Summary Minutes for the October 21 and 22, 2003 Meeting

International Code Council

Consensus Committee on Storm Shelters

(IS-STM)

Meeting location: Hilton Garden Inn, Tampa FL
Committee Chairperson: Marc Levitan
Committee Vice-Chair: Scott Tezak
Committee Secretary: Dave Bowman

Call to Order –A quorum being present, the meeting was called to order at 8:06 am on Tuesday, October 21. Chair Marc Levitan called the meeting to order. Marc reported that Committee Secretary Dave Bowman would not be attending due to a back injury. He advised that Vice Chair Scott Tezak was not able to make the meeting either. Danny Kilcollins was thanked for arranging the tours Tampa hurricane shelters, which were very informative and useful.

1. Roll Call/ Introductions
   Committee members in attendance:
   - Marc Levitan
   - Robert Wills
   - Majed Dabdoub (departed 10:45 am Oct 22)
   - Lawrence Twisdale (departed 10:00 am Oct 22)
   - Ernst Kiesling (departed 2:00 pm Oct 22)
   - Mitchell Hort
   - Jim Waller
   - Roger Robertson
   - Bob Franke
   - Kurt Roeper
   - Danny Kilcollins (departed 6:00 pm Oct 21)
   - Dennis Graber
   - Jim Messersmith (departed 2:00 pm Oct 22)

   Guests in attendance:
   - John Holmes
   - Corey Schultz, PBA Architects
   - Richard G. Reynolds, R.G. Reynolds Homes (for NAHB)
   - John "Bud" Plisich, FEMA Region IV Mitigation Branch

2. Approval of Agenda – Jim Messersmith moved and Roger Robertson seconded that the agenda be approved as presented. All approved.
3. Approval of minutes of July 22-23, 2003 – minutes were approved modified as follows, moved by Robert Wills and seconded by Majed Dabdoub:
   a. Remove Paul Tertell as committee member not present on p. 1 since he is not a committee member
   b. P. 1 Remove "Paul Tertell as an alternate to Bob Franke, and John Homes as an alternate to Marc Levitan" as this was not yet approved by ICC
   c. P. 3 Add reports for agenda Items 7-10 and reports from Wind Loads and Design Events/Wind Speeds. These were distributed by Chair Levitan at the current meeting.
   d. P.3 Add to item 8 "The Ingress/Egress & Life Safety and Special Occupancy task groups were merged with Danny Kilcollins and Bob Franke as co-chairs"
   e. Inspections TG Report - add to the end of the report a statement as provided by Jim Waller at the current meeting.
4. Discussion/report of any pertinent information from recent storms
   a. Marc Levitan – He and John Holmes traveled to North Carolina and found most of the media reports of significant structural damage to be greatly exaggerated. Primary direct wind damage was minor damage to roof coverings and wall cladding. Storm surge flooding was significant in some areas.

b. Roger Robertson – opened 3 shelters in his county – lost power in two shelters due generator failure. About 340 people were in main shelter. Most damage was from falling trees ($20 million damage) no flooding other than what was expecting in low lying areas. Thirteen people were killed in VA, most from falling trees, 2 from carbon monoxide poisoning.
c. Larry Twisdale – HAZUS model was pretty accurate – estimated that 40% of wind damage to buildings would be damage due to falling trees, caused in part by saturated ground from recent heavy rains. A lot of water damage due to breech of envelope.
d. John "Bud" Plisich - Report on Isabel damage from FEMA available in about 2 weeks.
e. Jim Messersmith – Over 1.8 million people without power resulting in water failure. Over $200 million in disaster relief. Storm surge damage up the rivers rather than on the coast. Time needed for restoration of power was the biggest complaint.

