

CHAPTER 3

DESIGN PERFORMANCE LEVELS

This chapter is unique to the ICC *Performance Code for Buildings and Facilities*. It is intended to provide a framework to establish minimum levels to which buildings or facilities should perform when subjected to events such as fires and natural hazards. The minimums established by this chapter are based on the types of risks associated with the use of the building or facility, the intended function of the building or facility, and the importance of the building or facility to a community. This information is then compared with the type and sizes of events that may affect the building or facility. As noted in the forward of this document, it is intended that this chapter provide a link between the policy makers and the designers. In many respects, this chapter is the performance code equivalent of the height and area requirements, occupancy classifications, and related requirements.

SECTION 301

MINIMUM PERFORMANCE

Limitations on the extent of damage or impact on a building or facility are provided through design performance levels to which the structure must conform when subjected to events of various magnitudes. Determination of the required design performance level for a building or facility and for a specific magnitude of event is determined based on the performance group classification. Sections 302 through 305 describe the use and occupancy classification process, the assignment of each use group to a performance group, and the relationship between design performance levels and magnitude of event.

SECTION 302

USE AND OCCUPANCY CLASSIFICATION

Section 302 defines use and occupancy classification as a means to categorize buildings, structures, and portions of buildings and structures by their primary use, the characteristics of the persons using them, the level of risk assumed by persons using them during and after certain hazard events, and their importance to the local community.

The definitions provided in Appendix A are based on the fundamental definitions provided in Chapters 3 and 4 of the *International Building Code* for general use and occupancy classifications and special occupancies. These use and occupancy classifications were modified in some cases to better categorize the use group in terms of occupant characteristics, risk, and importance. In addition, the definitions have been modified to include specific assumptions regarding the primary uses of buildings or structures, characteristics of persons using buildings or structures within that use group, the level(s) of risk assumed by persons using buildings or structures within that use and occupancy classification during and after certain hazard events, and the importance of the buildings or structures within that use group to the local community. The intent is to force a closer evaluation of who is at risk, how that person is at risk, and what the societal expectations are regarding the levels of safety and the necessary building and facility performance to address the risks. This appendix is provided as a means to relate the prescriptive and performance codes, but need not be used if other means of determining risk factors are acceptable to the designer and the code official. In general, the employment of the occupancy and use classifications from the *International Building Code* demonstrates that the concepts presented in Chapter 3 of this code are similar to those addressed in the *International Building Code* and provides a fairly solid starting point since many aspects of the importance of the facility, hazards, and occupant characteristics have been implicitly included over the years within these classifications.

The following factors are important to consider in addition to the prescriptive use and occupancy classifications. Again many of these factors (occupant density factors, for example) may already be implicitly addressed within the prescriptive classifications.

Nature of the Hazard. The nature of the hazard, whether it is likely to originate internal or external to the structure, and how it may impact the occupants, the structure, and the contents must be addressed. These factors are important as different hazards present different risks (e.g., fire versus earthquake). For a fire hazard, the primary risk includes toxic gases and heat, but for earthquakes the primary risk includes falling debris. There may be different vulnerable populations for these risks, and the impacts are clearly different. Whether the hazard originates internally or externally to the structure could also be important for many reasons, including the number of people impacted simultaneously. For example, an earthquake impacts a large area simultaneously, but fire tends to affect a more isolated area, such as a single building or floor of a building. It is unclear whether or not the prescriptive code has taken this into account, but in a performance code approach these broader issues may become more apparent.

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Number of Occupants. The number of persons normally occupying, visiting, employed in, or otherwise using the building, structure, or portion of the building or structure must be taken into account. The larger the number of persons, the higher the potential for multiple life loss. Additionally, the number of persons may be relevant as large-loss events are generally perceived as more devastating than large numbers of low-loss events (e.g., 100 people dying in one plane crash in a year is often perceived as being worse than 50,000 people dying annually in individual automobile accidents). As with the nature of the hazard, it is unclear whether these perceptions are taken into account within the prescriptive code. Generally, the focus has been on one building at a time. A performance code will force such discussions in the future. If a large number of persons will be in one location, it is expected that those persons will be reasonably protected from whatever hazards might befall them. In general, protection strategies should be selected that aim to prevent multiple deaths from occurring, with the tolerable number of deaths reflective of the hazard, the occupants, and the use.

