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I.  BACKGROUND

In July 2000, the Florida Department of Community Affairs, Division of Emergency Management hosted a workshop to address the complex issues involved in the hurricane shelter selection process. The workshop included representatives from national, state, and local agencies and non-governmental organizations involved in shelter planning. One of the recommendations from the workshop directed that the Division of Emergency Management conduct a meeting to re-review Florida’s hurricane shelter selection criteria.

To address this recommendation, a working group met in January 2001 to address the structural criteria of the state’s hurricane shelter selection guidelines. This report reflects the working group’s review of the structural guidelines, and not the shelter planning issue itself, i.e., square-footage requirements, logistical operation requirements, etc. In addition to Department staff, the working group was comprised of representatives from the American Red Cross, American Society of Civil Engineers, and other hurricane-related science, engineering, building codes and emergency management professionals. The agenda can be found in the attachments.

Florida’s hurricane shelter selection criteria were developed to meet a statutory requirement. In 1993, the Florida Legislature directed the Florida Department of Community Affairs, Division of Emergency Management (Division), to administer a program that would eliminate the state’s deficit of “safe” shelter space. In 1994, the statewide hurricane shelter space deficit reported through regional Hurricane Evacuation Studies (HES) was 154,593. However, it became apparent that a definition of a safe shelter was required.

For many years, most local governments relied on schools as the primary source of hurricane shelters. But, because of the lack of structural selection guidelines, many of the shelters were selected based on traditional mass care criteria rather than engineering studies that would consider the structural integrity of a facility to withstand hurricane-force winds. The state realized that the previously used ARC criteria usually only reviewed floor plans to determine sleeping and feeding accommodations, and perhaps, storm surge potential.

The effects of recent major hurricanes (i.e., Hugo in 1989, and Andrew in 1992) on buildings indicated a need to include the structures’ vulnerability to wind hazards in the shelter selection criteria. Based upon the current understanding of wind vulnerability, these “open space” shelter structures were determined to be unsuitable for use as hurricane shelters, thus causing a significant rise in the shelter space deficit. Therefore, the hurricane shelter capacities reported by many communities could not be used as the benchmark for defining the state’s deficit of safe shelter space.

In addition to developing an accurate hurricane shelter inventory, the Florida Legislature directed the Division to prepare a list of facilities that could be retrofitted, if the appropriate funds were made available. To assist in determining which facilities could most effectively be retrofitted, the Division established basic selection criteria. Identified
shelters could then be surveyed, and the statewide safe shelter deficit could be reduced. This was further enhanced by the statutory requirement for school boards to build new facilities to an enhanced “public shelter design criteria” that is driven by the shelter space deficit in each region. An inaccurate shelter inventory will result in fewer school facilities being constructed to the public shelter design criteria, thus continuing a cycle of constructing school facilities that may be unsuitable as hurricane shelters.

After researching various hurricane shelter survey methods available in 1994, the Division determined that the American Red Cross’ publication *Guidelines for Hurricane Evacuation Shelter Selection* (ARC 4496, July 1992) provided the most consistent basis for Florida’s shelter survey program. Over the next two years, the Division’s staff developed and implemented shelter survey criteria based upon ARC 4496. Because of the general scope of ARC 4496, the Division’s staff had to interpret and define guidelines to ensure a structure was suitable for use as a hurricane shelter. The state’s interpretation focused on “survivability” as the minimum criteria (referred to as “marginal” in the ranking process); that is, damage to the building was acceptable, but the structure and enclosure surrounding the shelter space must remain intact.

The application of the guidelines revealed that the deficit was, in fact, greater than previously indicated. Many of the structures identified as hurricane shelter spaces were deemed unsuitable because of the use of large open areas (cafeterias and gymnasiums) with long span roofs, the presence of unreinforced masonry walls, the lack of adequate window protection, and the lack of a suitable interior space.

Since the application of the State’s interpretation of ARC 4496 resulted in an apparent increase in the hurricane shelter deficit, three issues needed to be addressed: 1.) Did Florida’s criteria meet the intent of ARC 4496 (i.e., was it overly restrictive); 2.) Did the criteria adequately address the “survivability” of the shelter occupants; and 3.) Were the criteria consistent with current high wind resistance research, codes and standards? To address these questions, Florida’s Hurricane Shelter Selection Guidelines Review Working Group assessed the State’s criteria. The following report provides a summary of the working group’s findings.
II. Workshop Organization and Participants

The workshop was organized to provide the working group’s members with an opportunity to review Florida’s hurricane shelter selection criteria, and provide comments and recommendations. The members were chosen to represent a broad range of expertise from academic, national, state, and local agencies. The mission of this working group was to review the technical aspects of Florida’s criteria and their field application. The group’s mission did not include an assessment of the guidelines and procedures outlined in ARC 4496, but only Florida’s interpretation of ARC 4496.

The meeting’s agenda provided a brief history/background of ARC 4496 and the development of Florida’s criteria, an opportunity to review and discuss Florida’s interpretations/definitions of ARC 4496, a review of two practical applications of the criteria, and an opportunity to comment on the criteria during the meeting. After the meeting, the group members were provided a Response Workbook. The Response Workbook provided an opportunity to “vote” on whether or not each criterion, and its prescribed definition(s), appeared to meet the intent of ARC 4496. Or if not, provide specific recommendations to modify the criteria. The comments and recommendations were reviewed and compiled by the Florida Division of Emergency Management, and a list of prominent issues and recommendations prepared. The results of the poll are found in Section III.B., and the final recommendations listed in Section IV.

The voting members of the working group and their representative agencies are listed below.

ARC 4496 Interagency Group Participants

Mr. Luis Garcia, Disaster Services, American Red Cross, Falls Church, Virginia

Dr. Peter Sparks, Department of Civil Engineering, Clemson University, South Carolina

Mr. Allan McDuffie, United States Army Corps of Engineers, Wilmington, North Carolina

Mr. Paul Tertell, Mitigation Programs Specialist, Federal Emergency Management Agency, Washington, DC

American Society of Civil Engineers

Dr. James McDonald, Wind Engineering Research Center, Texas Tech University, Lubbock, Texas

Dr. Douglas Smith, Wind Engineering Research Center, Texas Tech University, Lubbock, Texas
State of Florida Wind Engineering Research

Dr. Ronald A. Cook, P.E., Department of Civil Engineering, University of Florida, Gainesville, Florida

Dr. Ajay Shankar, College of Architecture, School of Building Construction, University of Florida, Gainesville, Florida

State of Florida, Florida Building Code Commission

Mr. Richard Dixon, Florida Building Code Commission, Department of Community Affairs, Tallahassee, Florida

State of Florida, Department of Education

Mr. Jonathon Hamrick, Office of Facilities Planning, Department of Education, Tallahassee, Florida

State of Florida, Florida Emergency Preparedness Association

Mr. Steve Porter, Hillsborough County Emergency Planning Operations, Tampa, Florida
III. Hurricane Shelter Selection Criteria Discussion

The purpose of this meeting was to convene a working group composed of members from the American Society of Civil Engineers, American Red Cross, ARC 4496 Interagency Group, and Florida hurricane-related science, engineering, building code and emergency management professionals to thoroughly re-review Florida’s hurricane shelter selection guidelines. This was accomplished through presentation of the criteria, with follow-up discussion by the working group members. The following is a synopsis of the discussion, formatted to correspond to the format provided in ARC 4496.

A. Key Definitions

High Winds - Windstorm event with sufficient velocity to generate large windborne debris, topple trees, and cause extensive structural damage or destruction of non-engineered and lightly constructed buildings. Category 3 and 4 hurricanes and F2 tornadoes are considered high wind events. Buildings located within 100 miles of a hurricane oceanline are considered to be subject to high wind effects.

1. Both FEMA 361 and AFCESA ETL 97-10 indicate winds from a major hurricane are capable of structural damage extending inland for 100 miles.

![Figure 1: FEMA361 Wind Zone Map](image-url)
2. Hurricane Hugo caused significant damage in Charlotte, North Carolina, which is about 200 miles inland.
3. If you use 100 miles inland as your high wind zone, you might as well say the entire state of Florida is vulnerable to damaging wind conditions.
4. Hurricane Andrew still had Category 3 sustained winds when it exited back into the Gulf of Mexico...fortunately Andrew’s path was sparsely populated after it exited Dade County.
5. Conclusion: Assumption that all buildings selected as hurricane shelters need to consider high wind effects is appropriate and appears to meet the intent of ARC 4496.

Long or Open Roof Span - Lightweight roof structures with unsupported horizontal spans that exceed 40 feet.

1. FEMA 361 and AFCESA ETL 97-10 both indicate that lightweight roof spans should be limited to 40 feet unless special wind design and construction methods are used.
2. Roof spans of up to 70 feet may be suitable if special design and construction methods are used.
3. ARC 4496 guidelines state that uncertified (ref: ASCE 7 wind design standard) long or open roof spans should be avoided. ARC 4496 does not preclude the use of buildings that have long span roofs that are certified to ASCE 7.
4. Florida’s criteria requires that, at a minimum, roof spans in excess of 40 feet be certified as capable of withstanding wind loads in accordance with ASCE 7, Category III Importance Factor. (Considered “marginal” if span exceeds 40 feet, regardless of certification.)
5. When shorter spans fail they tend to blow off the structure, while longer span roofs tend to fail by falling into the space below.
6. Roof spans should be limited to 40 feet unless a detailed investigation is performed, regardless of roof’s weight. Collapse of pre-cast concrete roof planks is not uncommon in high wind events, and its effects can be devastating to building occupants.
7. Conclusion: Florida’s long span roof definition is appropriate and appears to meet the intent of ARC 4496.

Unreinforced Masonry (a.k.a., non-reinforced, ordinary or plain masonry) - Masonry walls in which the tensile resistance of masonry units and mortar are taken into consideration, and the resistance of steel is neglected. In general, a masonry wall, where the spacing of vertical reinforcing steel exceeds 48 inches on-center (o.c.) in either direction, is considered unreinforced.

1. When ARC 4496 was prepared, there was a deliberate attempt to exclude unreinforced masonry.
2. Unreinforced masonry has a very poor performance record in high wind events. Catastrophic failures are common.
Many buildings use “some” steel reinforcement or cross walls to provide a limited degree of lateral stability, but still perform poorly in high wind events.

Spacing of reinforcement, continuity of load-path/anchorage components and roof integrity (as a diaphragm) are essential to determine suitability of a building as a hurricane shelter.

Cantilever unreinforced masonry walls are particularly prone to failure.

Conclusion: Masonry walls with reinforcement spacing that exceeds 4 feet on center are considered unreinforced. Florida’s unreinforced masonry definition is appropriate and appears to meet the intent of ARC 4496.

Partially Reinforced Masonry – Masonry designed as plain (unreinforced) masonry except that reinforcement is provided in some portions to resist flexural tensile stresses. In general, plain masonry walls where the spacing of vertical reinforcing steel does not exceed eight (8) feet on-center are considered partially reinforced.

1. Partially reinforced masonry requirements are based upon empirical design criteria.
2. Partially reinforced masonry is intended to improve flexural tensile (bending) resistance in unreinforced masonry walls. Wind generated uplift forces are not considered in partially reinforced masonry designs (assumes gravity loads are sufficient to negate uplift loads).
3. For 8” hollow concrete masonry units (CMU), NCMA TEK 63-1975 design tables permit 8 foot maximum spacing between reinforced vertical cells for a 25 pounds-per-square foot (psf) wind load; or approximately 100 miles-per-hour (mph). According to modern design standards, partially reinforced masonry fails

**Figure 2:** Unreinforced masonry damaged by high winds.
at 100 mph. For design purposes, partially reinforced masonry fails at even lower wind speeds if uplift forces are applied simultaneously with bending forces.

4. For hollow CMU, tie-column and beam (a.k.a., pilaster & bond beam) wall construction can be considered suitable for hurricane shelters. NCMA TEK 37-1972 design tables permit 13.5 foot maximum spacing for 25 psf wind load. This system is considered equivalent to partially reinforced masonry by the Florida criteria.

5. FEMA 361 limits the maximum spacing of vertical reinforcement to 72 inches (6 feet) apart for partially reinforced masonry.

6. This system has negligible “redundant” strength; may be extremely susceptible to envelope breach effects and quality of construction concerns.

7. However, unless pelted by an unusual barrage of flying wreckage, low-rise residential and light commercial buildings constructed with partially reinforced masonry held up well during Hurricane Andrew. Historical evidence indicates adequate performance of this system, especially if wind vulnerability mitigation measures are taken (protect envelope, site buildings in sheltered locations, reduce exposure to large windborne debris sources, etc.)

8. Conclusion: The partially reinforced masonry system is considered “marginal” by Florida’s criteria, due to the large hurricane shelter space deficit the state is facing at this time (i.e., least-risk decision making process).

Reinforced Masonry – Masonry wall systems in which reinforcement is embedded in such a manner that the component materials act together in resisting shear and tensile loads. Generally, vertical and horizontal reinforcing steel is spaced no more than six times the wall thickness or 48 inches apart (whichever is the lesser spacing applies).
1. A maximum spacing of 48 inches (4 feet) for reinforced masonry is consistent with many building construction industry publications and standards.
2. In the absence of construction quality problems, reinforced masonry systems performed very well during Hurricane Andrew.
3. FEMA 361 defines fully reinforced masonry as having vertical reinforcement spacing that does not exceed 8 inches.
4. Florida’s criterion considers reinforced masonry to be a preferred wall system.
5. Conclusion: By industry definition, masonry walls with a reinforcement spacing of 4 feet on center or closer are considered reinforced. Florida’s reinforced masonry definition is appropriate and appears to meet the intent of ARC 4496.

Wind Exposure – The effects of terrain and topography can have a dramatic impact upon a building’s performance in a high wind event. ARC 4496 states that buildings exposed to the full force of hurricane winds should be avoided, and preference be given to those located in sheltered areas.

1. Unsheltered location is defined as flat open terrain that extends for a half-mile or more and can be characterized as having scattered obstructions with heights less than 30 feet. ASCE 7’s Exposures C and D are equivalent.
2. Sheltered location is defined as urban, suburban or wooded areas or other terrain with numerous closely spaced obstructions for a mile or more in every direction. Furthermore, the building cannot be within one mile of an ocean or other large body of water, or within a quarter-mile of an open area. ASCE 7’s Exposures A and B are equivalent.
3. Conclusion: Unless mitigated by debris resistant construction, including walls, doors, windows, etc., Florida’s criteria requires a shelter to be located within a sheltered location with little to no wind or debris exposure. Structures located within high exposure areas require appropriate structural hardening. This appears to meet national engineering standards and guidelines, as well as the intent of ARC 4496.

Roof Construction and Weight – A roof’s slope, geometry, style, construction materials and weight can have a dramatic impact upon a building’s performance in high winds.

1. A flat or shallow slope roof has the highest vulnerability to wind uplift forces. A flat slope roof has a pitch of 1/4:12, though there is little difference in performance for roofs with shallow pitches up to 2:12 (or 10°).
2. A steep pitched roof is generally less vulnerable to high winds effects than shallow pitched roofs. A steep pitched roof has a pitch of 7:12 (30°) or greater.
3. Lightweight roofs are more vulnerable to high wind effects than heavy roof structures. “Lightweight” is defined by roof construction materials; as much as it is by dead or self weight alone. Generally, lightweight roofs are constructed of wood boards, plywood, metal deck, poured gypsum on form board, etc., and typically have self weights of 25 psf or less.
4. Heavy weight roof systems are typically constructed of cast-in-place reinforced concrete, though some pre-cast reinforced concrete planks may also be considered heavy weight. A heavy weight roof system typically has a self-weight of 50 psf or greater. Intermediate or medium roof weights will tend to perform more like light weight roof systems.

