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This digital document created and presented by Richard Fleetwood. He is the founder, author, producer, and webmaster of the **SurvivalRing** *(http://www.survivalring.org)* and **Civil Defense Now!** *(http://www.survivalring.org/cd-main.htm)* websites.

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There are too many situations and incidents that can come to pass in everyday life, that when time is taken to learn and skills obtained, can mean the difference between life and death. Sept. 11, 2001 proved to the world that no matter how safe a person thinks they may be, death and injury can come from the most UN-LIKELY place, at any time. The documents presented in this series of digitized works, can help the average person with the knowledge within, to know how to save those persons closest to them in REAL disaster. Help spread this idea of sharing SURVIVAL INFORMATION.

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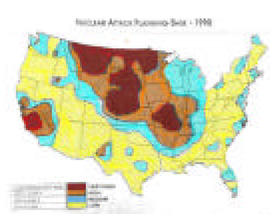

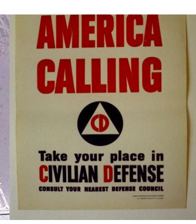

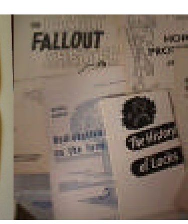
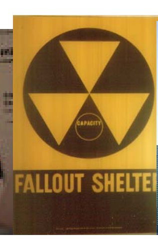


Appendix B
Site Assessment Checklists

Overview

FEMA has developed checklists for evaluating and compiling data about tornado refuge areas. This work was performed for FEMA by the engineering consulting firm of Greenhorne & O'Mara, Inc., under the Hazard Mitigation Technical Assistance Program. The checklists can be used to evaluate existing refuge areas or to select potential new refuge areas within buildings in tornado-prone areas as well as areas subject to high-wind events such as hurricanes. Prudent engineering guidelines were used in the development of the checklists. Therefore, using the checklists and reviewing design or construction plans in the absence of engineering analysis allows for a reasonable assessment of the vulnerability of potential refuge areas.

The objectives of the checklists are twofold: (1) to identify structural and non-structural vulnerabilities to tornado events, and (2) to rank a group of facilities to determine which have the least structural resistance to high wind forces and are in greatest need of retrofitting solutions.

The checklists are divided into five sections; the evaluation process is based on a multi-hazard approach with an emphasis on the wind hazard:

- General Building Information
- Selecting the Refuge Area
- Wind Hazard Checklist
- Flood Hazard Checklist
- Structural Seismic Hazard Checklist

In the *General Building Information* section, data pertaining to the building site are gathered, including site name, address, point of contact, and historical information about building performance, maintenance problems, and repairs. Other data collected for this section include population, building size and shape, power sources, and an assessment of the surrounding environment and general condition of the building.

In the section titled *Selecting the Refuge Area*, the user is guided through a preliminary process to identify potential refuge areas, eliminating areas that are more vulnerable to wind events and focusing on those that provide more protection. Several areas may be needed to accommodate all occupants. If refuge areas have not been identified by the building occupants, the designer/evaluator will need to calculate the refuge space requirement at the site. Thus, the first step in selecting the refuge area is to calculate the space needed for the maximum possible number of occupants (e.g., students, staff) at any given time. The next step is to look for available space, noting accessibility and potential vulnerabilities.

Once the refuge areas have been identified, the screening is focused on those areas. The hazard checklists consist of detailed questions about structural, cladding and glazing, envelope protection, and non-structural issues. Penalty points are assigned to answers that indicate inadequate building strength or unfavorable circumstances under hazard conditions. The checklists are used to gather information that provides a "big picture" and allows a thorough analysis to be conducted. Scores on the checklists will highlight specific deficiencies and provide the means of ranking a group of facilities. The scores will identify refuge areas that are candidates for retrofit designs as well as those that are poor candidates because of excessive vulnerabilities.

The wind hazard checklist is divided into four sections in which information is gathered related to common failure modes that occur under the effects of tornadoes. The four sections are as follows:

- Structural Issues – Building materials used for framing and critical components are identified. The existence of a continuous load path is determined, and the overall structural resistance of the building is assessed.
- Cladding and Glazing Issues – Non-structural components that are often vulnerable to missile impact and high wind pressures are identified (e.g., windows and roof coverings).
- Envelope Protection – Refuge walls and roof coverings are evaluated for their susceptibility to a breach by either missile impact or high wind pressures. When the building envelope is breached, additional wind pressures are imposed on interior surfaces.
- Non-structural Issues – Issues related to the adequacy of a refuge area that do not concern building performance are evaluated (e.g., ADA accessibility, availability and sufficiency of a backup power source, and having an evacuation plan in place prior to a severe event).

Flood and seismic hazard checklists are included to ensure that the building is not vulnerable to multi-hazards. If a multi-hazard vulnerability exists, a mitigation strategy must be developed that responds to all possible threats. The flood hazard checklist relies on information obtained from a National Flood Insurance Program (NFIP) Flood Insurance Rate Map (FIRM)—a map that shows 100-year flood hazard areas and 100-year flood elevations within a community. This section also examines localized flooding and drainage problems that may exist outside the identified floodplain. The seismic checklist uses the 1997 Uniform Building Code Seismic Zone Map of the United States and guidelines from FEMA 154, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook*, from the *Earthquake Hazards Reduction Series*. These two references are used to outline a simplified procedure for the seismic evaluation. If seismic calculations are required for the refuge in question, the designer is advised to use the seismic sections of the 2000 IBC or the guidance presented in FEMA 273, *NEHRP Guidelines for the Seismic Rehabilitation of Buildings*.

EVALUATION CHECKLISTS FOR HIGH-WIND REFUGE AREAS

Wind hazard evaluation checklists were developed by FEMA for use in assessing a building's susceptibility to damage from high wind events such as tornadoes. The checklist evaluation process will guide the user in identifying potential refuge areas at a site with 1 or more buildings. If the refuge area selected is to be considered for use as a "shelter," it should be structurally independent, easily accessible, and contain the required square footage. Most importantly, the refuge area should be resistant to wind forces or made more resistant with mitigation retrofits.

An inspector can use the checklists to assess the ability of the refuge area to resist forces generated by a tornadic event. These checklists were designed for the evaluation of tornado refuge areas but may also be used to evaluate refuge areas for other high-wind events, such as hurricanes. The checklists consist of questions pertaining to structural and non-structural characteristics of a facility. The questions are designed to identify structural and non-structural vulnerabilities to wind hazards based on typical failure mechanisms. Structural or non-structural deficiencies may be remedied with retrofit designs, but, depending on the type and degree of deficiency, the evaluation may indicate that the structure is unsuitable as a refuge area. The checklists are not a substitute for a detailed engineering analysis, but can assist the decision-makers involved with hazard mitigation and emergency management to determine which areas of buildings can best serve as refuge areas.

The checklists can also be used to comparatively rank a group of facilities within a given geographic region. A scoring system was developed for use with the checklists. For each question on the checklist, penalty points are associated with noted deficiencies. Therefore, a high score reflects higher hazard vulnerability and a low score reflects higher hazard resistance, but only relative to the other buildings considered in the scoring system. This evaluation process helps determine which building will perform best under natural hazard conditions in the least subjective manner possible. The checklists help identify the areas within buildings that are least vulnerable to damage from high winds and will likely require the least mitigation to achieve near-absolute protection.