5. Breakout sessions of the Special Occupancy/Life Safety, Design Wind Event, Wind Load, and Debris task groups continued throughout most of the rest of the day, until the entire committee reconvened at 4:30 to discuss item 7 below.
6. The next meeting was scheduled for 8:00 am to 5:00 pm February 11 & 7:30 am to 4:30 pm February 12 in Dallas, Texas. If possible, locate the meeting close to the airport. If possible, secure a second room (can be smaller) for breakout sessions. **Levitan** to bring laptop projector. **ICC meeting coordinator** to make sure wall of room suitable for projection or if not then secure a screen.
7. Meeting adjourned for the day at 5:00 pm
8. Meeting reconvened at 7:35 am on Wednesday, Oct 22
9. TG 7, Flood Multi-Hazard Group Meeting– Bob Franke. This TG met with the entire committee. Franke reviewed TG progress from July meeting. For additional details, see attached TG report.
    a. **Marc Levitan** will distribute HAZMAT information from current shelter selection guidelines to committee at the next meeting. LSU researchers are investigating hazardous materials release scenarios during hurricanes and their public health consequences, but results are a year away. He will report back to the committee next year with any relevant findings.
    b. Discussion was held on private homeowners wanting to install a storm shelter below the 500-year flood plain. Bud Plisich said that this was somewhat of a gray area particularly if the home is existing and the improvement to the home is less than 50% the value of the home. Marc stated that we need to be careful about discouraging a homeowner from building a tornado shelter, even if it will be below the flood plain. Bud Plisich suggested putting something in the commentary about not using these in mandatory evacuation areas and to include ramifications i.e. no federal funding for such installations. Also FEMA will not provide any Federal funding for a shelter located in a flood plain. Bob Franke also pointed out that a shelter does not need to be underground. Larry Twisdale suggested differentiating between shelters designated for wind (tornado and hurricane) resistance and flooding.
    c. Lightning – Ernie Kiesling indicated that some studies had been done at the University of Oklahoma that might be used. Jim Waller said that metal type structures will protect occupants by deflecting the charge around them and conducting to the ground.
    d. Rain – Marc Levitan has a climatologist looking into maximum rains expected during hurricanes. Larry Twisdale – HAZUS has a probabilistic rainfall model but wasn't sure how geographically specific it is. **Larry Twisdale** will send info to Marc Levitan. Discussion on secondary drainage systems in case primary one is blocked by debris. Roger Robertson said that a secondary drainage is required – i.e. drains and scuppers but we may need to address additional requirements. Jim Waller – NSSA standard requires 200 psf live load which would handle 3+ feet of water. Larry Twisdale – need to ensure that shelter remains near watertight after the roof covering is blown off – i.e. reinforced concrete roof. It was decided that the standard would address the structural aspects only and not address the roof covering since it is not a life-safety issue.
    e. **Marc Levitan** will start drafting language on rainfall intensity and rain loads. **Bob Franke** and **Paul Tertell** will start drafting language on flooding.

10. Bud Plisich raised an issue about the need to address how people will know that they have a storm shelter in their home since homeowners typically do not receive plans with their home. This is important to keep homeowners from making modifications that will compromise its effectiveness. Suggestions – plaque, additional inspections, etc. Roger Robertson suggested putting signage inside the breaker panel door regarding the storm shelter similar to what the mobile home industry does. Inspections task group will address.
11. TG 6, Structural Interaction/Separation Group Meeting - Jim Waller. This TG met with the entire committee. Waller reviewed TG progress from July meeting. For additional details, see attached TG report.
    a. Ernie Kiesling indicated that one of his students was performing a finite-element analysis to see if a 4-inch slab will be adequate to prevent overturning. He found that it appears to be adequate to prevent overturning if the structure was a solid grouted 8-inch masonry wall unless it is narrow. They are also looking at lighter structures to see if it will work.
    b. Jim Waller had a request from a Florida homebuilder about utilizing an exterior masonry wall as part of a storm shelter. Ernie Kiesling stated that it is not likely that the forces on the shelter would occur at the same time as the load is applied to the rest of the structure. Dennis Graber indicated that a solid grouted masonry wall would be more than adequate to accommodate any shear that would be imposed by remaining fragments of the house but overturning would need to be looked at.
12. Reports from task group meetings on Oct. 21 (full TG reports are attached)
    a. TG 5, Special Occupancy – Bob Franke
        i. Established designation of 1 for tornado shelter A- residential & B-nonresidential. Hurricane 2 - A- residential & B-nonresidential
        ii. Definition of shelter was prepared – see attached task group minutes
        iii. Discussed planned layout of standard. Are shooting to have something ready for distribution by first week of December.
        iv. Assignments were made to task group members.
    b. New Task Group on Shelter Operations (TG 9)