5. Conclusion: Florida’s selection criteria prefers a structure to have a heavy weight roof with roof overhangs of 2 feet or less, and be fully anchored into the load-bearing and foundation systems. Alternatively, a preferred roof can be light or medium weight, but with a roof slope of 30° degrees or greater. Other roof systems considered “marginal” include flat, lightweight, or large overhangs roofs, which have been specifically designed to resist wind uplift forces. This appears to meet national engineering standards and guidelines, as well as the intent of ARC 4496.

B. Florida’s Hurricane Shelter Selection Criteria – Summary of Discussion and Conclusions

The following section of this report provides a table with the State of Florida’s Least-Risk Decision Making (LRDM) Table prescriptive ranking definitions; a summary of the working group meeting’s discussion; and, a summary of the written comments provided by group members.

The State of Florida’s LRDM process is a comparative method developed to assist local emergency officials in choosing the best (“safest”) shelters for use during a major hurricane. Using LRDM tables prepared for all possible hurricane shelter facilities within a jurisdiction, local emergency officials can then compare each facility to the other. Ideally, local emergency officials would choose those facilities with the “least risk” associated with them.

The LRDM tables rank each of fifteen (15) distinct criteria into three categories: “Preferred,” “Marginal,” and “Needs Further Investigation and/or Mitigation.” This ranking assists local officials in recognizing the strengths and weaknesses of each facility. It also assists in identifying possible mitigation and retrofit projects to correct those issues.

It should be noted that the working group members received a Response Workbook that provided space to comment, in writing, on each individual prescriptive definition. If even only one “Recommend the following changes to achieve intent of ARC 4496” vote was made, the respondent was listed below as having voted for a change; regardless of the number of “Meets the Intent of ARC 4496” votes submitted.

Typically, there was an 85% or greater “Meets the Intent of ARC 4496” voting percentage, indicating that Florida’s criteria generally appears to meet the intent of ARC 4496. When comments were provided, the majority indicated that the criteria should be made more stringent. The conclusions listed below are based upon both meeting discussion and follow-up written comments.
## Criteria 1 – Surge Inundation Areas

<table>
<thead>
<tr>
<th>Storm Surge Inundation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preferred</strong></td>
</tr>
<tr>
<td>• Buildings located outside the Category 5 storm surge inundation zone, as determined by the latest edition of SLOSH</td>
</tr>
<tr>
<td>• Also, at least one access road must be outside of, or elevated above, the Category 5 storm surge zone.</td>
</tr>
<tr>
<td><strong>Marginal</strong></td>
</tr>
<tr>
<td>• Buildings within a Category 5 storm surge zone, and inundation potential that does not exceed two feet.</td>
</tr>
<tr>
<td>• Also, access routes may be within the Category 5 inundation zone, therefore the potential for isolation exists. Note that either inundation of the building or its access route is sufficient for this ranking to apply.</td>
</tr>
<tr>
<td><strong>Requires Investigation/Mitigation</strong></td>
</tr>
<tr>
<td>• Buildings subject to Category 5 hurricane storm surge inundation depths greater than two feet within the building and/or subject to velocity inundation.</td>
</tr>
<tr>
<td>• Coastal barrier islands should always be avoided due to their extreme isolation potential in the post-storm period.</td>
</tr>
</tbody>
</table>

### Working Group Meeting Discussion:

1. ARC 4496 states that hurricane evacuation shelters must be located outside of Category 4 inundation zones, but national ARC policy is to avoid areas subject to Category 5 inundation.
2. Florida’s *Public Shelter Design Criteria* [s. 7(24), SREF 1999] requires hurricane shelter floor elevation to be above Category 4 inundation.
3. Drowning has historically caused the greatest death toll from hurricanes.
4. There is no evidence that minor inundation of structures by still water (no velocity) has caused a major loss of life.
5. Storm surge maps indicate the worst-case surge potential for a given site; but a site may in fact be dry in any single event. Also, a Category 5 hurricane is a very low probability event.
6. Two feet of inundation potential was chosen for the following reasons: 1. ARC 4496 states that “puddling” of 1-3 feet requires further investigation (i.e., consistency with Rainfall Flood Criteria), 2. There are cost-effective dry flood-proofing mitigation measures available, 3. Two feet of inundation is approximately at knee-level for most adults, making movement possible. Most large room furnishings will be exposed above floodwaters.
7. Vertical evacuation to floors elevated above flood inundation may be considered, but requires evaluation by a qualified coastal construction structural engineer.
8. Besides the obvious health concerns associated with floodwaters, electrocution is a serious hazard in flooded structures. Wall outlets are usually located at about 16” above the floor. A recommendation to reduce the Category 5 inundation potential to one (1) foot was discussed at length.
**Working Group Votes**

Meets the Intent of ARC 4496: 5

Recommend Changes to Achieve Intent of ARC 4496: 3

a. 2 feet of water exceeds the 15 or 16 inch wall receptacle height for electric circuits, which will not be ground fault protected. Recommend reducing to 1 foot.
b. Exceeds ARC requirements, Category 4 indicated
c. Guidelines actually say Category 4. Inclusion of Category 5 areas seems overly restrictive unless forecast is for a Cat 4 or 5.

Abstain: 1

Conclusion 1-1:
Marginal ranking should be changed to one (1) foot of potential inundation depth instead of two (2) feet.

**Criteria 2 – Rainfall Flooding**

<table>
<thead>
<tr>
<th>Rainfall Flooding/Dam Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preferred</strong></td>
</tr>
<tr>
<td>- Buildings should be outside the 500-year floodplain [Zones C or X (unshaded background)], as determined in the latest edition of FIRM.</td>
</tr>
<tr>
<td>- At least one access route must lie above the 100-year floodplain.</td>
</tr>
<tr>
<td>- Also, the building and its access route must not be subject to inundation due to dam or levee failure following hurricane-related flooding.</td>
</tr>
<tr>
<td><strong>Marginal</strong></td>
</tr>
<tr>
<td>- Building’s floor elevation is at or above the 100-year floodplain BFE, but the building’s site is within the 500-year floodplain [Zones B or X (light-gray shaded background)], the building will be considered marginal. Shelter floor should not be inundated by more than two feet of flood waters by a 500-year event.</td>
</tr>
<tr>
<td>- Buildings where access roads are below the 100-year floodplain BFE (riverine or shallow ponding) will be considered marginal, as flooding may cause isolation. Damage to infrastructure due to inundation and/or erosion is possible in this circumstance.</td>
</tr>
<tr>
<td>- The building and its access route may be subject to minor inundation of less than two feet due to dam or levee failure following hurricane-related flooding.</td>
</tr>
<tr>
<td><strong>Requires Investigation/Mitigation</strong></td>
</tr>
<tr>
<td>- Buildings that are within the 100-year floodplain [Zone A, dark shaded background].</td>
</tr>
<tr>
<td>- Buildings that are within an outflow area of a dam or reservoir that is subject to containment failure due to hurricane related flooding, and the expected inundation depth is greater than two feet.</td>
</tr>
</tbody>
</table>
Working Group Meeting Discussion:

1. ARC 4496 states that hurricane evacuation shelters must be located outside of 100-year floodplain, and 500-year should be avoided. However, national ARC policy is to avoid any area subject to flooding.

2. Florida’s Public Shelter Design Criteria [s. 7(24), SREF 1999] relies upon local floodplain management requirements, but does recommend at least one access route be above the 100-year floodplain.

3. Two feet of inundation potential was chosen for the following reasons: 1. ARC 4496 states that “puddling” of 1-3 feet requires further investigation, 2. There are cost-effective dry flood-proofing mitigation measures available, 3. Two feet of inundation is approximately at knee-level for most adults, making movement possible. Most large room furnishings will be exposed above floodwaters.

4. Vertical evacuation to floors elevated above flood inundation may be considered, but requires evaluation by a qualified structural engineer.

5. Besides the obvious health concerns associated with floodwaters, electrocution is a serious hazard in flooded structures. Wall outlets are usually located at about 16” above the floor. A recommendation to reduce the 500-year flood inundation potential to 1 foot was discussed at length.

Working Group Votes

Meets the Intent of ARC 4496: 5

Recommend Changes to Achieve Intent of ARC 4496: 3

   a. Again, do not like the 2 feet standard though ARC 4496 is clearly vague. Recommend reducing to 1 foot.
   b. I don’t consider 2 feet water depth as minor.
   c. Locate hurricane shelters above 500-year floodplain. I do not feel comfortable with flooded floors in a shelter. My guess is people would not go to that shelter a second time if it flooded.
   d. Due to potential velocity flow, shelters should be located outside of dam break flooding areas.

Abstain: 1

Conclusion 2-1:
Marginal ranking should be changed to one (1) foot of potential inundation depth instead of two (2) feet for a 500-year flood event.

Criteria 3 – This working group did not discuss Hazardous Materials at length.
Criteria 4 – Wind Hazards: Lay-down Hazards

<table>
<thead>
<tr>
<th>Lay-down Hazard Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preferred</td>
</tr>
<tr>
<td>• There are no large trees or other tall structures within lay-down range of the building.</td>
</tr>
<tr>
<td>• At least one access route is not tree-lined and will not be blocked by fallen trees during and after a hurricane.</td>
</tr>
<tr>
<td>Marginal</td>
</tr>
<tr>
<td>• There may be trees or other large/tall structures within lay-down range of the building, but they are not considered:</td>
</tr>
<tr>
<td>• Large enough to inflict a significant breach of the building’s structural envelope; and/or</td>
</tr>
<tr>
<td>• Within lay-down range of actual shelter area(s) within building.</td>
</tr>
<tr>
<td>• All access routes are tree-lined. (Note: local emergency management/sheltering agencies should have plans to clear fallen trees from these routes).</td>
</tr>
<tr>
<td>Requires Investigation/ Mitigation</td>
</tr>
<tr>
<td>• Trees or other large/tall structures within lay-down range of the building are:</td>
</tr>
<tr>
<td>• Large enough to inflict a significant breach of the building’s structural envelope; and/or</td>
</tr>
<tr>
<td>• Within lay-down range of the actual shelter area(s) within building.</td>
</tr>
</tbody>
</table>

Working Group Meeting Discussion:
1. ARC 4496 states that preference should be given to hurricane evacuation shelters whose access routes are not tree-lined (due to isolation potential). However, it does not totally exclude the use of these facilities, either.
2. Florida’s Public Shelter Design Criteria [s. 7(24), SREF 1999] requires landscaping to not conflict with access routes or utilities, or cause lay-down or impact hazard to the building envelope.
3. Generally, any significant breach in a building’s envelope could affect the structural integrity of the entire facility.
4. Unfortunately, there is a great deal of subjectivity in the decision as to what constitutes a hazard; there is no research available to draw upon for guidance.

Working Group Votes

Meets the Intent of ARC 4496: 9

Recommend Changes to Achieve Intent of ARC 4496: 0

Abstain: 0

Conclusion 4-1: No changes recommended.
Criteria 5 – Wind Hazards: Wind and Debris Exposure

<table>
<thead>
<tr>
<th>Wind and Debris Hazard Exposure</th>
<th>Preferred</th>
<th>Marginal</th>
<th>Requires Investigation/Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The building has a sheltered exposure. ASCE 7 Exposures A &amp; B.</td>
<td>The building has a limited wind exposure. ASCE 7 Exposure C.</td>
<td>The building has unsheltered exposure with no mitigating factors. ASCE 7 Exposure D.</td>
</tr>
<tr>
<td></td>
<td>No large unanchored objects subject to “roll-over” impact of the building are within 100 feet.</td>
<td>No large unanchored objects subject to “roll-over” impact are within 100 feet of the facility.</td>
<td>Large objects that may be subject to “roll-over” impact are within 100 feet of the facility.</td>
</tr>
<tr>
<td></td>
<td>No potential lofted heavy debris sources within 100 feet, and</td>
<td>No potential lofted heavy debris sources within 100 feet, and</td>
<td>This classification also applies where buildings are within 100 feet, constructed in a manner that could lead to catastrophic failure and generate massive windborne debris.</td>
</tr>
<tr>
<td></td>
<td>No large or small windborne debris sources are within 300 feet.</td>
<td>There is minimal exposure to large and/or small windborne debris sources within 300 feet.</td>
<td>There is excessive exposure to large and/or small wind-borne debris sources within 300 feet of facility.</td>
</tr>
</tbody>
</table>

Working Group Meeting Discussion:
1. ARC 4496 states that preference should be given to hurricane evacuation shelters located in sheltered areas, and buildings exposed to the full force of hurricane winds avoided.
2. Florida’s Public Shelter Design Criteria [s. 7(24), SREF 1999] requires landscaping be designed to preserve safety and emergency egress, and vehicles be prohibited within 50 feet.
3. Generally, any significant breach in a building’s envelope could affect the structural integrity of the entire facility.
4. A sheltered location can reduce the vulnerability of a partially/marginally engineered structure.
5. See definitions of high wind and wind exposure as discussed in Key Definitions.

Working Group Votes

Meets the Intent of ARC 4496: 8
Recommend Changes to Achieve Intent of ARC 4496: 1

a. Only interior portions of buildings should be used as shelter space (to avoid exposure to windborne debris).
Abstain: 0

Conclusion 5-1:
No changes recommended.

Criteria 6 – Wind Hazards: Wind Design Verification

<table>
<thead>
<tr>
<th>Wind Design Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preferred</strong></td>
</tr>
<tr>
<td>• The building’s wind design is in accordance with ASCE 7-88 or a later edition.</td>
</tr>
<tr>
<td>• The building is designed and constructed prior to 1988, and uses the wind design criteria of ANSI A58 (1982).</td>
</tr>
<tr>
<td><strong>Marginal</strong></td>
</tr>
<tr>
<td>• The building’s wind design is in accordance with the Standard Building Code, other model codes, or the MBMA Code and there are no apparent design/construction flaws that could impact wind resistance.</td>
</tr>
</tbody>
</table>

In addition, buildings should receive a ranking based upon the following. The ranking scale is 0-4, with 0 being the least wind resistant and 4 being the most wind resistant.

- 0 – pre-1960
- 1 – 1960-1976
- 2 – 1977-1986
- 3 – 1987-1990
- 4 – 1990+

<table>
<thead>
<tr>
<th>Requires Investigation/Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• A building designed and constructed prior to 1960 and is a single story. There may be individual exceptions to this rule (e.g., monumental buildings), however, in every case a structural engineer should review any building built prior to 1960.</td>
</tr>
<tr>
<td>• A building where field surveys and other research indicate a lack of modern wind engineering design and construction attention, or</td>
</tr>
<tr>
<td>• The building is designed to wind speeds less than a Category 1 hurricane (90 mph), and/or</td>
</tr>
<tr>
<td>• Evaluated by a structural engineer to wind speeds less than local building code wind design requirements.</td>
</tr>
</tbody>
</table>

Working Group Meeting Discussion:

1. ARC 4496 states that hurricane evacuation shelters should be certified by a structural engineer as being capable of withstanding wind loads according to ASCE 7-88 or ANSI A58 structural design criteria. In the absence of ASCE 7/ANSI A58 certification, buildings that meet local codes are acceptable if they meet the other building safety criteria given in ARC 4496.

2. The minimum design criteria for Florida’s Public Shelter Design Criteria [s. 7(24), SREF 1999] is ASCE 7, Category III (Essential Buildings). Further, there is a recommendation to increase the map wind speed by 40 miles per hour (mph). SREF also requires a debris impact standard for all building envelope components, which ASCE 7 considers optional if the building is designed as a “partially enclosed” structure; a breached/partially enclosed structure would not provide a very good shelter environment.
3. The Community Shelter Design Criteria of FEMA 361 requires a minimum wind design of ASCE 7 with a wind speed of 200 mph throughout Florida.

4. Generally, local building codes, enforcement and customary construction practices are frequently inadequate for high wind events (i.e., “design-level events”).

5. Partially or marginally engineered structures behave more like non-engineered than engineered structures during high wind events.