Length of Occupancy. The length of time the building is normally occupied affects the risk characteristics of the occupants. This factor is intended to help address life-safety protection needs given such variations as having a structure occupied 24 hours a day (e.g., hospitals), during business hours only (e.g., offices), or rarely if at all (e.g., storage facilities). It also plays a role in hazard detection strategies. In some cases, structures will be occupied rarely but have large numbers of people when occupied (e.g., a sports stadium). As with all of these risk factors, such combinations must be considered.

Sleeping Characteristics. Hazard-induced risks are higher (from many hazards) when people are asleep. Reaction times are slower, and strategies such as faster notification times may be warranted.

Familiarity. This topic examines whether the building occupants and other users are expected to be familiar with the building layout and means of egress. If a hazard is such that people need to egress a structure quickly to avoid injury or death, unfamiliar surroundings can lead to confusion, especially if a) lighting is not available, b) people are disoriented because of the hazard, or c) people are focused on trying to help others.

Vulnerability. This topic examines whether a significant percentage of the building occupants are, or are expected to be, members of vulnerable population groups such as infants, young children, elderly persons, and persons with conditions or impairments that could affect their ability to a) make decisions, b) egress without the physical assistance of others, or c) tolerate adverse conditions. No protection strategy can ensure freedom from risk. To help decide what level of risk is acceptable, many regulations target protecting large percentages of the most vulnerable or sensitive populations. For example, in acute care hospitals where patients cannot be moved, a protect-in-place strategy is often taken, with multiple levels of redundant protection. More specifically, identifying vulnerable populations can be useful in selecting performance criteria for assessing protection schemes against specific hazards. For example, if fire is the hazard of interest, and the elderly are the vulnerable population of interest, incapacitation or thermal impact levels can be determined such that some predetermined percentage of the vulnerable population can be expected to reach a place of safety without being overcome by the hazard impacts.

Relationships. This topic examines whether the building occupants and other users have familial or dependent relationships. Those people who are dependent upon others are clearly at an increased level of risk and are considered vulnerable populations. Those who are responsible for others require special attention, as they may place themselves at higher levels of risk in order to care for their dependents. In some locations, such as hospitals, protection schemes often account for this concern. In other locations, such as residences, protection schemes may not normally consider delays in evacuation that may be incurred as one family member searches for another, for example.

SECTION 303

PERFORMANCE GROUPS

Background

Section 303 determines the performance group to which each building or facility should be assigned. The designation of a performance group is intended to capture the importance of the building or facility, the types of risks associated with that building or facility, and the intended function of the building or facility. The concept for Table 303.1 was taken from Chapter 16 of the prescriptive *International Building Code*, which establishes importance factors for buildings related to seismic design. This table was chosen since the assignment of a building or facility to a particular performance group is a value judgment and is not technical in nature. Since the table in Chapter 16 has been discussed by a broader group of stakeholders, it was decided that this would be an appropriate place to start. This was a decision similar to the use of occupancy and use group classifications from the prescriptive codes. The use and occupancy classifications for buildings are determined from the prescriptive *International Building Code* and address levels of safety versus hazard by requiring safety systems, such as fire alarm systems, automatic sprinkler systems, and fire-resistance-rated construction as appropriate to the perceived hazard. However, these requirements are often public policy based decisions that are reactions to the perceived hazard, which may not directly correlate with the actual risk.

One characteristic of the table from Chapter 16 of the prescriptive *International Building Code* is that it indicates that a natural hazard event, such as an earthquake, affects a building differently than a technological event, such as a fire. An earthquake affects a

broad range of buildings and facilities at the same time, but a fire is usually limited to a single building or facility. A community is less likely to need extensive facilities for shelter after a fire as compared to an earthquake or perhaps a tropical storm. Also, the magnitude and frequency of a natural hazard cannot be controlled, whereas a technological event is a function of its surroundings. The issue of an event being a function of its surroundings is discussed in more detail under Section 305, Magnitudes of Event.

