5 Types, Locations, and Siting of Safe Rooms

A community safe room will either be used solely for sheltering or will have multiple purposes, uses, or occupancies. This chapter discusses community safe room design concepts that relate to the type and location of safe rooms. How safe room uses (either single or multiple[1]) may affect the type of safe room selected and its location is also discussed.

5.1 Safe Room Types

This publication provides design guidance on two types of safe rooms:

- Stand-alone safe rooms
- Internal safe rooms: shelter areas that are located inside, or are part of a larger building, but have been designed to be structurally independent

This is not meant to imply that these are the only two types of safe rooms that should be considered. Other safe room options, such as groups of smaller, often proprietary shelter systems, may be appropriate for residential communities, hospitals, schools, or at places of business. It is not possible to provide guidance concerning all sheltering options for all locations. The guidance provided in this publication for stand-alone and internal safe rooms, including the design criteria, may be applied to other safe room options. If other shelter systems and types of safe rooms are designed to meet the criteria in this publication, they should be capable of providing near-absolute protection as well.

NOTE

This publication provides guidance for the design and construction of new safe rooms. The design professional performing retrofit work on existing buildings should apply the new design guidance presented in this publication to the retrofit design.

The guidance provided in this publication is intended for the design and construction of new safe rooms, as well as for the addition of safe rooms to existing buildings by hardening the existing room (i.e.,

[1] FEMA HMA Safe Room Policy MRR-2-07-1 uses slightly different terminology for multi-use safe rooms. The policy document refers to multi-use safe rooms as "dual use" safe rooms. Although the terminology is different, the intent is that the safe rooms are of the same type; that is, safe rooms that have a primary use other than being used as a safe room. Contact your FEMA regional office for the latest FEMA policy on safe rooms.

retrofitting). The variety of structural systems and the number of different configurations of existing buildings preclude a comprehensive look at various retrofit options, so that only a limited extent of guidance is provided on modifying existing buildings to create a safe room where none existed previously. However, a design professional engaged in a safe room retrofitting project should be able to use the guidance in this publication to identify the appropriate hazards at the site, determine the risk, and calculate the loads acting on the building that is the subject of the safe room retrofit. Additionally, the checklists in Appendix B and information presented in the case studies in Appendices C and D may be helpful in a safe room retrofitting project.

5.1.1 Stand-Alone Safe Rooms

The results of the risk and site assessments discussed in Chapter 2 may show that the best solution to providing protection for large numbers of people is to build a new, separate (i.e., stand-alone) building specifically designed and constructed to serve as a tornado or hurricane safe room.

Potential advantages of a stand-alone safe room include the following:

- The safe room may be located away from potential debris hazards.
- The safe room will be structurally separate from any building and therefore not vulnerable to being weakened if part of an adjacent structure collapses.
- The safe room does not need to be integrated into an existing building design.
- The size of the safe room may be determined according to the needs rather than be limited by available space in the existing building.

Case Study I (see Appendix C) shows the calculated wind loads for a safe room design as a combined hazard safe room and the manner in which the design criteria were met for a stand-alone safe room for both tornado and hurricane hazards. According to Figure 3-1, the safe room was located in an area with a 200-mph safe room design wind speed for the tornado hazard. By comparison, Figure 3-2 shows the range of hurricane speeds for the state of North Carolina as having a highest mapped design wind speed of 190 mph. As the tornado design wind speed is greater, this safe room would be designed to that wind speed to fulfill the requirements of a combined hazard safe room. This safe room was designed to serve communities in North Carolina that housed families displaced by flooding caused by Hurricane Floyd.

CROSS-REFERENCE

Site Assessment Checklists are discussed in Chapter 2 and presented in Appendix B. A risk assessment plan that uses these checklists can help determine which type of safe room is best suited to a given site.

5.1.2 Internal Safe Rooms

The results of the risk analysis presented in Chapter 2 may show that a specifically designed and constructed safe room area within or connected to a building is a more attractive alternative than a stand-alone safe room, especially when the safe room is to be used mainly by the occupants of the building. Potential advantages of an internal safe room include the following:

- A safe room that is partially shielded by the surrounding building may not experience the full force of the tornado or hurricane wind. (Note, however, that any protection provided by the surrounding building cannot be considered in the determination of wind loads and debris impact for safe room design.)
- A safe room designed to be within a new building may be located in an area of the building that the building occupants can reach quickly, easily, and without having to go outside during the storm.
- Incorporating the safe room into a planned renovation or building project may reduce the safe room cost.

Case Study II (see Appendix D) shows the calculated wind loads for a safe room located in an area with a 250-mph design wind speed for the tornado hazard according to Figure 3-1 and the manner in which the design requirements were met for a safe room connected to an existing building. This safe room was designed for a school in Wichita, Kansas, and replaced a portion of the school building that was damaged by the tornadoes of May 3, 1999. There is a risk of building debris collapsing on a safe room that has been constructed within another building. When this risk is properly considered by the design professional, a community safe room constructed within a building is an acceptable application of the safe room concept.

ICC-500 CROSS-REFERENCE

The ICC-500 does not explicitly address the use or application of shelters as stand-alone or internal shelters. Section 309 of the ICC-500, Shelters Enclosed or Partially Enclosed in a Host Building, provides specific design criteria for shelters that are connected to existing structures or new structures surrounding the shelter to specify the interaction between the two structures (the shelter and the non-shelter). FEMA 361 recommends that the structural and non-structural connections between internal safe rooms and the buildings surrounding them comply with Section 309 of the ICC-500.