       Bud Plisich indicated that it would be ideal if the shelters would meet or exceed the FEMA 361 standard and contain an appendix that would address operational considerations. Roger Robertson referred to Dave Bowman's preliminary outline of the standard, which has operations and maintenance included. He felt that type of expertise was not within the makeup of the current committee and that other members would need to added if the intent was to include operational and maintenance provisions. Discussion was held that preparation of an operational manual for storm shelter should be included as part of the designer's scope of work. Bob Franke moved and Kurt Roeper seconded a motion that we create another task group to look at the operation and maintenance issues for a storm shelter. Marc Levitan nominated Danny Kilcollins as chairman, Corey Schultz, Bud Plisich (pending approval from FEMA), Bob Franke, and himself as a task group to look at these items. All approved. The task group will look at other documents such as FEMA or Red Cross that can be referenced. **Bob Franke** and **Bud Plisich** said that they would also talk to **Paul Tertell** about FEMA preparing such a document since most of the information was already in FEMA 361. Bud Plisich asked that the committee keep FEMA informed as to what they will and will not include in the standard so that they can be working on it in the meantime.
    c. TGs 1 and 2, Design Wind Events/Wind Loads – Marc Levitan
        i. Larry Twisdale prepared 1,000, 2,000, 5,000, and 10,000 year return maps for hurricane wind speeds that were distributed to the committee. He said target risk/reliability levels should be determined, and suggested that it should be on the order of 10^{-5} per year (100,000 yr recurrence level)
        ii. The TG will try to work through email and conference calls to develop some recommendations for the next committee meeting as to wind speed maps.
        iii. The task group will also look at load combination requirements for both allowable stress design and strength design.
    d. TG 4, Debris– Ernst Kiesling

i. He distributed a baffle entry design comparison that he had prepared. Will look at doorless baffled entries as well. Roger Robertson indicated that there are egress requirements in IBC Chapter regarding geometry that need to be checked against.
ii. Debris impact criteria. Residential will remain the 100 mph, 15 lb 2 X 4 but for public shelters the task group will look at whether other types of missiles should be included due to the different types of materials used in construction of commercial structures – i.e. bar joists and other steel shapes that are commonly used. **Larry Twisdale** will look at other types of missiles and what speeds should be considered and make recommendations to the task group.
iii. Missile speed in relation to wind speed was also discussed. **John Holmes** will try to look at what type of work may have been done in that area and try to get back to the task group before leaving to go back to Australia on December 20.
iv. **Jim Waller** will rewrite the section in NSSA standard regarding maximum deflection of walls due to missile impacts as a recommended provision for the ICC standard.
v. Critical decisions that are needed – design wind speed and missile impact.
vi. Corey Schultz – need to address standardization on testing procedures. Marc Levitan reported that Dave Bowman had discussed within the ICC hierarchy approaching ASTM about preparing such a standard but their recommendation was to hold up until decision was made on missile requirements.