Importance

The purpose for considering importance is that some specific structures play critical roles in providing health, safety, and welfare to communities, especially after hazard events. For these structures, society demands a higher level of protection than for other structures. There is an expectation that they remain functional after the event. In some cases this expectation is regardless of the magnitude of the event. In determining the importance to the community, based on societal health, safety, and welfare objectives, the following were considered:

- The use or function of the building, structure, or portion of the building or structure in providing a health-related service, such as hospitals. These facilities are expected to a) contain vulnerable populations who cannot be moved during a hazard event, and b) provide emergency medical services after a hazard event.
- The use or function of the building, structure, or portion of the building or structure in providing a safety-related service, such as fire and police stations. These structures house essential safety service persons, equipment, and communications, and are expected to be functional during and after hazard events.
- The use or function of the building, structure, or portion of the building or structure in providing a societal related service, such as the sole school with all of the community's children in attendance. The life-safety of the children and the significant role of a school to a community increase its level of importance to the community.
- The use or function of the building, structure, or portion of the building or structure in providing a community welfare-related service, such as the primary employer for the community. The community may decide it would not be able to survive without it and may desire additional protection against any number of hazard events. The level of performance must also be balanced with cost effectiveness.
- The use or function of the building, structure, or portion of the building or structure after a hazard event, such as for emergency shelter. Some structures such as schools or places of religious worship may be designated emergency shelters and are expected to function during and after hazard events.

Performance group designation

A performance group is a designation that identifies the required performance of a building or facility when subjected to a particular magnitude design event. The magnitude may be based on historical statistical data or on development of credible scenarios. A performance group is described by defining a set of maximum tolerable impacts (levels of performance) for a set of specified magnitudes of design events.

The main criterion for determining the performance group in which a particular building should be classified is to decide which use group or occupancy classification is appropriate for the particular building. Alternatively, one needs to consider the hazards and risks associated with a specific building or facility in conjunction with societal expectations regarding the level of safety. Following the use-group classification approach, one uses Table 303.1 to determine the performance group. This table lists several facilities, but in many cases the performance group for facilities may need to be determined based on the risk factors discussed in Section 302 and relative hazards discussed in those use groups that are listed in Table 303.1.

Four performance groups have been established for this code:

Performance Group I. This group covers buildings or facilities, such as barns and utility sheds, where hazard-induced failure poses a low risk to human life. This group primarily includes utility-type buildings in which there is a low reasonable expectation of performance.

Performance Group II. This is the minimum for most buildings.

Performance Group III. This performance group includes buildings and facilities with an increased level of societal benefit or importance or large occupant load. Examples include post-disaster command control centers, acute care hospitals, and a school used as an emergency shelter.

Buildings and other structures that a) are equipped with a reliable means of limiting the area of impact resulting from an explosion or a release of highly toxic gas, and b) contain limited quantities of explosive materials or highly toxic gases can be classified under this performance group.

In hurricane-prone regions, buildings and other structures that contain toxic, explosive, or other hazardous substances and that do not qualify as Performance Group IV structures shall be eligible for classification as Performance Group II structures for wind

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loads if these structures are operated in accordance with mandatory procedures that are acceptable to the code official and that effectively diminish the effects of wind on critical structural elements or that protect against harmful-substance release during and after hurricanes.

Performance Group IV. The highest performance group contains buildings or facilities that pose an unusually high risk. Such facilities may include nuclear facilities or explosive storage facilities. These buildings, facilities, and classes of structures require increased levels of performance as they are expected to continue operations after a hazard. Their failure to do so could have a devastating effect within and/or outside the facility with any size incident. Certain businesses or facilities, such as semiconductor facilities, may voluntarily place themselves in this category because of the business interruption caused by a very small event.

Local government may increase the performance of any class of buildings (use group) if there are specific reasons. These reasons might include a situation in which the facility is the only employer, the only school, or the only hospital. Likewise, should a building owner desire a higher level of performance for a specific building and design load, the level of performance may be increased during preliminary design. A worksheet that assists with determining the level of performance required is provided in Appendix B of the code document. Performance cannot be reduced below this level without approval by the appropriate authority. Also, adjustments may be necessary based on, for example, a higher population of adults with disabilities than is normally expected in that particular use group.

Performance group application

Once the performance group is established, it is then applied to Table 303.3 to determine the tolerable level of damage and impact based on the performance group and the magnitude of event.

In the table, the horizontal axis contains the performance level (level of damage/impact), and the vertical axis contains a representation of the magnitude of event. As one reads from left to right along the horizontal axis, the performance groups increase, and thus, the allowable impact or damage decreases. As one reads from bottom to top along the vertical axis, the magnitude of event increases.

To use the table, the performance group classification that applies to the building or facility in question must be identified. One can then locate the appropriate magnitude of event and allowable impacts for the performance group.

Structures must be designed to the levels of performance and magnitudes of event indicated in every applicable square within Table 303.3. This can be illustrated by the following relationships.