5.2 Single-Use and Multi-Use Safe Rooms

A stand-alone (internal or external) safe room may be used for sheltering only, or it may have multiple uses. For example, a multi-use safe room at a school could also function as a classroom, a lunchroom, a laboratory, or an assembly room; a multi-use safe room intended to serve a manufactured housing community or single-family-home subdivision could also function as a community center. The decision to design and construct a single-use or a multi-use safe room will likely be made by the prospective client or the owner of the safe room. To help the designer respond to non-engineering and non-architectural needs of property owners, this section discusses how safe room use may affect the type of safe room selected.

> **ICC-500 CROSS-REFERENCE**
>
> This section of FEMA 361 and Section 104 of the ICC-500 provide the same design criteria for single-use and multi-use safe rooms with respect to occupancy requirements of the IBC and IRC. For single-use community safe rooms, the occupancy type should be A-3 (assembly). For multi-use safe rooms, the occupancy type should be that of the primary use of the protected space when not in use as a safe room.

5.2.1 Single-Use Safe Rooms

Single-use safe rooms are, as the name implies, used only in the event of a natural hazard event. One advantage of single-use safe rooms is a potentially simplified design that may be readily accepted by a local building official or fire marshal. Single-use safe rooms typically have simplified electrical and mechanical systems because they are not required to accommodate the normal daily needs of occupants. Single-use safe rooms are always ready for occupants and will not be cluttered with furnishings and storage items, which is a concern with multi-use safe rooms. Simplified, single-use safe rooms may have a lower total cost of construction than multi-use safe rooms. Examples of single-use safe rooms were observed during the BPAT investigation of the May 3, 1999, tornadoes, primarily in residential communities (FEMA 1999a). Small, single-use safe rooms were used in residential areas with a shelter-to-house ratio of 1:1 or ratios of up to 1:4. One example of a large, single-use community safe room was observed in a manufactured housing park in Wichita, Kansas. Since then many more community safe rooms have been designed according to the design requirements presented in this publication.

The advantage of ready availability of a single-use safe room in an emergency may easily turn to a disadvantage if a proper operations and maintenance plan is not followed diligently. In the absence of regular usage, the safe room may soon acquire other unintended functions (e.g., for temporary storage or similar uses) that could seriously impede its primary function. This issue can be addressed by the Safe Room Operations and Maintenance Plans.

The cost of building a single-use safe room may be the same as the cost of designing and constructing a multi-use safe room, or possibly lower due to the simplicity of the design requirements for a single function. However, the safe room project may result in the perception that a single-use safe room has a much higher cost than a multi-use facility because no other benefit is being provided with the construction of a new building. This perception may also be related to the fact that the operations and maintenance plans for multi-use facilities can be incorporated into operations and maintenance plans for the multi-use structure (for a small increase in overall plan costs), while in the case of single-use safe rooms, the costs of these plans would not be incurred if the safe room itself did not exist.

5.2.2 Multi-Use Safe Rooms

The ability to use a safe room for more than one purpose often makes a multi-use stand-alone or internal safe room appealing to a shelter owner or operator. Multi-use safe rooms also allow immediate return on investment for owners/operators; the safe room space is used for daily business when the safe room is not being used during a tornado or hurricane. Hospitals, assisted living facilities, and special needs centers are examples of building uses that may benefit from constructing multi-use, internal safe rooms. For these facilities, constructing multi-use safe rooms in building areas such as intensive care units or surgical suites, from which the occupants cannot be evacuated rapidly, is an example of a multi-use application that provides immediate return on investment for the safe room space. But, in addition to these safe room spaces, the hospitals may also need additional community safe rooms for staff, patients, and visitors who may not be allowed into these specially controlled facilities. Internal multi-use safe rooms in these types of facilities allow optimization of space while providing near-absolute protection with easy access for non-ambulatory persons.

It is important to note that multi-use safe rooms frequently require permanent fixtures and furnishings that reduce the effective area for safe room usage. Auditoriums, laboratories, and libraries have such fixtures or furniture that reduce the available safe room area and therefore the maximum safe room population that can be protected in that space. Sections 3.3.1 and 3.4.1 (Part n in both sections) provide criteria for calculating usable square footage for safe room areas.

CROSS-REFERENCE

Sections 3.3.1 and 3.4.1 (Part n in both sections) provide criteria for calculating usable square footage for safe room areas. Auditoriums, laboratories, and libraries have permanent fixtures or furniture that reduce the available safe room area and must be accounted for when determining the maximum safe room population.

Recent FEMA-sponsored projects have evaluated the construction cost of hardening a small area or room during the design and construction of a new building. The FEMA projects indicate that, although the cost to construct this portion of a building may be 25 to 50 percent higher than the construction cost for a non-hardened version of the same area or room, the entire impact to the total project cost is often less than 5 to 10 percent of the entire building construction project.

The MAT investigations of the May 3, 1999, tornadoes, as well as investigations conducted after numerous hurricanes in the 1990s, found many examples of multi-use areas designed or retrofitted for use as safe rooms. They include multi-use safe rooms constructed as:

- Cafeterias, classrooms, hallways, music rooms, and laboratories in school buildings

- Cafeterias/lunchrooms, hallways, and bathrooms (see Figure 5-1) in public and private buildings
- Lunchrooms, hallways, and surgical suites in hospitals

