

IBC Requirements for Power Generator Sets



**Power
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Agenda

- Seismic requirement and building code
- Introduction – International Building Code
- Defining Seismic Requirements
- Additional information

Building Code and Seismic Requirements



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Northridge Earthquake, 1994

The Kaiser Permanente Clinic at Granada Hills on Balboa Blvd.

Photo Credit: M. Celebi, U.S. Geological Survey Source: National Geographical Data Center





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Northridge Earthquake, 1994

At the Northridge Fashion Center, near the earthquake epicenter, the second floor of Bullocks Department Store collapsed onto the bottom story

Photo Credit: J. Dewey, U.S. Geological Survey Source: national Geographical Data Center



1994 Northridge Earthquake in California

- Over 60 deaths
- More than 5,000 injuries
- Over 25,000 people left homeless
- Over \$25 billion in direct financial loss
- But it wasn't even the big one!!!

Magnitude 6.7 (not even in US Top 10)

The main shock duration was only 15 seconds

Buildings and critical systems are now facing new requirements



Building codes are now written to ensure that **critical systems** can withstand the same forces the building is required to withstand and **must remain online and functional** after a seismic event!

The IBC Code - Introduction



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International Building Code

- The IBC (International Building Code) is recognized as the model building code for the United States
- The IBC is published by the ICC (International Code Council)
- To maintain a single set of national model construction codes the ICC was founded in 1994 to combine the efforts of the following regional code publishing entities:
 - Building Officials Code Administrators (BOCA): East Coast, Midwest
 - Southern Building Code Congress International (SBCCI): Southeast
 - International Conference of Building Officials (ICBO): West Coast

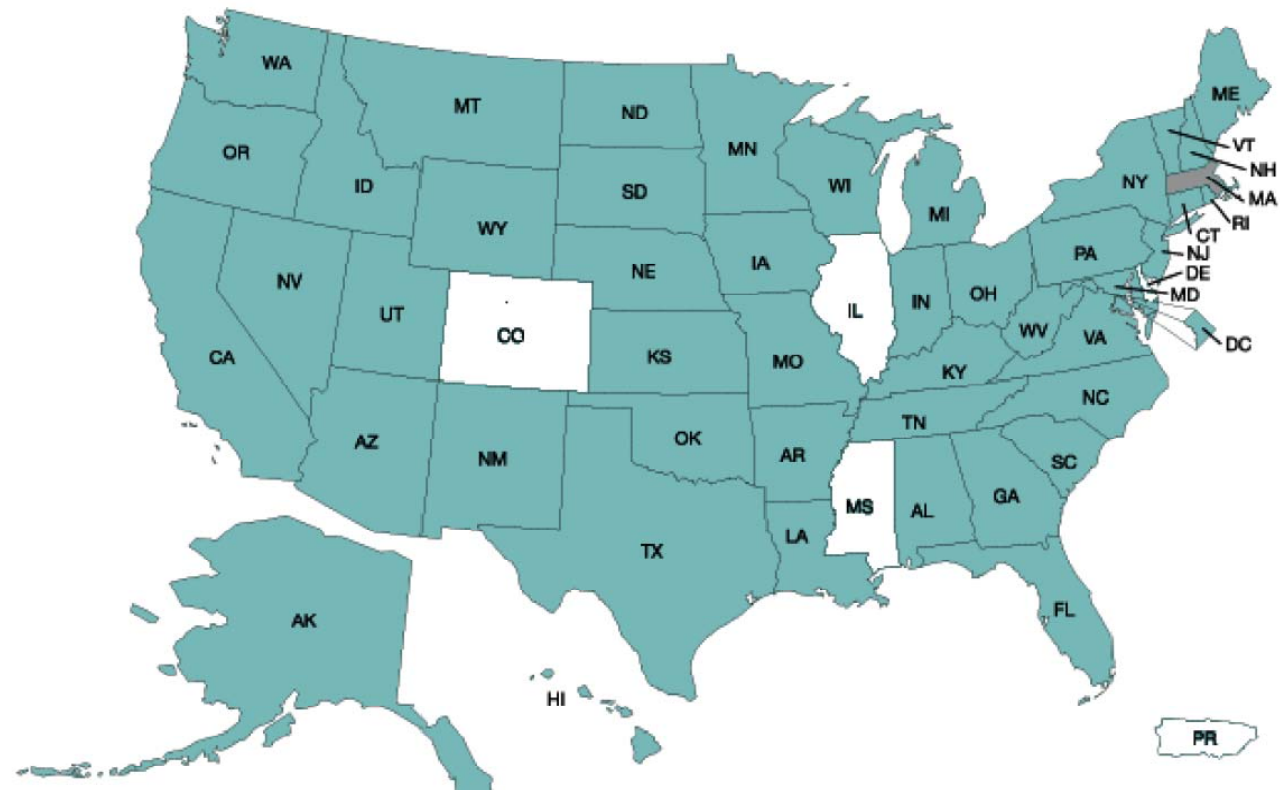
Major differences between editions IBC 2000/2003/2006

	2000	2003	2006
Seismic requirement	Yes	Yes	Yes
Wind load requirement	No	No	Yes
Allow Self-certifying	No	No	Yes

- There are three editions of IBC code
- States or local jurisdictions may adopt different version of the IBC

IBC adoption status - by states (as of 8/13/08)

- Adopted & Effective statewide: 45 states plus DC
- Adopted by various local jurisdiction: MS, DE, CO, IL
- Adopted with unknown future effective date: Massachusetts



IBC 2000	IBC 2003	IBC 2006
8 states	17 states	19 states

*Data source: International Code Council website
www.iccsafe.org

How do states adopt building codes?

