

THE INTERNATIONAL BUILDING CODE & ITS IMPACT ON HOSPITALS AND THEIR MEP SYSTEMS



Hospital: An institution that provides medical, surgical or psychiatric care and treatment for the sick or injured. (American Heritage Dictionary)

What would happen to this institution if there were no lights in the corridors, no heat to maintain sanitary and drinking services, no air conditioning to maintain functional operating temperatures, no extended electrical power to ensure laboratory and medical equipment function and no ability to retrieve patient and test information. In short, what would happen if the facility was not capable of continuing its “intended function” due to wind, earthquakes or floods? The answer is obvious, failure of the facility to serve the community!

Referred to as “Essential Facilities,” hospitals and related health care structures are “buildings that are intended to remain operational in the event of extreme environmental loading.”¹

Highlighted herein, the understanding, design and implementation of the “on line” requirements for mechanical, electrical and plumbing (MEP) systems as stated in the International Building Code (IBC) and its related document, the American Society of Civil Engineers, Standard 7-05 (ASCE 7-05).²

Hospital Montage, Lester Lefkowitz © 2008
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BACKGROUND

The need for a U.S. model building code became evident after the Northridge, California earthquake in 1994. With the closing of nine hospitals and nearly 2500 beds lost, the requirement for a standard to keep critical MEP systems operationally viable became transparent. More recently, Hurricane Katrina enforced what was already known when wind and rising flood waters devastated the vast majority of health care capabilities from the City of New Orleans. Lessons are learned after major catastrophic events, and these lessons are what shape our construction codes.

In the mid 1990s, three formerly competing code agencies joined to form the International Code Council (ICC). Their mission was to take the recommendations of the NEHRP³ agencies and develop a national model construction code. The codes they developed are known as the International Codes of 2000, 2003 and 2006 of which volume number 1, the International Building Code, is the structural

handbook for the building. Every state has adopted one of the versions of the

IBC code with most states adopting at the state level and others at the county

level (**Figure 1**). As of this writing, 43 states have a seismic requirement for