6. “Engineered” structures from the 1960s through the mid-1980s are often a mixture of engineered components with non-engineered customary practice construction techniques (i.e., unreinforced masonry bearing walls with engineered roof trusses and connections).

Working Group Votes

Meets the Intent of ARC 4496: 5

Recommend Changes to Achieve Intent of ARC 4496: 3

a. Do not accept Metal Building Manufacturers Association (MBMA) Code unless there is evidence of other engineering attention to the structural design.

b. Need to insure not only the frame (structural engineer’s responsibility) but also the wall and roof components (architect’s responsibility) are designed according to ASCE 7.

c. Do not agree with the corrections suggested in the model code ranking table.

d. I am somewhat hesitant about using metal buildings as hurricane shelters. They are very sensitive to minor construction errors, and are more likely to have problems during a hurricane.

e. Studies conducted for the Florida Building Code indicate that Standard Building Code low-rise provisions result in equivalent design to ASCE 7-98 in certain zones and exposures, so long as windows and doors are protected.

Abstain: 1

Conclusion 6-1:
Pre-engineered Metal Buildings must be thoroughly scrutinized for compliance with ASCE 7 before use as a hurricane evacuation shelter. This evaluation must include, not only, the frame, but also metal roof & wall panel and purlin design and construction, as well as window and door protection.
Criteria 7 – Wind Hazards: Construction Type/Load-path Verification

<table>
<thead>
<tr>
<th>Construction Type/Load-path Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preferred</strong></td>
</tr>
<tr>
<td>• A building has a heavy steel or reinforced concrete frame and/or fully reinforced masonry or concrete load-bearing/shear walls. (see Criteria 9 for definitions of fully reinforced masonry)</td>
</tr>
<tr>
<td>• A clearly defined and continuous load-path from roof deck to foundation must be present.</td>
</tr>
<tr>
<td>• All connections between MWFRS components must be able to withstand vertical uplift and shear forces. Connections that depend upon gravity, grout-friction, or withdrawal-friction reactions do not provide a continuous load-path.</td>
</tr>
<tr>
<td><strong>Marginal</strong></td>
</tr>
<tr>
<td>• Engineered buildings that have masonry exterior walls with partial reinforcement (complies with NCMA TEK 63 [1975], or the equivalent) with or without a light steel frame. (see Criteria 9 for definitions of partially reinforced masonry)</td>
</tr>
<tr>
<td>• Engineered buildings constructed of light wood or metal stud bearing walls</td>
</tr>
<tr>
<td>• Pre-engineered Metal Buildings (PEMBs) designed to the MBMA 1986 (or more recent edition) will also be included in the marginal classification; bracing must be present in both the roof diaphragm and longitudinal wall planes</td>
</tr>
<tr>
<td><strong>Requires Investigation/Mitigation</strong></td>
</tr>
<tr>
<td>• A building has unreinforced masonry loadbearing walls, or roof systems that lack sufficient shear connections to provide diaphragm action effectively.</td>
</tr>
<tr>
<td>• PEMBs constructed before mid-1980s (i.e., to a standard other than MBMA 1986) or better and lacking adequate bracing.</td>
</tr>
<tr>
<td>• Buildings with no observable or verifiable continuous load-path from roof deck to foundation to resist wind uplift forces.</td>
</tr>
<tr>
<td>• All buildings that have connections between MWFRS components that depend upon gravity, grout-friction, or withdrawal-friction reactions are considered to not have a continuous load-path.</td>
</tr>
</tbody>
</table>

**Working Group Meeting Discussion:**

1. ARC 4496 primarily discusses types of structural systems and characteristics that should be avoided, with the exception of giving preference to multi-story buildings. Otherwise, ASCE 7 or building code requirements are the selection criteria.
2. For Florida’s *Public Shelter Design Criteria* [s. 7(24), SREF 1999] only the design and construction standard ASCE 7, Category III (Essential Buildings) is referenced.
3. Generally, the consensus was that this criterion is adequate as prescripted, except for additional discussion of adequacy/appropriateness of Pre-Engineered Metal Buildings and partially reinforced masonry wall bearing (or equivalents) buildings.
4. The only subject discussed at length was the use of the top-story of a multi-story building. The consensus was that top-stories can be used as hurricane shelters, as long as they meet the other criteria listed in ARC 4496, or are certified to meet ASCE 7. Upper floors of high-rise buildings should be
avoided, unless a substantial interior safe space is present (i.e., reinforced masonry or concrete walls).

Working Group Votes

Meets the Intent of ARC 4496: 4

Recommend Changes to Achieve Intent of ARC 4496: 4

a. Do not accept MBMA Code unless there is evidence of other engineering attention to the structural design.
b. Hybrid Pre-Engineered Metal Buildings require the same level of scrutiny as “classic” metal building systems.
c. Instead of specifying materials, indicate standards that frame and walls should meet.
d. Update TEK notes to latest revisions, and delete criteria items 7Mc and 7Rc.

Abstain: 1

Conclusion 7-1:
See Conclusion 6-1.

Conclusion 7-2: The load-path effectiveness of partially reinforced masonry wallbearing structures requires the attention of a structural engineer. In the absence of a structural engineer, mitigating factors such as location in a sheltered area, protection of the envelope, and/or structural retrofits are recommended.

Criteria 8 – Wind Hazards: Building Condition

<table>
<thead>
<tr>
<th>Building Condition</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Preferred</td>
<td>• The building is in good condition with no apparent signs of deterioration.</td>
</tr>
<tr>
<td></td>
<td>• The building is approximately as sound as it was when new.</td>
</tr>
<tr>
<td>Marginal</td>
<td>• A building has minor deterioration. There are some cracks in walls and other signs of slight deterioration that do not appear to impact significantly on wind resistance.</td>
</tr>
<tr>
<td>Requires Investigation/</td>
<td>• A building shows major deterioration. There is observable deterioration of a facility’s superstructure that may impact on wind resistance.</td>
</tr>
<tr>
<td>Mitigation</td>
<td></td>
</tr>
</tbody>
</table>

Working Group Meeting Discussion:
1. ARC 4496 states that a building must be in compliance with local building and fire safety codes.
2. It is assumed in Florida’s Public Shelter Design Criteria [s. 7(24), SREF 1999] that the facility is new construction.
3. Generally, the consensus was that this criterion is adequate as prescribed; the Division’s student manual provides more in-depth discussion of the criteria than listed above.

Working Group Votes

Meets the Intent of ARC 4496: 8

Recommend Changes to Achieve Intent of ARC 4496: 0

Abstain: 1

Conclusion 8-1:
No changes recommended.

Criteria 9 – Wind Hazards: Exterior Wall Construction

<table>
<thead>
<tr>
<th>Exterior Wall Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preferred</strong></td>
</tr>
<tr>
<td>• A building’s exterior walls are constructed of reinforced masonry or concrete wall systems and has less than one percent of any wall face’s area comprised of soft-spot area.</td>
</tr>
<tr>
<td>• No soft-spot area in the building can have direct exposure to the shelter area(s).</td>
</tr>
<tr>
<td>• Fully reinforced masonry is defined per ACI 530/ASCE 5. Generally, if #4 rebar (or larger) is spaced 4’ on center or closer, at the corners and wall-to-wall intersections, and around all openings, this indicates that a building probably complies with ACI 530 requirements.</td>
</tr>
<tr>
<td>• Metal panel exterior wall claddings must be equivalent to 20-ga or thicker.</td>
</tr>
<tr>
<td>• Pre-cast reinforced concrete wall panels (monolithic structural or cladding panels) with a minimum thickness of 4” or greater.</td>
</tr>
</tbody>
</table>

| **Marginal**               |
| • The building has partially reinforced masonry exterior walls. For 8” hollow CMUs, rebar typically spaced 8’ on center or closer, at the corners, wall-to-wall intersections and around wall openings. Masonry wall systems equivalent to NCMA TEK 63-1975. (12’ hollow CMU is 11’4” o.c.) |
| • Other masonry exterior wall systems with similar wind-resistance characteristics (flexural, shear, uplift load-path, etc.) to partially reinforced masonry. For 8” hollow masonry, 4-rebar minimum pilasters spaced at 13’6” on center are assumed to be equivalent. See NCMA TEK 37-1972 for additional guidance. (12” hollow CMU is 20’0” o.c.) |
| • Pre-cast reinforced concrete wall panels (monolithic structural or cladding panels) with a minimum thickness of 2”. |
| • Other non-masonry systems that include lightwood or steel framed exterior walls, fully wrapped in 1/2 inch or greater thickness plywood, with a relatively impact-resistant exterior veneer or cladding. |
| • A building with one to five percent of any wall face’s area comprised of soft-spot area, but the soft-spot area cannot have direct exposure to the shelter area(s). |
| • Metal panel exterior wall claddings must be a minimum of 22-ga structural and 26-ga non-structural or equivalent. |
Requires Investigation/ Mitigation

- A building has unreinforced masonry exterior walls, glass panel facade walls, light metal cladding less than 26-ga in thickness, EIFS cladding, or other lightweight panels
- Pre-cast reinforced concrete wall panels (structural or monolithic cladding panels) with a thickness of less than 2” and no adequate backup sheathing or masonry.
- Any building that has a soft-spot with direct exposure to the shelter area(s).

Working Group Meeting Discussion:
1. ARC 4496 primarily discusses types of structural systems and characteristics that should be avoided; otherwise leaves decisions on debris resistance to the surveyor. Florida’s criterion considers materials and systems that meet Miami-Dade County’s “Construction Assemblies Deemed Resistant to Windborne Debris” impact requirements as the minimum suitable for use in a hurricane shelter, and are thus ranked as marginal.

2. The materials and systems with a preferred ranking will meet the requirements of Florida’s Public Shelter Design Criteria [s. 7(24), SREF 1999].

3. Generally, the consensus was that this criterion is adequate as prescribed, except for additional discussion of adequacy/appropriateness of Pre-Engineered Metal Buildings and partially reinforced masonry wallbearing (or equivalents) buildings.

Working Group Votes

Meets the Intent of ARC 4496: 4

Recommend Changes to Achieve Intent of ARC 4496: 4

a. Attachment of metal panels is as important as the thickness; attachments should be checked for adequacy to resist high winds by a structural engineer.
b. All partially reinforced masonry should have minimum rebars at least according to schedules published by “FCPA and SBCCI Deemed-to-Comply Standards for Masonry Construction”; NCMA TEK notes should be updated to 2000 edition.
c. Need to add some aspect ratio to partially reinforced masonry prescription to insure plate action and adequate boundary conditions.
d. Shutters or other covering required to protect soft-spot area. Otherwise, there is potential for increasing internal pressure in building, which can lead to roof uplift and wall failure.

Abstain: 1

Conclusion 9-1:
Florida’s criteria will be checked for consistency with industry standards and guidelines.
Criteria 10 – Wind Hazards: Fenestration/Window Protection

<table>
<thead>
<tr>
<th>Fenestration/Window Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preferred</strong></td>
</tr>
<tr>
<td>• All exterior wall fenestration assemblies and/or protection systems comply with, or exceed, the performance standards/protocols of SSTD 12-94, or the Dade County version of the South Florida Building Code (Testing Protocols PA 210, 202 and 203).</td>
</tr>
<tr>
<td>• One percent or less of any exterior wall face is composed of unprotected window area.</td>
</tr>
<tr>
<td><strong>Marginal</strong></td>
</tr>
<tr>
<td>• A building has other types of fenestration protective systems that are not certified to meet the standards/protocols required for the preferred category above.</td>
</tr>
<tr>
<td>• All fenestrations with direct access to shelter area must be protected from penetration by windborne debris.</td>
</tr>
<tr>
<td>• <strong>Note: Systems not certified to meet or exceed the standards listed in the “Preferred” criterion above may not provide sufficient windborne debris impact and/or wind load resistance under major hurricane conditions.</strong></td>
</tr>
<tr>
<td>• One to five percent of any exterior wall face is composed of unprotected window area.</td>
</tr>
<tr>
<td><strong>Requires Investigation/Mitigation</strong></td>
</tr>
<tr>
<td>• A building has unprotected fenestration(s) that lead into shelter areas.</td>
</tr>
<tr>
<td>• Greater than five percent of any exterior wall face is composed of unprotected window area.</td>
</tr>
</tbody>
</table>
Figure 4 (Left): Window and door assembly damaged by high winds and debris.

Figure 5 (Below): Example of window protection system.
Working Group Meeting Discussion:
1. ARC 4496 guidelines state that areas near glass should be avoided unless protected by an adequate shutter.
2. The materials and systems with a preferred ranking will meet the requirements of Florida’s Public Shelter Design Criteria [s. 7(24), SREF 1999].
3. Percentage of wall area comprised of glass came from ASCE 7-88 and ASCE 7-95, and several other engineering reference sources. Percentage of glass/weak envelope materials is important due to envelope breach effects.
4. Generally, the consensus was that this criterion is adequate as prescripted.

Working Group Votes

Meets the Intent of ARC 4496: 5
Recommend Changes to Achieve Intent of ARC 4496: 3

a. All wall areas with glass in excess of one percent requires shutters to prevent envelope-breaching effects.
b. Delete 10Ma and 10Mb; window protection must meet SBCCI SSTD 12 or Miami-Dade County equivalent shutter performance standards.
c. Add ASTM Standards (to list of preferred performance requirements).

Abstain: 1

Conclusion 10-1:
American Society of Testing and Materials (ASTM) Standards E 1886 and E 1996 will be included with the list of preferred debris impact resistance performance criteria.

Criteria 11 – Wind Hazards: Roof Slope and Construction

<table>
<thead>
<tr>
<th></th>
<th>Roof Construction / Roof Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preferred</strong></td>
<td>• A building has a roof of heavy construction, such as reinforced structural concrete with a 4” minimum thickness deck.</td>
</tr>
<tr>
<td></td>
<td>• Heavy weight roof systems have a minimum self-weight of 50 psf.</td>
</tr>
<tr>
<td></td>
<td>• A light or moderate weight deck with a roof slope 30 degrees or greater.</td>
</tr>
<tr>
<td></td>
<td>• Roof eave or overhang lengths are limited to 2’ or less.</td>
</tr>
<tr>
<td></td>
<td>• Also, no unanchored roof appendages can be present.</td>
</tr>
<tr>
<td></td>
<td>• Metal decks must be equivalent to 20 ga. or thicker.</td>
</tr>
<tr>
<td><strong>Marginal</strong></td>
<td>• A building has a flat and/or lightweight roof system with engineered mechanical connections (bolts, welds, etc.) to support structures below.</td>
</tr>
<tr>
<td></td>
<td>• Roof eave or overhang that is greater than 2’ and mitigating factor (ASCE 7 certification, shielding by adjacent structures, end-condition load-path, etc.)</td>
</tr>
</tbody>
</table>
|                      | • If it is a gable roof system, it must be braced against racking failure, or the gable walls must
be constructed of a reinforced or partially reinforced masonry wall system.

- No unanchored roof appendages are present.
- Metal decks with equivalent thickness of 22 ga. structural or 26 ga. non-structural.

### Requires Investigation/Mitigation

- A building has a flat, lightweight roof system with gravity or friction/grout connection or other nominal connections to support structures below (i.e., fiberboard and PCF).
- Includes all lightweight roof systems with a roof overhang that is greater than 2’ and no mitigating factors.
- Unanchored roof appendages are present, thus the potential for a significant envelope breach exists.

### Working Group Meeting Discussion:

1. ARC 4496 primarily discusses types of structural systems and characteristics that should be preferred or avoided. Otherwise, the roof system must be certified to ASCE 7 standard. Florida’s criterion considers materials and systems that meet Miami-Dade County’s “Construction Assemblies Deemed Resistant to Windborne Debris” impact requirements as suitable for use in a hurricane shelter, and are thus ranked as marginal.

2. The materials and systems with a preferred ranking will meet the requirements of Florida’s Public Shelter Design Criteria [s. 7(24), SREF 1999].