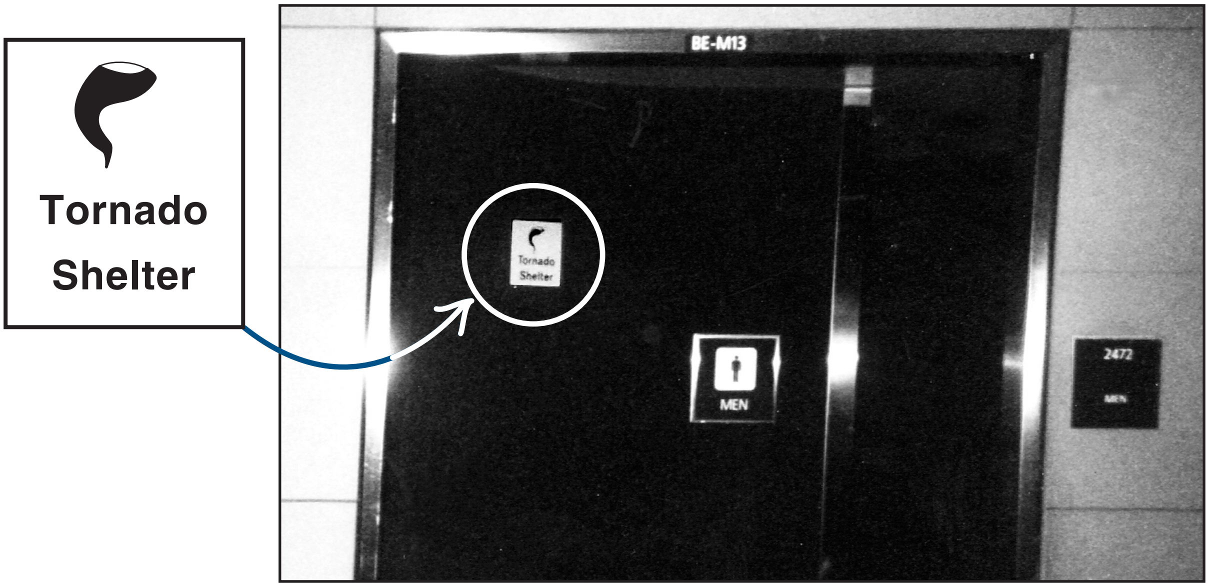


Figure 5-1. The Denver International Airport (a public-use facility) evaluated the tornado risk at the airport site and identified the best available areas of refuge. Signs were placed at these areas to clearly identify the refuge areas to the public.

5.3 Modifying and Retrofitting Existing Spaces

If a tornado or hurricane safe room is designed and constructed to the criteria presented in this publication, it will provide its occupants with near-absolute protection during an extreme-wind event. However, it may be difficult to meet the structural and envelope design criteria of this publication in a cost-effective manner when modifying an existing building. A retrofit project that modifies a space in a building for safe room use but that does not meet the design criteria of Chapter 3 will improve the ability of the space to function as a shelter or refuge area from extreme-wind events, but it cannot be relied upon to provide near-absolute protection as defined by FEMA 361.

5.3.1 General Retrofitting Issues

Although retrofitting existing buildings to include a safe room can be expensive and disruptive to users of that space, it frequently is the only available option. When retrofitting an existing space within a building is considered, corridors are often designated as the safest areas because of their short roof spans and the obstruction-free areas they provide. Recent safe room evaluation projects, however, have indicated that, although hallways may provide the best refuge in an existing building, retrofitting hallways to provide a near-absolute level of protection may be extremely difficult. Hallways usually have a large number of doors that would need to be upgraded or replaced before near-absolute protection can be achieved based on the criteria outlined in Sections 3.3.2 or 3.4.2 for tornadoes and hurricanes, respectively. Designers should be aware that an area of a building usually used for refuge may not necessarily be the best candidate for retrofitting when the goal is to provide near-absolute protection.

CROSS-REFERENCE

The checklists in Appendix B may be used to identify refuge areas as candidates for retrofit projects.

Examples of interior spaces within buildings designed or retrofitted as safe rooms for life-safety protection from tornadoes and hurricanes were listed in Section 5.2.2; additional examples include interior offices, workrooms, and lounges. Guidelines for building vulnerability assessments that can help in the selection of the best available space for a safe room are discussed in Chapter 2. The design modifications that might be required should follow the recommendations of this publication for new construction (see Appendices E and F for examples of wall sections, doors, and door hardware that are capable of withstanding the impact of a 15-lb design missile at 100 mph – the most restrictive debris impact requirement for the tornado and hurricane hazards).

Upgrades to improve levels of protection to create refuge areas in rooms, hallways, and other spaces (until a safe room can be designed and constructed) may include the following retrofits:

- Replacing existing doors (and door hardware) vulnerable to failures from wind pressures or missile impacts with metal door systems meeting the criteria described in Chapters 3 and 7
- Removing all glazing or wall sections vulnerable to failure from wind pressures or missile impacts and replacing with wall sections that meet impact criteria defined in Chapters 3 and 7
- Protecting glazing, doors, or openings with metal doors, shutter systems, or impact-resistant glazing systems, meeting the criteria described in Chapters 3 and 7 to replace glazing that is vulnerable to failure from wind pressures or missile impacts
- Adding alcoves and walls to protect existing doors from the direct impact of windborne debris, as described in Chapters 3 and 7

5.3.2 Specific Retrofitting Issues

An existing area that has been retrofitted to serve as a shelter or refuge area is unlikely to provide the same level of protection as a safe room designed according to the criteria presented in this publication. MAT investigations and FEMA-funded building science investigative projects have indicated that, when existing space is retrofitted for safe room use, issues have arisen that have challenged both designers and shelter operators. These issues occur when attempts are made to improve the level of protection in areas not originally designed for use as safe rooms or refuge areas. Frequently, this cannot be accomplished within the constraints of the project scope or budget. Additional problems may arise when retrofit projects call for improving the levels of protection by implementing specific mitigation measures that address only a specific set of building vulnerabilities without consideration for other potential vulnerabilities of the designated space. For example, before retrofitting doors, windows, and other openings to meet the missile impact criteria identified in Chapter 3 (using Chapter 8 of the ICC-500), the structural characteristics of the area being retrofitted should be carefully analyzed.