- Constitutionally, states have jurisdiction over the regulation of construction
- Most states mandate a model or state code to cover all buildings
- States may make amendments, with permission of the publishing organization, to adopted model building codes to meet specific regional needs
- States may establish statewide building codes that prohibit local amendments without state approval

How do local jurisdictions adopt building codes?

- Building regulations are generally carried out by local government building or safety departments
- In some case this local jurisdictions can be a special district such as school districts or utility districts
- Code enforcement often emanates from local jurisdictions that issue permits and inspect private projects for conformance
- Local jurisdictions may develop their own regulations, like Chicago building code, or adopt building codes based on national model codes.

Example - Sammamish City, WA

Sammamish Municipal Code

Title 16 BUILDINGS AND CONSTRUCTION

Chapter 16.05 CONSTRUCTION CODES

16.05.070 International Building Code adopted.

16.05.070 International Building Code adopted.

The 2006 Edition of the International Building Code, as adopted by the State Building Code Council in Chapter 51-50 WAC, as published by the International Code Council, including Appendix Chapter E (Accessibility), ICC A117.1-2003 (Accessible Standards), Appendix Chapter H (Signs), and Appendix Chapter M (2006 International Existing Building Code), excluding Chapter 1, Administration, is adopted, together with the following amendments:

(1) Add new stand-alone section as follows:

Design Criteria shall be as follows:

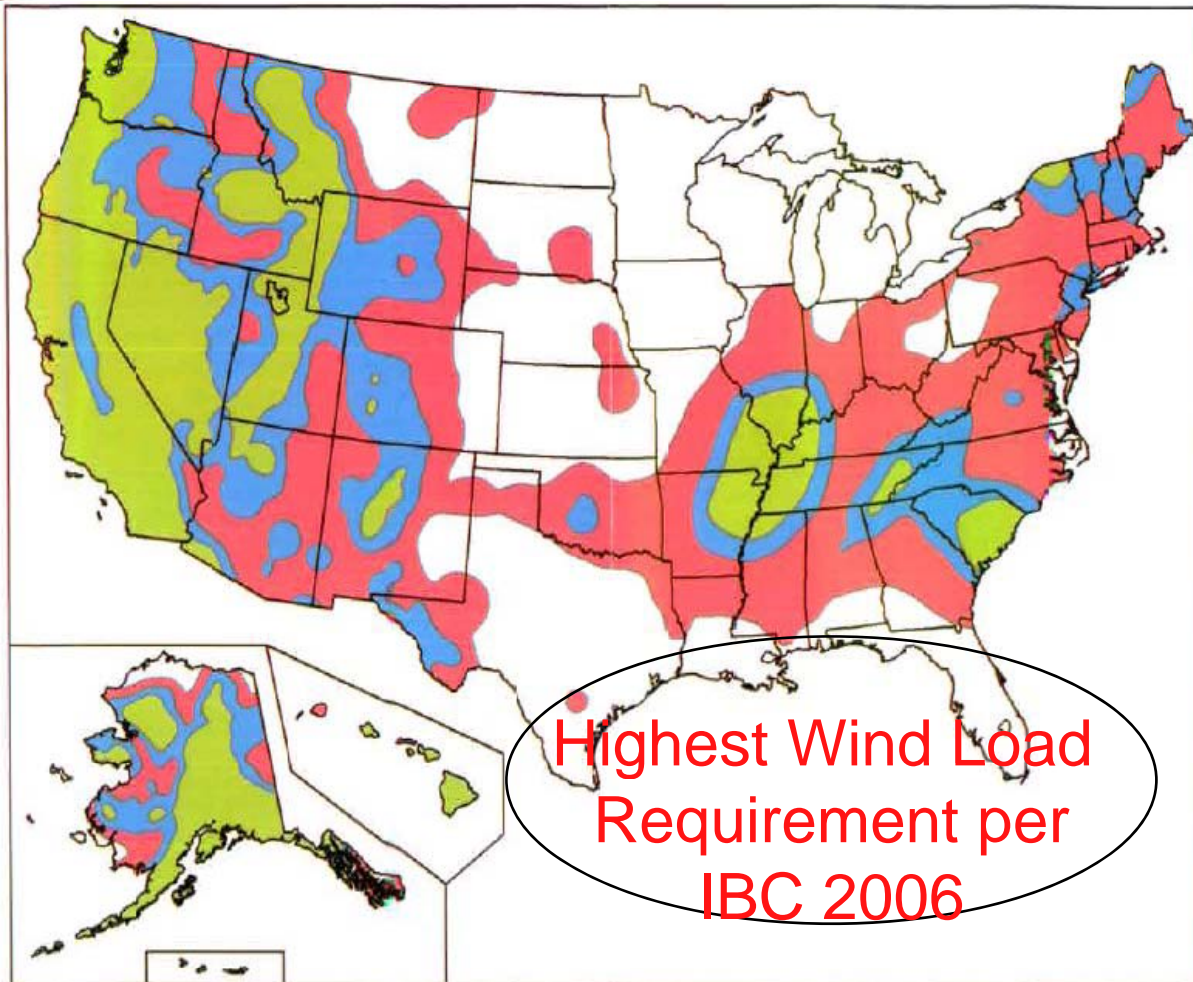
GROUND AND ROOF SNOW LOAD: 25 PSF

SEISMIC DESIGN CATEGORY: D

WIND SPEED: 70 mph sustained with 85 mph gust

- The Washington state has adopted IBC 2006 edition
- Municipal codes may raise the standard in addition to the minimum code requirement of IBC 2006 adopted by the state