13. Draft Outline - The draft outline prepared by Dave Bowman was reviewed by the committee
    a. Inspection and repair was included in section 102 Scope. Roger Robertson said this could be handled similar to current requirements for elevators, amusement equipment and back flow preventers where the code requires annual inspection by the building department or inspection and certification by a certified third party. The standard needs to identify which governmental entity is responsible to ensure that the inspection is performed at specified intervals.
    b. Discussion on the requirements for different applications –i.e. tornado vs. hurricane & residential vs. public. It was decided that separate documents be created at the start and then look at combining common requirements into a general section. Designations at the onset will be separated into tornado (1) and hurricane (2) and then further subdivided into residential (A) and 'other than residential' (B). For now, residential will be considered one & two family and may be revised later (i.e. expanded residential might include small businesses).
    c. The standard is envisioned to be in addition to normal code requirements. Items (such as earthquake loads) would be in accordance with the building code and not have special requirements for storm shelters provided that no special provisions are warranted.
    d. Discussion on live load reductions and safety factors. 100 psf was suggested based on other code requirements. The code does not allow live load reductions for 100 psf and over. This item to be taken up by the wind loads task group.
    e. Task groups were asked to discuss applicable items within their group and make modifications as necessary.
14. The committee broke up again at 2:00 pm into task groups that continued to work on developing more detail for the draft outline and identifying specific tasks and target deliverable dates. This continued until the task groups adjourned at 4:30 pm.

Recorded by Dennis Graber and Marc Levitan

Attachments – Task Group Reports

Task Groups 1 and 2 Reports
Design Wind Event and Wind Load Groups
Scott Tezak, Chair
Submitted by Marc Levitan

1. Discussion on design wind speed. Larry Twisdale prepared 1,000, 2,000, 5,000, and 10,000 year return maps for hurricane wind speeds that were distributed to the committee. These were based on a methodology published in ASCE J. Structural Engg.
    a. Due to uncertainties, his best estimate was that the 10,000 year map wind speeds would be +/- 20-30 miles per hour.
    b. Inland wind speeds were extrapolated from data by Peterka and were used to determine the location of the farthest inland hurricane contour.
    c. The crossover between tornado and other design wind events occurs between 1000 and 20,000 years depending on location
    d. Twisdale felt that appropriate risk level would be the order of 10^{-5} to 10^{-6} per year (100,000 to 1,000,000 yr recurrence level). The original nuclear industry standard was 10^{-7}. In some cases now, 10^{-5} is allowed for conservative analyses and 10^{-6} is allowed for realistic analyses. The committee should also consider providing options for multiple levels of protection, and perhaps different risk levels for large vs small (community vs residential?) shelters. HE suggested a possible target reliability for large (community) shelters might be 10^{-5}. He also discussed the concept of voluntary vs. involuntary exposure and mentioned risk studies that had been done in these areas.
    e. Robert Wills suggested that selection of appropriate risk level was also an emergency management and political decision, and perhaps a separate document should be prepared to provide guidance to these decision makers.
    f. Twisdale commented that for the rare events, a 2x4 missile was not appropriate, as the extreme level of damage and wind speeds would move larger and heavier objects through the air, such as steel roof joists. Further discussion on this matteer was postponed to the Debris TG meeting
    g. It was suggested that design events/maps be reported in a "xx% chance of exceedance in yy years" format rather than a mean recurrence internal, as this might prove more acceptable. Jim Messersmith suggested tying into ASCE 7 map but assign different importance factors depending on the use (similar to current table). Tornadoes would have a different map. Levitan said that discussions on presentation format would be more efficient after the decisions were made on appropriate return periods and wind speeds.

Larry Tisdale, **John Homes** and **Scott Tezak** will look appropriate risk levels and how this impacts selection of design wind speeds.

2. Load Combinations
    a. The document should address both ASD and Strength design combinations
    b. ASCE 7 has a method for load combinations for low probability events in the commentary that should be investigated.
3. Prescriptive designs. The general consensus was that prescriptive designs are needed for residential similar to other aspects of the IRC since the sophistication of a residential designer is generally much less than for a commercial building. Jim Waller felt that they should not be included.
4. It was decided that the building should be considered partially enclosed unless it can be demonstrated that the structure will remain in an enclosed condition for the duration of the event. E.g., even if a debris impact resistant door and hardware is present, what is to keep the door from being opened either accidentally (leaning against panic bar) or on purpose (trying to let someone else in, claustrophobia, curiosity). What if missile larger than test missile impacts glazing? Test should be considered as openings and ASCE 7 tests for opening percentages in various walls

should be used to determine if it is still an enclosed structure or not. **Marc Levitan** will work up code language.