Most structural and wall systems of existing buildings will not be able to resist the wind forces and debris associated with the safe room design wind speed. If this is the case, retrofitting windows and doors without improving the structural system is not recommended for life-safety protection.

Issues related to the retrofitting of existing refuge areas (e.g., hallways/corridors, bathrooms, workrooms, laboratory areas, kitchens, and mechanical rooms) that should be considered include the following:

- **The roof system (roof deck and structural supporting members).** Are the roof deck and structural supporting members over the proposed refuge area structurally independent of the remainder of the building? If not, is it possible to strengthen the existing roof to resist the expected wind and debris loads? Can the openings in the roof system for mechanical equipment or lighting be protected during an extreme-wind event? It may not be reasonable to retrofit the rest of the proposed safe room if the roof system is part of a building-wide system that was not designed for ultimate-wind load requirements.
- **The wall system.** Can the wall systems be accessed so that they can be retrofitted for improved resistance to wind pressure and missile impact? It may not be reasonable to retrofit a proposed safe room area to protect the roof or the openings if the wall systems

NOTE

It is difficult to retrofit an existing area of a building to serve as a shelter or refuge area and meet the level of protection of a safe room designed according to the guidance presented in this publication. Designers of safe rooms should also consider comparing costs for a new, multi-purpose room with the costs for retrofitting an existing space for safe room use. However, limited space at the proposed safe room site or other constraints may make retrofitting a practical alternative in some situations.

CROSS-REFERENCE

Design criteria for safe room envelope systems are provided in Chapters 3, 6, and 7. Examples of wall and door systems that have passed missile impact tests are presented in Appendixes E and F, respectively.

(load-bearing or non-load-bearing) cannot withstand wind pressures or cannot be retrofitted in a reasonable manner to withstand wind pressures and missile impacts.

- **Openings.** Windows and doors are extremely vulnerable to wind pressures and debris impact. Shutter systems and doors rated to meet FEMA 320 and 361 debris impact criteria may be used as shutters over windows for tornado protection. There is often only minimal warning time before a tornado; therefore, a shelter design that relies on manually installed shutters is impractical. Automated shutter systems may be considered, but they would require a protected backup power system to ensure that the shutters are closed before an event. Doors should be constructed of impact-resistant materials (e.g., steel) and secured with six points of connection (typically three hinges and three latching mechanisms); regardless of the number of hinges and latches, all doors should be tested to meet the debris impact testing requirements of ICC-500, Chapter 8. Door frames should be constructed of at least 16-gauge metal and adequately secured to the walls to prevent the complete failure of the door/frame assemblies.
- **The existing functions and conditions in the refuge area.** For example, bathrooms have been used as refuge areas during tornadoes and hurricanes since they often have minimal numbers of openings to protect. However, emergency managers may find it difficult to persuade people to sit on the floor of a bathroom when the sanitary condition of the floor cannot be guaranteed. Also, mechanical rooms that are noisy and may contain hot or dangerous machinery should be avoided as refuge areas whenever possible. The permanent fixtures and furnishings in a proposed safe room area (e.g., permanent tables, cabinets, sinks, and large furniture) occupy some of the available space within the safe room, and may make the safe room uncomfortable for its occupants, or may pose a hazard to the occupants. These types of safe room areas should be used only when a better option is not available.

5.4 Community Safe Rooms for Neighborhoods

Community safe rooms intended to provide protection in the residential neighborhoods require designers to focus on a number of issues in addition to structural design. These include ownership, rules for admission, pets, parking, ensuring user access while preventing unauthorized use, and liability issues. All of the structural, envelope, and additional issues are typically collected into a set of criteria called a "design program" that should be provided to designers by safe room owners to govern the safe room design process. In addition to being identified in the safe room design program, these issues should also be addressed by the Safe Room Operations Plan. It is therefore of utmost importance that the development of a design program and the Safe Room Operations Plan be coordinated from the very beginning of the planning and design process. FEMA post-disaster investigations have revealed many issues that need to be addressed in the planning of such community safe rooms. Many of these issues are addressed in the sample Safe Room Operations Plans in Chapter 9 and Appendix C for community safe rooms. The following are additional considerations:

- **Access and entry.** Confusion has occurred during past tornado events when residents evacuated their homes to go to a community shelter, but could not get in. During the

Midwest tornadoes of May 3, 1999, residents in a Wichita community went to their assigned shelter only to find it locked. Eventually, the shelter was opened prior to the event, but had there been less warning time for the residents, loss of life could have occurred. The Safe Room Operations Plan should clearly state who is to open the safe room and should identify the backup personnel necessary to respond during every possible emergency.

- **Signage.** Signage is critical for users to be able to readily find and enter the safe room, especially when a safe room is located inside a larger building. In addition to directing users to the safe room, signs can also identify the area the safe room is intended to serve. Confusion about who may use the safe room could result in overcrowding, or worse, people being turned away from the safe room. Signs can also inform the residents of the neighborhood served by the safe room about the occupancy limitations during any given event. Examples of tornado safe room signage are presented in Chapter 9 and the North Carolina safe room case study in Appendix C. It should be noted, however, that signage is the tool of last resort to direct safe room occupants. Potential users in the neighborhood should be informed well in advance of the community's emergency plans and should be prepared to seek refuge in their pre-assigned safe room or best-available refuge space. Communities and neighborhoods that operate community safe rooms are encouraged to conduct regular exercises in order to test their operational preparedness.