Performance Group I. This means that the performance of the building or facility shall be such that:

1. Small magnitude events are permitted to result in, but not exceed, moderate impacts,
2. Medium magnitude events are permitted to result in, but not exceed, high impacts,
3. Large magnitude events are permitted to result in, but not exceed, severe impacts, and
4. Very large magnitude events are permitted to result in, but not exceed severe impacts.

Performance Group II. This means that the performance of the building or facility shall be such that:

1. Small magnitude events are permitted to result in, but not exceed, mild impacts,
2. Medium magnitude events are permitted to result in, but not exceed, moderate impacts,
3. Large magnitude events are permitted to result in, but not exceed, high impacts, and
4. Very large magnitude events are permitted to result in, but not exceed, severe impacts.

Performance Group III. This means that the performance of the building or facility shall be such that:

1. Small and medium magnitude events are permitted to result in, but not exceed, mild impacts,
2. Large magnitude events are permitted to result in, but not exceed, moderate impacts,
3. Very large magnitude events are permitted to result in, but not exceed, high impacts, and
4. Severe impacts are not permitted for any magnitude of event foreseen by and described within the code.

Performance Group IV. This means that the performance of the building or facility shall be such that:

1. Small, medium, and large magnitude events are permitted to result in, but not exceed, mild impacts.
2. Very large magnitude events are permitted to result in, but not exceed, moderate impacts (high and severe impacts are not permitted for any magnitude of event foreseen by and described within the code).

Note that this approach serves two functions. First, it provides a benchmark for design loads against which a building must perform in an acceptable manner. Second, it recognizes that there is always some likelihood of a small event growing larger (i.e., for a fire event), and that the losses associated with large events can be significant for some performance groups. If a community, a building owner, or other stakeholder believes the expected loss to be unacceptable, a higher level of performance may be warranted.

SECTION 304

MAXIMUM LEVEL OF DAMAGE TO BE TOLERATED

Section 304 of the code establishes how a building or facility is expected to perform in terms of tolerable limits of impact under varying load conditions, based on the determination of Table 303.3.

Tolerable limits of impact reflect various limit states of damage, injury, or loss. The term “tolerable” is used to reflect the fact that absolute protection is not possible, and that some damage, injury, or loss is currently tolerated in structures, especially after a hazard event.

Additionally, the phrase “provide high confidence” is included to describe the extent to which these damage limits can be achieved. This addresses the fact that performance design inherently entails significant uncertainty and variability both with regard to the magnitude of event as well as the capacity of the facility to resist such events. Prescriptive codes provide only a high expectation that the intended performance will be met. Also, with regard to many issues addressed by the prescriptive code, the expectation and capacity of building design and use is difficult to determine. The term “impact” is used as a broad descriptor of damage, injury, or other types of loss. The four levels of performance are provided to “bound” the expected performance of buildings and facilities when subjected to various design loads. The intent is to describe this performance in terms of variables that can be measured or calculated.

Section 304 of the code is based heavily on concepts used in the Federal Emergency Management Agency (FEMA) 273, FEMA 274, the Vision 2000 report [copyright Structural Engineers Association of California (SEAOC) 1995], and the Performance-Based Seismic Engineering Guidelines — Part I (Draft 1, SEAOC Seismology PBE Ad hoc Committee, May 5, 1998). These documents establish performance levels in terms of after-event damage states (impacts) and establish hazard levels in terms of magnitude of event, which may be deterministic or probabilistic descriptions of the magnitude of the event. In these documents, as in this code, design performance levels consider structural integrity, building operation, injury to people, and damage to contents. The magnitude of event (design load) reflects an increasing level of the event magnitude (e.g., ground motion). The term “design load” was chosen for this code because both normal loads (e.g., dead loads) and hazard events (e.g., snow, flood, earthquake, fire) can be expressed as loads. This allows the format in Chapter 3 of this code to be used with all loads that a structure must resist.

Section 304.2 of the code defines the fundamental limiting states of tolerable impact to which a building should be designed and constructed and correlates with those in Table 303.3.

Note: Section 304.2 provides only a skeletal description of levels of performance, as the tolerable impacts (limit states) will vary based on the load. As such, details on additional or specific tolerable limits of impact are found in other appropriate sections of the code.