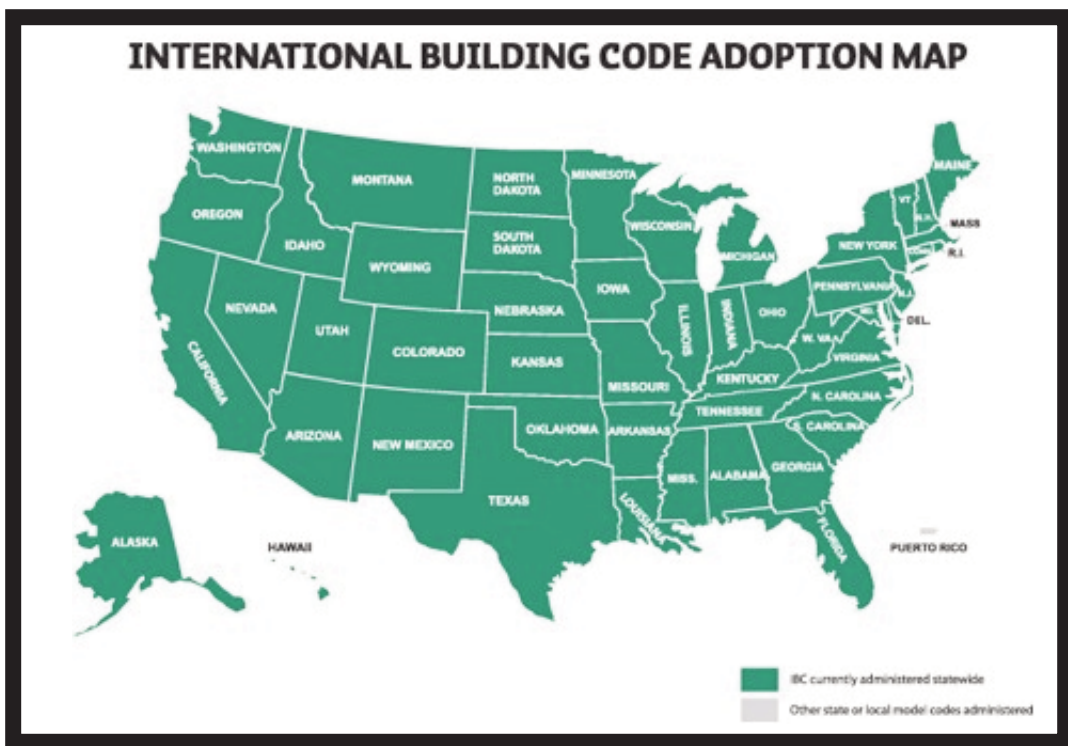


Figure 1, (Bottom Right) Source: International Code Council

health care facilities for all or part of their state (Figure 2) and all states have specific wind load

requirements (Figure 3). Additionally, our coastal regions and river basins from Maine to Texas

succumb to floods and design engineers, contractors and building owners need to understand the code requirements for these regions.

The IBC code significantly differs from all previous building codes as it relates to the field of health care. Manufacturers, equipment suppliers, design engineers, specifying engineers and building owners must fully understand the applicable provisions of the code in order to minimize their exposure to risk and liability -- with the ultimate goal of guaranteeing the insurability of the facility. The single

biggest change for everyone is that hospital related critical equipment needs to be designed, constructed and installed not just for anchorage but for full proven performance operation after a seismic, wind or flood event. Previous codes only required anchorage of equipment through examination of the fastening device and did not address the specific on line functionality of the equipment after an event.

LIABILITY CONCERNS

The preceding three editions (and soon the fourth edition) of the IBC code, holds architects, engineers, contractors and equipment manufacturers alike responsible for the “on line” capability of MEP systems in hospitals and related facilities. As a state adopts a version of the building code, it becomes the law governing all but

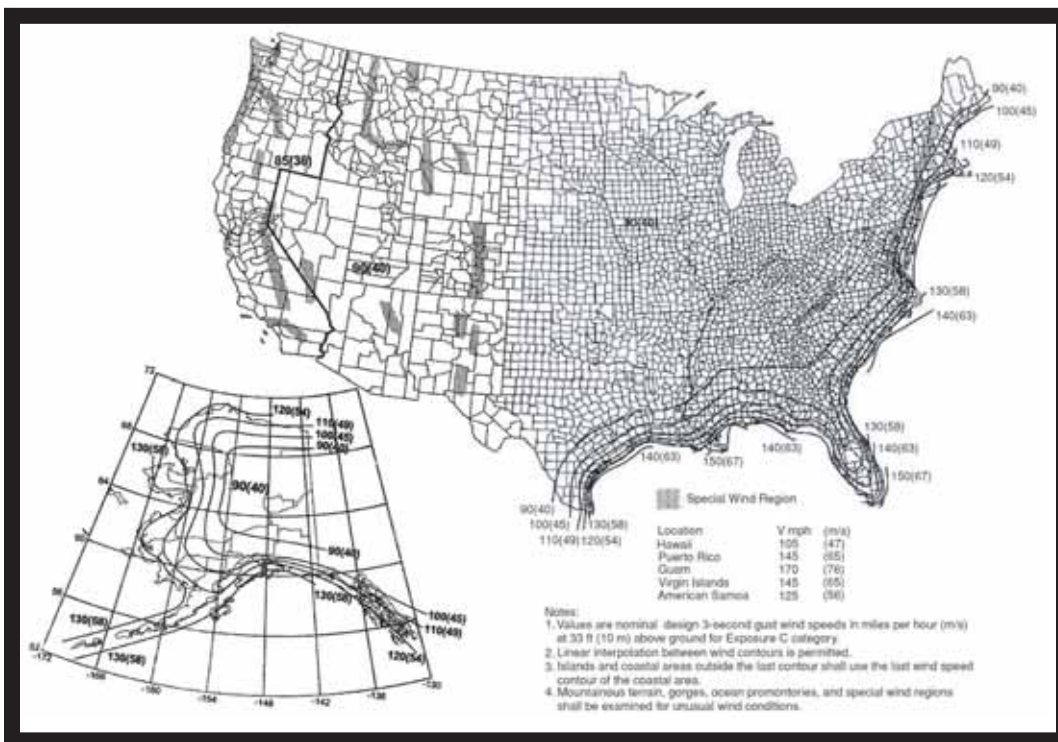
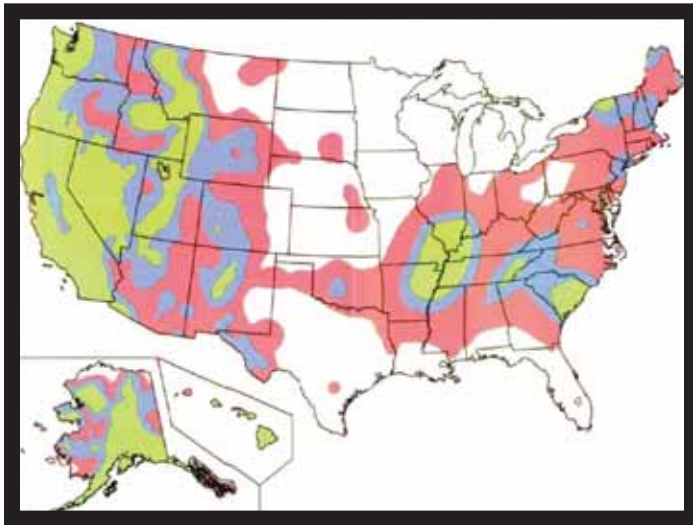