5. Directionality factor: It was decided to use 1.0 for tornadoes and consider 1.0 for hurricanes as well. **Marc Levitan** has several references on this and will send to John Homes, Larry Twisdale, Scot Tezak, and Dennis Graber to review. **Marc Levitan** will work up code language.
6. Use Exposure C (or D if applicable) unless it can be demonstrated that a lower exposure will remain during the entire event. Use Exposure C for tornadoes. **Marc Levitan** will work up code language.

Task Group 3 Report
Ingress/Egress/Life Safety
Merged with Special Occupancy, see Group 5 Report

Task Group 4 Report
Debris Task Group
Submitted by Ernst Keisling, Chair

The committee discussed baffled entry systems (alcoves) at some length. We then discussed needed revisions, extensions, or clarifications of provisions of the NSSA Standard concerning debris impact criteria for hurricane; warnings or protection from missile impact forces on shelters; permanent displacements of shelter walls from debris impacts; debris generated inside the shelter from spalling or loosing of parts; reductions in structural integrity resulting from debris impacts; and siting for falling objects.

Baffled (Alcove) Entry Systems

Several examples of possible entry systems were provided for consideration along with a table showing first and second impact response angles and speeds for various coefficients of restitution. The table presented was for a particle missile with no friction assumed. A similar table with friction will be developed by Kiesling.

It was decided that we should consider geometries with and without doors. We should state the criteria for secondary impact surfaces that are not in the line of sight. Larry Twisdale will point us to a publication on missiles other than particles, e.g. boards, impacting and rebounding from surfaces. Kiesling and Carter will pursue this at Texas Tech, including a list of tests performed using various types of missiles.

Design Missile Criteria

Following extensive discussion on appropriate debris impact design criteria, it was concluded that, for residential shelters, we continue with a 15 lb. 2 x 4 board traveling at 100 mph horizontally (67 mph vertically) in zones where the design wind speed for tornadoes is 250 mph. It was felt by some that for community shelters we should consider other types of missiles if we decide to design community shelters for wind speeds above a certain level.

At high wind speeds, even engineered buildings will fail and will generate debris more likely to perforate a shelter than a 2 x 4 board. Larry Twisdale is to guide us to a publication of his that describes a hurricane debris impact model. Further, he will produce a brief white paper on what types of missiles we should consider for community shelters in high wind speed zones and will e-mail it to everyone on the subcommittee.

Considerations of Sections 4.6 of NSSA Standard

4.6.2 No change needed to the NSSA Standard
4.6.3 RE: Permanent displacements of shelter walls from debris…….
James Waller will rewrite to clarify

4.6.4 RE: Potentially dangerous fragments
Propose as written in the NSSA Standard

4.6.5 RE: Threats to structural integrity from missile impacts.
James Waller will reword.

Return to July minutes: RE: Test Procedures/Protocols

It was stated "Test procedures and protocols must be developed for walls, doors, and hardware. ASTM standards will be studied for usefulness in designing test methods."

Russell Carter, Tim Reinhold, and Ernie Kiesling will serve on this subcommittee and will pursue these objectives.

Siting for Falling Objects

It was generally felt that FEMA 361 statement is adequate. Twisdale will review.

Rolling Hazard

It was decided that we should put words in the Commentary that rolling hazards must be considered.

Task Group 5 Report
Special Occupancy Task Group
Bob Franke and Danny Kilcollins, Co-Chairs
Submitted by Bob Franke

Group decided to merge the special occupancy and ingress/egress committees into one group. Bob Franke and Danny Kilcollins will be the co-chairs for the group.