Five sections are provided: General Building Information, Selecting the Refuge Area, Wind Hazard Checklist, Flood Hazard Checklist, and Structural Seismic Hazard Checklist. A summary score sheet has been provided with the evaluation checklists to compile the evaluation scores for each natural hazard. A description of common building types and a glossary of terms are presented following the checklists.

CHECKLIST INSTRUCTIONS

The checklists are designed to walk the user through a step by step process and should be filled out in sequence. This process is a rapid visual screening and does not involve any destructive testing or detailed engineering calculations. A large portion of the checklists can be filled out using data obtained from design or construction plans. It is important to verify this data during a field inspection and note upgrades (i.e., expect roof replacements on older buildings). If building plans are not available for this evaluation, the accuracy of the checklists is compromised. Additional information can be acquired from building specifications, site visits, and interviews with building maintenance personnel who can provide historical information on specific problems, repairs, upgrades, and school procedures.

General Building Information: This section is for collecting information for reference purposes. All questions relate to the entire building or buildings at the site. The user may need to refer back to the General Building Information section to answer hazard related questions in other sections. This section is not scored.

Selecting the Refuge Area: The focus of the evaluation is to select appropriate refuge areas that might provide protection from high wind and tornadic events. The criteria contained in this section will guide the user on how to select good candidate refuge areas. Several refuge areas may be needed to provide enough usable space for the entire population in need of protection. A separate checklist should be filled out for each potential refuge area. This section is not scored.

Wind Hazard Checklist: This checklist applies only to the refuge area(s). If more than one area is selected, a separate checklist should be filled out for each area. A glossary with diagrams is provided (starting on page 26) to help the user with unfamiliar terminology. Answer the questions and determine a score for this hazard.

Flood Hazard Checklist: This section applies to both the refuge area and to the entire building. A Flood Insurance Rate Map (FIRM) is required to answer most of the questions in this section. Answer the questions and determine a score for this hazard.

Structural Seismic Hazard Checklist: The checklist for the seismic threat pertains to the entire building. A Seismic Activity Zone Map is provided to help assess the seismic threat. Answer the questions and determine a score for this hazard.

Summary Score Sheet: After answering and scoring all of the questions in the checklists, the Summary Score Sheet should be filled out. The score sheet is used to compile all of the scores for each refuge area associated with each site for comparison. The total scores will enable the user to rank each building and its potential as an adequate refuge area.

Transfer checklist scores to the Summary Score Sheet to include subscores from the wind section for each refuge area evaluated. The highest Area Total Wind Hazard Score should be placed in the Highest Wind Hazard Score block. The Total Score is the sum of the Highest Wind Hazard Score, Flood Hazard Score, and Seismic Hazard Score. The Total Scores will reflect the expected performance ranking of the buildings when placed in order from lowest to highest score, (i.e., least vulnerable to most vulnerable structure).

Low scores on the checklists indicate structural features that provide some level of protection. Higher scores indicate that a refuge area is more vulnerable to wind damage. The lowest possible cumulative score for Zone 4 (region most vulnerable to tornado hazards) is 20 and a refuge area with this score would likely provide significant protection from a high-wind event; however, it is very unlikely that any building, even one with an engineered storm shelter, would have this score. For example, a pilot study of 10 schools in Wichita (located in Zone 4) resulted in scores ranging from 56 to 161.

General Building Information

CONTACT INFORMATION

Site Name: ______________________________

Street Address: ______________________________

City, State, Zip: ______________________________

Contact Person : ______________________________

Contact Phone #: ______________________________

Total population: ______________________________

Typical hours the building is occupied: ______________________________

Is the building locked at any time? ______________________________

BUILDING DATA

Size/Square Footage: ______________________ Number of Stories: ______________________

Describe the building configuration: ______________________________

General description of surrounding area: ______________________________

____

Are there any portable/temporary units: ______________________ How many: ______________________

Describe the condition of the building (are there cracks in the walls, signs of deterioration, rusting, peeling paint, or other repair needs):

____

____

____

What are the power or fuel sources for the following utilities (natural gas, oil, electric, LP, etc.)? ______________________

☐ Heating: ______________ ☐ Cooling: ______________ ☐ Cooking: ______________

Is there a refuge area or shelter already identified within the building? ______________________________

____

Was this shelter designed for high winds? (indicate the design professional and all relevant design parameters, specifically design wind speed): ______________________________

____

____

____

____

____

____

____

Evaluator's Name: ______________________________ Date of Evaluation: ______________________

Site Name: ______________________________

Provide a general sketch of the building

Additional Comments:

Evaluator's Name: ______________________ Date of Evaluation: ______________

Site Name: ______________________

SELECTING THE REFUGE AREA

What are all the potential areas in the building that provide adequate space for the entire population during a high-wind event?
(For Tornado Use, Required Square Footage [RSF] = Total Population x 5 square feet)
(For Hurricane Use, RSF = Total Polulation x 10 square feet)

Which areas should be eliminated because of excessive glazing (greater than 6% windows) and/or long unsupported wall and roof spans (greater than 40 feet)?

Which areas should be eliminated because of potential damage from nearby heavy collapsed structures (e.g., concrete towers, telephone poles, chimneys)?

Of remaining candidates, how accessible is the refuge area to all building occupants, including the disabled?

If refuge area is cluttered, can materials be easily moved to create additional usable space?

How much usable space exists? Is USF≥RSF [USF = ASF x 0.85]?
Required Squared Footage = RSF Available Square Footage = ASF Usable Square Footage = USF
[Note: when bathrooms are used, USF = ASF x 0.50]

On basis of information above, choose best refuge areas (interior spaces provide best protection). Explain choice and rank them from most desirable to least desirable.

Evaluator's Name: Date of Evaluation:

Site Name:

Sketch refuge areas within building layout and show access routes (an existing floorplan may be marked up and attached in lieu of the sketch):

Additional Comments:

Evaluator's Name: ______________________ Date of Evaluation: ______________

Site Name: ______________________

WIND HAZARD CHECKLIST

Address the following evaluation statements, giving the most appropriate answer for each question. After selecting the appropriate answer, take the score for that answer (# in the parentheses) and enter it into the score block for that question. Evaluation judgment is subject to limitations of visual examination. Questions have been grouped into sections based on structural issues, cladding and glazing, envelope protection, and non-structural issues. <u>These questions apply only to the refuge area.</u> **After all questions have been appropriately scored, sum the score column and determine the final wind hazard score for the refuge area.**