Figure 2: (Top Left) In General, Colored Regions Represent Areas With Seismic Requirements for Hospitals and Health Care Facilities

Figure 3, (Bottom Left) Source: ASCE 7-05, Basic Wind Speed (3 Second Gust)



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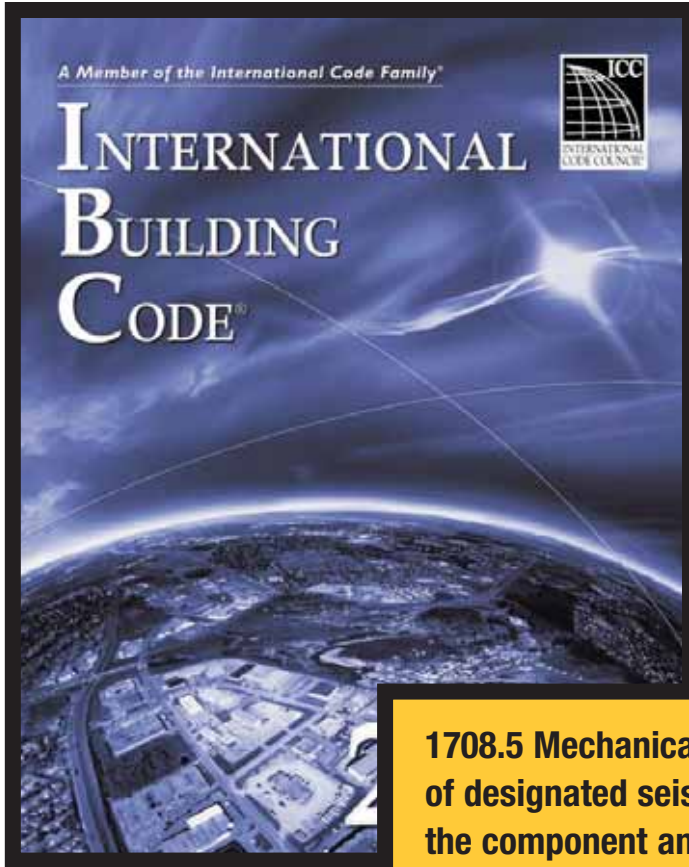


Figure 4.

Source: International Code Council

residential construction. Accordingly, both professional and construction licenses are at risk for those who do not adhere to the law's life safety requirements. That liability is further extended with the inclusion of the "Consequential Damage" section of the code, making the work or omissions of one party the responsibility and liability of another.

The first liability concern is with the selection of equipment. Equipment manufacturers now need to guarantee "on line"

performance through testing and analysis as outlined in section 1708.5 of the code (see Figure 4).