Definition of storm shelter – Kilcollins presented a definition of a storm shelter. Use the first sentence as a basis of the definition, the rest is commentary. Need a definition for tornado and hurricane shelters.

There will be two tracks, a hurricane and a tornado track. Keep separate the residential and non-residential

Duration – 2 hours or less for tornado shelter, 24 hours or less for tornado shelter.

Definition of terms, safe room denotes a residential shelter for less than 12 persons. If larger than 12 persons, then it is a community shelter, which will require maint. & operations plans.

The group needs to consider that there will be two types of shelters, hurricane and tornado. Within the two groups, there will be different uses, such as residential, community, or a private.

Shelter - A building, structure, or portion(s) thereof, constructed in accordance with this standard, designated for use during a severe storm event.

Tornado - Type 1A, residential (1 and 2 family and town homes less than three stories); Type 1B, everything not 1A (use the definition in the I-Code)

Hurricane - Type 2A, residential (1 and 2 family and town homes less than three stories); Type 2B, everything not 2A (use the definition in the I-Code)

Create a crosswalk between FEMA 361, 320, NSSA, and I-Code to see what is the same, and where there are differences. This would be similar to the NFIP I-Code crosswalk.

Motion – Look at the existing guidance (FEMA 361, NSSA, and Florida statue) to provide the definition for shelter types. Motion passed.

If now, this sub-committee will define the elements that are required for the shelters. Will not look at planning considerations for the operation of the shelter.

What sections of the I-Code will apply -

- Chapter 1, Administration (leave to later)
  - Scope
  - Enforcement, who it applies to, role of code official, owner, design professional,
  - If shelter will be constructed, then the shelter shall meet the requirements of the shelter standard.
- Chapter 2, Definition (leave to later)
  - Shelter, Shelter Type 1A, 1B, 2A, 2B
- Chapter 3, Use Group (Majed, with assistance from Roger)
  - Add Item 11 to 302.1 that identifies storm shelter construction
  - Add Section 313
  - Footnote for Table 302.3.2
  - Multiple use, 2-hour separation, and requirements of Section 302.3.2
- Chapter 4, Special Detailed Requirements Based on Use Occupancy
  - None identified at this time
- Chapter 5, General Bldg. Heights and Areas (Majed)
  - Single use structure should have limitations on size and height. Suggestion, if wood, limit to 6000 sq. ft. and one-story (A3 use in Table 503).
- Chapter 6, Types of Construction (Majed)
  - Classify all single use shelters as ???, and shall comply with the code for that type of construction. This would address set backs, adjacentancies.
- Chapter 7, Fire Resistance Rated Construction (Mitch)
  - Fire resistance rating
  - Wall and roof penetrations
  - Fire dampers, rating of openings
- Chapter 8, Interior Finishes (Mitch)
  - Flame spread rating
  - 2 hour
  - Smoke development
  - Similar to assembly classification
- Chapter 9, Fire Protection (Roger)
  - Alarms
  - Suppression
  - Follow code requirements for the normal use of the facility
  - Increase in the number of fire existinquisters based on occupancy (at least 1 per 300 occupants, min of two)
- Chapter 10, Means of Egress (Majed and Roger)
  - Type 1B, based on normal occupant load
  - Type 2B, based on maximum occupant load for normal or shelter use.
  - Location of doors
  - Ingress – half of the egress to be located at the at the main entrance
- Chapter 11, Accessibility
  - Follow existing code, warning times are adequate for movement to shelter
- Chapter 12, Interior Environment
- Chapter 13, Energy Efficiency
- Chapter 14, Exterior Walls
- Chapter 15, Roof Assemblies and

Chapter 16, Structural Design

Chapter 17, Structural Tests and Special Inspection

Chapter 27, Electrical (Mitch)

Lighting
Backup power

Chapter 28, Mechanical Systems (Majed)
Ventilation - Refer to International Mech. Code, chapter 4. 1B based on normal use. 2B based on normal or shelter use, whichever is greater.
Chapter 29, Plumbing Systems (Danny)
1B – all shelter occupants have access to at least two toilets
2B – use Red Cross recommendations
Toilets in excess of code requirements can be chemical
Source of drinking water, bottled water is OK.
Chapter 30, Elevators and Conveying Systems

Chapter 31, Special Construction

Chapter 34, Existing Structures

Will have something by first week of December
Will have a teleconference around the same time

Will try for completion by mid-February.