ICC-500 CROSS-REFERENCE

The ICC-500 addresses signage requirements for community shelters in Section 108. The guidance for signage provided here and in Chapter 9 is meant to meet or exceed the criteria specified in the ICC-500.

- **Warning signals.** It is extremely important that safe room users know the warning signal that calls for them to proceed to the safe room. The owners/operators of safe rooms should conduct public information efforts (e.g., mass mailings, meetings, flyer distribution, and actual exercises) to help ensure that the residents of the neighborhood served by the safe room know the meaning of any warning signals to be used.

- **Parking.** Parking at community safe rooms can be a problem if neighborhood residents, who are expected to walk, drive to the safe room instead. Residents returning home from work may drive directly to the safe room. Parking problems can adversely affect access, thereby preventing occupants from getting to the safe room before a tornado or hurricane strikes. The sample Safe Room Operations Plan in Appendix C discusses approaches to addressing parking limitations.

- **Pets.** Many people do not want to leave their pets during a storm. However, tornado and hurricane safe rooms are typically not prepared to accommodate pets. The policy regarding pets in a community safe room should be clearly stated in the Safe Room

Operations Plan by the AHJ and posted to avoid misunderstandings and hostility when residents arrive at the safe room. There are many different types of pets that people may want protected with a safe room, including cats, dogs, snakes and other reptiles, ferrets, horses, birds, etc. The requirements for their care can be very different, such as separation distances, food, cleaning, and space. If a safe room owner, operator, or AHJ chooses to provide protected space for pets, operational plans should be developed and coordinated with designers so they can address these needs (e.g., readily cleanable animal areas having drainage and materials capable of being washed down, areas for quarantining animals that may be sick, etc.).

- **Maximum recommended occupancy.** In determining the maximum recommended number of people who will use the safe room, the design professional should assume that the safe room will be used at the time of day when the maximum number of occupants is expected. A community may also wish to consider increasing the maximum recommended occupancy to accommodate additional occupants such as visitors to the community who may be looking for a refuge during a wind event. However, any safe room owner, operator, or designer should request from the FEMA regional office the most current safe room policy addressing the safe room population issue, since that may be different from safe room design requirements in this publication. Regardless of the means by which the appropriate safe room population has been identified, the maximum recommended occupancy should be posted within the safe room area.

ICC-500 CROSS-REFERENCE

Sample community Safe Room Operations Plans are presented in Chapter 9 and the case study in Appendix C.

5.5 Community Safe Rooms at Public Facilities

Community safe rooms at public facilities also require designers to focus on issues other than structural design requirements for extreme winds. Similar to the process of planning and design of neighborhood community safe rooms, these issues should also be addressed in a design program for public safe rooms and in the Safe Room Operations Plan. It is of utmost importance that the development of the design program and the Safe Room Operations Plan be coordinated from the very beginning of the planning and design process. Some issues that have arisen from post-disaster investigations include:

- **Protecting additional areas.** If the safe room is at a special needs facility such as a nursing home or hospital, additional areas within the facility may need to be protected. These include medical and pharmaceutical supply storage areas and intensive/critical care areas that house non-ambulatory patients. A safe room should address the needs of all of its users.

- **Signage.** Signage is critical for users of public facilities to be able to readily find and enter the safe room. However, signage can be confusing. For example, tornado safe rooms in schools in the Midwest are often designed for use only by the school population, but aggressive signage on the outside of the school may cause surrounding residents to assume that they may use the safe room as well. This may cause overcrowding, or worse, people being turned away. Similar problems may occur at hospitals, where the public may seek refuge from a tornado or hurricane. The owners/operators of safe rooms in public-use facilities such as these should inform all users of the facility about the occupancy limitations of the safe room during any given event. The potential safe room occupants in the facility should be informed well in advance of the community's emergency plans and should be prepared to seek refuge in their pre-assigned safe room or best-available shelter space. Examples of tornado safe room signage may be found in Chapter 9 and the North Carolina safe room case study in Appendix C. Without performing this critical coordination, the shelter will not function as well as it could and it may be expensive to modify years after the initial construction if use requirements change.
- **Warning signals.** It is extremely important that safe room users know the warning signal that calls for them to proceed to the safe room. In schools, work places, and hospitals, storm refuge drills and fire drills should be conducted to ensure that all persons know when to seek refuge in the safe room and when to evacuate the building during a fire or other hazard.
- **Pets.** Many people do not want to leave their pets during a wind storm. The same problem was identified for the community safe rooms in neighborhoods. Tornado and hurricane safe rooms are typically not prepared to accommodate pets. The policy regarding pets in a public facility safe room should be clearly stated in the Safe Room Operations Plan and posted to avoid misunderstandings and hostility when residents arrive at the safe room.
- **Off-hours safe room expectations.** It is important for safe room owners and operators to clearly indicate to the potential safe room users when the facility will be open. For example, will the safe room at a school be accessible after the regular school hours? At places of business, will the safe room be accessible after normal work hours? At hospitals, can employees bring their families to the hospital safe room? These types of questions should be anticipated in the design and operational planning for a community safe room.

ICC-500 CROSS-REFERENCE

Additional human factors criteria are presented in Chapter 8. In addition, sample community Safe Room Operations Plans are presented in Chapter 9 and Appendix C.

5.6 Safe Room Site Selection

Safe rooms by their very function are exceptionally site-specific facilities (i.e., their effectiveness is dependent on their location). Safe rooms must be located in the closest proximity to their potential users – the population at risk from extreme-wind hazards. In addition to the functional factors, the location of the safe room is determined by other considerations, such as safety, accessibility, and a whole series of environmental factors. This section examines the most important factors that determine the location of the safe room.