As specified in Section 304, there are four design performance levels defined in terms of tolerable limits of impact to the structure, its contents, and its occupants: mild, moderate, high, and severe. The language used reflects that although no amount of protection can guarantee complete prevention of damage, injury, or death as a result of a hazard event (e.g., damage, injury, or death could occur indirectly due to unknown conditions or reactions), some criteria for assessing compliance are required. The designer must translate this language into specific numerical criteria based on the specific situation and the supporting data used. This criteria needs to be approved by the code official, and in some cases the code official may provide numerical criteria for the impact statements found in Section 304 where such numerical criteria are deemed necessary, appropriate, or desirable, and where appropriate supporting data is available.

SECTION 305

MAGNITUDES OF EVENT

A large number of normal, natural hazard, and technological hazard-based loads or events of various magnitudes can reasonably be expected to impact on a building or facility during its projected life span. These loads and events can vary across a broad spectrum, from seismic, wind, temperature, and water on the natural hazard side, to fire, explosion, moisture, occupant safety, and air quality hazards on the technological side. Normal loads and events can also vary broadly, from the myriad live and dead loads associated with a structure to factors such as the potential for changes in soil conditions due to temperature and moisture variations. In order to evaluate the performance of a building or facility against these loads and events, a representative number of design loads needs to be considered and applied. (For simplification purposes, the term “design load” covers normal and hazard events as well.)

Design loads are characterized by four classes: small, medium, large, and very large, indicating increasing magnitudes. Some design loads may be expressed as point values, whereas others may be expressed as distributions. As each type of load has unique characteristics, details are not provided in Chapter 3, but rather are provided in appropriate chapters of the code [e.g., Stability (Chapter 5), Fire Safety (Chapters 6 and 17) and Hazardous Materials (Chapter 22)] and are based on the Committee’s understanding of current practice and limits on quantification.

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In general, design loads may be defined, quantified, and expressed deterministically or probabilistically. How these loads are expressed also varies by type. For example, a current approach to earthquake loads involves a probability of exceedance in a 50-year period. A very rare earthquake, or “very large” design load earthquake (in the parlance of this code), would be a very large magnitude event. This is a probabilistic approach. When designing for snow, however, the design load may be expressed in terms of a ground snow load, based on historical data, modified by exposure and importance factors. This is a deterministic approach. Fire loads may be expressed in such terms as heat release rate or mass (smoke) production rate and may have an associated time component (e.g., a 5 MW fire for 10 minutes). These would also be considered deterministic.

With regard to subjects like fire, the definition of design loads is dependent on the measurement of performance, which is in turn based on the use of the structure. In this code, performance is expressed in terms of tolerable impacts on buildings or facilities, occupants, and contents. Thus, a mild fire impact to contents of an office may be different than a mild impact in a fabrication area in a semiconductor facility. As a result, a small design load fire for an office may be different than a small design load fire for the fabrication area. Similarly, the mild impact to contents of an office may be different than a mild impact to an occupant of the office, and the resulting design load fires may be different as well. For earthquakes, the design loads are described generically in terms of mean recurrence intervals and are unrelated to the building.

When considering and developing design loads for a particular building or facility, it is imperative that the various design professionals associated with a project consider the range of possible events and how they may impact a building or facility beyond the earthquake and fire events discussed above. A wide range of design situations and scenarios must be considered, including, for example, the possibility of changing soil conditions or the possibility of moisture accumulation. How the design loads may impact a building or facility and that different design loads may have different impacts must also be considered.

For example, soil expansion can create different magnitude of event levels and associated impacts for different systems or subsystems of a building; the impact on structural stability may be low, yet the architectural appearance may be impacted significantly. In addition, certain critical features may be significantly impacted. For example, the shifting of a foundation can lead to the inability to open an exit door or close a door in a fire or smoke barrier, or to an unacceptable impact on utilities such as the rupturing of water or gas supply lines into the building or facility. Likewise, moisture-induced expansion of building elements can also result in the inability to open an exit door or close a door in a fire or smoke barrier. These conditions can likely exceed design performance levels.

As discussed above, the quantification of loads such as soil expansion or moisture accumulation can be probabilistic or deterministic. For any building or facility and its site, it should be possible to assess the likelihood of soil expansion, moisture build-up, temperature variation, and other factors. One can then compare this assessment with the tolerable levels of impact defined earlier.