Use and occupancy –

Space requirements – Use the use factors determined by Florida to account for furniture and other fixed equipment. Suggested values are 85% for open floor plans, 65% for rooms with high density of furniture, and 50% for restrooms and others with a lot of fixed fixtures. These values are based on actual experience from Florida.

Roger will obtain I-code copies for the sub-committee

Discussion of operation & maintenance of shelter to include shelter management, supplies, operational readiness and on-going maintenance of the shelter. Full committee agreed that it should be addressed in some manner, but it may not be consistence with the scope of the committee. It may be included as an appendix, or a paragraph or two in the commentary. Another suggestion was the creation of a separate document, perhaps by FEMA, to cover the shelter operation. A task group was created to look into the issue, and to make recommendations to the full group. Marc, Corey, Danny, Bud.

Task Group 6 Report
Structural Interaction/Separation Group
Submitted by Jim Waller, Chair

This task group met with the entire committee.

I. Structural Interaction between Host Building & Storm Shelter

Discussions relating to Structural Interaction/Separation summarized prior subcommittee discussions and proposed methods of defining acceptable structural connectivity/interaction between storm shelter structures ("shelter structures") and structural components of the surrounding or contiguous host building ("primary structure") in which the shelter is contained or to which the shelter is adjoined. These discussions pertained to the toleration of the storm shelter structure to wind forces on the primary structure under forces from the *primary structure design windstorm* and under forces from the *storm shelter design windstorm*. The purposes for continuity between the shelter structure and primary structure were discussed.

- Architectural requirement for continuity between interior wall and ceiling finishes of the storm shelter and the host structure
- Need for in-residence storm safe rooms to be finished to be compatible with the interior of the host building. Exposed steel, concrete, or masonry boxes are not architecturally acceptable above ground, in-residence storm safe rooms
- Incidental structural connectivity between structural and non-structural components of the host building and the shelter structure such as the interface of interior partitions, whether abutting the shelter structure from the side or from the top
- Incidental bearing of wood roof trusses on roofs or wood framing connected to roofs of in-residence storm safe rooms
- Safe rooms must be able to carry wind forces imposed on them by wind on structurally connected, un-collapsed walls without overstressing safe rooms walls or exceeding stability requirements

II. Shelter Anchorage and Interaction with the Primary Structure Floor Slab or Foundation

The second subject discussed was the interaction between the storm shelter and the floor of the primary structure to provide stability of the storm shelter against uplift, overturning, and lateral movement using the floor slab and/or foundation elements of the primary structure. Ernie Kiesling indicated that finite element analyses of lightly reinforced, 4" thick concrete floor slab configurations were being conducted at Texas Tech University to determine acceptable floor slab areas and boundary conditions for locating typically sized shelters of varying weights to obtain adequate factors of safety for stability. Preliminary results of analyses indicate that safe rooms which are not very narrow in the direction of wind can be carried on 4" slabs.

Discussions were held in a second breakout session of the subcommittee which touched on consideration of wind uplift forces directly on ground level floor slabs, resistance to slab uplift by suction forces under large areas of floor slab, the inertial resistance to short duration peak uplift forces, consideration of the dissipation of force energy resulting from inelastic deformations of the anchoring floor slab, and application of inelastic analysis (large displacement theory) in the stability evaluation. Answers to these questions were not proposed during the session.. Input from ICC committee members is requested to be sent to Jim Waller. The Texas Tech analytical study of slabs will be very helpful.