5.6.1 Site Function and Use Considerations

Community safe rooms may be designed and constructed to serve a single property or facility, such as a school or hospital campus or a manufactured housing park, or as true community oriented public facilities, to serve multiple properties such as a neighborhood.

The site selection criteria that pertain to the functionality of a safe room are closely associated with the risk assessment criteria mentioned in Chapter 2. They include among others, the size and the geographic distribution of the population at risk and the relative vulnerability of that population both with respect to the physical vulnerability of the buildings they normally occupy and to their own ability to reach the safe room in a timely manner during an emergency. Examples for the latter include public facilities like hospitals, assisted living facilities, and special needs centers, as well as schools and child care centers that house large populations that may not be able to reach a remote safe room quickly enough. That is why such facilities are commonly served by safe rooms that are inside the facility or are attached to it, which minimizes the evacuation problems. When the physical vulnerability of the buildings is considered, residents of manufactured housing parks must be regarded as highly vulnerable because of the frequent failures of these structures during wind storms. Neighborhoods with predominantly older homes, either wood-frame or unreinforced masonry, are also extremely vulnerable to extreme winds.

5.6.2 Site Safety and Accessibility Considerations

The safety of the site is evaluated on the basis of its exposure to any kind of hazard. Sites exposed to flooding are not suitable for safe rooms, not only because of the dangers flooding may pose for the occupants, but also because flooding can isolate the facility and its occupants, or make it inaccessible in an emergency. Other hazards that must be considered are seismic hazards, landslides, and fires (especially the exposure of the site to wildfire hazards).

The accessibility of the site is directly related to safe room service area and the proximity of the potential users. All safe room owners, operators, or designers should request from the FEMA regional office the most current safe room policy addressing the safe room population issue, to verify the most up-to-date safe room requirements regarding the maximum travel time/distance allowed. The potential users should be able to reach the safe room within the required time period using a designated pedestrian pathway. This pathway should not have restrictions or obstructions such as multi-lane highways, railroad tracks, bridges, or similar facilities and topographic features.

5.6.3 Other Criteria to Consider

Environmental and historic preservation, economic, zoning, and other administrative factors may also play an important part in site selection and should be considered from the very start of the process.

5.7 Locating Safe Rooms on Building Sites

The location of a safe room on a building site is an important part of the design process for any safe room. The safe room should be located such that all persons designated to take refuge may reach the safe room with minimal travel time; this is of particular importance for tornado safe rooms. Safe rooms located at one end of a building or one end of a community, office complex, or school may be difficult for some users at a site to reach in a timely fashion. Routes to the safe room should be easily accessible and well marked.

Safe rooms should be located outside areas known to be flood-prone, including areas within the 500-year floodplain and susceptible to storm surge inundation as defined in Chapter 3. Safe rooms in flood-prone areas will be susceptible to damage from hydrostatic and hydrodynamic forces associated with rising floodwaters. Damage may also be caused by debris floating in the water. Most importantly, flooding of occupied safe rooms may well result in injuries or deaths. Furthermore, safe rooms located in Special Flood Hazard Areas (SFHAs), with flood depths of 3 feet and higher or within the 500-year floodplain may become isolated if access routes are flooded. As a result, emergency services would not be available if some safe room occupants are injured.

WARNING

Safe rooms should be located outside known flood-prone areas, including the 500-year floodplain, and away from any potential large debris sources.

When possible, the safe room should be located away from large objects and multi-story buildings. Light towers, antennas, satellite dishes, and roof-mounted mechanical equipment could topple or become airborne during tornadoes or hurricanes. Multi-story buildings adjacent to a safe room could be damaged or could fail structurally during tornadoes and hurricanes and may damage the safe room by collapsing onto it or exposing it to large debris impact. The impact forces associated with these objects are well outside the design parameters of any building code. Only limited debris impact testing was performed in the preparation of this publication and is discussed in Chapter 7.

Examples of improper and proper locations of tornado or hurricane safe rooms on residential sites are presented in Figures 5-2 and 5-3. Figure 5-2 is an example of a community that has several residential and community safe rooms. The figure shows which safe rooms are properly sited with respect to the mapped flood hazards. Figure 5-3 shows a series of building section details illustrating elevation criteria for the different safe rooms as a function of their location in different areas of flood risk.