QUESTION	**SCORE**
STRUCTURAL ISSUES	
Refuge Area Size Length: ____________ Width: ____________ Height: ____________ Stories: ____________	**NO SCORE**
Usable square footage for this area:	**NO SCORE**
When was building constructed? Check box below. ☐ 1995 or newer (0) ☐ 1994 - 1988 (2) ☐ 1987 - 1980 (4) ☐ 1979 - 1970 (6) ☐ 1969 - 1951 (8) ☐ Pre - 1950 (10) **Date on plans:**	
The building was designed according to the following building code: ☐ Uniform Building Code, Year: ☐ International Residential Code: Year: ☐ Standard Building Code, Year: ☐ International Building Code, Year: ☐ National Building Code, Year: ☐ Other Code:	**NO SCORE**
What is the structural construction material of the refuge area? ☐ Concrete (10) ☐ Pre-Cast Concrete (10) ☐ RM (10) ☐ Engineered/Heavy Steel Frame (12) ☐ PRM (15) ☐ URM (20) ☐ Wood or Metal Studs (20) ☐ Light Steel Building/Pre-engineered (20) ☐ Unknown (20)	

Evaluator's Name: ________________________________ Date of Evaluation: ____________

Site Name: ____

What building plans are available for the inspection? ☐ As-built Plans (including full architectural and structural plans (0) ☐ Design/Construction Plans (including full architectural and structural plans) (2) ☐ Structural Plans only (3) ☐ Architectural Plans only (5) ☐ Partial set of plans (8) ☐ No plans are available (12)	

Vertical and Lateral Load Resisting Systems (select the system that applies)
☐ Moment Resisting Frame (identify infill wall below) (0)
  ☐ Concrete Beams/Columns ☐ Precast Concrete Beams/Columns
  ☐ Steel Beams/Columns ☐ Wood Beams/Columns
  ☐ Steel Bar Joist and Concrete or Masonry Columns
☐ Infill Wall of Moment Resisting Frame (identify infill/shear wall below)
  ☐ Concrete Shear Wall (0) ☐ RM Shear Wall (0)
  ☐ PRM Shear Wall (2) ☐ URM Shear Wall (5)
  ☐ Plywood Shear Wall (5) ☐ Other: ____________ (5)	

☐ Braced Frame (or cannot confirm moment frame) (0)
  ☐ Concrete Beams/Columns ☐ Precast Concrete Beams/Columns
  ☐ Steel Beams/Columns (heavy) ☐ Wood Beams/Columns
  ☐ Steel Beams/Columns (light)
  ☐ Steel Bar Joist and Concrete or RM Columns
☐ Shear Wall of Braced Frame; bracing or support is provided by:
  ☐ Concrete Shear Wall (0) ☐ RM Shear Wall (0)
  ☐ PRM Shear Wall (2) ☐ URM Shear Wall (5)
  ☐ Plywood Shear Wall (5) ☐ Other: ____________ (5)
☐ Load Bearing Wall System
  ☐ Concrete Walls (0) ☐ RM Walls (0)
  ☐ PRM Walls (4) ☐ URM Walls (6)
  ☐ Framed Walls (wood or metal stud) (6) ☐ Other: ____________ (6)	

Elevated Floor or Roof Deck Systems (check all that apply) ☐ Concrete Beams & Slab ☐ Concrete Flat Slab ☐ Precast Concrete Deck ☐ Steel Deck with Concrete ☐ Steel Deck with Insulation Only ☐ Diagonal Sheathing ☐ Plywood Sheathing ☐ Wood Joists/Beams ☐ Wood Trusses ☐ Wood Plank ☐ Concrete Plank ☐ Concrete Waffle Slab ☐ Open Web Steel Joist ☐ Steel Beam	**NO SCORE**

Evaluator's Name: ______________________ Date of Evaluation: ____________

Site Name: ______________________

Do the connections in the structural systems provide a continuous load path for all loads (gravity, uplift, lateral)?

☐ Yes (0) ☐ No (10)

If YES, identify the following connections:

Actual connectors of the roof structure and the spacing ____________________

____

Actual connectors between the roof and wall and the spacing ____________________

____

Connection Details for Refuge Area (check at least one item in each column)

	Roof to Roof Structure	Roof Structure to Wall Structure	Within Wall	Walls to Foundation
Reinforcing Steel	☐ (0)	☐ (0)	☐ (0)	☐ (0)
Welded (not tack)	☐ (0)	☐ (0)	☐ (0)	☐ (0)
Bolted	☐ (0)	☐ (0)	☐ (0)	☐ (0)
Metal Clips/Fasteners	☐ (1)	☐ (1)	☐ (1)	☐ (1)
Metal Hangers	☐ (1)	☐ (1)	☐ (1)	☐ (1)
Self Tapping Screws	☐ (1)	☐ (1)	☐ (1)	☐ (1)
Wire Fastener	☐ (2)	☐ (2)	☐ (2)	☐ (2)
Nailed	☐ (4)	☐ (4)	☐ (2)	☐ (4)
Other:__________ (possible tack weld)	☐ (5)	☐ (5)	☐ (5)	☐ (5)
Gravity Connection	☐ (6)	☐ (6)	☐ (6)	☐ (6)
Unknown	☐ (6)	☐ (6)	☐ (6)	☐ (6)

If walls are masonry units, are they grouted? Which cells are grouted (every cell, every 4th cell, etc.?

____

NO SCORE

Evaluator's Name: ____________________ Date of Evaluation: ____________________

Site Name: ____________________

For all unreinforced masonry walls, both load-bearing and non-load-bearing-fill in the blanks and answer the following two questions. Maximum height: ____________ Longest span: ____________ Thickness: ____________	**NO SCORE**
Is the maximum wall height/wall thickness (h/t) ratios for **unreinforced masonry walls (URM)** in excess of those noted in AFM 32-1095, page G-63 (see chart below.) ❑ Yes (5) ❑ No (0) ❑ Not applicable (0)	
Is the maximum wall length/wall thickness (l/t) ratios for **unreinforced masonry walls (URM)** in excess of those noted in AFM 32-1095, page G-63 (see chart below). (Measure longest span between column or pilaster supports or from end wall to wall opening.) ❑ Yes (5) ❑ No (0) ❑ Not applicable (0)	

NOTE: Additional guidance concerning the design and construction of masonry walls is provided in *Design of Conrete Masonry Warehouse Walls*, TEK 37, published by the National Concrete Masonry Association.

Allowable Value of Height-to-Thickness Ratio of URM Walls in High Wind Regions

Wall Types	Maximum l/t or h/t	
	Solid or Solid Grouted	All Other
Bearing Walls		
Walls of one-story buildings	16	13
First-story wall of multi-story building	18	15
Walls in top story of multi-story building	13	9
All other walls	16	13
Nonbearing Walls (Exterior and interior[1])	15	13
Cantilever Walls	3	2
Parapets	2	1 1/2

[1] Interior wall ratio should be the same as the exterior wall ratio due to the risk of internal pressure through breached openings.

Chart from Air Force Manual (AFM) 32-1095: Structural Evaluation of Existing Buildings for Seismic and Wind Loads, page G-63.