Impact of IBC code requirement



- Construction projects in a pink, blue or green area will be most affected by the seismic requirements of the IBC Code
- The white areas along the coastal region may have higher wind load requirement
 - Proper attachment to the building for IBC 2000/2003
 - Proper attachment AND equipment certification required per IBC 2006

IBC Code Requirement for Power Generation System

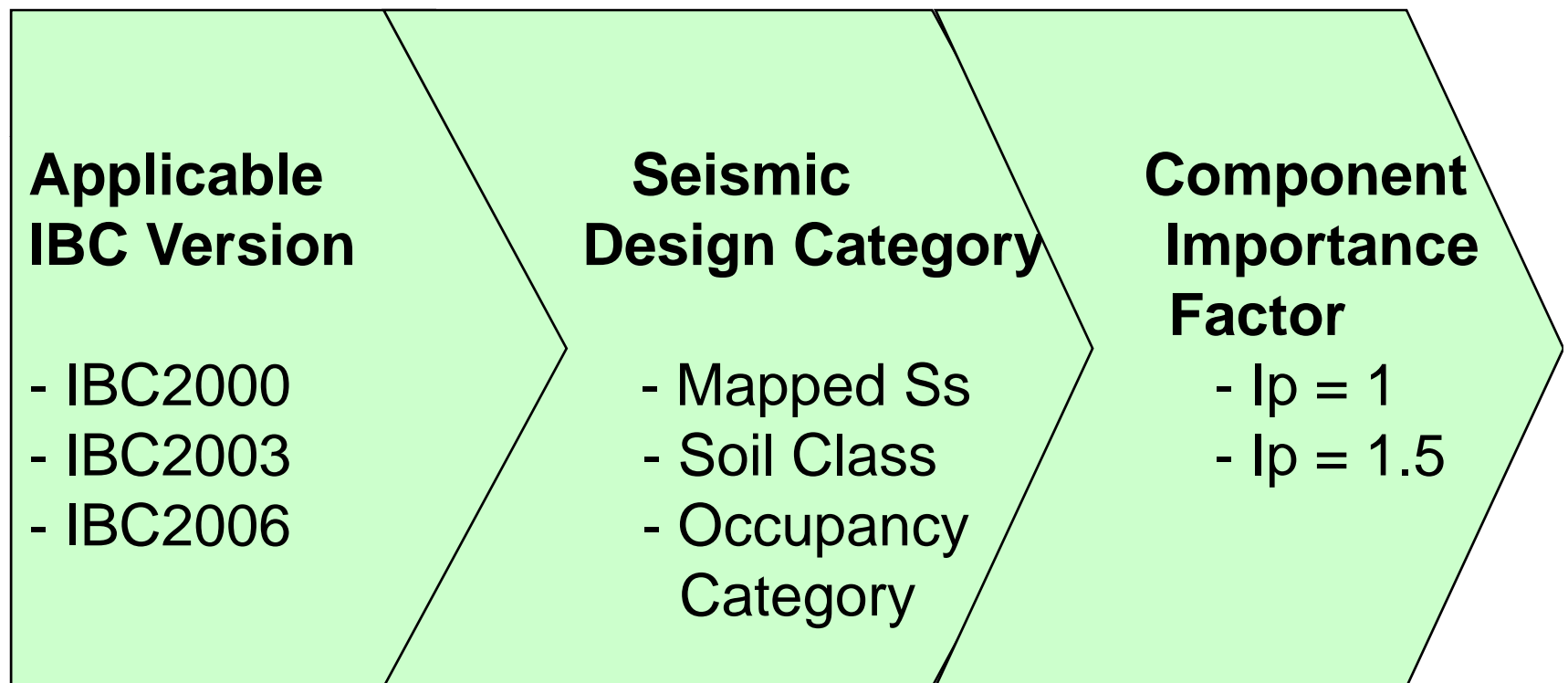
- Critical equipment should meet specific performance requirements to withstand seismic loads AND wind loads (2006 version) – “remain online and functional after a seismic event”
- IBC Code specifically addresses both “design” and “installation” of building systems with emphasis on performance
- Suppliers of equipment are required to test and analyze the equipment and provide a certificate of compliance and proper labeling per IBC

International Building Code Seismic Design Requirement



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Key elements that dictate equipment design requirements per IBC



Different versions of IBC may be applicable to different construction sites

Applicable IBC version

- IBC2000
- IBC2003
- IBC2006

- Design professionals are responsible for specifying the right version of code in the bid document/ spec – IBC 1708.5
- IBC 2006 has wind load requirement up to 150MPH
- IBC adoption information by state or by local jurisdiction is also available on International Code Council website