Section 305 of the code addresses the magnitudes of event that “can be reasonably expected to impact on a building.” In recent years, there has been a significant increase in terrorist activities, such as the 1995 Murrah Building in Oklahoma City, the 1993 and 2001 attacks on the World Trade Center in New York City, and the 1998 embassy bombings in the Kenyan and Tanzanian capitals, which has certainly heightened the awareness of the building community and its role in possible prevention. Historically, the codes have not dealt with such extraordinary events, but this may change as the codes continue to evolve. A code such as the *ICC Performance Code* provides an improved framework where such events could be addressed, should the decision be made to design buildings to address such events.

Given such variations in design loads and impacts as described above, and in some cases the lack of readily available methodologies and data, the definition, quantification, and expression of design loads is best accomplished by the appropriate professionals (e.g., structural, seismic, and fire protection engineers) using the design performance levels established by this code. Also, given the broad spectrum of loads that may impact a building, it is imperative that all design professionals be involved in the process and that all realistic events or conditions that may impact a building or facility are considered in an appropriate manner. In the end, it is the responsibility of the design professionals to identify and evaluate an appropriate number of scenarios to validate the design analysis, the design details (e.g., system and component performance), material and product specification, and ultimately, the material and product selection and installation in regard to the objectives, functional statements, and performance requirements of the code.

ACCEPTABLE METHODS

Design performance levels are considered the performance criteria, and the magnitudes of event are considered the design loads and stresses. Due to the complexity of the issues, there will never be one single prescriptive solution for all designs. The *International Building Code* and *International Fire Code* have been deemed to satisfy as at least one of the acceptable methods for complying with the performance code. Essentially, buildings and facilities or portions of buildings and facilities that are designed and constructed in accordance with all applicable requirements of the *International Building Code* and *International Fire Code* associated with the uses and occupancies listed in Chapters 3 and 4 shall be deemed to comply with the performance groups for that use group or occupancy. For example, a school designed and built to all applicable requirements in the *International Building Code* for an educational occupancy is deemed to comply with the performance group requirements for a building in the Educational Occupancy.

Though it is assumed that the *International Building Code* is deemed to comply with the design performance levels outlined in this code, the performance of buildings designed and constructed according to the *International Building Code* has not been analytically determined.

As noted, there are also no singular acceptable methods of performance. Rather, a suite of acceptable methods (acceptable analytical tools and methods) are required to be applied to demonstrate that the design performance levels and magnitudes of event comply with the performance group requirements for the pertinent use groups or occupancy types. Examples of such acceptable methods include the recently published SFPE *Guide to Performance-Based Fire Safety Analysis and Design* and the ASCE/SFPE *Guide to Performance-Based Fire Safety Design of Structural Members*, which is currently under development.

EXAMPLE:

Assume: A high school (Grades 9-12) with an attendance of approximately 400 students is to be built in Anytown, Mystate, USA.

Step 1. The first step in determining the requirements of this section (and of the *Performance Code for Buildings and Facilities*) would be to turn to Section 302 and/or Appendix A of the code to determine under which use group classification the school would fall. Clearly, the school would fall under Educational, with information provided as follows:

A103.1.3 Educational. A building, structure, or portion of a building or structure in which six or more persons, generally under the age of 18, gather for formal educational purposes.

1. It shall be assumed that occupants, visitors, and employees are awake, alert, and familiar with the building or structure.
2. Persons under the age of 10 will require assistance in exiting, and persons 10 years of age and older will predominantly be able to exit without assistance.

These assumptions reflect nominal characteristics of persons using an educational occupancy and provide the basis for such estimations as time to recognize an alarm, begin to exit, and find the way to a place of safety. Additional characteristics can be used if the information is available and supportable.

In this case, persons under 10 years of age will normally not be expected to be in the building. This would be acceptable grounds for modifying any assumptions regarding the level of assistance required for helping children out of the school in the event of an emergency. Additional guidance for these and other assumptions in the form of Functional Statements and Performance Requirements are found in various sections of the code.

3. Risks of injury and health assumed by occupants, visitors and employees during their use of the building or structure are predominantly involuntary.

This assumption reflects the fact that the people using educational spaces have limited responsibility for their own safety and are relying on the owners, managers, employees, and insurers of the space to provide an adequate level of safety.

In this case, one might want to make additional assumptions about the use of athletic facilities and any additional risks voluntarily assumed by the student athletes. Assumptions about the need for protection against sick building syndrome and other health related effects associated with the close proximity of large numbers of persons might also need to be considered. Additional guidance for these assumptions in the form of Functional Statements and Performance Requirements are found in various sections of the code.