What are the debris hazards (choose all that apply): ❑ Large light towers (such as for an athletic field) and/or antennas within 300 ft of structure? (2) ❑ Portable classroom/trailers, small light frame buildings, HVAC units within 300 ft of the structure? (4) ❑ Unanchored fuel tanks within 300 ft of structure? (5)	
Is the refuge area located such that occupants must go outdoors to get to it? ❑ No (0) ❑ Yes (2)	

Evaluator's Name: ______________________________ Date of Evaluation: ______________

Site Name: ____

If the refuge area is a section of a building, are the wall systems separated from the remainder of the building structure with expansion joints? ❑ Yes (0) ❑ No (3)	
Does the refuge area have its own roof system (i.e., the roof does not extend over other sections of the building outside the refuge area or is separated by joints)? ❑ Yes (0) ❑ No (5)	
Is the height of the refuge area roof less than 30 feet above ground level? ❑ Yes (0) ❑ No (2)	
Is there a roof span in the refuge area longer than 40 feet from support to support? ❑ Yes (10) ❑ No (0)	
Is the pitch of the roof less than 30^{0} or less than 6/12 pitch? ❑ Yes (4) ❑ No (0)	
Are there any parapet walls taller than 3 feet (as compared to the adjacent roof level)? If yes, check any of the following that apply. ❑ Structurally attached to the refuge area (2) ❑ Adjacent egress routes (if parapet walls collapse, may block egress routes to the refuge area) (2)	
Does a roof overhang exist that is more than 2 feet wide? ❑ Yes (2) ❑ No (0)	
STRUCTURAL ISSUES SUBTOTAL =	

Evaluator's Name: ______________________ Date of Evaluation: ______________

Site Name: ______________________________________

CLADDING AND GLAZING ISSUES	
What is the percentage of windows and doors on the outer perimeter of the refuge area? ☐ no windows/protected doors (0) ☐ no windows/unprotected doors (1) ☐ 0% - 1% (1) ☐ 2% (2) ☐ 3% - 4% (4) ☐ 5% - 6%(6) ☐ 7% or more (10)	
Are doors to the refuge area secured at top and bottom with connections to resist suction effects that may pull the doors open (3-point latches)? ☐ Yes (0) ☐ No (10)	
Are there skylights or overhead atrium glass or plastic? ☐ Yes (5) ☐ No (0)	
What is the roof covering on the refuge area? **NOTE: If more than one material type is used on the roof, choose the one with the highest penalty.** ☐ Storm-resistant shingles (0) (greater than 100 mph rating) ☐ No roof covering (0) ☐ Traditional metal roofing (1) ☐ Built-up roof, without ballast (1) ☐ Single-ply membrane without ballast (1) ☐ Asphalt/metal shingles (1) ☐ Built-up roof, with stone ballast (2) ☐ Single-ply membrane with ballast (2) ☐ Wood shingles and shakes (2) ☐ Clay tile (2) ☐ Material other than those listed above (2)	
CLADDING AND GLAZING ISSUES SUBTOTAL =	

Evaluator's Name: ______________________ Date of Evaluation: ____________

Site Name:

ENVELOPE PROTECTION	
Is there roof mounted equipment (e.g., air handling units, fans, large satellite dishes, large equipment screens/shields) that may separate from the roof, leaving large holes or openings? ❑ Yes (5) ❑ No (0)	
❑ Are there buildings with roof gravel within 300 ft of the structure? (including building site itself) (2) ❑ Are there debris generating sources (e.g., lumber yards, nurseries, and junk yards) within 300 ft of the structure? (4) ❑ Is the refuge area vulnerable to trees, telephone poles, light poles, and other potential missiles? (4)	
What is the material on the exterior walls of the refuge area (excluding window and door systems)? ❑ Concrete (0) ❑ RM (0) ❑ PRM (4) ❑ Brick & block composite wall with reinforcing steel @ 4'-0" O/C (6) ❑ 3-wythes of solid masonry brick (6) ❑ URM (8) ❑ Metal/vinyl siding (10) ❑ Metal panels (pre-engineered metal building) (10) ❑ Wood or metal studs with drywall (12) ❑ Combination (other than EIFS) (12) ❑ EIFS (on substrate other than reinforced concrete or RM) (15)	
What is the material of the roof deck/elevated floor at the refuge area? ❑ Reinforced concrete at least 6 inches thick (0) ❑ Metal deck at least 14 gauge (0) ❑ Reinforced concrete at least 3 inches thick (2) ❑ Metal deck at least 20 gauge (4) ❑ Wood panels at least 1 inch thick (4) ❑ Cement fiber board/deck (tectum) (6) ❑ Metal deck 22 gauge or higher (8) ❑ Wood panels at least ½ inch thick (8) ❑ Other (10)	

Evaluator's Name: ____________________ Date of Evaluation: __________

Site Name: ____________________

Will the structure adjacent to the refuge area or surrounding it pose a threat if subject to collapse (structural components become debris that creates impact loads on the refuge area)? Specify. ❑ Yes (5) ❑ No (0)	
Are there large, roll-down or garage type doors (metal, wood, plastic) on the exterior of the refuge area? ❑ Yes (5) ❑ No (0)	
In what wind zone region is the school located based on the Wind Zones Map provided in Figure 1? ❑ Zone I [130 mph] (4) ❑ Zone II [160 mph] (6) ❑ Zone III [200 mph] (8) ❑ Zone IV [250 mph] (10)	
ENVELOPE PROTECTION SUBTOTAL	