3. Generally, the consensus was that this criterion is adequate as prescribed, except for some discussion of the origin of the two (2) foot roof overhang prescriptive.

### Working Group Votes

- Meets the Intent of ARC 4496: 7
- Recommend Changes to Achieve Intent of ARC 4496: 1
  - a. Roof decks must have a self-weight of at least 50 psf to be considered heavy weight.

- Abstain: 1

Conclusion 11-1:
No changes recommended.
### Criteria 12 – Wind Hazards: Roof Long or Open Span

<table>
<thead>
<tr>
<th></th>
<th>Roof Open Span</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preferred</strong></td>
<td></td>
</tr>
<tr>
<td>• A building with a flat sloped light or medium-weight roof system and a distance between vertical support elements (bearing walls and/or columns) less than 40’.</td>
<td></td>
</tr>
<tr>
<td>• Heavy weight roof systems with a flat or greater slope and a maximum span between roof supports of 60’ or less.</td>
<td></td>
</tr>
<tr>
<td><strong>Marginal</strong></td>
<td></td>
</tr>
<tr>
<td>• A building has a light or medium-weight roof system(s) with a moderate to steep roof slope and maximum span between roof supports of 50 feet or less.</td>
<td></td>
</tr>
<tr>
<td>• Heavy weight roof systems with a flat or greater slope and a maximum span between roof supports greater than 60’ with ASCE 7 certification.</td>
<td></td>
</tr>
<tr>
<td>• Light or medium-weight roof systems with spans 60’ or less -- ASCE 7 (Cat III) certification by a structural engineer is required.</td>
<td></td>
</tr>
<tr>
<td><strong>Requires Investigation/Mitigation</strong></td>
<td></td>
</tr>
<tr>
<td>• A building has a flat or shallow slope, light or medium-weight roof system with a distance between vertical supports that is greater than 40’ without certification, or greater than 60’ with ASCE 7 (Cat III) certification.</td>
<td></td>
</tr>
</tbody>
</table>

*Figure 6:* Long span roof damaged by high winds.
Working Group Meeting Discussion:

1. ARC 4496 primarily discusses types of structural systems and characteristics that should be preferred or avoided. Otherwise, the roof system must be certified to ASCE 7 standard.

2. A building designed and constructed to Florida’s Public Shelter Design Criteria [s. 7(24), SREF 1999] using the recommended 40 mph increase in wind speed should be suitable as a hurricane evacuation shelter. However, the minimum criterion is at best marginal for buildings with spans greater than 60 feet.

3. Generally, the consensus was that this criterion is adequate as prescribed, though there was heavy emphasis on the need for a structural engineer to certify any long span roof system before use as a hurricane evacuation shelter.

Working Group Votes

Meets the Intent of ARC 4496: 8

Recommend Changes to Achieve Intent of ARC 4496: 0

Abstain: 1

Conclusion 12-1:
A structural engineer’s certification is needed for buildings with long or open span roofs in excess of 40 feet.

Figure 7: Example of ASCE 7 certification by a structural engineer.
Criteria 13 – Wind Hazards: Roof Drainage

<table>
<thead>
<tr>
<th>Roof Drainage/Ponding</th>
<th>Preferred</th>
<th>Marginal</th>
<th>Requires Investigation/Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preferred</td>
<td>• A building has no parapet walls that confine roof drainage and no evidence of ponding.</td>
<td>• A building has a roof parapet that will confine rainfall drainage, and scuppers are present in parapet walls.</td>
<td>• A building roof parapet that will confine roof drainage and:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• A building with drainage confining parapets and no scuppers, but with mitigating factors (i.e., no nearby source of drain clogging debris, etc.)</td>
<td>• Scuppers are either not present or have insufficient drainage capacity.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Evidence of minor roof ponding that does not exceed 4”.</td>
<td>• There is significant evidence of ponding and/or roof damage due to excessive ponding to depths that could lead to roof collapse.</td>
</tr>
</tbody>
</table>

Working Group Meeting Discussion:

1. ARC 4496 states that a building must be in compliance with local building codes.
2. A building designed and constructed to Florida’s Public Shelter Design Criteria [s. 7(24), SREF 1999] is required to have adequate slope and drains with emergency overflow scuppers to accommodate a two-inch per hour rainfall rate for six hours.
3. Roof drains are often used on flat roofs, but overflow scuppers are not always installed. Hurricanes tend to cause accumulation of debris on roof surfaces, which may block drains. Therefore scuppers or emergency overflow capability is necessary.
4. Generally, the consensus was that this criterion is adequate as prescribed.

Working Group Votes

Meets the Intent of ARC 4496: 7

Recommend Changes to Achieve Intent of ARC 4496: 1

a. For criteria item 13Mc, depth of ponding a structure can handle is dependent on the type of structure; move to R ranking.

Abstain: 1

Conclusion 13-1:
No changes recommended.
Criteria 14 – Wind Hazards: Interior Safe Space

<table>
<thead>
<tr>
<th>Interior Safe Space</th>
<th>Preferred</th>
<th>Marginal</th>
<th>Requires Investigation/Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| **Preferred**       | • A building has interior corridor/rooms with reinforced masonry or concrete walls and a reinforced concrete overhead deck above.  
|                     | • Walls should at a minimum extend to roof (or floor) support structures and/or deck above.  
|                     | • A definable and continuous load-path must be present from roof/ceiling deck to corridor foundation.  
|                     |           |          |                                  |
| **Marginal**        | • A building’s interior corridor/rooms have partially reinforced masonry walls (or equivalent) and concrete or metal roof/ceiling deck above.  
|                     | • A definable and continuous load-path must be present from roof/ceiling deck to corridor foundation.  
|                     |           |          |                                  |
| **Requires Investigation/Mitigation** | • ARC 4496 does not require an interior room or corridor to be present for a hurricane shelter, if the remainder of the building meets ARC 4496.  
|                     | • Interior spaces with unprotected fenestrations that are directly exposed to wind effects and debris sources.  
|                     | • Corridors with unreinforced masonry walls.  
|                     | • Interior corridors or rooms surrounded on all sides by building areas that meet ARC 4496 are considered suitable shelter space.  

**Figure 8 (Left):** Common interior corridor in a school.

**Figure 9 (Right):** Similar interior corridor damaged by high winds.
Working Group Meeting Discussion:
1. ARC 4496 states that interior rooms or corridors should be used, and that rooms attached or adjacent to unreinforced masonry should not be used.
2. The materials and systems with a preferred ranking will meet the requirements of Florida’s Public Shelter Design Criteria [s. 7(24), SREF 1999].
3. Generally, the consensus was that this criterion is adequate as prescribed. However, concerns stated for considering an interior space preferred when it does not have an independent ceiling or roof deck.

Working Group Votes

Meets the Intent of ARC 4496: 8
Recommend Changes to Achieve Intent of ARC 4496: 0
Abstain: 1

Conclusion 14-1:
Interior safe space criteria will be modified so that only spaces with either a heavy roof deck, or independent ceiling or roof deck are ranked as preferred.

Criteria 15 – Wind Hazards: Life Safety

<table>
<thead>
<tr>
<th>Life Safety and Emergency Power</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preferred</strong></td>
</tr>
<tr>
<td>• The building has an Emergency or Standby Power Generator-Set. The gen-set should have a minimum 24-hour on-site fuel supply (a 72-hour fuel supply is recommended). The generator, its fuel supply, and other ancillary equipment and fuel lines should be hazard protected.</td>
</tr>
<tr>
<td>• The building must be in compliance with all pertinent fire and safety codes.</td>
</tr>
<tr>
<td><strong>Marginal</strong></td>
</tr>
<tr>
<td>• The building will fall into the marginal category if it has battery backup exit signage and lighting.</td>
</tr>
<tr>
<td>• Installation of generator prewiring systems for expediting connection of a portable gen-set is recommended, but not required.</td>
</tr>
<tr>
<td>• The building must be in compliance with all pertinent fire and life safety codes.</td>
</tr>
<tr>
<td><strong>Requires Investigation/Mitigation</strong></td>
</tr>
<tr>
<td>• The building is not in compliance with the pertinent local fire and life safety codes.</td>
</tr>
</tbody>
</table>

Working Group Meeting Discussion:
1. ARC 4496 states that a building must be in compliance with local building and fire safety codes.
2. All new schools must be in compliance with fire and life safety codes to receive an occupancy permit. Buildings designed and constructed to Florida’s
Public Shelter Design Criteria [s. 7(24), SREF 1999] must meet the same requirements.

3. Generally, the consensus was that this criteria is adequate as prescripted.

Working Group Votes

Meets the Intent of ARC 4496: 8

Recommend Changes to Achieve Intent of ARC 4496: 0

Abstain: 1

Conclusion 15-1:
No changes recommended.

III. Recommended Changes to Florida’s Criteria

This section provides a list of recommendations for implementation. The recommendations are based upon the working group’s discussions at the January 30-31, 2001 meeting, follow-up written comments, and conclusions drawn from Section B above. As the information in this report is further analyzed, additional action items may be recommended.

Recommendation 1. The Least-Risk Decision Making Table/Matrix approach to ranking a potential hurricane evacuation shelter building appears to be consistent with the intent of ARC 4496. There are no required changes to this format.

Recommendation 2. The “marginal” ranking for both storm surge inundation (Criteria 1) and rainfall flooding (Criteria 2) will be modified, such that only one (1) foot of inundation potential of the shelter’s floor is considered suitable for a Category 5 hurricane surge or a 500-year rainfall event.

Recommendation 3. Pre-engineered Metal Buildings (PEMB) must be thoroughly scrutinized for compliance with ASCE 7 before use as a hurricane evacuation shelter. This evaluation must include not only the frame, but also metal roof & wall panels and purlin design and construction, as well as window and door protection. The State’s criteria will be modified to indicate that PEMBs are ranked “marginal” after certification for compliance with ASCE 7 verified.

Recommendation 4. The load-path effectiveness of partially reinforced masonry wallbearing structures requires the attention of a structural engineer. In the absence of a structural engineer, mitigating factors such as location in a sheltered area, protection of the envelope, and/or structural retrofits are recommended.
Recommendation 5. The Division will verify that Florida’s hurricane shelter selection criteria reflects current industry standards, publications, guidelines and “state-of-knowledge”.

Recommendation 6. The “preferred” debris-impact resistance standards listed in Florida’s criteria for window and door protection will be modified to include the American Society of Testing and Materials (ASTM) Standards E 1886 and E 1996.

Recommendation 7. All roofs with unsupported spans that exceed forty (40) feet in length will require an ASCE 7, Category III certification to be considered suitable for use as a hurricane evacuation shelter. Long span roofs that receive the required certification will be ranked as “marginal”.

Recommendation 8. Interior safe space criteria will be modified so that only spaces with either a heavy roof deck, or an independent ceiling or roof deck are ranked as “preferred.” Interior spaces that do not have overhead protection that is independent of the roof structure will be ranked “marginal”.

Recommendation 9. Due to concerns over the safety of some marginal buildings, the Division will further investigate the need for certifications by structural engineers for certain types/classes of buildings and materials.
Attachment A: ABBREVIATIONS

AFCESA – Air Force Civil Engineer Support Agency
ANSI – American National Standards Institute
ARC – American Red Cross
ASCE – American Society of Civil Engineers
ASTM – American Society of Testing and Materials
CMU – Concrete Masonry Unit
ETL – (AFCESA) Engineering Technical Letter
FEMA – Federal Emergency Management Agency
FCPA – Florida Concrete Products Association
FIRM – Flood Insurance Rate Map
LRDM – Least-Risk Decision Making (Table)
MBMA – Metal Building Manufacturer’s Association
MWFRS – Main Wind Force Resisting System
NCMA – National Concrete Masonry Association
PEMB – Pre-engineered Metal Building
PSF – Pounds per Square Foot
SBC – Standard Building Code
SBCCI – Southern Building Code Congress International
SLOSH – Sea, Lake and Overland Surges from Hurricanes
SREF – State Requirements for Educational Facilities (Florida)
SSTD – (SBCCI) Standard, Technical Publications
TEK – (NCMA) Information Series, Technical Publications
**Attachment B: AGENDA**

**Florida’s Hurricane Shelter Selection Guidelines Review**  
**Working Group Meeting**

Holiday Inn-Capital East, Tallahassee, FL  
January 30 and 31, 2001

**Purpose Statement:** Convene a working group composed of members from the American Society of Civil Engineers, American Red Cross, ARC 4496 Interagency Group, and Florida hurricane-related science, engineering, and emergency management professionals to thoroughly re-review Florida’s hurricane shelter selection guidelines.

<table>
<thead>
<tr>
<th>Day/Time</th>
<th>Topic</th>
<th>Speaker</th>
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<tbody>
<tr>
<td><strong>Monday, January 29</strong></td>
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<tr>
<td>3:00 -</td>
<td>Participant Arrival and Hotel Check-in</td>
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<tr>
<td>3:00 - 5:00</td>
<td>Early Registration</td>
<td>DEM Staff</td>
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<tr>
<td><strong>Day 1</strong></td>
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<td><strong>Tuesday, January 30</strong></td>
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<td>7:30 - 8:30</td>
<td>Registration</td>
<td>DEM Staff</td>
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<tr>
<td>8:30 - 8:40</td>
<td>Opening Remarks &amp; Meeting Purpose</td>
<td>Eve Rainey</td>
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<tr>
<td>8:40 - 9:00</td>
<td>ARC 4496 Historical Perspective</td>
<td>Mike Logan</td>
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<tr>
<td>9:00 - 10:00</td>
<td>Overview of Florida’s Shelter Selection Process and Discussion of Key Definitions</td>
<td>Danny Kilcollins</td>
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<tr>
<td>10:00 - 10:20</td>
<td>BREAK</td>
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<tr>
<td>10:20 - 12:00</td>
<td>Florida’s Least-Risk Decision Making Table Storm Surge and Rainfall Flooding Criteria</td>
<td>Danny Kilcollins, Michael Conrad</td>
</tr>
<tr>
<td>12:00 - 1:30</td>
<td>LUNCH (on your own)</td>
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<tr>
<td>1:30 - 3:00</td>
<td>Florida’s Least-Risk Decision Making Table Wind Hazards Criteria</td>
<td>Danny Kilcollins, Michael Conrad</td>
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<td>3:00 - 3:20</td>
<td>BREAK</td>
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<tr>
<td>3:20 - 5:00</td>
<td>Florida’s Least-Risk Decision Making Table Wind Hazards Criteria (cont’d)</td>
<td>Danny Kilcollins, Michael Conrad</td>
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### Day 2

**Wednesday, January 31**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tbody>
<tr>
<td>8:30 - 8:45</td>
<td>Summary of Day 1’s discussion</td>
<td>Danny Kilcollins</td>
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<tr>
<td>8:45 - 10:00</td>
<td>Florida’s Least-Risk Decision Making Table</td>
<td>Danny Kilcollins</td>
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<tr>
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<td>Wind Hazards Criteria (cont’d)</td>
<td>Michael Conrad</td>
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<tr>
<td>10:00 - 10:20</td>
<td>BREAK</td>
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<tr>
<td>10:20 - 12:00</td>
<td>Florida’s Least-Risk Decision Making Table</td>
<td>Danny Kilcollins</td>
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<tr>
<td></td>
<td>Hazmat Criteria and Life-safety/Fire Codes</td>
<td>Michael Conrad</td>
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<tr>
<td>12:00 - 1:30</td>
<td>LUNCH (on your own)</td>
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<tr>
<td>1:30 - 3:00</td>
<td>Field Application of Hurricane Shelter Selection Criteria (w/ example buildings)</td>
<td>Danny Kilcollins</td>
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<tr>
<td>3:00 - 3:20</td>
<td>BREAK</td>
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<tr>
<td>3:20 - 4:30</td>
<td>Open Discussion of Criteria and Application</td>
<td>Michael Conrad</td>
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<tr>
<td>4:30 - 4:50</td>
<td>Discussion of Consensus Process</td>
<td>Danny Kilcollins</td>
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<tr>
<td>4:50 - 5:00</td>
<td>Closing Remarks</td>
<td>Danny Kilcollins</td>
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</table>
The following guidelines, prepared by an interagency group, reflect the application of technical data compiled in Hurricane Evacuation Studies, other hazard information, and research findings related to wind loads and structural problems. These guidelines are intended to supplement information contained in ARC 3031, Mass Care: Preparedness and Operations, concerning shelter selection for hurricane evacuation situations.
Planning considerations for hurricane evacuation shelters involve a number of factors and require close coordination with local officials responsible for public safety. Technical information contained in Hurricane Evacuation Studies, storm surge and flood mapping, and other data can now be used to make informed decisions about the suitability of shelters.