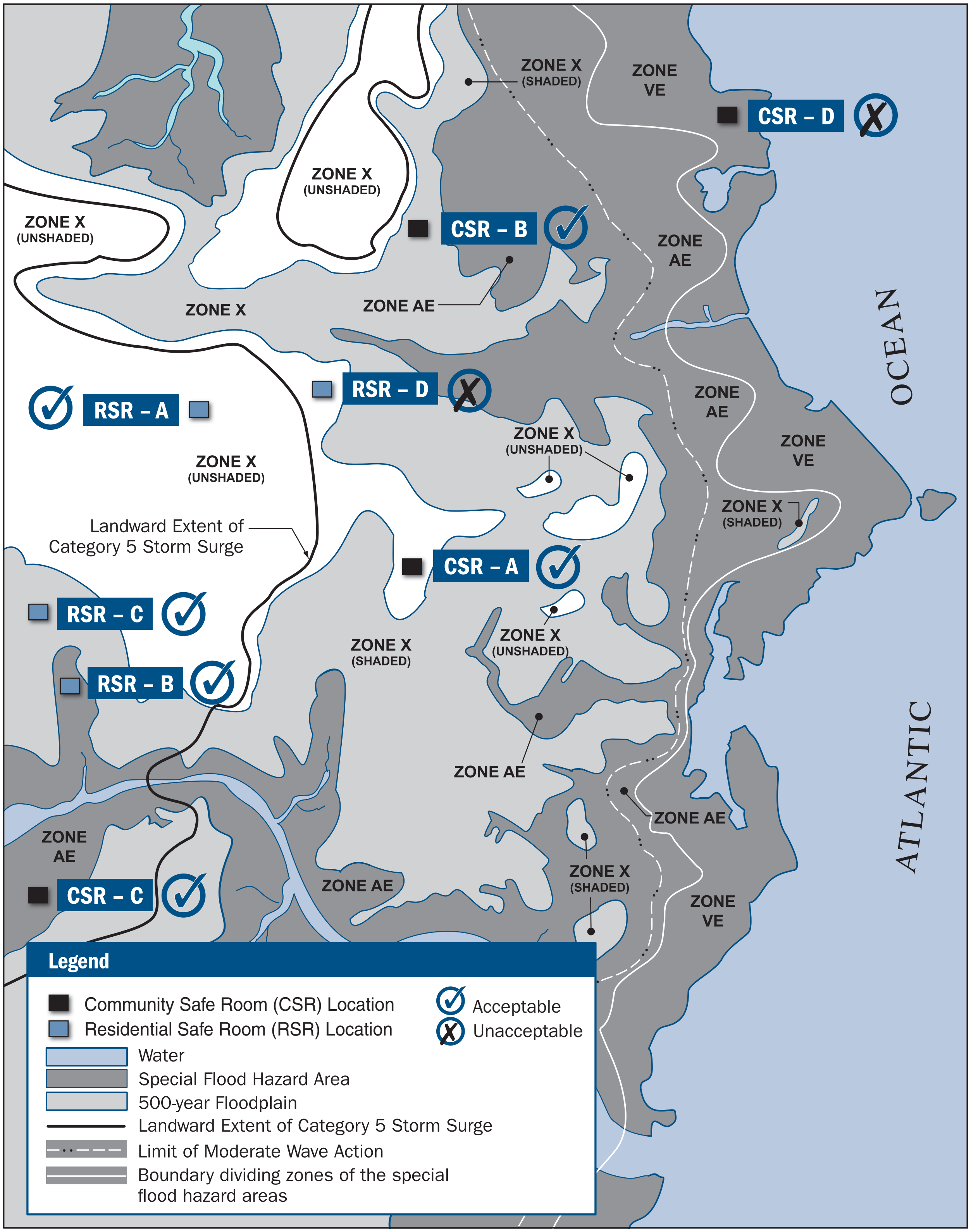
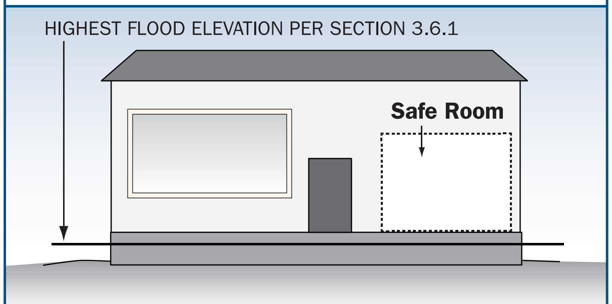


Figure 5-2. Illustration of properly and improperly sited community and residential safe rooms in a coastal environment.

Community Safe Room A

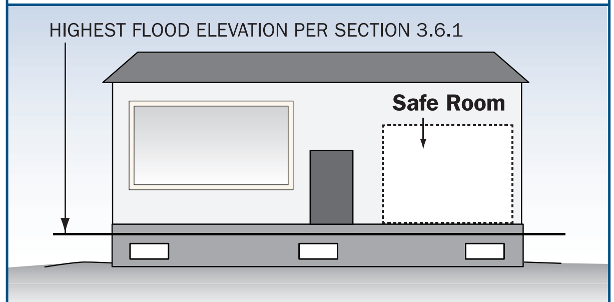
Location: The building containing the safe room is located within the Category 5 Storm Surge Inundation Zone, but outside the SFHA and the 500-year floodplain.



Elevation: The lowest floor of the building that contains the safe room may not need to be elevated as it is in an unshaded Zone X. However, the top of the safe room floor in this building should be set at the highest elevation of the following at the site: the elevation required by the local floodplain ordinance or the Category 5 storm surge elevation.

Community Safe Room B

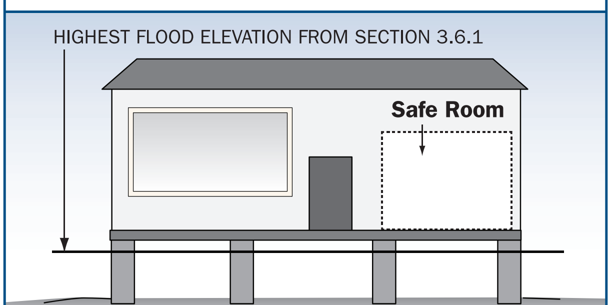
Location: The building containing the safe room is located within the Category 5 Storm Surge Inundation Zone, the 500- year floodplain, but outside the SFHA.



Elevation: The lowest floor of the building that contains the safe room may not need to be elevated as it is in a shaded Zone X. However, the top of the safe room floor in this building should be set at the highest elevation of the following at the site: the elevation required by the local floodplain ordinance, the stillwater elevation of the 0.2 percent chance of exceedence flood (500-year flood), or the Category 5 storm surge elevation.