Evaluator's Name: ____________________ Date of Evaluation: __________

Site Name: ____________________

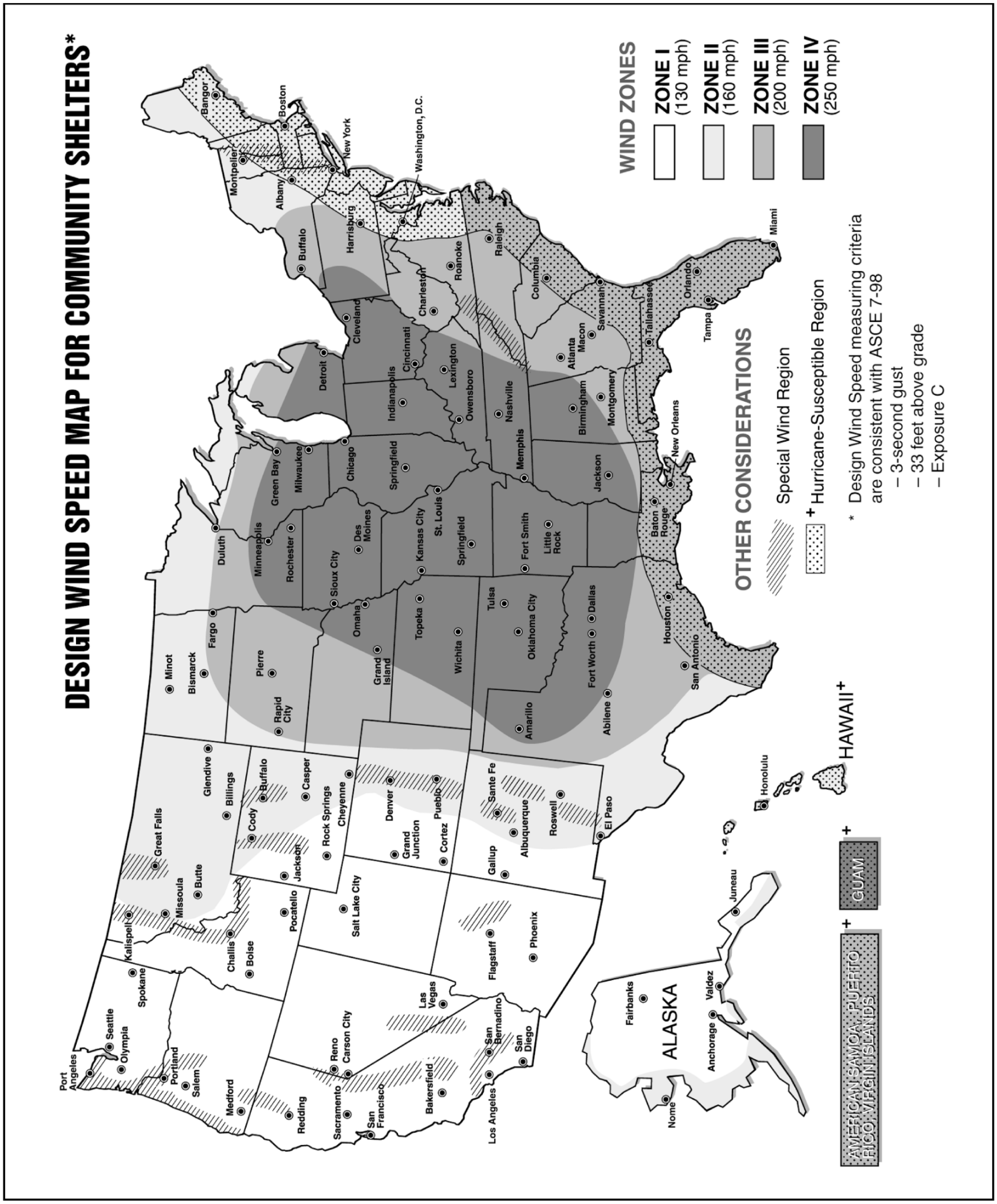

Figure 1: Design wind speed map for community shelters (Federal Emergency Management Agency). Additional information about wind zones is presented in Chapter 10 of *Design and Construction Guidance for Community Shelters*, FEMA 361.

Evaluator's Name: ______________________ Date of Evaluation: ______________

Site Name: ____

NON-STRUCTURAL ISSUES	
Does a combustible gas line run through the refuge area? ☐ Yes (10) ☐ No (0) ☐ Unknown (10)	
Is there a back-up power source/generator? ☐ Yes (0) ☐ No (8) If YES, what is the power source: ☐ Battery powered (0) ☐ Other power (indicate fuel type) (2) Is there an automatic transfer switch? ☐ Yes (0) ☐ No (2) What is the duration of lighting under the back-up power source? ☐ 0-2 hours (2) ☐ 3-6 hours (1) ☐ 7 or more hours (0)	
If the back-up power supply is not within the refuge area, is it in a place where it will be protected during a high wind event (in an interior room, or below grade)? ____ ☐ Yes (0) ☐ No (5) ☐ Not Applicable (0)	
Is there a back-up communication system (if yes, list type)? ☐ Yes (0) ☐ No (2)	
Are bathrooms accessible within the refuge area? ☐ Yes (0) ☐ No (2)	
Is the refuge area ADA accessible? ☐ Yes (0) ☐ No (2)	
Is an operations plan in place for evacuation to a refuge area during a high-wind event? ☐ Yes (0) ☐ No (8) If YES, answer the following questions. Does the evacuation plan include practice drills? ☐ Yes (0) ☐ No (2) What type of warning signal is used to indicate a tornado drill?: Does it differ from a fire drill alarm? ☐ Yes (0) ☐ No (1) Can all occupants reach the candidate refuge area within 5 minutes? ☐ Yes (0) ☐ No (2) ☐ Unknown (2) List time: ____	
NON-STRUCTURAL SUBTOTAL =	
TOTAL WIND HAZARD SCORE =	

Evaluator's Name: ____ Date of Evaluation: ____

Site Name:

FLOOD HAZARD CHECKLIST

Address the following evaluation statements, giving the most appropriate answer for each question. After selecting the appropriate answer, take the score for that answer (# in the parentheses) and enter it into the score block for that question. Evaluation judgment is subject to limitations of visual examination. Elevations are required only if a flood hazard has been identified at the building site. If no flood hazard exists at the site, answer all flood-related questions "not applicable." **After, all questions have been appropriately scored, sum the score column and determine the final flood hazard score for the building/structure.**

QUESTION SCORE	SCORE
FLOOD HAZARD ISSUES	
What is the Base Flood Elevation (BFE) at the building site?* ______ What is the 500-year flood elevation at the building site?** ______ Flood Hazard Zone: ______ Community Panel No.: ______ Date Revised: ______ Not applicable (Explain): ______	**NO SCORE**
Is there a history of floods at the building site? ☐ Yes (5) ☐ No (0) ☐ Unknown (5) ☐ Not applicable (0)	
Is there a history of drains (storm or sanitary) backing up due to flooding? ☐ Yes (2) ☐ No (0) ☐ Unknown (2) ☐ Not applicable (0)	
Does the surrounding topography contribute to flooding in low-lying areas? Are there poor drainage patterns, basement stairwells, etc.? ☐ Yes (5) ☐ No (0)	
Are access roads to the building site sufficiently elevated and expected to not be closed during periods of high water (based on local flooding history and/or FIRM panel information)? ☐ Yes (0) ☐ No (2)	
Is the building within the 100-year floodplain and/or 500-year floodplain? ☐ Yes - 100-year and 500-year floodplains (10) ☐ Yes - 500-year floodplain only (5) ☐ No - Outside 500-year floodplain (0)	
If the building is within a 500-year floodplain, complete the following. If not, STOP HERE and skip to page 20 for STRUCTURAL SEISMIC HAZARD CHECKLIST.	

* BFEs are shown on the Flood Insurance Rate Map (FIRM) for the community.
** 500-year flood elevations are not shown on the FIRM; they are provided in the Flood Insurance Study (FIS) report for the community.

Evaluator's Name: ______ Date of Evaluation: ______

Site Name: ______

STRUCTURAL ISSUES ***	
What is the building/structure type? ❑ Concrete (0) ❑ RM (2) ❑ Steel (2) ❑ PRM (5) ❑ URM (8) ❑ Wood (10) ❑ Unknown (10)	
What is the elevation of the lowest floor/level of the building? ____________ Is this elevation: ❑ Above the 500-year flood elevation (0) ❑ Above the BFE, below the 500-year flood elevation (4) ❑ Below the BFE or unknown (8) ❑ Not applicable (0)	
What is the elevation of the second lowest floor of the building? ____________ Is this elevation: ❑ Above the 500-year flood elevation (0) ❑ Above the BFE, below the 500-year flood elevation (5) ❑ Below the BFE or unknown (10) ❑ Not applicable (0)	
If the lowest floor is below the 500-year flood elevation, are there openings in the walls to allow water to pass through the wall, thus avoiding pressure buildup on foundation and first floor walls? ❑ Yes (0) ❑ No (5) ❑ Not applicable (0)	
Is the space below the 500-year flood elevation used for classroom or office space? (If this area is used for storage, access, and parking only, answer "No"). ❑ Yes (2) ❑ No (0) ❑ Not applicable (0)	
Is the building material below the 500-year flood elevation constructed of entirely flood-resistant material? ❑ Yes (0) ❑ No (2) ❑ Not applicable (0)	
FACILITY AND UTILITY ISSUES	
Are the heating, electrical, and other utilities located in a basement or on a slab area that is below the 500-year flood elevation? ❑ Yes (4) ❑ No (0) ❑ Not applicable (0)	
Is there a method of removing flood waters from the building (e.g., sump pump)? What is the size and capacity of the pump? ❑ Yes (0) ❑ No (4) ❑ Not applicable (0)	
TOTAL FLOOD HAZARD SCORE =	

******** Ensure that all structure elevations that are compared to either Base Flood Elevations (BFEs) or 500-year flood elevations are referenced to the vertical datum stated on the FIRM panel. (Do not compare local benchmarks to MSL, NGVD 1929, etc.)