In the experience of the American Red Cross, the majority of people evacuating because of a hurricane threat generally provide for themselves or stay with friends and relatives. However, for those who do seek public shelter, safety from the hazards associated with hurricanes must be assured. These hazards include—

- Surge inundation.
- Rainfall flooding.
- High winds.
- Hazardous materials.

Recommended guidelines follow for each of these hurricane-associated hazards.

**Surge Inundation Areas**

In general, hurricane evacuation shelters should not be located in areas vulnerable to hurricane surge inundation. The National Weather Service has developed mathematical models, such as Sea, Lake, and Overland Surges from Hurricanes (SLOSH) and Special Program to List Amplitudes of Surges from Hurricanes (SPLASH), that are critical in determining the potential level of surge inundation in a given area.

- Carefully review inundation maps in order to locate all hurricane evacuation shelters outside Category 4 storm surge inundation zones.
- Avoid buildings subject to isolation by surge inundation in favor of equally suitable buildings not subject to isolation. Confirm that ground elevations for all potential shelter facilities and access routes obtained from topographic maps are accurate.
- Do not locate hurricane evacuation shelters on barrier islands.

**Rainfall Flooding**

Rainfall flooding must be considered in the hurricane evacuation shelter selection process. Riverine inundation areas shown on Flood Insurance Rate Maps (FIRMs), as prepared by the National Flood Insurance Program, should be reviewed. FIRMs should also be reviewed in locating shelters in inland counties.

- Locate hurricane evacuation shelters outside the 100-year floodplain.
- Avoid selecting hurricane evacuation shelters located within the 500-year floodplain.
- Do not locate hurricane evacuation shelters in areas likely to be isolated due to riverine inundation of roadways.
- Make sure a hurricane evacuation shelter’s first floor elevation is on an equal or higher elevation than that of the base flood elevation level for the FIRM area.
- Consider the proximity of shelters to any dams and reservoirs to assess flow upon failure of containment following hurricane-related flooding.

**Wind Hazards**

Consideration of any facility for use as a hurricane evacuation shelter must take into account wind hazards. Both design and construction problems may preclude a facility from being used as a shelter. Local building codes are frequently inadequate for higher wind speeds.

**Structural Considerations**

- If possible, select buildings that a structural engineer has certified as being capable of withstanding wind loads according to ASCE (American Society of Engineers) 7-88 or ANSI (American National Standards Institute) A58 (1982) structural design criteria. Buildings must be in compliance with all local building and fire codes.
- Failing a certification (see above), request a structural engineer to rank the proposed hurricane evacuation shelters based on his or her knowledge and the criteria contained in these guidelines.
- Avoid uncertified buildings of the following types:
  - Buildings with long or open roof spans
  - Un-reinforced masonry buildings
  - Pre-engineered (steel pre-fabricated) buildings built before the mid-1980s
  - Buildings that will be exposed to the full force of hurricane winds
  - Buildings with flat or lightweight roofs
- Give preference to the following:
  - Buildings with steep-pitched, hipped roofs; or with heavy concrete roofs
• Buildings more than one story high (if lower stories are used for shelter)
• Buildings in sheltered areas
• Buildings whose access routes are not tree-lined

**Interior Building Safety Criteria During Hurricane Conditions**

Based on storm data (e.g., arrival of gale-force winds), determine a notification procedure with local emergency managers regarding when to move the shelter population to pre-determined safer areas within the facility. Consider the following guidelines:

• Do not use rooms attached to, or immediately adjacent to, un-reinforced masonry walls or buildings.
• Do not use gymnasiums, auditoriums, or other large open areas with long roof spans during hurricane conditions.
• Avoid areas near glass, unless the glass surface is protected by an adequate shutter. Assume that windows and roof will be damaged and plan accordingly.
• Use interior corridors or rooms.
• In multi-story buildings, use only the lower floors and avoid corner rooms.
• Avoid any wall section that has portable or modular classrooms in close proximity, if these are used in your community.
• Avoid basements if there is any chance of flooding.

**Hazardous Materials**

The possible impact from a spill or release of hazardous materials should be taken into account when considering any potential hurricane evacuation shelter.

All facilities manufacturing, using, or storing hazardous materials (in reportable quantities) are required to submit Material Safety Data Sheets (emergency and hazardous chemical inventory forms) to the local Emergency Planning Committee (LEPC) and the local fire department. These sources can assist you in determining the suitability of a potential hurricane evacuation shelter or determining precautionary zones (safe distances) for facilities near potential shelters that manufacture, use, or store hazardous materials.

• Facilities that store certain types or quantities of hazardous materials may be inappropriate for use as hurricane evacuation shelters.
• Hurricane evacuation shelters should not be located within the ten-mile emergency planning zone (EPZ) of a nuclear power plant.
• Service delivery units must work with local emergency management officials to determine if hazardous materials present a concern for potential hurricane evacuation shelters.

**Hurricane Evacuation Shelter Selection Process**

General procedures for investigating the suitability of a building or facility for use as a hurricane evacuation shelter are as follows:

• Identify potential sites. Evacuation and transportation route models must be considered.
• Complete a risk assessment on each potential site. Gather all pertinent data from SLOSH and/or SPLASH (storm surge), FIRM (flood hazard), facility base elevation, hazardous materials information, and previous studies concerning each building’s suitability.
• Inspect the facility and complete a Red Cross Facility Survey Form and a Self-Inspection Work Sheet / Off-Premises Liability Checklist, in accordance with ARC 3031. Note all potential liabilities and the type of construction. Consider the facility as a whole—one weak section may seriously jeopardize the integrity of the building.
• Have the building certified as being capable of withstanding the wind loads according to ASCE 7-88 or ANSI A58 (1982) structural design criteria. In the absence of certification, have a structural engineer review the facility and rate its suitability to the best of his or her ability.
• Ensure that an exhaustive search for shelter space has been completed. Work with local emergency management officials and others to identify additional potential sites.
• Review, on a regular basis, all approved hurricane evacuation shelters. Facility improvements, additions, or deterioration may change the suitability of a selected facility as a hurricane evacuation shelter. Facility enhancements may also enable previously rejected facilities to be used as hurricane evacuation shelters.
• If possible, work with officials, facility managers, and school districts on mitigation opportunities. Continue to advocate that the building program for new public buildings, such as schools,
should include provisions to make them more resilient to possible wind damage. It may also be possible to suggest a minor modification of a municipal, community, or school building in the planning stages to make for a more useful hurricane evacuation shelter site, such as the addition of hurricane shutters.

**Least-Risk Decision Making**

Safety is the primary consideration for the American Red Cross in providing hurricane evacuation shelters. When anticipated demands for hurricane evacuation shelter spaces exceed suitable capacity as defined by the preceding criteria, there may be a need to utilize marginal facilities. It is therefore critical that these decisions be made carefully and in consultation with local emergency management and public safety officials. Guidance should be obtained from Disaster Services at national headquarters, in consultation with the Risk Management Division.

This process should include the following considerations:

- No hurricane evacuation shelter should be located in an evacuation zone for obvious safety reasons. All hurricane evacuation shelters should be located outside of Category 4 storm surge inundation zones. **Certain exceptions may be necessary, but only if there is a high degree of confidence that the level of wind, rain, and surge activities will not surpass established shelter safety margins.**

- When a potential hurricane evacuation shelter is located in a flood zone, it is important to consider its viability. By comparing elevations of sites with FIRM, one can determine if the shelter and a major means of egress are in any danger of flooding. Zone A (within the 100-year flood plain and puddling of 1–3 feet expected) necessitates a closer look at the use of a particular facility as a sheltering location. Zones B, C, and D may allow some flexibility. **It is essential that elevations be carefully checked to avoid unnecessary problems.**

- In the absence of certification by a structural engineer, any building selected for use as a hurricane evacuation shelter must be in compliance with all local building and fire codes. Certain exceptions may be necessary, but only after evaluation of each facility, using the aforementioned building safety criteria.

- The Red Cross uses the planning guideline of 40 square feet of space per shelter resident. During hurricane conditions, on a **short-term basis**, shelter space requirements may be reduced. Ideally, this requirement should be determined using no less than 20 square feet per person. Adequate space must be set aside for registration, health services, and safety and fire considerations. Disaster Health Services areas should still be planned using a 40 square feet per person calculation. On a **long-term recovery basis**, shelter space requirements should follow guidelines established in ARC 3031, *Mass Care: Preparedness and Operations.*
American Red Cross

Mr. Joseph Myers, Director
Division of Emergency Management
State of Florida
Department of Community Affairs
2555 Shumard Oak Boulevard
Tallahassee, FL 32399-2100

Dear Mr. Myers:

This letter is in regards to your request for support of Florida’s Hurricane Shelter Selection Criteria and how well those criteria meet the intent of the Red Cross Guidelines for Hurricane Evacuation Shelter Selection (ARC 4496).

Luis Garcia represented the American Red Cross at the January 30 and 31, 2001 meeting of Florida’s Hurricane Shelter Selection Guidelines Review Working Group. Mr. Garcia has reviewed the Response Workbook provided by Danny Kilcollins that was a product of the Working Group meeting. Mr. Garcia reports that the guidelines established by the state of Florida Division of Emergency Management for hurricane evacuation shelter selection are well thought out and should assist local Emergency Management, as well as our local Red Cross chapters, in making the best decisions in the selection of facilities to be used as hurricane evacuation shelters. I feel the guidelines used by your office in the selection of sites to be used as shelters meets the intent of the Red Cross Guidelines for Hurricane Evacuation Shelter Selection (ARC 4496).

Please feel free to contact my office if there are any questions regarding the use of ARC 4496.

Sincerely,

[Signature]
John A. Clizbe
Vice President
Disaster Services

Help Can’t Wait
Attachment E: Summary of Meeting Discussion

January 30, 2001
Hurricane Shelter Selection Guidelines
Meeting in Tallahassee, FL

Present were as follows:

Danny Kilcollins  DEM  (850) 413-9859
David Bujak  DEM  (850) 413-0256
Allan McDuffie  USACOE  (910) 251-4724
Michael Conrad  DCA  (850) 922-1920
Dr. Ronald Cook  Dept of Civil and Coastal  (352) 392-1036
Rick Dixon  DCA  (850) 921-2278
Ben Doan  PBS&j  (813) 282-7275
Chris Evans  AG  (850) 487-9081
Luis Garcia  ARC  (703)206-8627
Dean Griffin  DEM  (850) 413-9954
Karen Hagan  ARC  (850) 878-6080
Jonathan Hamrick  Dept of Education  (850) 487-1578
Adrian Hurlbutt  DEM  (850) 413-0258
Annette Marshall  AG  (850) 487-9156
Dr. James McDonald  Texas Tech University  (806) 742-3446
Jim Naum  DEM
Steve Porter  Hillsborough Co. EM  (813) 276-2385
Eve Rainey  DEM  (850) 413-9914
Jorge Romano  DEM
Dr. Ajay Shanker  University of FL  (352) 392-7517
Dr. Peter Sparks  Dept of Civil Engineering  (864) 656-3326
Dr. Douglas Smith  Texas Tech University  (806) 742-3446

C. Invited

Robert G. Dean  Dept of Civil and Coastal
Charlie Everly  Code Technology
Jane Kushma  ARC
Paul Tertell  FEMA
Charles Chesnutt  USACOE

Danny Kilcollins introduced himself as moderator.

Purpose: Review FL criteria to see if it meets the intent of set forth in ARC 4496. Also, address any changes in state of knowledge, and assure that Florida’s
criteria consistent with the state of knowledge. Incorporate new knowledge into the criteria.

**Michael Conrad** - trained facilitator will assist in certain segments of meeting.

**Eve Rainey** welcomed and provided with opening remarks. Bureau Chief - Bureau of Compliance Planning and Support.

What a priority this issue is for the Governor, Dept and EM communities. In 1993 major changes in EM Statutes- requires safe and adequate supply of shelters in Florida.

Factors - clearance times, vulnerable populations. Short supply of facilities available for shelters.

Shelter selection and retrofit - one piece of the puzzle that the Dept has been looking at. Building Codes implications.

Funding push statewide - 2.3 million from hurricane catastrophe fund. Eight million dollars this year available for shelter retrofit ($3 million to be appropriated annually from hurricane catastrophe fund)

EMPATF – 1 million for shelters

4.5 million from local - match for federal funds

Changes in Legislation (passed in 2000 legislation) Prior - 3-mile exemption allowing if 2 schools being built, but only one had to be built to hurricane shelter standards - exemption has now been removed.

Extended to private facilities (beyond schools) - extended liability protection to private-owned buildings like they have to schools.

How do we explain to the public?

**Danny** - Purpose - re-review the state's criteria.

There have been some changes in the state of knowledge. This working group is not meeting to discuss ARC 4496 itself - but how we apply it to Florida.

Shelter Implementation Workshop last year. Making significant progress.
Capture any recommendation, from local level to meet their needs as well.
One objective – written statements from the American National Red Cross and ASCE stating we are meeting the intent of ARC 4496.

Training around the state -- over 600 people and 40 courses about employing the shelter selection criteria.

Participants were introduced and agenda reviewed. Putting minutes on the Division’s website.

**Luis Garcia, Planning and Evaluation Directorate at American Red Cross National Headquarters** – Interpretation and history of ARC 4496. Exception process.

History – 1986-87 Hurricane conference raised structural integrity of public hurricane shelters as a concern. Needed a non-technical guide.

Conducted evaluations of hurricane shelter facilities in coastal North Carolina. Felt it was important to use shelters in coastal counties because of the risk. May 1989 SLOSH models used to review facilities in Corpus Christy. 1991 – ARC convened Hurricane Shelter Selection Guideline task force group with the objective to develop a user-friendly guidance of state and local applications of new research findings. FEMA, USACOE, Clemson University, etc.

July 1992 – ARC publishes guidelines hurricane shelter selections 4496 – surge inundation, rainfall flooding, hazardous materials, least risk decision making. 4 criteria applied to make sure we were going in the right direction.

May 1996 – ARC approves the first exception – Beauford, SC – analyzed all available data, structural integrity, SLOSH, MOMs


May 1998 – ARC surveyed 4496 partnered to determine if there needed to be any technical updates.


ARC NHQ will take this meeting’s opportunity to make sure we have the appropriate info and make it available.

Dr. Shanker – Q-What kind of exceptions were approved. A – schools boards. Louisiana – Acadiana last one. Right now no requests for exceptions for other
than schools. Mostly isolation issues – w/in a Cat 4 inundation. Evacuations – if all individuals couldn’t get out we needed a safe place for them to get off the roads.

Danny -- in the case of SW Florida – issues were due to very unique geography – most of the exception was high and dry during exiting and paralleling storms.

Lewis Commission Report – recommendation # 24 – recommendation that State has a shelter survey program and eliminates the deficit of safe space. Perform shelter survey, and do a shelter retrofit report (looking at in the light of 4496). $2.3 million appropriated in 1998. Approximately $23 million available for shuttering, wall reinforcement, etc., this year.

New school facilities are being constructed as hurricane shelters throughout the state.