Task Group 7 Report
Flood/Multi-hazard Task Group
Paul Tertell, Chair
Submitted by Bob Franke

Present –Franke, Levitan, Twisdale, Plisich (pending FEMA approval)
Absent – Bowman, Kilcollins, Tertell

This task group met with the entire committee. Franke reviewed the minutes from the last meeting.

HAZ-MAT – LSU is currently working on a multi-year assessment of public health issues related to disasters. This research may be of use to the shelter committee.

Lightning – At the last meeting the sub-committee identified this as a possible hazard, but had little information concerning the hazard. Dr. Kiesling mentioned that Arizona State has a group of researchers that may have data on lightning. Jim Waller also provided additional data as well.

Rain – The sub-committee identified a potential problem of ponding if the roof drains are blocked in conjunction with wind loads. A climatologist at Louisiana State University is conducting research on the maximum rainfall from a hurricane. It was mentioned that HAZUS-MH has rainfall-modeling capability. **Twisdale** will provide some data on maximum rainfall.

The draft NSSA standard includes a 200-psf live load. The proposed live load should include the rain load identified by the sub-committee.

Since most roof coverings will not resist the wind speeds we identify, is the loss of the roof covering may be a concern. With the loss of the roof covering shelter occupants may get wet. Moisture may also present problems for the mechanical and electrical systems. This may not be a concern for tornado shelters, but may be a problem for hurricane shelters. The committee may consider the inclusion in the commentary that the loss of roof covering should not lead to life safety issues.

The current code includes primary and secondary drainage.

Flood - For residential shelter, the initial thoughts were the requirements of the National Flood Insurance Program would suffice. Below ground shelters may be allowable per the NFIP minimum requirements in some circumstances. However, several committee members expressed a desire to prohibit below ground shelters in the SFHA due to the risk from flooding.

Assignments – **Tertell** and **Franke** will draft the flood section. **Levitan** will draft the rain section.

Task Group 8
Inspections
No report – this group did not meet

Task Group 9 Report
Shelter Operations Task Group
Danny Kilcollins, Chair
Submitted by Marc Levitan

This new task group met with the entire committee.

Role of Operations in Shelter Design –

Bud Plisich discussed examples of where operations were not considered during the design phase that ultimately rendered the shelter nonfunctional. E.g., a tornado shelter for an elementary school that was located in a fire station across the street. There wouldn't be adequate time from the initial warning to round up all the kids and get them across the street. No matter how good the shelter was from a structural standpoint, it was ultimately not useable. This was a planning failure, which could have been avoided had there been involvement of someone knowledgeable of sheltering operations during the design phase.

One of the problems here is that the neither the facility owner (usually a school district) nor the architect developing the building program generally has an appreciation of sheltering operations. When the school is opened as a shelter, it will likely be managed by the Red Cross or County-level emergency management. A knowledgeable representative from the group that will manage the shelter and develop the sheltering plan (see below) should be part of the initial design team.

Sheltering Plan -

Consideration was given to requiring the submission of a sheltering operations (possibly including maintenance as well) plan along with the design documents at permitting time. This would hopefully assure that these items were considered during the design. Questions arose as to who would then approve these sheltering plans. Building Departments would not generally have the expertise needed. One possibility would be that the plan must be approved by the city, county or state emergency management department.

Maintenance Plan and Reports

Consideration was given to the need for requiring annual testing and of operable hurricane protections systems and how these results would be reported. A possible model is the requirement in the existing code for inspection/testing/reporting of elevator operations. Items to be tested to make sure they are in good working order would include such things roll-down, accordion, and other types of operable shutters. Fabric debris protection systems, like the ones we saw on the Florida EHPA site tours, should be installed once per year, thus testing that the system is still operational, all hardware and tools needed are available, and personnel are trained on installation techniques.

Tampa?/Florida? already has a plan for annual testing and maintenance. Ask **Kilcollins** to provide details.