Evaluator's Name: ______________________ Date of Evaluation: ____________

Site Name: ______________________________________

STRUCTURAL SEISMIC HAZARD CHECKLIST

Address the following evaluation statements, giving the most appropriate answer for each question. After selecting the appropriate answer, take the score for that answer (# in the parentheses) and enter it into the score block for that question. Evaluation judgment is subject to limitations of visual examination and availability of plans. (NOTE: This checklist is based on the guidelines set forth in the FEMA publication *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook*, FEMA 154. One significant difference is the scoring procedure used in this manual. Do not compare a building scored on this checklist system with a building scored according to the procedure in FEMA 154. The comparison will not be valid.) **After, all questions have been appropriately scored, sum the score column and determine the final structural seismic hazard score for the building/structure.**

QUESTION SCORE	
See the Seismic Zone Map of the United States (Figure 2 on page 21) to determine the seismic zone of building locale.	
Is the building located in the unshaded area on the Seismic Activity Zone map (Figure 2) and was it designed by a design professional? ❑ Yes (0) ❑ No (2) If yes, further inspection within the seismic checklist is not necessary. STOP HERE. Is the building located in a Seismic Activity Zone (shaded area on Seismic Activity Zone map in Figure 2)? ❑ Yes (5)	
If yes, complete all remaining questions on this checklist. What is the building/structure type? ❑ Wood (10) ❑ RM & PRM (12) ❑ Steel (12) ❑ Concrete (14) ❑ Pre-cast "Tilt-up" Concrete (15) ❑ URM (17) ❑ Unknown (20)	

Evaluator's Name: ______________________ Date of Evaluation: ______________

Site Name: ______________________________________

Add penalty points for deficiencies as noted during inspection. Select one column based on the building type determined in the previous question. Under each column, circle the penalty points if they apply for the criteria listed. (Use descriptions provided on the following page when filling out the matrix below.) When complete, sum the penalties that have been circled and place that total in the score box at right.

Bldg. Characteristic	RM & PRM	URM	Steel	Wood	Conc.	Pre-cast	UNK
High Rise	1.0	0.5	1.0	N/A	1.0	0.5	1.0
Poor Condition	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Vert. Irreg.	0.5	0.5	0.5	0.5	1.0.	1.0	1.0
Soft Story	2.0	2.0	2.0	1.0	2.0	2.0	2.0
Plan Irreg.	2.0	2.0	1.5	2.0	1.5	2.0	2.0
Pounding	N/A	N/A	0.5	N/A	0.5	0.5	0.5
Heavy Cladding	N/A	N/A	N/A	N/A	1.0	1.0	1.0
Post Benchmark	2.0	N/A	2.0	2.0	2.0	2.0	2.0

TOTAL STRUCTURAL SEISMIC HAZARD SCORE =

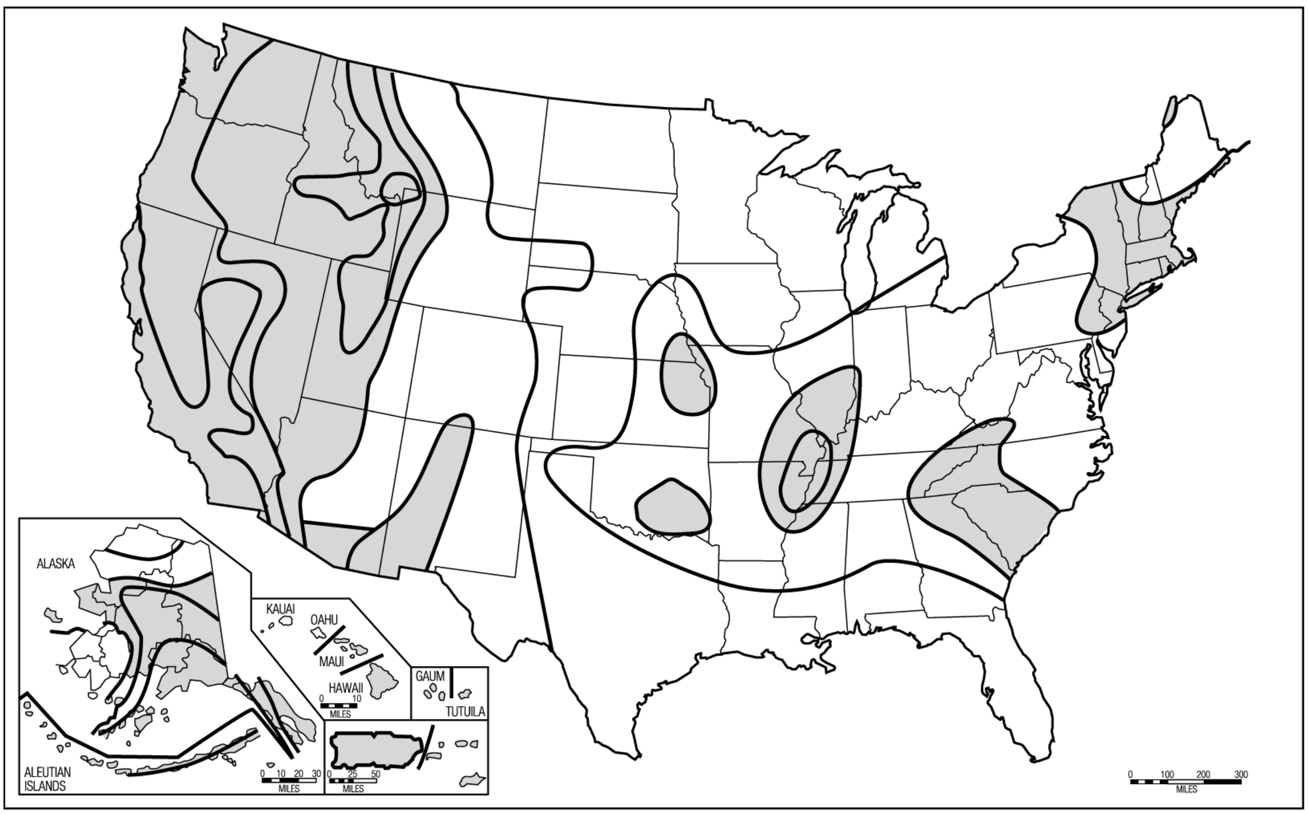

Figure 2 Seismic Activity Zone Map of the United States.