In previous shelter surveys, local official’s looked only at “mass care” appropriateness. Some counties want to use the older buildings because of “damage” related to the shelter function (i.e., the school board would rather have an old gym floor damaged by shoe scuffs, than to have a new gym floor scuffed up. However, the newer ones are generally more structurally resistant to severe wind storm effects.

Existing shelter capacities had been based on footprint area.

D. Overview of FL’s Shelter Selection Process

Many criterions used publications (i.e. after Andrew), ASCE 7
Take prescriptions and model it
FEMA criteria originally generated a 1-5 “vulnerability” ranking. Florida needed another format that was easier to use and matched field conditions.
Emphasize least risk decision-making. There is no perfect shelter. We need to remove the ambiguities and conform to ARC 4496.

Attachment H – damage mechanism matched to prescription methods.

Survivability – damage acceptable, but shelter area envelop had to remain in tact to protect occupants.

DOE – public shelter design criteria – Danny worked with Dr. Shanker.
Went back to 4496, FEMA TR-84 and FEMA TR83-B to come up with State’s hurricane shelter selection criteria.
Planning assumptions stated (see presentation slides)

Least Risk Decision Making LRDM Table – 15 criteria checklist – used 4496 terms
Terms used in 4496 and how State defines them:

High Winds – p 1 in yellow book – Danny asked if it was an appropriate definition of high winds. Dr. Sparks – trees fall at surprisingly low wind speeds. – one thing we’ve learned from 4496 – serious structural damage at 100 mph. Saffir Simpson scale – written in terms of gusts and hurricane center picked it up as sustained winds. Things happen all around the world at the same speed. We tend to overestimate wind conditions, particularly inland. Watch out for trees coming down – earlier than we originally thought.

Danny – Unreinforced Masonry Definition - criteria based on seeing the pattern of unreinforced masonry failures.

Dr. Cook – If we’re going to put 100 miles from the coast – might as well say the whole state of FL. Danny – Vulnerability to high wind effects extends inland 100 miles; per FEMA document 361, Air Force Document ETL 97-10, etc.

Dr. Sparks – HUGO – once you got a very short distance from the coast if you were in that part of the storm – it really didn’t change for 100 miles inland. For a large storms moving fast across a state, especially in FL – it really doesn’t make much difference.

Mr. Porter – We learned that the state of Florida doesn’t slow anything down.

Danny – Storms with high winds generate windborne debris. Dade Co. standards – 9 lbs 2x4 wood stud @ 34 mph. Dr. McDonald – 15 lbs wood stud used for tornado-type debris impact effects.

Dr. Shanker – Category 2 and up destroys mobile homes, etc.

Mr. Porter – Agreement – Cat 2 requires mobile homes to be evacuated.

Eve – Practical matter – w/in 100 miles of coastline – a non-technical person would say – why bother? Definition of high wind – Dr. Cook says say the entire state of Florida – subject to high winds. ARC 4496 concerned with safety of hurricane shelters in high wind conditions.

Long or Open Span Roof – reviewed preferred criteria. FEMA TR-84. Both "Wind-rite" and damage bands has a few options. Roof span could be up to 70
feet. Dr. McDonald – when shorter spans fail they tend to blow off the facilities. Longer span structures tend to fail by falling into shelter space below. Danny – when we went to Dr Shanker – 40 feet were the preferred systems. Long Span was roof spans greater than 40 feet.

Danny -- 40-70 foot range – structural engineer can send a letter stating it conforms to ASCE 7, Category III Importance Factor. Certification serves as a mitigating factor. ARC 4496 language does not preclude use of ASCE 7 certified long span roof systems.

Unreinforced Masonry – Florida does accept the pilaster option. Well over half of the shelters in So FL use pilasters masonry reinforcement. Historically they have performed fine as long as the spacings don’t get too far apart. Dr. Cook – He doesn’t see why we are allowing 8 feet for partially reinforced cell masonry and 13.5 feet on pilaster reinforced masonry. Seems like they should be the same. Questions about pilasters and spacings. Pilasters act like reinforced cell masonry. Why diff. Requirement? Per NCMA TEK 37, for an 8” masonry wall – 13.5 was the minimum – if you exceed it you must bring in a structural engineer. Engineers stated this seems to be appropriate. Some of this is based on history. You won’t find pilasters on 8’ centers. Danny – prescribed this to maximize the number of buildings across the state. Pilasters – much stiffer vertical element than single rebar in vertical cell.

Dr. Sparks – No comments there on anchorage to the roof. Cantilevers. Load path verification.

Mr. Hamrick – question about no horizontal limitation. Danny – Horizontal reinforcement is normally present if adequate vertical spacings are present. Danny asked about reservations about extra spacing of the pilasters. Dr. Smith – Not a stiffened area where it is actually thicker. Dr. Sparks – So FL system – Is this a concrete frame? Dr. Cook – So FL system – Pilaster does not have exact same thickness in the wall.

Danny – Majority of pilasters are embedded. Not thicker.

Dr. Sparks – Suggested we call it “tie-column” like they use in South Carolina.

Group felt this needs to be clarified. Embedded pilaster should be considered a “tie column”.

Dr. Sparks – NCMA accepts this and understands it.
Mr. Porter – As a layperson, he agrees with the Dr.’s statements – need to clarify. If it doesn’t give structural integrity, use 8 feet on center only.

Dr. Sparks - Is it a series of beams going the other way? How would it actually perform? Local reinforcement and looking at a width. Most systems in South Florida have a tie column – maybe you get better plate action. Danny - in all cases a wall bearing structure – 4 #5 rebar in the bond beam. Dr. Sparks - would be delighted with an element of steel in the walls in South Carolina. This system may have saved hundreds of lives in Hurricane Andrew.

E. Least Risk decision-making

Dr. Shanker – Best option use technical analysis used by NCMA. Perform technical analysis.

Dr. Smith - sketch a picture. Danny - What you will have is a #4 or larger rebar spaced at 13.5’ on center – what NCMA TEK 37 calls for. What you will have is 4 rebars tied down to the foundation and into a bond beam at the top of the wall. This provides a definable load-path. Plywood formwork inside and out with blocks on each side. Horizontal reinforcement or dove-tail anchors tie the pilaster to the surrounding wall. Used the word pilaster because the term is used frequently on construction blueprints (i.e., consistency with field conditions).

Danny - By the mid-90’s the vast majority of masonry buildings are fully reinforced systems.

Dr. Sparks -- ARC 4496 says to avoid unreinforced masonry. These pilaster systems are unreinforced masonry. You do not have enough steel in the wall to behave like a reinforced structure. However, even unreinforced masonry walls may work well if you can keep the roof in place.

Dr. McDonald - Seen examples in the field where pilasters do not hold up do to lack of rebar placement or continuity at connections. Danny - we have a rebar detector to check that there is rebar in the wall. It is not fool proof.

Mr. Hamrick – What makes 13.5 feet so magical? Danny - Came from NCMA TEK 37- 25lbs per square foot – 13.5 was a minimum spacing requirement. If you exceed that you need to bring in a structural engineer.

Dr. Sparks - Why the 25 psf number? Danny - Previous building code requirement. These are not partially enclosed structure. Dr. Sparks -- You cannot have it pressurized from within.
Dr. Cook – There are many times when contractors poured in the wall – the grout does not spread down adequately and you get a void. The walls reinforcement system needs to be drilled to check for voids. Danny – when you add those steps you’re adding time and costs. The pilasters interior and/or exterior is usually an unfinished surface. Not true for block walls.

Mr. Hamrick – School boards get very upset when you drill holes in their walls.

Dr. Cook -- Many buildings got built without knockouts to confirm that grout was continuous to the foundation.

Danny – You will not find knockouts in the majority of the walls (maybe only 2%). Keep in mind that we are going in to do an observational analysis, not going behind them to do threshold inspections. If we can’t see it we can’t go in and perform destructive analysis – the price, etc. goes up.

**Partially Reinforced Masonry** – ARC 4496 says avoid unreinforced masonry. Technically, partially reinforced masonry is considered an unreinforced masonry system.

Dr. Cook – In the new ACI 530 this criterion is different. Danny – at 8 ft on center – buildings in Hurricane Andrew that were constructed of partially reinforced masonry performed adequately as long as structures were built properly. There’s very little redundancy. In the standards ACI 530 there is nothing called partially reinforced masonry. Danny – should we remove this – think about it and provide some written comment. The ramification is that an entire class of buildings will be deemed to not meet ARC 4496, this will have a dramatic negative impact upon what shelter space we do have in our inventory.

Dean Griffin – What should we do? Danny – we may need to change definition. Per FEMA 361, if less than 6’ on center the uplift of the walls is greatly reduced. We may have to make the “partially” reinforced masonry more restrictive.

Dr. Shanker – FL FVCCI (Concrete Association) – Published some new documents that should be looked at – tie-column, tie beam.

Drawing – Danny – Q: In SE and West FL areas – 10’ on center is called “partially” reinforced masonry on blueprints. Tie beams at the top. Greenhorne & O’Mara, Inc (G&O) stated that 8’ on center fails at 100 mph fastest mile design. – Structural engineers are reluctant or unwilling to certify this system. You could not construct this bldg today based on 100 mph wind speed. These are really on the edge whether these things should be used as hurricane shelters.
Dr. Sparks – Failure analysis is different than an engineering analysis – also need to look at the correct exposure. Danny -- We look at exposure in the 15 criteria ranking table. We can expect this system to perform fine even though we’re accepting some risk.

We are trying to come up with a system that uses historical evidence that they will perform adequately.

Dr. Sparks – When ARC 4496 was prepared there was a deliberate attempt to exclude unreinforced masonry. Danny – there is evidence that this system should perform adequately as a hurricane shelter.

**Infill Masonry** – 4” block and 4” brick. Terminology confused Dr. Cook. Composite masonry – a different topic. Seem like you could put the same rules as the tie-beam tie-column. Ties assume they are acting like a composite - needs to be grounded.

Dr. Sparks – We need to be careful about this (i.e. gymnasium in Hurricane Elena). Danny - you can go farther apart with a thicker wall. Danny asked if we should keep it at the same prescription as we currently have or space it out a little more due to increase in wall thickness, per NCMA TEK 48 and URM Table from ETL 97-10(i.e., 9” or 10” for a 4” brick&4” CMU wall instead of 8”).

URM Wall calculations – data includes downward loads but not uplift loads on wall. You can go a little further apart. Chart prepared by G&O and available to us. Go from 8’ to 11.5’ on center. But your height is limited. You have to tie into the top beam.

**Reinforced Masonry** – ARC 4496 recommends reinforced masonry. Danny asked for comments. Dr. Sparks has stated that some of these definitions have changed a little – ACI 530. Seismic C still calls for 48” on center. (Today as much as 24” on center.) Dr. Sparks will look up. The 2/10 ths % has gone away (though it is still published in ACI 530). Danny - We focus on the 48” on center. The definition comes out of FEMA TR-84, which is consistent with a number of other publications. Sounds correct to everyone.

**Flat Roof** – criteria says to avoid flat roofs. This poses many restrictions. Look at some other considerations. Dr. McDonald – does not see any reasons to summarily cut out flat roof buildings. Danny – We have provisions for flat roof systems. Florida’s criteria already allows for mitigating factors, otherwise there would have been an even greater reduction in hurricane shelter capacity than we are currently seeing. Dr. Sparks – avoid them if possible.
Lightweight Roof -- There wasn’t any definition in ARC 4496. Almost intended to go more toward materials. Fairly lightweight systems like plywood and metal decks. If survey purposes, used 25 lbs per square foot dead weight. (Not heavier than the local building code wind uplift requirements.) Moderate roofs do not seem to do a whole lot better. Handled basically the same way.

Heavy Concrete Roof – 50 lbs per square foot. Performed well in Hurricane Andrew. Dr. Shanker -- FEMA comes in – uniform pressure – impact load – is it a concern? Danny – reinforced concrete decks considered adequate to resist the missile. Dr. Cook – did some testing on the 8” hollow CMU walls. The 6” did not do so well. 15lb missile will penetrate into the bldg but will stay embedded in the wall at 34 mph. The 9-pound had passed – considered adequate by the DOE criteria.

Overview of FL’s Shelter Selection Process – Procedure used as a screening mechanism for selecting areas of buildings that meet ARC 4496, and for mitigation purposes. W/in the limits of the prescriptions, we should come out with a similar evaluation as a structural engineer. Anything exceeding – you must bring in a Structural Engineer.

Dr. Sparks – Any tests on schools after Hurricane Andrew? Danny – all that data is embedded back into these prescriptions. Rudimentary modeling procedure.

F. Least-Risk Decision Making Table

Looked at ARC4496. Preferred – outside Category IV.

Dr. Sparks – recommend we look at probability of Categories of storms in different part of the state. It seems odd to pick criteria where in some parts of FL it is highly unlikely. Danny – the ARC wanted to avoid Cat 5 Storm surge areas everywhere. Cat 5 was chosen for safety reasons keeping surge in mind and eliminating risk. Dr. Sparks – remember it’s only going to get your feet wet. There are situations where you are going to accept some risk. Danny – the majority of FL is outside the Cat 5 storm surge. Dr. Sparks – SC survey wasn’t right. If the people walked ½ mile inland to Route 17 they wouldn’t have even gotten their feet wet. In any individual storm event, Cat 5 storm surge might not affect anyone and the inundation profile would be different. How can you determine it though? To reduce risk dramatically – keep them out of there – given surge is the biggest killer. SW Florida – most affected by this. Exception process in place and we picked up some shelters – looking at storm direction (exiting or paralleling).

Surge – 2 feet of water has been quite a discussion item. Electrical Breakers shut off and are triggered pretty quickly. One recommendation is that we drop it down to 1 foot instead of 2 feet of inundation potential. Actually the error rate of SLOSH is significant. In preferred we’ve mostly eliminated the risk. In marginal we accept some risk but there are mitigation implications.
**Rainfall Flooding** – we define access route as a paved road going from your building to a major highway or airport. Need to look at the downstream profile as well.

Mr. Porter – asked Luis Garcia – working with local ARC – EM wants to use top floor – ARC says that they have to go to NHQ to use that top floor – is this true? If it meets 4496 it does not need an exception. Clarification – does the shelter floor meet the criteria? Special criteria have to be there. Need to take a look at other issues. Dave Bujak – ARC rumor – ARC doesn’t do second floor or above. If it meets 4496 there isn’t an issue. If there is water on the first floor – then we need to look at other issues and it may need to go through the exception process. A multi-story building opens the options up. Clarification is needed in the ARC 4496 about multi-story buildings, the exception process, etc. In multi-story buildings, the wind effects may go up appreciably as you go up in elevation.

If a local community wants to pay for a more detailed analysis by a structural engineer – they are free to do so.

**Documents Available:**
Implementations Workshop: All statements by participants are not completely accurate.
Procedures
LRDM Table – Prescriptions

Michael Conrad/Facilitator– What is our purpose? To make sure that the Appendix D and Criterion 1 and 2 meet the purpose for which we are coming together. Are these criteria going to meet the intent of ARC 4496? We’re asking you to reflect critically on these two criteria – are these acceptable to you and if not what do we need to do to get them to the level to meet the intent.

