FEMA-297, 10/92

Code Compatibility Report

Appendices A and B

Federal Emergency Management Agency
Federal Insurance Administration

10/92
Volume 2 of 3

APPENDIX A

COMPARISON BETWEEN THE BOCA NATIONAL CODES AND THE NFIP STANDARDS AND TECHNICAL GUIDELINES

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BOCA NATIONAL BUILDING CODE COMPARISON

NFIP Regulations for Floodplain Management and Flood Hazard Identification (44 CFR 59.1, 60.3 & 60.6)

44 CFR 59.1	BOCA Code	Analysis
Appurtenant Structure	201.0	FEMA definition relates to incidental structures while BOCA uses the term relative to systems used to support equipment. Although not literally compatible, this term should not cause conflicts relative to the code requirements.

Recommendation: None

44 CFR 59.1	BOCA Code	Analysis
Base flood	2101.6.1	Both FEMA and BOCA describe the base flood as being a flood with a one percent chance of being exceeded.

Recommendation: None

44 CFR 59.1	BOCA Code	Analysis
Basement	201.0 2101.6.3.1	FEMA indicates basements to be entirely below grade while BOCA's definition would consider a portion below grade as constituting a basement. However, both documents include requirements for unoccupied spaces below the BFE which is the key consideration. See analysis of 44 CFR 60.3 (c)(2) and (c)(3) for comparison of requirements.

Recommendation: None

44 CFR 59.1	BOCA Code	Analysis
Breakaway wall	1109.4 2101.6.4.2	Both FEMA and BOCA require the wall to be capable of breaking away without effecting the structural integrity of the structure.

Recommendation: Provide exception to BOCA Section 1109.4 to address breakaway walls. See also recommendation to 44 CFR 60.3 (e)(5).

44 CFR 59.1	BOCA Code	Analysis
Building-See structure	201.0	FEMA definition distinguishes between flood plain requirements and insurance coverage and also indicates the building is "walled". BOCA's definition of "building" does not mandate a wall while BOCA's definition of structure is something "that is built or constructed". Given the application of these terms in their respective documents there are no conflicts relative to BOCA and FEMA requirements.

Recommendation: None

44 CFR 59.1	BOCA Code	Analysis
Critical feature	None	FEMA identifies this term as a key consideration in the flood protection system while BOCA contains no definition. BOCA does not differentiate between key components and non-key components but rather defines the required system performance.

Recommendation: None

44 CFR 59.1	BOCA Code	Analysis
Development	None	FEMA definition indicates a man made change. BOCA does not define the term as it is not relevant to the application of the code.

Recommendation: None

44 CFR 59.1	BOCA Code	Analysis
Elevated buildings	2101.6.3.1 2101.6.3.3 2101.6.4.1	FEMA contains prescriptive requirements and attributes which are used to evaluate whether a building is considered an elevated building. For purposes of FEMA, an elevated building is one in which the floor elevation is above the ground level or the perimeter walls have sufficient openings to allow flood water in or the walls are breakaway. BOCA does not include a definition but rather contains prescriptive requirements for structures in A and V zones which mirror the definition in FEMA. Also, the FEMA definition includes subclassifications of zones (i.e. A1, AE, etc.) and zones such as B, C, X, and D while BOCA requirements only identify A and V zones.

Recommendation: FEMA should provide direction to the model codes concerning the need to include the subclassification of flood zones versus the current zones found in the model codes.

44 CFR 59.1	BOCA Code	Analysis
Existing construction	103.0	FEMA definition is used to determine rates and is a function of a start of construction date relative to FIRM or 1/1/1975. BOCA would consider any structure existing on the date of adoption of the BOCA code as an existing structure.

Recommendation: None

44 CFR 59.1	BOCA Code	Analysis
Existing structures - See existing construction	103.0	See "existing construction"

Recommendation: None

44 CFR 59.1	BOCA Code	Analysis
Flood	2101.6	FEMA provides a definition which addresses the idiosyncracies of water over normally dry land including mud slides and subsidence. BOCA's provisions do not define the term flood and solely rely on the Flood Insurance Rate Map to determine the applicability of the flood provisions. BOCA does not address mud slides or subsidence. The utility of this definition relative to enforcing code requirements is not apparent. Reliance on the map is the key consideration.