NOTE: This map is based on data compiled from the 1997 UBC and the 1997 NEHRP spectral response maps for a 0.2-second response. This map should be used for multi-hazard evaluation only. If seismic design calculations are required, the designer should use the 2000 IBC or the 1997 NEHRP provisions (FEMA 273).

Evaluator's Name: ______________________ Date of Evaluation: ____________

Site Name: ______________________

Explanation of Building Characteristics

High Rise:
For the purposes of this checklist, a wood frame structure will not be considered a high-rise building. For buildings constructed of masonry units (i.e., brick, block, etc.) if the building is five stories and taller, it is considered a high-rise. For all remaining building types, the building must be eight stories or taller to be considered a high-rise building. If the building is determined to be a high-rise, assess penalty.

Poor Condition:
A building will be considered to be in poor condition if the building condition for the appropriate building type has been observed. Assess penalty if:

MASONRY JOINTS: The mortar can be easily scraped away from the joints by hand with a metal tool, and/or there are significant areas of eroded mortar.

MASONRY UNITS: There is visible deterioration of large areas of masonry units (i.e., significant cracking in the mortar joints, cracks through the masonry blocks themselves, voids or missing blocks or units, etc.).

DETERIORATION OF STEEL: Significant visible rusting, corrosion, tearing, or other deterioration in any of the steel elements in the vertical or lateral force-resisting system.

DETERIORATION OF WOOD: Wood members show signs of decay, shrinkage, splitting, fire damage, or sagging, or the metal accessories are deteriorated, broken, or loose. Wood members also showing signs or “tracks” from insect infestation.

DETERIORATION OF CONCRETE: Visible deterioration of concrete (i.e., cracking, spalling, crumbling, etc.) or significant exposure of reinforcing steel in any of the frame elements.

CONCRETE WALL CRACKS: Diagonal cracks in the wall element that are 1/4 inch or greater in width, are found in numerous locations, and/or form an X pattern.

CRACKS IN BOUNDARY COLUMNS: Diagonal cracks wider than 1/8 inch in concrete columns on any level of the structure.

Vertical Irregularity:
Are there “steps” in elevation of the building? Are some floors set back or do they extend outward from the footprint of the building? Are all of the walls of the building vertical or are there walls that slope inward or outward as viewed from the base of the building? Is the building located atop a small hill? If so, there are vertical irregularities; assess penalty.

Soft Story:

Are there open areas with tall ceilings on any floor of the building? Tall ceilings will typically be 1.25 times greater in height than the height of the floor just above or just below. Does the first floor (first few floors) contain parking areas, shops, large common areas, or lobbies? Is the first floor of the building taller than the other floors of the building? Are large windows (floor to ceiling) or open areas present in one or all walls of the building? If any of the above elements are observed, the building is said to have a soft story; assess penalty. Note: One-story buildings do not have a soft story.

Plan Irregularity:

Does the building have a highly irregular floorplan? Is the floorplan of the building an “L,” “E,” “H,” “+,” “T,” or other such irregular configuration? Is the building long and narrow; length/width ratio greater than 2:1? If so, there are plan irregularities; assess penalty.

Pounding:

How close is the next adjacent building? Are the floors of two adjacent buildings at different elevations? An adjacent building presents a threat of pounding if the lateral distance between the two buildings is less than 4" x # stories of the smallest building. For example, if a ten-story building and a four-story building are adjacent to one another, there is a potential pounding problem if the buildings are not more than 16" apart. (4" x 4 stories = 16" of separation required); assess penalty.

Large (& Heavy) Cladding:

Is the exterior of the building covered in large concrete, or stone panels? If large panels exist, were the connections that secure these panels designed for seismic requirements? If it cannot be positively determined that the connections were designed for seismic requirements, assume that they were not. If large panels are present and they have been determined to be connected with non-seismic connectors, cladding deficiencies exist; assess penalty.

Post Benchmark:

A building is considered to be “Post Benchmark” if it was designed after modern seismic provisions were accepted by the local building code or the code that has been specified by the local jurisdiction. If the building was not designed for seismic requirements or it is not known if the building was designed for seismic requirements, it is not post benchmark; assess penalty.

COMMON BUILDING TYPES AND GLOSSARY OF TERMS

The following is a guide for selecting the type of building/type of construction of the building evaluated. The primary designations that the building types are divided into are Wood, Steel, Concrete, Pre-Cast Concrete, Reinforced Masonry, Partially Reinforced Masonry, and Unreinforced Masonry.

BRACED FRAME

A building frame system in which all vertical and lateral forces are resisted by shear and flexure in the members, joints of the frame itself, and walls or bracing systems between the beams and columns. A braced frame is dependent on bracing, infill walls between the columns, or shear walls between the columns to resist lateral loads.

CONCRETE

These buildings have walls and/or frames constructed of reinforced concrete columns and beams. Reinforced concrete walls will be seen as smooth surfaces of finished concrete. If this is a concrete frame, concrete masonry units (CMUs) are often used as shear (internal) walls placed between the columns and the beams.

ENGINEERED STEEL (Heavy)

These buildings are constructed of steel beams and columns and use either moment or braced frame systems. These buildings are designed specifically for that site and are not a "pre-engineered" or "prefabricated" building.

LOAD BEARING WALL SYSTEM

A building structural system in which all vertical and lateral forces are resisted by the walls of the building. The roof structure will be attached to the walls of the building and any forces in the roof system will be transferred to the walls through this roof/wall connection.

MOMENT FRAME

A building frame system in which all vertical and lateral forces are resisted by shear and flexure in members and joints of the frame itself. A moment frame will not utilize bracing, infill walls between the columns, or shear walls between the columns to resist lateral loads.

PARTIALLY REINFORCED MASONRY (PRM)

These buildings have perimeter, bearing walls of reinforced brick or CMU and the vertical wall reinforcement is spaced at more than 8 inches apart and a maximum spacing of 72 inches apart. Reinforcing for these walls will not be evident when viewing the walls; this information may be attained by using reinforcement locating devices or from reviewing project plans. Roof systems will typically be constructed of wood members, steel frames and trusses, or concrete. They may also have roofs and floors composed of precast concrete.

PRE-CAST (Including Tilt-up Construction)

These buildings typically have Pre-cast and Tilt-Up Concrete that will run vertically from floor to ceiling/roof. These buildings often have pre-cast or cast-in-place concrete roof systems, but may have very large wood or metal deck roof systems. These buildings could also be Pre-cast Concrete Frames with concrete shear walls, containing floor and roof diaphragms typically composed of pre-cast concrete.

REINFORCED MASONRY (RM)

These buildings have perimeter, bearing walls of reinforced brick or CMU and the vertical wall reinforcement is spaced at a maximum spacing of 8 inches apart; if the reinforcement is in CMU walls, every cell must contain reinforcing steel and grout. Reinforcing for these walls will not be evident when viewing the walls; this information may be attained by using reinforcement locating devices or from reviewing project plans. Roof systems will typically be constructed of wood members, steel frames and trusses, or concrete. They may also have roofs and floors composed of precast concrete.