You would only want to deviate from the criteria if you were short of space. Then you have to look at what is the risk (i.e. getting caught in their cars?) In the Caribbean they sit in their cars. Have we started this idea and developed a process to get everyone out – then continued to permit additional population growth into these areas. If you have chosen to live there – there are places you can go to. If the problem is you don’t have enough space for people within a reasonable area – then you may have to let these things slip. From an engineering standpoint – there’s a low possibility of it happening. Florida’s criteria meets the intent – to minimize the risk. David Bujak – What amount velocity surge threatens the survivability of the buildings? In Mexico there were some buildings that were damaged by surge velocity effects. It does seem strange watching you move frail people out of reinforced concrete buildings
inland – how sensible is this when you can just move them to inside halls? If you’re going to move them move them to a non-risk place. Big unknown about the foundations of buildings we want to shelter vertically in. And every one’s trying to do it on a shoestring. Big concern about vertical evacuation is what happens to the first floor. We don’t want to be in the v-zone on the assumption that the walls might fall down. The group feels that the basic criterion that Florida has laid out meets the intent of ARC 4496. Question about dry feet and ARC policy issue (2 feet). Dr. Sparks – if you’re worried about 2 feet and slosh model – you’re probably not going to get wet. 20% error rate in SLOSH could get water higher. The chance of a category 5 event is very limited. Being an adult up to your shoulders is survivable – but not for a 3 year old child. And this criterion does not buy us that much more shelter space. SW FL is the only exception.

Wind Hazards -
Lay-down hazards – 4496 only discusses lay-down hazards at regress routes, not for the structures themselves. This area has a certain amount of subjectivity. The towers are often so light that they would not have a great structural impact on the buildings. Some are designed to even snap and fold at the middle. But you have to check on this.

4.P.b – ARC 4496 recommends one access route not tree-lined. Some schools actually removed some trees on an access route. DOE Public Shelter Design Criteria will match much of what we have in our preferred category.

Pine trees start snapping at anything over 40-50 mph.

Establishing the Environment Around a Building

Dr. McDonald – generally – any breach of a building could affect the structural integrity of the entire sheltering facility.

“Windrite” recommends a 300-foot radius for windborne debris sources.

Michael Conrad - #4&5 – Power Lines – poles would be considered in the same category as trees. No one could think of a case where a power pole caused a problem. Cars parked away from schools.

Dr. Sparks asked if there was any information about trees falling on masonry buildings. Where he had seen damage (studies at Clemson) is on wooden buildings.

Schools allow roofing tiles and we do not do anything to say they can’t. We just need to make sure that we resist penetration by the tiles. Slips into marginal.
With marginal we are accepting some additional risks. But preferred and marginal are both considered suitable; marginal may require some additional measures to reduce risk, where preferred indicates no additional measures required.

Mr. Hamrick – Raised issue of parking lots. Danny stated this is a planning issue. If you’re not within 50 feet from the building, it doesn’t matter where you park.

Shelter exposure – preferred – Category A&B exposures and FEMA TR-84. Limited exposure – fields near building that would allow wind velocity to increase.

Dr. Shanker – would like to see more explanation about parking lots, cars, and trees. Rollover implies cars that are parked nearby. More commentary is provided in the Blue Book (student manual).

Dr. Smith – Shelter exposure – you could actually have some trees etc w/in the 300’ radius. The best possible circumstance is to have a sheltered environment around the cleared 300’ radius.

Mr. Porter -- Suggestion that we first need a building that meets ASCE 7, then go to look for other debris, etc. If we’re trying to build a matrix to use buildings – lets start with the priorities. For example – ASCE 7 certification needs to be completed before looking at lay-down/debris hazards.

The order of priority is:

Surge
Wind
Hazmat

One of the things that came up when we were developing the criteria dberis impact resistance (i.e. tiles). Plywood is being eliminated. Dr. McDonald is agreeing with the way it is.

Damage to building but not sufficient to cause pressurization within the structure itself is acceptable. During course instruction, and within the manual it is clarified.

6.P.a - Wind Hazards

Dr. Cook – recommends in marginal building item that we scratch the second item. The purpose of the ranking – if the buildings are built before 1960 there was little based on wind design. We’re trying to show improvements in the
codes over the years. FEMA TR-84 does this sort of “ranking”. There are marginally engineered buildings out there with apparent problems in design and construction. These would not be designed in today’s standards. Some of the apparent design flaws are actually code flaws. This is exactly why the rating system is there. Pre-1960 wind loading was not a very high priority. We’re trying to aim mitigation dollars at the 80’s and 90’s buildings. Miami – Dade has pilasters. The newer buildings can take a whole lot more wind effects.

Dr. Sparks – Difference between a category of hurricane and time – 1-4 minutes. Compare the speed with what we would now require in this area. Generally the old Standard Building code is very conservative. Need to separate a design wind speed, and what is locally acceptable. We need not tie it to category 1. It might be in the current edition of ASCE 7. When you specify a number it always has to have a modifier.

Michael Conrad-open discussion
Dr. Sparks Discussing #6 (Wind Hazards). More specific ASCE 7. The preferred bldg structural system and the envelope should be designed to meet the criterion. It includes the envelope.

Rick Dixon stated Shingle system do not meet ASCE 7 so there is a disconnect.

Dr. Sparks – there are buildings out there that did not fail to meet the code because they contained elements of the structure that were prescribed.

Distinction between the preferred and the marginal – a model building code. You may want to word this in the marginal as well. Dr. McDonald and Dr. Sparks could come up with a date for the standard building code prior to ’87. A building built in the 60’s and 70’s might meet the criteria. It is a question of dealing with the gray area. Need to include verbage about check the locally established building code.

1985 – 1986 is when the wind design pressures went up. In the 70’s we never assume that there is reinforced masonry without checking. There was a very clear change from ’86 to the early 90’s. In 1994 everything after that is generally reinforced. There is a very clear pattern.

Dr. Sparks – There was a traditional way of doing things that crept into the code. Dr. Cook – It is really hard to pin down dates.

Components and cladding generally aren’t “designed” to meet ASCE 7. Dr. Sparks -- If you can't show the roofing system and you can't justify it on the basis of ASCE 7 then you should move into the marginal category. Use verbage like: “The envelope or its substrate (see number 9)”.
7.P.a - This type of engineered structured has never had a documented catastrophic failure and includes reinforced masonry structures.

7.P.a. Dr. Cook stated: If this is intended to be code-like language, the verbage needs to be adjusted. Add, “may not”.


7.M.b. Most of the building design community has not complained about the statement of their design being marginal.

7.M.c. Dr. Shanker recommended that their be a bracing material in the walls.

Dr. McDonald -- Would not feel comfortable with a pre-engineered metal building being used as a shelter. The doors, cladding not attached, etc. make the building very vulnerable unless there is something else there. Often it is not properly tied. Does not want to give the impression that a pre-engineered metal building could be a safe shelter. In many of the schools you see a hybrid system. The ones with metal cladding are very vulnerable. “26 is debatable”. A sharp end missile will go through.

Dr. Sparks – As a general rule, we are excluding the use of gymnasiums because of the roof spans. The concern is the purlins and how they are fastened to the deck. When you get into long span structure – you have to look at the other elements in the chain.

ARC 4496 states just avoid the ones built before the mid 80’s.

Dr. Smith – In FL you have to have Structural Engineer stamps for the schools. All have a Structural Engineer and an Architect on the design team.

We've been able to keep skewing the buildings toward the 1990’s – especially for mitigation dollars.

7.R.a. - Requires more analysis

7.R.b. – If there is a break the building should be further reviewed, retrofitted, etc. If we can’t find out we must assume unreinforced – especially before the 1980’s.

7. R.C. – Don’t count on the cladding system. Some buildings have no bracing system at all so no structural load path. The newer buildings have the bracing. The older ones depend on the cladding.
Thoughts about the “7” Criteria:

Dr. Cook stated: The main wind systems should be included in the definition of continuous load path, and should be placed elsewhere – not on the main page. Should be a sub note.

#9: Two sides here: 1. The Loads 2. The Resistance. You almost have to leave it to the professional engineer to design all the parts. You hope he has a continuous load path. Can the untrained person pick up the lack of a load path? Load path does come up a couple more times – should be redundant – as it is a critical component.

Concern about the ARC 4496, which only says before 1980’s these buildings shouldn’t be used. We may need to be more concerned about PEMB’s. The hybrids are safer. Can we further define them? But even the hybrids are looked at as PEMB’s. We need a way to differentiate. Further mitigation is warranted. One of the dangers is the system. The manufacturers supply the components. The contractor will buy the bits. He put them together and makes the system. There may be an engineer’s seal on the truss – but not for the roof, etc. Often no one looks at it all. These are Threshold buildings. The Threshold Inspector looks at the connections. There was a quirk in Dade County – built to the codes, which were actually very low. In Charleston – the walls fell down in Hugo across from EM – because no one ever coordinated. An engineer could design sheer walls and a roof, which could withstand 100 mph, winds. If it’s signed off on by an engineer, you wind up with a bldg with exterior walls and no interior rooms. But the alternative is the gymnasium. They could put in interior halls but they don’t. This varies from place to place. The probability of failure is high in PEMB’s. This is really not a pre-engineered metal building – it really needs to be engineered – it may be a mistake to call some of these a PEMB. We used these terms in order to be consistent with the industry. There is definitely a language problem that needs clarification.

Thoughts about the “8” Criteria:

8.P.a. – No comments

8.M.a. – Many buildings in coastal locations showed salt damage effects on the frames. Schools have a lot of mixture systems on the newer campuses – not uncommon. The D.O.E. criterion, since 1997, designers and school boards have taken the PEMB-type frames and inserted columns to reduce the roof spans.

9.P.a. – Soft-spots is like EIFS that has been added someplace.
9.M.a. - Showed a design by G&O – truss anchorage detail and wall support detail. Put in the anchors in order to resist the uplift force. There are some concerns about partial reinforcements but there are opportunities to mitigate and retrofit.

**Question:** Is a “two-bar” pilaster spaced 10’ feet on center equivalent to partially reinforced masonry?

9.M.e. - Showed Dade County Wall Systems – much of our marginal criteria comes from this. You have to put something with plywood, however. EIFS and gypsum wallboard systems can not meet the impact requirements.

**Michael Conrad: Thoughts about the “9” Criteria:**

Dr. Sparks - you’ve got one system out there – with wind load criteria. Leave structural system to the Structural Engineer - but there’s two layers going on – meets ASCE 7 (preferred system) then what you’ve got is a middle layer that is a little better based on experience. The experience has been these systems work well. Do they all meet the criteria – yes they are all tested. It is prescriptive. A tech looks at it differently than the Structural Engineer.

Marginal is an acceptable performance level.

10.P.a. - Goes back to the DOE shelter criteria. FEMA 361 calls for a missile that is 1600% greater impact energy than Dade County’s testing protocols. Florida’s shelter selection criteria is quite a bit lower. The South Florida building Code will probably disappear in five months but the testing criteria is still recognized. The shutter projects will recognize the ASTM’s.

10.P.b. - Question about outside ambient light for school– Florida statute is 5%. But the local codes don’t require it. There is a disconnect in what the regulations say. Building the standards into new schools or retrofitting old schools is expensive. There’s no maximum allowable. “Safety glass” (ANSI Z97.1) does not perform well.

**Michael: Thoughts about the “10” Criteria:**

Doors are held to the same criteria as windows. There are very few plywood systems. It is in there because there are still a few. Dixon – OSB has a standard. Criteria is the same for all counties when it comes to the preferred system – SSTD 12.
January 31, 2001

Danny kicked off the second day.

A duality exists in both the state’s shelter selection and the ARC 4496, particularly when you talk about the impact. There is a certification option and then a recommendation of specific materials.

Dr. Sparks - ASCE is rather conservative near the coast.

ARC 4496 used the term “avoid” but the locals did not find it satisfactory. The state used non-compliant, then we settled on “Needs Further Investigation/Mitigation”.

Wind Hazards cont.

Roofs

11.P.a. - Concrete fill on top of a metal deck is medium weight. 25+ lbs. Dr. Shanker: 4” concrete meets debris impact requirements. There might be a layered system that NEPE will certify.

11.M.a. - We’re not eliminating flat slope stuff.

11.M.b.- If you can find a building located in the middle of a complex it is preferable. Our preference is to go to ASCE 7 certification.

11.R.c. - This must be around the 5%.

If the roof’s weather membrane is pulled back it does not harm the people in the shelter.

Dr. Cook – re: gable roof system – has seen a lot of problems with the ones that go up to the ceiling level. The balloon-framing top to bottom is not included here and needs to be. Danny – the steel roof systems are usually not a problem. It’s when you get into smaller structures with less engineering detail (i.e. community centers, etc.) This is more of a problem with gable ends in the marginally engineered structures.

Most preferred structures have a bond beam running around the perimeter of the building.

12.P.a. - Long Span Situation. ARC 4496 says avoid Long Span. This is described with a variety of lengths.
12.M.a. - We’re getting some uplift reduction because of the slope of the roof.

12.M.c. - 60 foot or greater is the point where we like to look for that ASCE 7 certification.

**Question** - Are purlin spacings more critical than beam/girder spans? Should techs be looking for this span, and what should the length of the purlins be? Dr. Sparks – it turns out that framing systems are over designed. The cladding system is relatively stiff - the loads go out to the sides - shed to the end. The framing systems have been pretty well analyzed. It’s the bits and pieces that are added on that make them vulnerable. Dr. McDonald – the uplift can lead to loss of roof.

Danny requested the working group to put their comments down. At what point do we need a structural engineer to do an analysis? What analysis can we do that will assure an acceptable level of safety?

Dr. Sparks – Is there any kind of guidance about windows being protected? Are windows covered in site preparation plans?

12.R.a. - Several have said even with this certification, should these buildings be used at all. DOE criteria - 40 mph increase in base wind speed. The intent is that if you’re between 40-60’ that ASCE 7 certification is an acceptable mitigating factor- beyond 60’ the 40 mph increase should be applied.

Dr. Sparks – If there is a failure, the potential for people injured is great.

A 60’ span or greater needs a Structural Engineer to take a look at it. It precludes local governments from going to buildings with long span roofs as shelters. It is very expensive to have a Structural Engineer come in to do a complete analysis. If a Structural Engineer certifies a shelter, we don’t go back and reevaluate it.

Engineers building EHPA’s wanted to go to 20 gage because of the redundant strength, but went to 22 gage due to cost factors and school board requests (i.e., value engineering).

The verbage in this section needs to be clarified. For training and planning purposes, Danny requested any videos of long span roofs being affected by high winds.

13.R.a. - Dr. Sparks – FEMA produced a video after Hurricane Andrew recommending parapets be removed from buildings due to potential for collapse.
Danny - ASCE 7-98 says a 3’ high parapet wall can reduce the pressure in zone 3. Roofs can collect rainwater because of ponding problems, and may present a very dangerous situation. When there is a question about possible ponding problem because of a parapet, a specialist should be brought in to analyze it.

Dr. McDonald - Make sure techs know the difference between primary drains and scuppers.

**Michael Conrad - Thoughts about the “11-13” Criteria:** Discussion on Roofs. Are these criteria appropriate to each of the categories involved? Is there anything that is missing?

On 12: (Dr. Shanker) Medium to steep needs to be clarified: “10-30 degrees”.

On 11:
* 30 degrees or greater: add verbage “in all directions”.
* Add “Balloon framing” as well.

On 13:
* ¼” per foot is desirable (1/8th is acceptable)

G. **Interior Safe Spaces**

**14.P.a.** - Trying to create an interior pod. Dr. McDonald - Do you find many of these - answer - yes. In recent school construction it is an area for children to go to during a tornado. Typical interior partition loading requirements are 5 PSF (compared to 25 to 30 psf for exterior walls). The entire interior structure must remain intact in a preferred circumstance. It is actually like an independent structure. Dr. McDonald - what is the purpose of requiring reinforced masonry on the inside if the building as a whole is good? Dr. Cook - There is confusion on the rating system in the first column. If you have the rest of the building protected then why are you worried about the inside? Danny - We could clarify this in each of the blocks and put the non-applicable statement in all three columns, instead of only the further investigation/mitigation column. It is only placed in the third column because that is where the most confusion usually is found (i.e., previous ARC statements to not staff shelters with a “non-compliant” criteria.)

#5 – Are you requiring impact resistant doors? Answer – yes to meet the preferred criteria. Wood doors would not pass. 16 gage doors would pass.

Compliant is both preferred and marginal.