Recommendation: None

44 CFR 59.1	BOCA Code	Analysis
Flood plain or flood prone areas	2101.6	See "flood"

Recommendation: None

44 CFR 59.1	BOCA Code	Analysis
Lowest Floor	2101.6.3.1 2101.6.3.3 2101.6.4.1	This term as defined in FEMA relates to the term "elevated building", also defined in FEMA. This term references a basement which has been previously identified in this comparison. The criteria which identifies how a space can be used and not be considered the lowest floor is similar to BOCA with the key consideration being whether the space is used for human occupancy.

Recommendation: None

44 CFR 59.1	BOCA Code	Analysis
Manufactured home	201.0	FEMA's definition is consistent with BOCA's definition of "mobile unit".

Recommendation: None

44 CFR 59.1	BOCA Code	Analysis
100-year flood - see base flood	2101.6.1	See "base flood"

Recommendation: None

44 CFR 59.1	BOCA Code	Analysis
Storm cellar	None	The term is not defined in BOCA since there are no requirements for this type of use.

Recommendation: None

44 CFR 59.1	BOCA Code	Analysis
Structure	201.0	See "building".

Recommendation: None

44 CFR 59.1	BOCA Code	Analysis
Substantial improvement	2101.6.9	FEMA uses this term to identify when the construction equals or exceeds 50% of the market value. BOCA does not define this term since the requirements in BOCA are stated in 2101.6.9 and also require the entire structure to be upgraded if the reconstruction or restoration exceeds 50% of replacement cost.

Recommendation: FEMA to evaluate whether the criteria to determine compliance should be based on "market value" or "replacement cost".

44 CFR 60.3	BOCA Code	Analysis
(b)(8) Manufactured home installation	2101.6.7	FEMA requires manufactured homes in Zone A to be installed to minimize damage by elevating and anchoring the structure. BOCA's requirements do not distinguish between manufactured homes versus site built and would also require the home to be located above the BFE. Also BOCA would permit these in either Zone A or V.

Recommendation: None. FEMA has indicated that these installations are not prohibited in either zone as a result of a 1986 rule change.

44 CFR 60.3	BOCA Code	Analysis
(c)(2) Elevation for residential structures	2101.6.3.1 103.3 2101.6.9 2101.6.2 2101.6.3 2101.6.4 2101.6.6	FEMA's provisions (Zone A) require the lowest floor (including basement) to be above the BFE. This is consistent with BOCA. Additionally, this section cites "substantial improvements" which are defined based on a cost consideration for determining applicability. BOCA invokes the 50 percent replacement cost to require the entire structure to comply with the current provisions. Also, the FEMA requirements include subclassifications of zones (i.e. A1, AE, etc.) while BOCA addresses these zones as Zone A.

Recommendation: See 44 CFR 59.1 - Elevated buildings.

44 CFR 60.3	BOCA Code	Analysis
(c)(3) Elevation for non-residential structures	2101.6.3.1 2101.6.3.4 103.3 2101.6.2 2101.6.3 2101.6.4 2101.6.6	FEMA's provisions (Zone A) require the lowest floor (including basement) to be either above the BFE or the space designed to be watertight. This is consistent with BOCA. However, FEMA cites "substantial improvements" - see discussion for FEMA (c)(2). Also, the FEMA requirements include subclassifications of zones (i.e. A1, AE, etc., while BOCA addresses the zones as Zone A.

Recommendation: See 44 CFR 59.1 - Elevated buildings.

44 CFR 60.3	BOCA Code	Analysis
(c)(5) Flood Openings	2101.6.3.3	FEMA's provisions (Zone A) are requirements for enclosed spaces below the BFE and are consistent with BOCA. However, FEMA cites "substantial improvements" - see discussion for FEMA (c)(2).

Recommendation: None

44 CFR 60.3	BOCA Code	Analysis
(e)(4) Pilings	2101.6.4.1 2101.6.11.3 2101.6.6 2101.6.2 2101.6.3	FEMA's provisions (Zone V) require the lowest horizontal structural member to be above the BFE with the foundation system of piles and columns to be designed to withstand the loads. This is consistent with BOCA. However, FEMA cites "substantial construction" - see discussion for FEMA (c)(2). Also, the FEMA requirements include subclassifications of zones (i.e., V1, VE, etc.) while BOCA addresses the zones and Zone V. Both FEMA and BOCA require a design by a registered professional.

Recommendation: See 44 CFR 59.1 - Elevated buildings.