Community Safe Room C

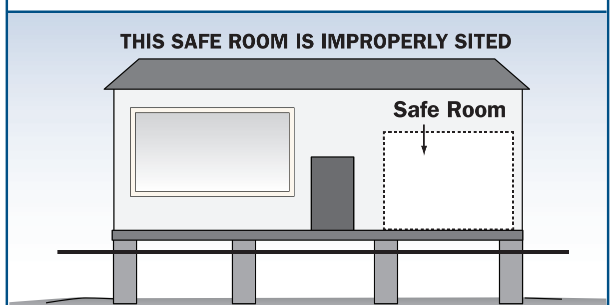
Location: The building containing the safe room is located outside the Category 5 Storm Surge Inundation Zone, but is in a mapped SFHA, with shallow flooding.



Elevation: The lowest floor of the building that contains the safe room should be elevated as it is in a SFHA. Additionally, the top of the safe room floor in this building should be set at the highest elevation of the following at the site: the elevation required by the local floodplain ordinance, the BFE + 2 feet, or the stillwater elevation of the 0.2 percent chance of exceedence flood (500-year flood).

Community Safe Room D

Location: The building containing the safe room is located near the coastline in a VE Zone.

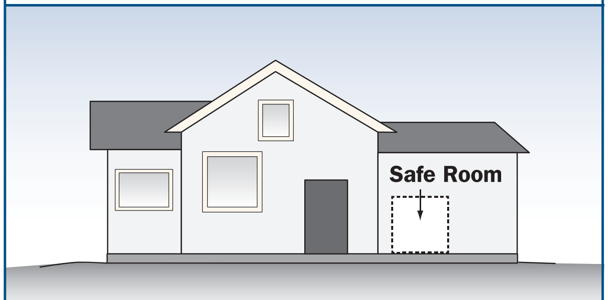


Elevation: Although a community safe room may be physically constructed on this site and be elevated to predetermined flood and surge elevations, it is not considered appropriate. The risk from flooding at this site from storm surge, wave action, and high velocity flows is such that a community safe room should not be sited at this location regardless of the elevation of the safe room.

Figure 5-3a. Elevation details for sample community safe rooms presented in Figure 5-2.

Residential Safe Room A

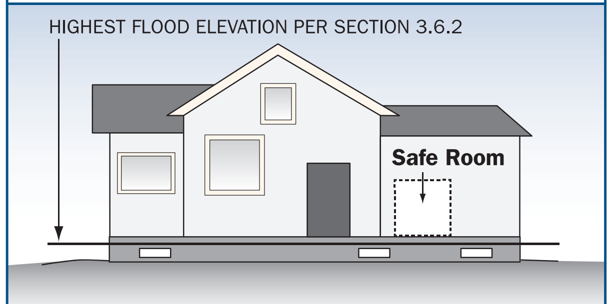
Location: The home containing the safe room is located outside the Category 5 Storm Surge Inundation Zone and is not located within a mapped SFHA.



Elevation: The lowest floor of this house may be located as allowed by the building department. Since there are no flood parameters associated with the site, the safe room may be placed on a slab or elevated on a foundation.

Residential Safe Room B

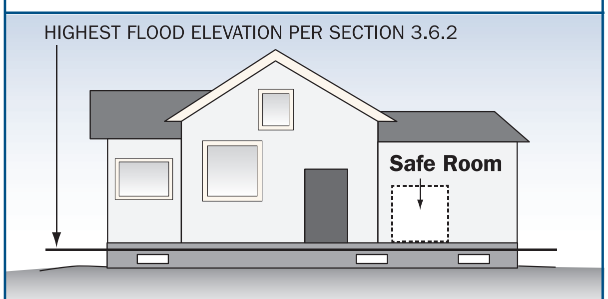
Location: The home containing the safe room is located outside the Category 5 Storm Surge Inundation Zone, but is in a mapped SFHA, with shallow flooding.



Elevation: The top of the safe room floor in this house should be set at the highest elevation of the following at the site: the elevation required by the local floodplain ordinance, the BFE + 2 feet, or the stillwater elevation of the 0.2 percent chance of exceedence flood (500-year flood). See note below for elevating residential tornado safe rooms outside the hurricane-prone region.

Residential Safe Room C

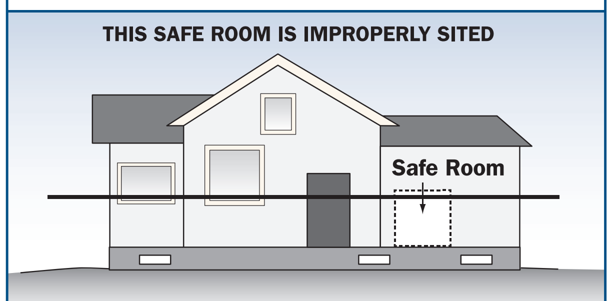
Location: The home containing the safe room is located outside the Category 5 Storm Surge Inundation Zone, the SFHA, but within the 500-year floodplain.



Elevation: The top of the safe room floor in this house should be set at the highest elevation of the following at the site: the elevation required by the local floodplain ordinance or the stillwater elevation of the 0.2 percent chance of exceedence flood (500-year flood). See note below for elevating residential tornado safe rooms outside the hurricane-prone region.

Residential Safe Room D

Location: The home containing the safe room is located outside the SFHA, but within the extent of the Category 5 Storm Surge Inundation Zone.



Elevation: Although a residential safe room may be physically elevated on this site, it is not considered appropriate to do so due to the risk of associated with storm surge and high velocity flows.

Note: When a residential tornado safe room is located outside the hurricane-prone region identified on Figure 3-2, the top of the safe room floor need only be elevated to the lowest floor elevation identified by the floodplain ordinance of the community for that location. See Section 3.6.2 for additional information.

Figure 5-3b. Elevation details for sample residential safe rooms presented in Figure 5-2.