IBC code adoption information – ICC website



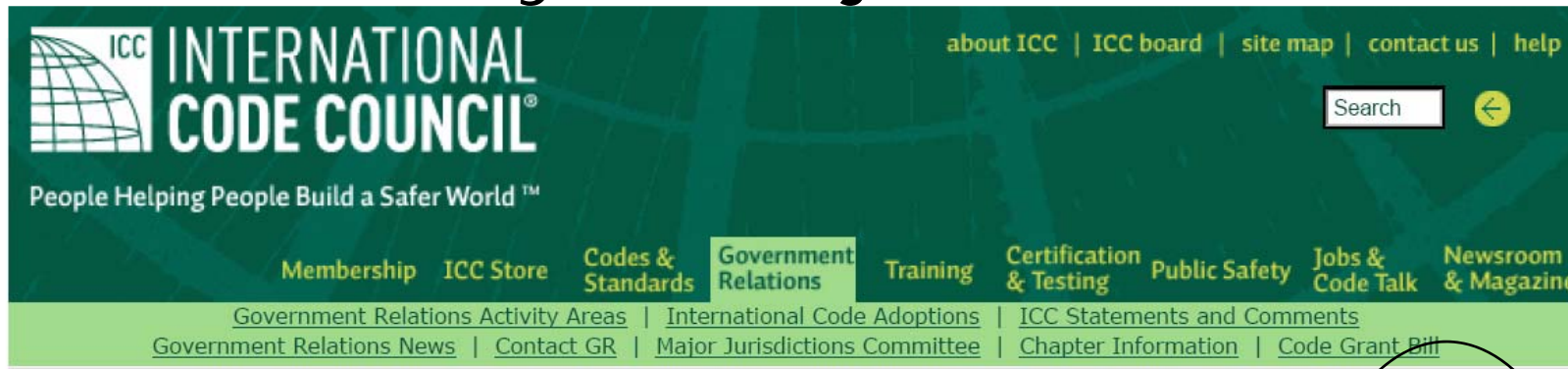
The screenshot shows the ICC website homepage with the following elements:

- Header:** ICC INTERNATIONAL CODE COUNCIL logo, tagline "People Helping People Build a Safer World™", and navigation links: about ICC | ICC board | site map | contact us | help. A search bar is also present.
- Navigation Menu:** Membership, ICC Store, Codes & Standards, Government Relations, Training, Certification & Testing, Public Safety, Jobs & Code Talk, Newsroom & Magazine.
- Left Sidebar:**
 - I-Code Adoptions:** A map of the United States with a red dot in the South, circled in red.
 - PARTNERS:** A logo with two interlocking blue and yellow shapes.
 - SMARTcodes:** A logo with a red and blue square.
 - ICC Subsidiaries:** A section titled "click icons to visit" containing logos for ICC-ES, IAS, and ICC FOUNDATION.
- Main Content Area:**
 - ICC Daily News:** A green header for a list of news items:
 - Register Now for [Annual Conference](#).
 - Make your vote count at the [Final Action Hearings](#).
 - [Code Council testifies](#) before Congress.
 - [Building Code Grant](#) Passes House.
 - Are you going green? [Tell us](#).
 - [Download](#) Final Action Hearing Schedule.
 - Guides reference [Florida Code changes](#).
 - New Vendor for [Contractor UST Exams](#).
 - [New standard](#) will save lives when tornados strike.
 - ICC-ES to Launch [Green Service](#).
 - [ICC Chapters Save](#) on Bulk Membership in 09.
 - ICC Councils & Code Technology [Committee Call](#).
 - Proposed [Bylaws Amendments](#).
 - New [PMG product listings](#).
 - [Proposed Committee Interps](#) open for comments.
 - [Acreement promotces building safety](#) in Uruguay.
 - Visit the [PMG Resource Center](#).
 - Updated [Building Valuation Data](#).
 - [greenVision](#) ICC Facilities Expansion Project.
 - [Campus online, training and special events](#).
 - Advertisements:**
 - Top Right:** "Please Urge Your Senator To Support It." with an image of the US Capitol dome.
 - Middle Right:** "Code Council Leads the Way in Building Green." with an image of green leaves.
 - Bottom Right:** "Check out this Summer's ICC Webinars! Increase your efficiency and effectiveness. Earn CEU/LUs. CLICK HERE!" with an image of a construction site.

www.iccsafe.org

Check code adoption by state or by local jurisdiction

ICC Online | Government Relations



International Code Adoptions

Has your jurisdiction adopted any of the I-Codes? Let us know, [click here](#).

- The *International Building Code* (IBC) is adopted at the state or local level in 50 states plus Washington, D.C.
- The *International Residential Code* (IRC) is adopted at the state or local level in 46 states plus Washington, D.C.
- The *International Fire Code* (IFC) is adopted at the state or local level in 41 states plus Washington, D.C.
- The *International Plumbing Code* (IPC) is adopted at the state or local level in 35 states and Washington, D.C.
- The *International Mechanical Code* (IMC) is adopted at the state or local level in 47 states and Washington, D.C.
- The *International Fuel Gas Code* (IFGC) is adopted at the state or local level in 46 states and Washington, D.C.

Green Codes Clearinghouse. [Click here](#) to view.

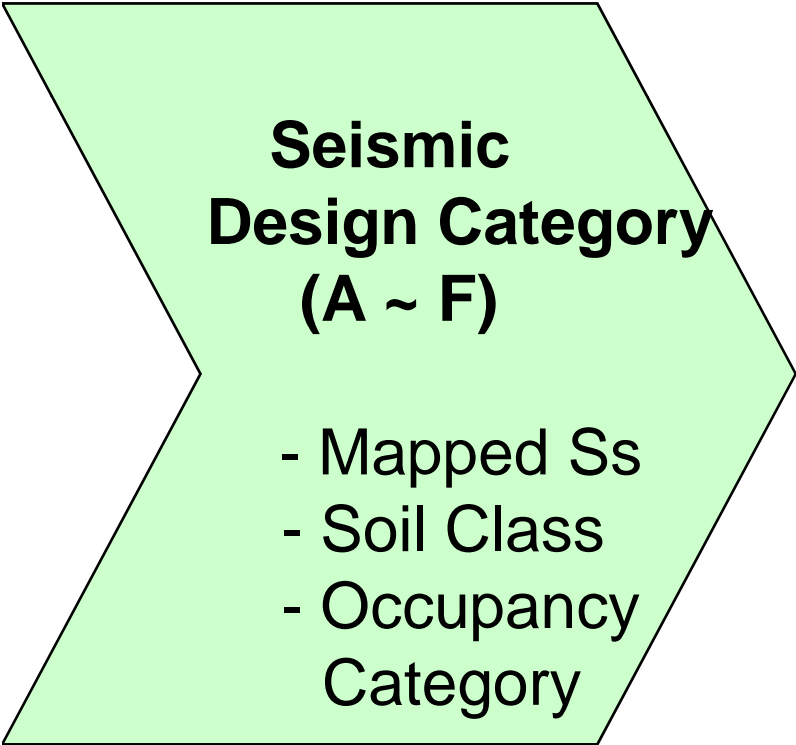
Submit Code Adoption Info
[Submit/Update](#)