STEEL (Light/Pre-engineered)

These buildings, at a minimum, will have a frame of steel columns and beams. These buildings may be constructed with braced frames. These buildings may be "pre-engineered" and/or "prefabricated" with transverse rigid frames. Interior shear walls may exist between the columns and beams of the frame. In addition, exterior walls may be offset from the exterior frame members, wrap around them, and present a smooth masonry exterior with no indication of the steel frame.

UNREINFORCED MASONRY (URM)

These buildings have perimeter bearing walls of unreinforced brick or concrete-block masonry. Roof systems will typically be constructed of wood members, steel frames and trusses, or concrete. They may also have roofs and floors composed of precast concrete. Most masonry wall systems that were constructed prior to the 1970s are unreinforced masonry.

WOOD

These buildings are typically single or multiple family dwellings of one or more stories. Wood structures may also be commercial or industrial buildings with a large floor area and with few, if any, interior walls. Typically, all walls and roof systems are constructed of timber frames.

The following is a glossary of terms that has been provided to ensure clarity and provide definitions for terminology used in these checklists.

BASE FLOOD

The flood having a 1-percent probability of being equaled or exceeded in any given year; also referred to as the 100 year flood.

BASE FLOOD ELEVATION (BFE)

The elevation of the base flood in relation to the National Geodetic Vertical Datum of 1929 (or other vertical datum as specified). BFEs are shown on NFIP Flood Insurance Rate Maps (FIRMs) as either A zones or V zones.

CONTINUOUS LOAD PATH

A continuous load path can be thought of as a “chain” running through a building. The “links” of the chain are structural members, connections between members, and any fasteners used in the connections (such as nails, screws, bolts, welds, etc.). To be effective, each “link” in the continuous load path must be strong enough to transfer loads without breaking. Because all applied loads (gravity, dead, live, uplift, lateral, etc.) must be transferred to the foundation, the load path must connect to the foundation.

EXTERIOR INSULATION FINISHING SYSTEM (EIFS)

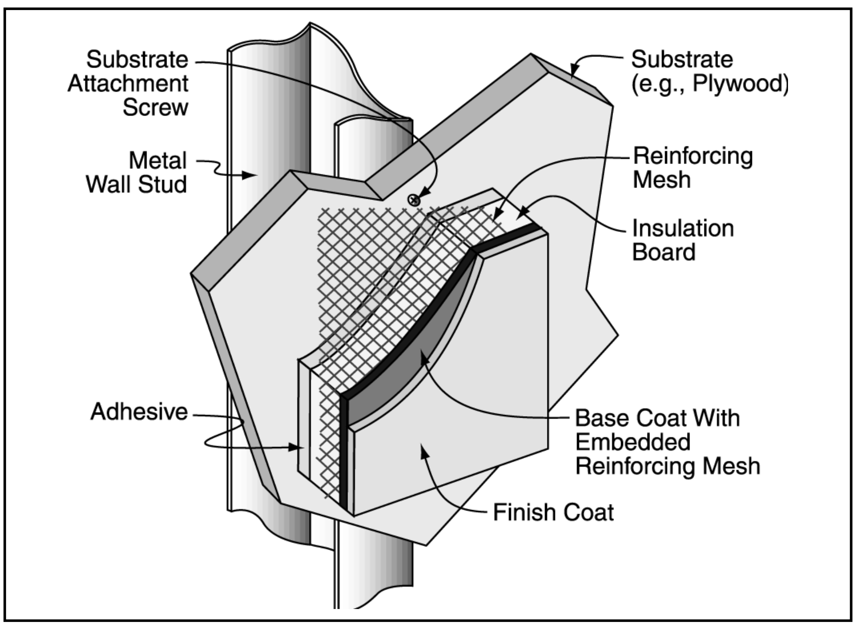

Figure 3: EIFS wall construction.

EIFS is a multi-layered exterior wall system used on both commercial buildings and homes. It comprises an insulation board mounted to a substrate. The insulation is protected by a plastic finish coat. Mesh reinforcing may be used to strengthen the system. Mesh reinforcing is located in a base coat that is between the insulation board and the finish coat.

500-YEAR FLOOD ELEVATION

The elevation of the 500-year flood in relation to the National Geodetic Vertical Datum of 1929 (or other vertical datum as specified). 500-year flood elevations can be found in NFIP Flood Insurance Study (FIS) reports. 500-year floodplains are shown on NFIP Flood Insurance Rate Maps (FIRMs) as either B zones or shaded X zones.

FLOOD INSURANCE RATE MAP (FIRM)

Insurance and floodplain management map issued by FEMA that identifies areas of 100-year flood hazard in a community. In areas studied by detailed analyses, the FIRM also shows BFEs and 500-year floodplain boundaries and, if determined, floodway boundaries.

FLOOD RESISTANT MATERIAL

Any building material capable of withstanding direct and prolonged contact with flood waters without sustaining significant damage. The term “prolonged contact” means at least 72 hours, and the term “significant damage” means any damage requiring more than low-cost cosmetic repair (such as painting).

MASONRY WALL: HEIGHT TO THICKNESS RATIO (h/t)

Height to thickness refers to the height of a masonry wall compared to the thickness of the wall. The height of the wall should be measured from the foundation up to the point at which the wall is laterally supported. In a one-story building, the maximum height will typically be found at the point at which a wall extends to the highest roof support. In a multi-story building, the tallest floor height will indicate the height of the wall. Inspection of a doorway section in a masonry wall will allow an evaluator to determine the thickness of the wall. The largest ratio that is found is the most critical.

MASONRY WALL: LENGTH TO THICKNESS RATIO (l/t)

Length to thickness refers to the length of a masonry wall compared to the thickness of the wall. The length of the wall is typically measured from a wall corner to the next adjacent wall corner. Wall spans, however, can be quite long. If there are any vertical columns in a wall, the length will then be measured from column to column or from vertical support to vertical support. Inspection of a doorway section in a masonry wall will allow an evaluator to determine the thickness of the wall. The largest ratio that is found is the most critical.

PARAPET

A parapet is a small wall located atop a building that extends above the roof level. Parapets are typically located along a wall face at the top of the roof. They are most commonly seen on flat roofs and are usually a few feet tall and will be a minimum of 8" thick. They are often constructed of unreinforced masonry and are susceptible to damage by lateral forces caused by wind and seismic forces.

TACK WELD

A small weld intended only to secure a building element (i.e., roof deck) in place during construction. If the type of weld cannot be determined, it should be considered no better than a tack weld and “Other” should be selected.

SUMMARY SCORE SHEET

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10
WIND HAZARD SCORE										
Area 1 Total										
Structural										
Cladding/Glazing										
Envelope										
Non-structural										
Area 2 Total										
Structural										
Cladding/Glazing										
Envelope										
Non-structural										
Area 3 Total										
Structural										
Cladding/Glazing										
Envelope										
Non-structural										
Area 4 Total										
Structural										
Cladding/Glazing										
Envelope										
Non-structural										
Area 5 Total										
Structural										
Cladding/Glazing										
Envelope										
Non-structural										
Highest Wind Hazard Score										
Flood Hazard Score										
Seismic Hazard Score										
TOTAL SCORE										