Luis requested a discussion on using interior space on the second floor. Dr. Sparks - if you have 2 stories and you can retreat to the first story – it is preferable. If you have the appropriate footing inside the building, the second
floor could be used. You can base your shelter capacity on all of the floors. Danny – for long span roof structures, lower areas might be usable as well as the interior corridors on the second or third floors. Regarding high winds – if the bldg is fully compliant it is OK to use second and potentially third floors. Is there a limit? The taller the building, the more engineering attention it gets. We need to look out for the envelope components – Saga Bay event. The roof structures may not be as strong as it should be so you may not want to use the top floors. The two-story apartments of wood construction often lose the top floor. The break point seems to be based on the fire regulations. The higher up the condos on the beach are – are probably very useable. Luis – we would still avoid the beachfront types; look at the Cat 5 storm surge areas. A lot of hotels are elevated including the lobbies. These are probably some of the best structures. Dr. Cook – if you’re in a big city – don’t go home – go to your office. One of the dangers – the higher up you go the greater the wind pressure is. What point should you stop going up? Danny has been saying not above 60’ – is this a realistic number to use? That 60’ was based on the building of metal buildings. So – you can use any number of stories? If things go wrong – you are that much more exposed. There are exceptions. PBSJ – most of the condos on the beach are concrete on slabs. The structures do fine but the EIFS exterior cladding failed. There was an extra layer of plywood. The EIFS came off causing the biggest damage. The hallways with the fire rated doors on the end were fine. The AC unites were gone. Biggest concern is the smaller and cheaper hotels (slab on grade, masonry walls with concrete decking).

14.M.a. - You don’t have an independent roof deck. The doors and windows have got to be impact resistant. Once you loose your roof deck they just pile down. Showed picture of FEMA 361: Unreinforced Interior Masonry Failure.


15.M.a. - ARC does not want to staff the facility if the building does not meet the fire and safety codes understandably. Mr. Hamrick – Lee Co. is spending millions of dollars to bring their schools up to fire standards. If a school district has done what they are supposed to do and corrected problems along the way – this wouldn’t be a concern. Q- how much does it cost to build a building to fire and safety codes as well as ASCE 7?

Michael Conrad- Thoughts about the “14 & 15” Criteria:

ARC takes care of mass care and sanitation.

H. Criteria 3 - Hazardous Materials
3.P.a. - Is there a minimum amount of materials. There’s no easy way to
prescript that out. Ask the question: are there reportable materials? Use MSDS
sheets.

3.P.b. - Is that hazardous materials facility a problem during a hurricane event?

3.M.a. - There is adequate protection of the materials. You can put in place
methods to protect facility.
3.M.b. - There is some consideration by ARC to except some shelters within the
EPZ.

3.R.b. - You can’t secure the facility.

3.R.c. - Not applicable within the State of Florida.

Michael - Thoughts about the “3” Criteria:
The nuclear power plant areas would not be used.

Mass Care Issues
Reviewed the surveys in the blue books.

How do you determine if a water system is survivable? We look for redundancy.
We may plan for potable water.

I. Field Application of Florida’s Hurricane Shelter Selection Criteria

The person doing the survey puts notes together in the field as well as finalizes
the report and analysis in an office environment. Generally the surveys error on
the side of conservatism.

Example: Cherry Elementary School, Panama City, Florida.

There are no pilasters on the interior.

Q - How did you judge the overhang?
A - Will come in as needing further investigation.

Several Structural Engineers feel that a building built with a sill course shouldn’t
even be used as a shelter. The code allows for a sill course construction. There
is a concern with even 4’ on center rebar spacing. Instead of using pilasters,
they can use 4’ on center and use a sill-course bondbeam. There should be a
full bond beam on top of the wall – more redundant strength associated with it.
Recommendations from the group about usability of this shelter: they wouldn’t use it.

Comment on how valuable the work Danny and DEM is doing.

It takes surveyors roughly 8 hours to survey a facility using local resources. A high school would take a couple days. If a survey of a building shows up marginal it will take longer.

We are not a regulatory agency and do not question a survey if it is stamped by a Structural Engineer. If it meets the 1985 standard of the Building Code we would accept it.

We looked at Sexton Elementary School in St. Petersburg and their problems with soft spots caused by GWB (gypsum wall board) above the windows. Mitigation was a possibility but not done.

Q - Do we do a failure analysis during the retrofit process?  
A – We are not aware of this being done.

We assume Category 4 type damage and analyze from that premise.

Comment about what we’re calling the storms.

The engineered structures did very well in Hurricane Andrew. Those not built well failed.

If there is a shelter deficit the new schools must be built with sheltering in mind (EHPA).

By statute a government building can be used for sheltering if requested by local Emergency Management.

20 square feet per person is the standard for hurricane sheltering. Most facilities are 8-hour facilities.

J.  **Steve Porter, Hillsborough county EM, Representing FEPA**

Dollars were granted for retrofitting East Bay high School 5 years ago, which was a building that was not worth retrofitting. After 20 years of being a shelter in south Hillsborough County, this year it is off the shelter list. Sat down with the Red Cross, School Board and took the criteria with the 2000 retrofit program and are working backward from the newest schools. Requested dollars to retrofit 20 schools. They will lose shelter space after PBS&J gets done, but they are gaining
22,000 spaces by retrofitting and choosing buildings that have a chance of surviving the wind loads. They will mitigate via diking, covering windows, covering doors, etc. Schools built in the mid 80’s will probably not be suitable. Due to growth, many schools are being built in Hillsborough County. Schools on the drawing board prior to the EHPA standards do not have to meet shelter selection standards.

There are alternate funding sources besides the Hazard Mitigation Grant Funds. CBDG funds are available for low-income areas.

The School Board is chartered with building schools, State Statutes call for them to be built suitable for sheltering. They have to build to code.

People are directed to shelters in a variety of ways. Statewide shelter database, signs on the interstate, RPC’s etc.

Anywhere from 3-15% of an evacuating population will seek public shelters. The 25% figure is a fallacy based on experience.

We are advising people to have their own disaster plans. Evacuees are reminded to go to friends and family first, hotels/motels second. And a shelter as a last resort. People without recency often times have complacency about personal disaster preparedness or even evacuation. When people leave late, more enter public shelters.

DOT has developed a task force to one way the highways if need be.

We only evacuate residents in mobile homes for wind.

People with Special Needs register with the counties. The counties are responsible for special needs sheltering.

EM and ARC often survey shelters together.
K. **Michael Conrad - Discussion**

Is Florida’s Hurricane Shelter Program Consistent With ARC 4496?

- It goes beyond the scope of what needs to be accomplished in 4496 and that is a good thing.
- It is consistent with it.
- ARC 4496 may not change as a result of Florida’s Hurricane Shelter Program
- By concentrating on the problem of unreinforced masonry it is at least warning people
- ARC 4496 is guidance to non-technical people
- Occasionally we were taking ARC 4496 to literally (i.e. flat roofs)
- EM – ARC 4496 is a good guidance document but using it strictly is not enough – the state’s quantification gives some more answers. And easier to justify decisions
- Doing it jointly btw ARC and EM makes it so much easier and productive.
- Florida’s HSP goes beyond. It makes it easier for EM’s to do accurate shelter surveying.
- Earlier use of ARC 4496 was leading to conservative decisions. The State’s 15 points makes it clearer.
- How are other states using ARC 4496 – it varies. Some are taking advantage of the exception process. This gets into how can we make facilities survivable. It also asks what types of systems will be put in place for safety and preventing loss of life. The basis of the document is still being used.
- Exceptions and flexibility are part of the ARC 4496 process.
- Each state has different statutes and codes that have to come into play when using the ARC 4496.
- All of the states are depending on engineers to get information that a lay person could not give.
- Asked Rick Dixon his perspective. We should rely on the engineer – with a degree of skepticism. From what we have heard from all areas of the state – the engineering design process is not as reliable as we might think.

L. **Question: Does it meet the intent of ARC 4496?**

- It goes beyond the set base as set forth in ARC 4496.
- Why do you want this question answered? Because it came from the shelter implementation workshop. We’ve been looking at modifying this for the last couple of years and reevaluate the criteria.
• If the intent of ARC 4496 is to provide safe shelter space, then Florida’s criteria meets the intent of the 4496.
• This was really critical for DEM for mitigation purposes. This procedure was set up to help guide us.
• Does the state meet the minimum expectations of ARC 4496 – Dr. Sparks: not sure there was a minimum purpose.
• State provides more detail and calls attention to the fact that there are certain types of structures that should not be used. Let people benefit from the experience learned.
• Q to Dr. Sparks (Luis) would it be a good idea to develop a support document that goes along with ARC 4496 with clarifications and points? Dr. Sparks – yes I think it would help – wonders if there is a halfway measure btw ARC 4496 and Florida Criteria.
• Let people benefit from what other people know.
• 15 point survey ensures you have safest shelter possible.
• Much of FEMA 361 assessment form Annex B came from the same sources as FL’s Guidelines. It has a point scale system. FL experience with a scoring system in early 90’s/late 80’s showed it did not work.
• ARC 4496 prepared in 1992, since then there are a few changes. I might be a good idea to revise it. Luis – we will try to make some changes around the beginning of hurricane season. Especially for the exception process.
• Each state having a different situation – but Dr. Sparks really thinks we should use ARC 4496 as a base document, then each state should develop their own companion document based on their uniqueness (codes, building style, statutes etc.)

Does it exceed the intent of ARC 4496?

• Yes – but it is a good thing.
• Has it gone too far?
• Does it meet the needs of Florida?
• Someone might say that what you are asking people to do in the retrofit process is to produce a building above what is required.
• Now all building codes are based on ASCE 7. If that was the goal than many things we are trying to do – then it is not going beyond it.
• The fact that there is a large # of buildings that do not meet – is not the fault of either ARC 4496 or Florida’s criteria.
• We are not asking people to do something beyond what ASCE 7 asks.
• Dr. Sparks – What disturbs him a bit is there may still be an accident in the long span systems, i.e. dead weight works fine as long as there is no internal pressure. Buildings have gotten into trouble because of the breach in the envelope.
The building codes in ASCE 7 are rather conservative regarding the envelope and the internal pressure. Concerned about protecting the openings. This has to be stressed to the counties. That's why we have the shuttering initiatives. Protection of the envelope / soft spots are critical. Doors are usually fine. (3-point hitches or other reinforcing element.) 3-point hitches are very maintenance intensive.

ARC is looking at the exception process for minimal water in a building. Approval will be on a case-by-case situation.

The EM communities in the 67 counties are divided on this question.

ARC 4496 gave them some “room” for interpretation. The 15 Point Survey is more finite and restrictive. However, buildings found to be compliant by a local official was found to be constructed of unreinforced masonry or other problems (i.e., ARC 4496’s perceived “flexibility” was leading to selection of buildings that clearly did not meet the intent of the original publication).

The Florida survey provides a security

There are still people willing to staff shelters that don’t meet the criteria. There is an element of risk.

ARC will train anyone in shelter management.

The planning assumption is that the building will be used. If you are saying a building is a safe sanctuary then you do need to apply higher criteria to the building.

Risk consistent systems – you don’t have this when you apply the standards across the state.

Is the elimination of shelter space warranted in the relative unlikelihood of a breech happening?

Dr. Sparks - We may be designing buildings to withstand a higher category of storm than we think – especially in the inland areas. We are looking at worst-case scenario.

FEMA 361 – All of Florida is considered vulnerable to “high wind” effects, we use the same criteria throughout the state.

Most emergency managers plan and operate with the worst-case scenario in mind.

Does the selection criteria reflect appropriate parameters for survivability?

Pre-engineered classic metal building considered marginal – that construction form has not survived in the last 40 years.

There are many hybrid systems.

The MBMA will assure safety of their buildings. ARC 4496 states avoid stuff pre-1980.

ARC will be looking at this.

Concern about PEMB. Often they don't work well because they aren't assembled properly.
• Should be evacuated very carefully – for shelter. There is a problem with certification.
• Generally speaking the criteria do reflect appropriate parameters for survivability.

Are the qualifications of current hurricane shelter evaluators adequate?

• Lowest common denominator is a building inspector. They can do the prescriptives.
• Most of them have 2-3 years of experience. Some have degrees in engineering.
• They have worked together with engineers, especially if there is a marginal question.
• An engineer already has inspected school buildings.
• The caveat is that you need to do some sort of quality assurance and check for consistency. This way you can make a judgment.
• There is a training program for people who do the inspections.
• Inspectors are able to actively call DEM staff.
• You also might not have to have an engineer check every building – just spot-check them – for prescriptive type analysis, etc.
• Should we eliminate sill beams? They may not work in an existing building.
• Dr. Sparks – Small fear that someone would look at one of these buildings and think it is stronger than it is.
• Training definitely makes a difference in the ability of the inspectors.
• We're accepting some risk but we had to move forward on shelter selection. We started at the least common denominator, gave them prescriptions and training.
• It would be terribly difficult to just use ARC 4496 without the checklist.
• The qualifications for the evaluations are not PE trained, however with the proper training and guidance, QA, spot checks etc., building inspectors should perform adequately.
• PBS&J – long ago Structural Engineers could be the only Threshold Inspector. When a bldg is under construction – they have a rep on site who monitors construction. There is a desire for seasoned professionals.
• PBS&J – They use seasoned inspectors. The engineer responsible for the building inspectors has to have some sort of certification. They look for more than the class currently offered. This is the quality control part. The quality assurance side comes from the engineer who signs off on the reports.
• None of the counties would accept a new building under the conditions we are talking about here. They want quality assurance.
• It is possible to train people in the details – but it might need to be filtered. You can reject a building but you cannot “pass” it. It can then
go to someone who is trained in at least the technician level. Or unless there is a recent engineer’s seal on it.

- There are details that anybody can evaluate (checklist - pass/fail) as you get further along it gets trickier. This is one of the problems with prescriptive requirements.
- ASCE 7 came out in 1988 but is still not being used in recent construction. It did not see widespread use until 1998.
- The building construction inspections are not being conducted, as they should be in high growth areas of the state. The design A&E for schools are not being inspected properly.
- The inspection process goes beyond that. Things happen in construction. When you find a failure the inspections get very lengthy.
- The issue EM has with using the Structural engineer is the cost.
- Some of the inspections are “pending certification”. Some of the counties are willing to pay for the Structural Engineers to inspect the roof systems (uplift requirements in ASCE 7, etc.).
- If we have to put a seal on a marginal building, neither the state nor the locals have the money to do this.
- Dr. Sparks - Through Florida’s shelter survey program, you have rejected the shelters that are grossly inadequate, and this is a remarkable achievement by itself.
- As we get more sophisticated, without doing a very thorough inspection with an engineer, then we will err on the side of safety.
- People who take training can be retrained. Local EM’s can recommend retraining. Florida’s course is certified by Fire Safety Board, Construction Industry Licensing Board, Architects Board, etc. Persons taking the course get their professional contact hours.

M. Danny Kilcollins - Discussion of Consensus Process

Summary of Comments will be placed on the DEM’s Shelter Program website (February 2, 2001).

Comment Booklets to be returned to DEM (paper or email) (February 12, 2001).


Danny can set up conference calls if there is a need to.

Danny would like a letters from ASCE and ARC NHQ stating that Florida’s process meets the intent of ARC 4496. (Prior to the National Hurricane Conference; April 9, 2001) Dr. Hayes is the ASCE representative/liaison to the American Red Cross.
Implement modifications to Florida’s hurricane shelter survey process and criteria (Spring 2001)

N. Final Remarks

- A school ought to be designed based on the conditions it could face during its lifetime.
- Because of conservatism we should not have to worry about elevation of danger (i.e. Category II to Category IV Hurricane).
- The filter process is very good. Should it be a two-way process?
- This is constantly a least risk decision-making process. And it has been a delicate balance.
- Once you label a building as preferred or marginal it becomes a critical facility and meets the intent of ARC 4496 – not under any other special requirements.