View I-Code Adoptions
[Adoption Map](#)

State Adoptions
[Excel Chart](#)
[PDF Chart](#)

Jurisdiction Adoptions
[Excel Chart](#)
[PDF Chart](#)

Seismic Design Category will dictate if **the building** is required to comply with the **certification requirement of the code**

A large green arrow pointing to the right, containing text about seismic design categories.

**Seismic
Design Category
(A ~ F)**

- Mapped S_s
- Soil Class
- Occupancy Category

IBC certification requirement:

- Manufacturer shall test or analyze the component that shall remain operable after a seismic event using:
 - **Actual test on a shake table** or
 - **Analytical method using dynamic characteristics and forces** or
 - Other more rigorous analysis
- Supplier of the equipment must provide certificate of compliance
- Proper product labeling required per IBC 1703.5

What determines the seismic design category of a building?

How bad an earthquake can be at the construction site?
S_s : Mapped Spectral Accelerations for Short Periods

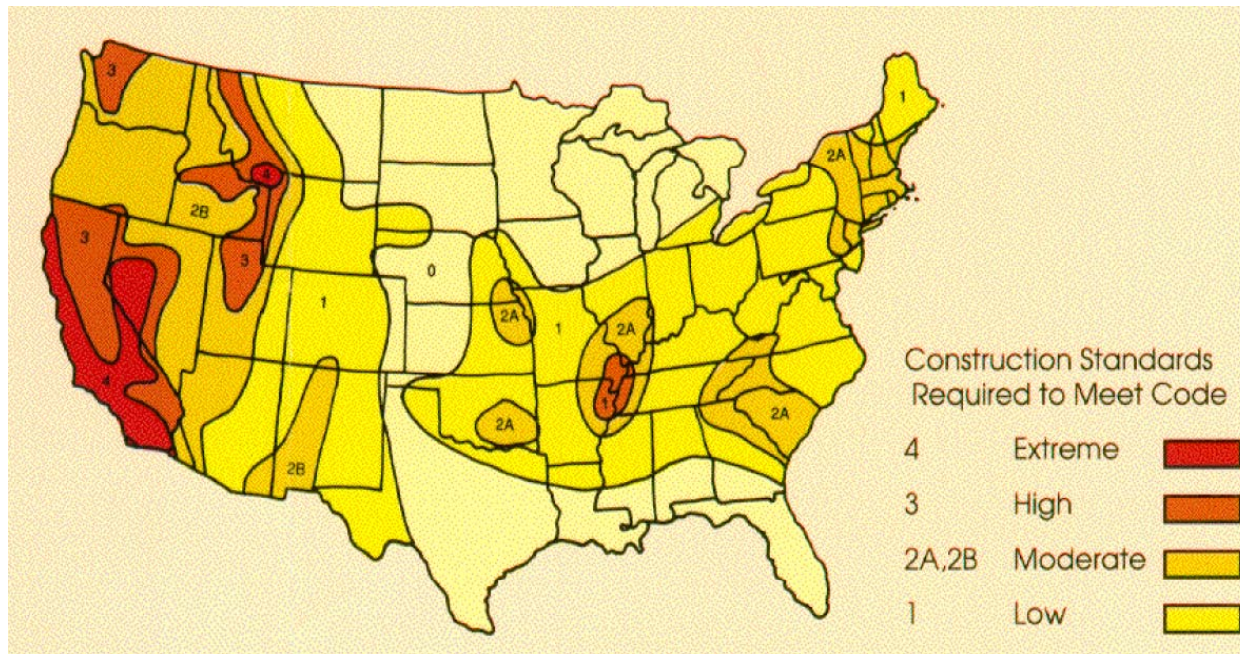
What is the soil profile at the site?

- Site Class A - F

What is the intended function of the building?