This requirement occurs when the design engineer or specifying engineer deems a component a designated seismic system. In the simplest of terms, a designated seismic system is an electrical, plumbing or mechanical system or component that is required to function after an earthquake in order for the hospital or health care facility to remain open in its intended function. It is the

1708.5 Mechanical and electrical equipment. Each manufacturer of designated seismic system components shall test or analyze the component and its mounting system or anchorage and shall submit a certificate of compliance for review and acceptance by the registered design professional in responsible charge of the design of the designated seismic system and for approval by the building official. The evidence of compliance shall be by actual test on a shake table, by three-dimensional shock tests, by an analytical method using dynamic characteristics and forces, by the use of experience data (i.e., historical data demonstrating acceptable seismic performance), or by more rigorous analysis providing for equivalent safety. The special inspector shall examine the designated seismic system and shall determine whether the anchorages and label conform with the evidence of compliance.

role of the design and/or specifying engineer to clearly state these types of systems in the specifications by assigning them an Importance Factor (I_p) equal to 1.5 (see **Figure 5**). Additionally, it is the responsibility of the equipment manufacturer to supply a certificate of compliance to the engineer in responsible charge of the system. The certificate of compliance must acknowledge the equipment being supplied

for the project is in compliance with the code. When required by the code, the equipment manufacturer must also affix a label to the equipment that contains sufficient information for the inspector to determine that the installed product is the same as that which was approved during plan review. A special inspector acts on behalf of the building owner or MEP engineer and verifies that the labeling of the

equipment and anchorage or mounting conforms to the previously supplied certificate of compliance. Additionally, Authorities Having Jurisdiction (AHJ) look for product labeling and certificates of compliance to ensure adherence to code.

Another source for liability concerns rests with the installing contractor. The IBC code requires contractors involved with the installation of

designated seismic systems or a wind-resisting or seismic-resisting component to supply a statement of responsibility to the building owner and the code official prior to commencement of work.⁴ Specifying and design engineers, working on behalf of the building owner, must request and review these statements of responsibility in order to reduce their exposure to risk and liability. Additionally, engineers must carefully review any “value engineering” proposals set forth by contractors to ensure adherence to the code’s requirements.

Currently, notable insurance carriers such as Factory Mutual (FM) have issued guidelines to their clients for design and inspection based on the new IBC requirements. Additionally, the largest specification writing community, the American Institute of Architects (AIA) MasterSpec, now lists the term “withstand”⁵ under its seismic requirements to help the engineering community write specifications ensuring equipment will be in compliance with the code.

13.1.3 Component Importance Factor ASCE 7-05

Section 13.1.3- Component Importance Factor. All components shall be assigned a component importance factor as indicated in this section. The component importance factor, I_p , shall be taken as 1.5 if any of the following conditions apply:

- 1. The component is required to function for life-safety purposes after an earthquake, including fire protection sprinkler systems.**
- 2. The component contains hazardous materials.**
- 3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.**

All other components shall be assigned a component importance factor, I_p , equal to 1.0.

Figure 5, Source: ASCE 7-05



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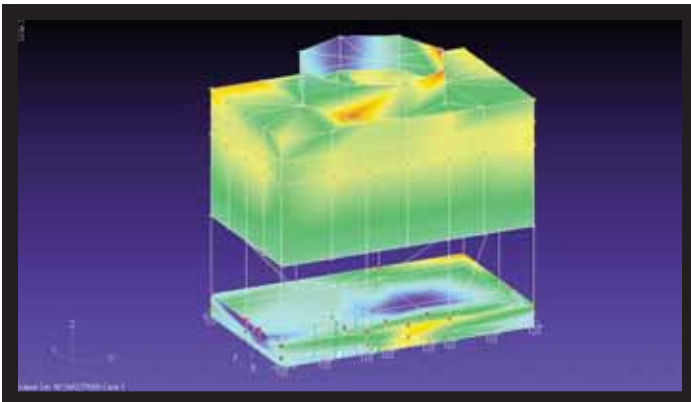


Figure 6 (Top). A VMC Group Seismic Curb Prior to Shake Table Testing at the University of Buffalo. A 28,000 lb rooftop unit was installed on the curb and tested to an S_{DS} value of 2.0.

Figure 7 (Bottom). Sample finite element modeling of a cooling tower.