4. Public expectations regarding the protection afforded those occupying, visiting or working in an educational building, structure or portion thereof are high.

This reflects the expectation that spaces wherein large populations of children are gathered will be afforded a high level of protection to avoid catastrophic losses, i.e., a large loss of life in a single space is perceived as being worse than the loss of one or two lives in multiple, smaller events.

These assumptions and the design performance levels provide the basis for structural requirements. Additional guidance for these and other assumptions in the form of Functional Statements and Performance Requirements are found in various sections of the code.

If one wanted to determine the basis for the assumptions included in the use group descriptions, one could reference the appropriate section of Appendix A of the user's guide.

Step 2. Next, one refers to Section 303, Performance Groups, to determine the appropriate performance group for educational use buildings. The first place to look is Table 303.1. From Table 303.1, it is determined that the performance group will be dependent upon whether there are more than 250 students expected to attend the Anytown High School. Because the expected attendance is 400, Anytown High School would be placed in Performance Group III. Performance groups are based on the importance factor tables from Chapter 16 of the *International Building Code*. This is where the 250 person criterion originates.

In addition to the risk factors discussed above, the school may be considered important as a structure that may serve a necessary purpose in the event of an emergency. This information would come forth in the application of the work sheet in Appendix B.

Step 3. Now that the school is classified as Performance Group III, one then would go to Table 303.3 to determine the appropriate design performance level for the associated magnitudes of event to which the school is likely to be subjected. The first thing that should be noted is that Performance Group III allows only minimal impact for the medium magnitude of event for design purposes as well as the small magnitude of event. This reflects the assumptions in the determination of use, risk factors, and importance that

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there are higher societal expectations for the level of protection provided in schools than there are for many buildings in the other use groups, such as a typical office building.

Step 4. At this point, one could choose to take the prescriptive approach and simply meet all the applicable requirements for an Educational Occupancy found in the *International Building Code* and *International Fire Code*. Alternatively, one could choose to take a performance-based approach.

Step 5. If the performance-based approach is taken, the next step is to look at the descriptions of the tolerable impact for the appropriate design performance levels indicated in Table 303.3. These provide a qualitative description of the design performance levels required and can be used directly for a deterministic performance-based design approach or, in conjunction with the magnitude of event (load) found within Section 305, can be used for a probabilistic performance-based approach. Specific details on design load-related levels of performance are found in appropriate chapters (e.g., Stability, Chapter 5; Fire Safety, Chapter 6).

For example, for a medium magnitude event, the design performance level for a building in the Educational Use Group is Mild Impact as stated in Section 304.2.1 of the code as follows:

304.2.1 Mild impact. The tolerable impacts of the design loads are assumed as follows:

304.2.1.1 Structural damage. There is no structural damage, and the building or facility is safe to occupy.

304.2.1.2 Nonstructural systems. Nonstructural systems needed for normal building or facility use and emergency operations are fully operational.

304.2.1.3 Occupant hazards. Injuries to building or facility occupants are minimal in numbers and minor in nature. There is a very low likelihood of single or multiple life loss.

304.2.1.4 Overall extent of damage. Damage to building or facility contents is minimal in extent and minor in cost.

304.2.1.5 Hazardous materials. Minimal hazardous materials are released to the environment.

For more specific details on magnitudes of design loads and design performance levels for specific hazards, one references the descriptions in the appropriate sections of the code (e.g., Chapter 5, Stability; Chapter 6, Fire Safety). Similarly, to determine additional performance requirements that need to be met, the designer would reference the Functional Statements and Performance Requirements provided in Chapters 5 through 22 of the code.

Step 6. Given defined magnitude of event, design performance levels, and commentary as discussed above, a structure can be designed. In the case of the structural design, one would take the magnitude of event and design performance levels and translate them into loads and resistances. Guidance on translating the ground motion into loads can be found in acceptable solutions (e.g., prescriptive code, SEAOC Blue Book, ASCE 7, etc.) where a set of maps and formulas provide a set of loads, based on geophysical conditions, that the structural engineer can apply to the structural design process. Similarly, fire protection engineers would take the defined hazard levels, frequency, and extent of growth for the design fire condition and with the defined design performance levels (See Sections 602.2 and 1701.2 for further information on design performance levels as they pertain to fire) and assumptions, design appropriate fire safety measures using acceptable methods.