div.-22/23 sections applicable to equipment (vs. those sections applicable to distribution systems). This disconnect will be fixed as the affected equipment sections are revised.

<sup>21</sup> This does not include internal parts that are contained by the enclosure

B. The [ ] is a Designated Seismic System and, as such, shall remain in place and [(1) be fully operational] [(2) and] [(3) maintain containment]<sup>22</sup> following the design-basis earthquake [(4) per Section 01 8734, *Seismic Qualification of Nonstructural Components (IBC)*] [(5) as represented by the seismic forces derived from the criteria indicated [(6) on the drawings] [(7) in Section 22 0548.23, *Vibration and Seismic Controls for Mechanical Systems*].

Note: Bold/parenthetical numbering above added in guide to aid with editing instructions that follow.

- Q2 and Q3: Is the component required to remain in place after a DBE? (i.e., position retention). If so, then paragraph A above is applicable and should be edited as follows:
  1. Replace the brackets with the name or ID of the component.
  2. Retain the 1<sup>st</sup> option – “per Section 01 8734, *Seismic Qualification of Nonstructural Components (IBC)*” -- if ASCE 7 Ch. 13 will be complied with via manufacturer’s certification.
  3. Retain the 2<sup>nd</sup> and 3<sup>rd</sup> options if ASCE 7 Ch. 13 will be complied with via Project-specific design and documentation prepared by the seismic engineer of record.
  4. Retain the 2<sup>nd</sup> and 4<sup>th</sup> options if ASCE 7 Ch. 13 will be complied with via Project-specific design and documentation prepared by the construction Subcontractor.

If the component is a designated seismic system, then paragraph B is applicable, and should be edited as follows:

1. Replace the brackets with the name or ID of the component.
2. The first three options have to do with the reason(s) the component is a designated seismic system. Either one or both of fully operational and maintain containment can apply. Retain the option(s) that are actually applicable.
3. Retain the fourth option if either or both of the following apply:
  - a. ASCE 7 Ch. 13 will be complied with via manufacturer’s certification.
  - b. The component must be fully operational and is active/includes active parts or energized components, and/or if the component must maintain containment.
4. Retain the fifth and sixth options if neither “active” nor “containment” are applicable, and ASCE 7 Ch. 13 will be complied with via Project-specific design and documentation prepared by the structural engineer of record.
5. Retain the fifth and seventh options if neither “active” nor “containment” are applicable, and ASCE 7 Ch. 13 will be complied with via Project-specific design and documentation prepared by the construction subcontractor.

Finally, if the component is a DSS, the Project Mechanical Drawings must note/indicate this.

- A DSS is too important to risk being missed/overlooked (because it’s only mentioned in the component-specific Project Spec section).

### **PART 3**

If a Project Spec includes 22 0548.23, and the component-specific Div-22/23 section includes requirements associated with installation, testing, and inspection of mounting and/or anchorage devices

<sup>22</sup> At the time of writing, “maintain containment” wasn’t included in several of the Div.-26 sections. Since this doesn’t mean that it’s not applicable to all electrical components, “maintain containment” is included here (since it must be included in the component-specific section if it’s applicable to/for a particular component).

that differ from those in 22 0548.23, then the differing requirements must be included in PART 3 of the component-specific Div-22/23 section.

The remainder of this guide concerns flexible connections.

**FLEXIBLE CONNECTIONS**

Install flexible connections for [\_\_\_\_\_] where shown on drawings.

Q1: If the component is seismically exempt, then the component-specific Project Spec section and Mechanical Drawings must require flexible connection(s) of/to the component by whatever is running to/from it (as mentioned earlier in the Guide).

1. Fortunately, connections consisting of certain products/materials are inherently flexible (e.g., small-diameter copper tubing, etc.); thus, a PART 3 Flexible-Connections Article (like the example above) isn't always necessary.
2. In the event that such an Article is necessary, a "companion Article" is required in PART 2 that specifies either the flex-connection product(s), or the material(s) to be used in the flex connections.
  - Div.-22 and -23 section templates may (already) include products in their respective PART 2 that will suffice as flexible connections (for "seismic-exemption purposes").
  - Examples include the flexible Victaulic mechanical coupling and the metal hose vibration eliminator in 23 2113.
  - Examples of connections that aren't flexible include those that are threaded or bonded, or consist of compression or grooved couplings.

Q2 and Q3: If the component isn't seismically exempt then, regardless of who is responsible for compliance with ASCE 7 Ch. 13, and what the component's seismic performance requirements are, flex connections will be required if and/or when the seismic-displacement requirements of ASCE 7 Ch. 13 can't be accommodated without them.

The seismic-displacement requirements in ASCE 7 Ch. 13 are as follows:

- a. Relative displacement within structures. In a seismic event, structures will "sway," the result of which is different locations along the height will have different displacements (i.e., typically higher floors/stories will displace more than lower ones). Thus, a component attachment/mounting at one height will undergo a different displacement than an attachment/mounting at another height.
- b. Relative displacement between structures. In a seismic event, adjacent structures will "sway" differently (i.e., due to their differing structurally, being different heights, and/or the seismic ground motion affecting them at different points in time). Thus, a component attachment/mounting on one structure will undergo a different displacement than an attachment/mounting on an adjacent structure.
- c. Both of these types of relative/differential displacement must be accommodated by/within the component and/or the attachments/mountings, or by flexible connections. Regardless of what's being counted on to accommodate a given displacement, the displacement amount/size must be known (in order to determine whether it can be accommodated by the component and or its attachments, to specify a particular type of flex connection).

- d. ASCE 7 Ch. 13 stipulates two methods for determining the size/amount of both of these types of relative displacement: empirical and analytical, either of which is always permitted.

Even if these displacement requirements can be satisfied without specific flex-connection products/materials, it is good practice to require such for distribution/distributed systems (e.g., mechanical raceways) in the following instances:

- When crossing building-expansion or seismic-control joints,
- When passing from one structure to another, and
- When passing from one floor/story of a structure to another floor/story.

NOTE: Section 22 0548.23 template requires flexible connections in these instances; thus, they need not be included in the component-specific Project Spec section if/when 22 0548.23 is a Related Section and the flexible connection content of PART 3 therein is retained.

For more information/education on flexible connections, refer to the following:

- [FEMA E-74](#), *Reducing the Risks of Nonstructural Earthquake Damage*: Fig. 6.4.3.3-6, Flexible connections and expansion joints (ER).
- ASCE 7 Commentary para. C13.6.8, specifically the portion of it on the left-hand side of pp. 452.