BASIS OF CERTIFICATION

Two commonly accepted methods for equipment certification include shake table testing (see Figure 6) and computer modeling (FEA analysis) (see Figure 7). Shake table testing must strictly adhere to test standard ICC-ES AC 156 and engineers reviewing

certificates of compliance must ensure the certificate states the basis of certification. Certification is granted if, after testing, the component restarts and runs within the manufacturer's acceptable limits.

Qualification by mathematical modeling or FEA is also an accepted method per the IBC code. Structural analysis of equipment can be performed by developing finite element models and applying the specified seismic design forces to both internal components as well as the overall component. Large components such as generator sets, cooling towers, air handling units and chillers are often qualified by finite element modeling. However, it is important to note that electronic components and other flexible elements with low natural frequencies, that are a part of these systems, should be shake tested as computer modeling is a structure based program and not always appropriate for guaranteeing equipment performance.

In general, all MEP hospital components, from heating and air conditioning systems to generator sets

and transfer switches, need to be certified to this IBC guideline. Since hospitals are classified as an "Essential Facility" and most, if not all, of its components have an Importance Factor of 1.5, compliance becomes a requirement for most, if not all, of its operational systems.

It is also important to note that these systems need to be designed to endure lengthy power outages. It is not sufficient for systems to stay on line just long enough to get people out of the building. Staying on line means critical components such as electrical generating systems need to be designed to handle all the electrical needs of the hospital to keep it up and running. Electrical generating systems need to produce enough power to run all components and equipment that are given an I_p of 1.5.

The IBC codes are the minimum design criteria for buildings and their systems to minimize earthquake and wind-related risk to life and property. Their express purpose is to improve the capability of the health care facility and insure that it will function after a disaster.

REDUCING RISK

To minimize risk and liability, equipment manufacturers, suppliers, design professionals and installing contractors need to clearly understand their roles and responsibilities as defined in chapters 16 and 17 of the IBC code. It is crucial to look further than just the black and white of the IBC. Additional design issues to address include the following: acceptable run time for emergency power generation; the establishment of separate utilities feeding an older and new addition to a hospital; the handling of underground services to accommodate drift; properly designed roof steel to withstand uplift and moment forces on curb mounted equipment; proper attachment of equipment to the building structure to ensure a continuous load path; and the applicability of seismically designed and restrained ductwork and piping. These are but a few of the issues that need addressing and where The VMC Group can help. In recent years, the

insurance industry has put equipment manufacturers and building owners on notice. Post-Northridge and Katrina studies proved that buildings designed to the most current building codes had a higher survival rate than those that were not designed to these codes. The insurance industry concluded that proper design and installation does reduce insurance losses and that failure to properly design and install equipment will lead to lawsuits to recover part of their losses. Additionally, policy writers are expected to set premiums based on a building owner's adherence to the code. Will the insurance industry be willing to pay out claims for equipment that was not in compliance with the building code requirements? This is yet to be seen.

The best way for building owners, engineering firms, contractors and equipment manufacturers to reduce their risk is through proper code requirement education and how it applies to them. As a certifying agency, The

VMC Group can help navigate through the IBC code and offer solutions to meet the needs of each. Equipment certification is available for manufacturers that serve the health care industry. Additionally, management tools such as design team questionnaires, specifications, installation details and a full suggested office management program for health care projects, is available for free. The VMC Group also provides full day, code-based accredited seminars nationally. For more information, please contact The VMC Group or our local representative. ♦

REFERENCES

1. Reference ASCE 7-05, Chapter 1, Section 1.2.
2. The ASCE 7-05 contains the standards for *Minimum Design Loads for Buildings and Other Structures* to which the IBC code refers. The sections of the IBC code most relevant to non-structural building components are Chapters 16 and 17.
3. NEHRP is the National Earthquake Hazard Reduction Program agencies consisting of the National Science Foundation, the National Institute of Standards and Technology, Federal Emergency Management Agency (FEMA) and the United States Geological Survey (USGS).
4. Section 1706.1 of the IBC code outlines the contractor's requirements for supplying a written statement of responsibility.
5. MasterSpec defines "withstand" as "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."



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