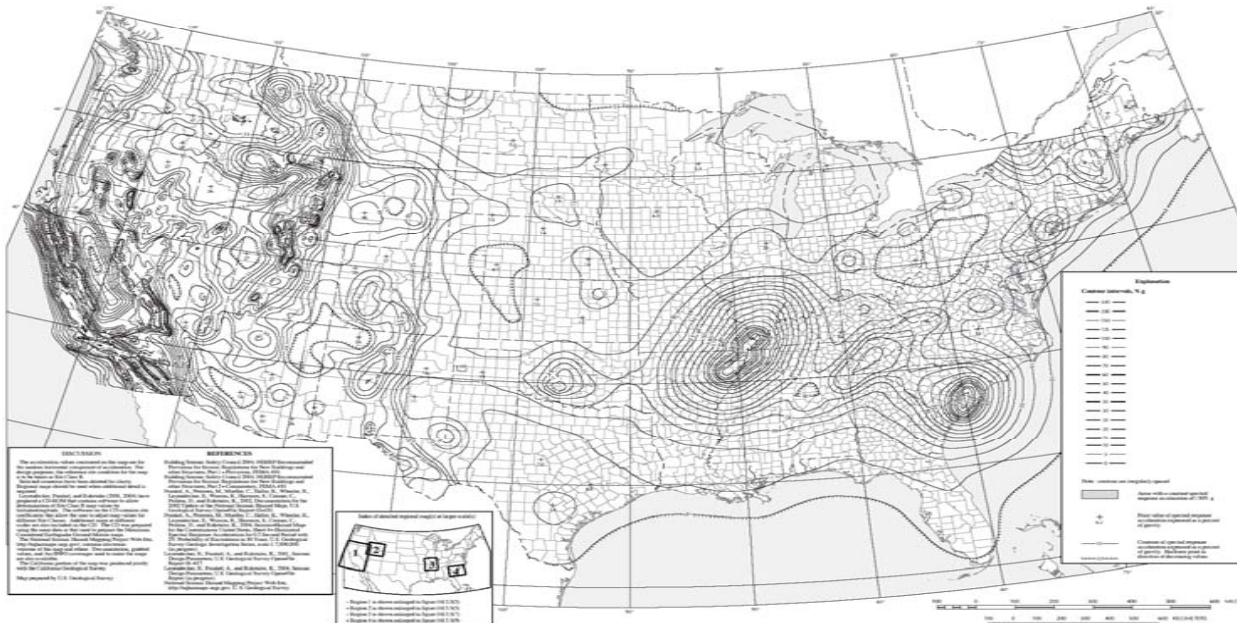
- Occupancy Category I ~ IV

How bad an earth quake can be at the site?



- The old UBC Zone 1 ~ 4 definition is no longer used
- The seismic design force for equipment installation was the same regardless of where the building were located within the zone
- New design force requirement will be based on **S_s value** mapped by U.S. Geological Survey

How Bad an Earth Quake Can Be at the Site?



- The U.S. Geological Survey has now mapped the ground accelerations throughout the United States and have assigned various values.
- Calculation of the seismic design force for equipment attachment AND equipment selection is now based on these new mapped accelerations (Ss: Short Period Spectral Response Acceleration)
- Specifying Engineers must now be referencing these values in equipment specs and **not the old UBC zones**

Ss value will be used to define the seismic design force required at a specific site

How bad an earthquake can be at the construction site with certain soil profile?

Site Class	Soil Profile
A	Hard Rock
B	Rock
C	Very dense soil and soft rock
D	Stiff soil profile
E	Soft soil profile
F	Special soil profile that is extremely vulnerable

- There are six different soil profiles defined in IBC (Site Class A ~ F)
- Design professionals need to determine and calculate the Sds based on the Site Class information
- In absence of detailed site analysis, IBC allows specifying engineers to use site Class D unless Authority Having Jurisdiction or geotechnical data determines site Class E or F soils are present at the site

Sds value will be determined after factoring in the soil characteristic

Occupancy Category – intended function of a building (Category IV is the most critical)

- **Category IV – Buildings and other structure designated as essential facilities (include but not limited to the following)**
 - Hospitals and other health care facilities having surgery or emergency treatment facilities
 - Fire, rescue and police stations and emergency vehicle garages
 - Designated earthquake, hurricane or other emergency shelters
 - Designated emergency preparedness, communication, and operation centers and other facilities required for emergency response
 - Power-generating stations and other public utility facilities required as emergency backup facilities for Occupancy Category IV structures.
 - Structures containing highly toxic materials as defined by Section 307 where the quantity of the material exceeds the maximum allowable quantities of Table 307.1.(2).
 - Aviation control towers, air traffic control centers and emergency aircraft hangars.
 - Buildings and other structures having critical national defense functions.
 - Water treatment facilities required to maintain water pressure for fire suppression.

Occupancy Category – intended function of a building (Category III is second to Category IV)

Category III – Buildings and other structures that represent a substantial hazard to human life in the event of failure

- Covered structures whose primary occupancy is public assembly with an occupant load greater than 300
- Buildings and other structures with elementary school, secondary school or day care facilities with an occupant load greater than 250
- Buildings and other structures with an occupant load greater than 500 for colleges or adult education facilities
- Health care facilities with an occupant load of 50 or more resident patients, but not having surgery or emergency treatment facilities.
- Jails and detention facilities
- Any other occupancy with an occupant load greater than 5,000
- Power-generating stations, water treatment for potable water, waste water treatment facilities and other public utility facilities not included in Occupancy Category IV
- Buildings and other structures not included in Occupancy Category IV containing sufficient quantities of toxic or explosive substances to be dangerous to the public if released

Occupancy Category I & II

- Category I – low hazard to human life in the event of failure, include but not limited to:
 - **Agricultural facilities**
 - **Certain temporary facilities**
 - **Minor storage facilities**
- Category II – Building & structures not included in I, III, IV
- Multiple Occupancy
 - If a separate portion of a structure:
 - Provides required access to,
 - Requires egress from, or
 - **Shares life safety systems** with another portion having higher occupancy category
 - Both portions will be assigned to the higher occupancy category

Seismic Design Category

SEISMIC DESIGN CATEGORY BASED ON SHORT-PERIOD RESPONSE ACCELERATIONS

Table 1613.5.6(1)

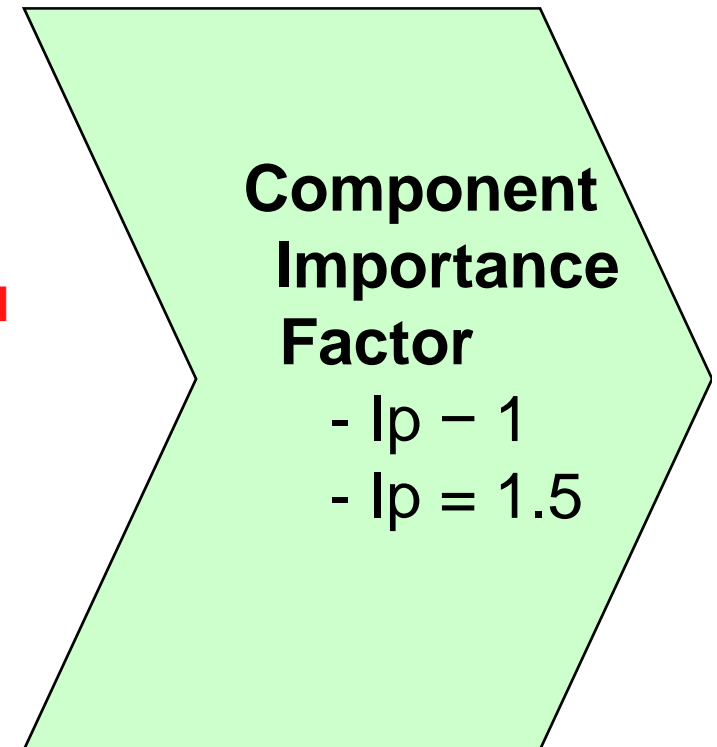
Value of S_{DS}	Occupancy category		
	I or II	III	IV
$S_{DS} < 0.167g$	A	A	A
$0.167g \leq S_{DS} < 0.33g$	B	B	C
$0.33g \leq S_{DS} < 0.50g$	C	C	D
$0.50g \leq S_{DS}$	D	D	D

Table 1613.5.6 (1): Seismic design category based on 0.2 second period response accelerations.

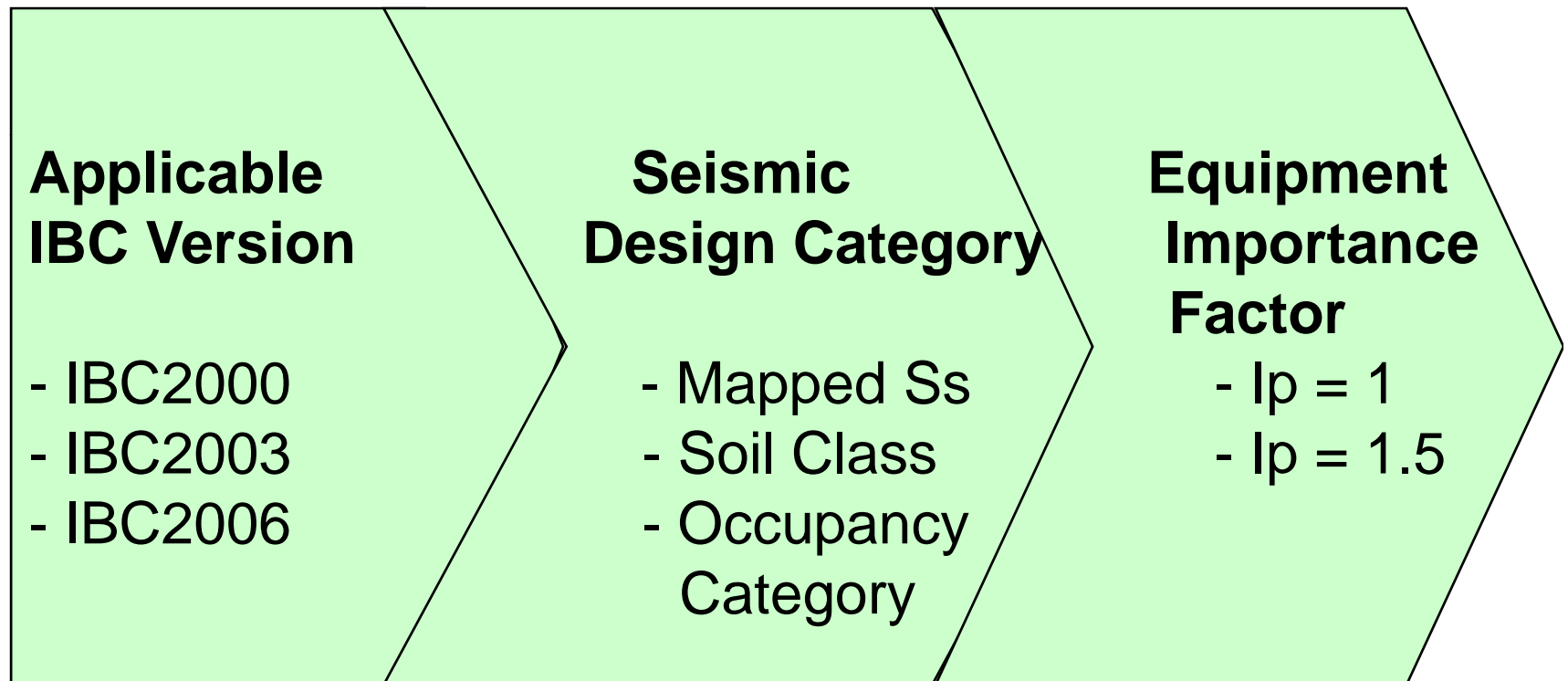
- With S_{DS} information and assigned building occupancy category, the seismic design category can be determined
- Category A and B are exempt from the IBC seismic certification requirement
- Category E and F are not listed here but have even greater S_{DS} value and need to comply with seismic requirements unless otherwise specified

Component Importance factor

- Equipments given I_p of 1.5:
 - The component is required to function for life-safety purpose after an earthquake (ex. fire sprinkler systems)
 - Components containing hazardous materials
 - The component is **in** or **attached to** an Occupancy Category IV structure and is **needed for continued operation of the facility** or **its failure could impair the continued operation of the facility**
- **Equipment given I_p of 1:**
 - All equipment other than above
- **Equipments given importance factor of 1.5**
 - **Required to function after seismic event**
 - Manufacturer must **supply a certificate of compliance and product labeling**



Key elements that dictate equipment design requirements per IBC



Exempt from IBC Seismic Requirement

- Components in Seismic Design Category A or B.
- Components in Seismic Design Category C **and** Component Importance Factor, I_p , is equal to 1.0
- Components in Seismic Design Category D, E and F where I_p is equal to 1.0 **and either:**
 - Flexible connections between the components and associated ductwork, piping, and conduit are provided
 - The component is mounted at 4ft or less above a floor level **and** weighs 400lb or less

Additional Information



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Shake table test is used by equipment supplier to test and analyze equipment performance per IBC

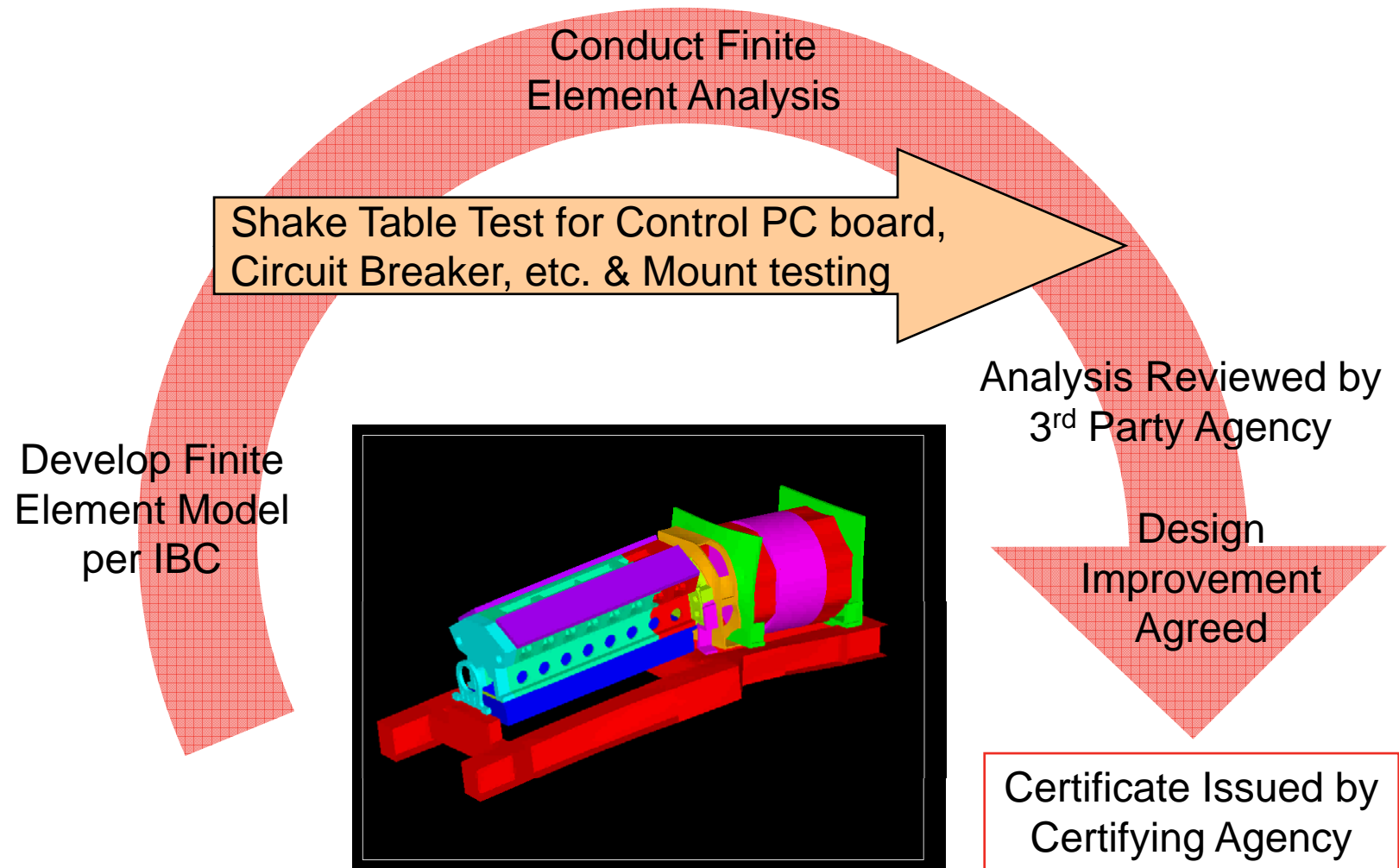


- The generator set has to provide electrical output after the 30 second shake table test to qualify the seismic force design requirement

- The video is available at:

<http://www.cumminspower.com/www/common/images/MOV03129.MPG>

Finite Element Analysis is another acceptable approach equipment supplier may use per IBC



Other information available

- Cummins Power Generation White Paper:
 - PT-8002: IBC requirements for power generator sets
 - <http://www.cumminspower.com/www/literature/technicalpapers/PT-8002-IBCGensets.pdf>