44 CFR 60.3	BOCA Code	Analysis
(e)(5) Breakaway walls	2101.6.4.1 2101.6.4.2 2101.6.11.3	FEMA's provisions (Zone V) require the lowest horizontal structural member to be above the BFE with the space below free of obstructions or constructed of breakaway construction or open lattice. This is consistent with BOCA with the exception that FEMA provides a design safe loading resistance of 10-20 psf. BOCA does not provide this criteria. Additionally, FEMA cites "substantial improvements" - see discussion for FEMA (c)(2). Also, the FEMA requirements include subclassifications of zones (i.e., V1, VE, etc.) while BOCA addresses the zones as Zone V. Both FEMA and BOCA require a design by a registered design professional.

Recommendation: FEMA should conduct the necessary research to support the 10-20 psf design loading for breakaway walls. A system designed in this load range may breakaway under a design wind condition. Upon resolution of this issue, it would then be appropriate to prepare a code change which reflects the results of the research as design criteria to be included in BOCA. See also 44 CFR 59.1 - Elevated buildings and FEMA-55 Section 4.3.5.1.

44 CFR 60.3	BOCA Code	Analysis
(e)(6) Fill	2101.6.4.3	FEMA's provisions (Zone V) do not permit the use of fill for structural support. BOCA does not include this limitation. Also, the FEMA requirements include subclassifications of zones (i.e. V1, VE, etc) while BOCA addresses the zones as Zone V.

Recommendation: It would be appropriate to propose a revision to BOCA to include this prohibition. See also 44 CFR 59.1 - Elevated buildings.

44 CFR 60.6	BOCA Code	Analysis
(c)(2)(i) Flood-proof walls	107.2 107.4 2101.6.3 2101.6.3.1 2101.6.3.2 2101.6.3.3	FEMA provides criteria for local communities to evaluate relative to granting requests for variances of residential buildings in Zone A. Included in this section is requirements for basements below the BFE to be flood proofed with watertight walls designed to resist flood waters. BOCA requires residential basements to be located above the BFE. The only exceptions being basements not used for human occupancy. The BOCA codes, however, provide for evaluating alternative methods and materials to that required by the code but do not provide prescriptive criteria. Any alternative approval must be shown to comply with the intent of the code and approved by the local code official.

Recommendation: None

44 CFR 60.6	BOCA Code	Analysis
(c)(2)(ii) Basement top floor elevation	103.3 107.2 107.4 2101.6.3 2101.6.3.1 2101.6.3.2 2101.6.3.3	FEMA's variance criteria requires the top floor of the residential basement in Zone A to be no lower than 5 feet below the BFE. See analysis to 44 CFR 60.6 (c)(2)(i).

Recommendation: None

44 CFR 60.6	BOCA Code	Analysis
(c)(2)(iii) Fill	103.3 107.2 107.4 2101.6.3 2101.6.3.1 2101.6.3.2 2101.6.3.3	FEMA's variance criteria requires the surrounding grade to be filled around the residential basement to above the BFE in Zone A. See analysis to 44 CFR 60.6 (c)(2)(i).

Recommendation: None

44 CFR 60.6	BOCA Code	Analysis
(c)(2)(iv) Use of registered professional	103.3 107.2 107.4 2101.6.3 2101.6.3.1 2101.6.3.2 2101.6.3.3 2101.6.11.3	FEMA's variance criteria requires a registered professional engineer or architect to design the structure (Zone A). BOCA requires a registered professional only for V-Zones. See analysis to 44 CFR 60.6 (c)(2)(i).

Recommendation: None

44 CFR 60.6	BOCA Code	Analysis
(c)(2)(v) Building inspection	109.0 110.0	FEMA and BOCA both require inspections to ascertain compliance with the permit although BOCA's requirement is applicable to all types of construction projects.

Recommendation: None

Elevated Residential Structures (FEMA-54)

FEMA-54	BOCA Code	Analysis
P.68 Posts	1207.2	FEMA requires concrete collars or bearing pad. BOCA requires the poles to be treated in accordance with AWPA C2 or C4. The wood foundation system shall be designed in accordance with NFoPA TR7 and all lumber in accordance with AWPB-FDN.

Recommendation: None

FEMA-54	BOCA Code	Analysis
Pgs. 69-70 Post Embedment	1207.1 1205.1	BOCA and FEMA both require the depth of the embedment to be below the frost line. FEMA states that special loading such as the forces from flooding, and debris which is carried in a flood be taken into account when designing. FEMA cites prescriptive criteria for embedment of the posts and for subsequent backfill. BOCA cites design criteria.

Recommendation: None

FEMA-54	BOCA Code	Analysis
P. 75 Piers	1212.0 2101.6.4.3	FEMA requires that the piers resist the effects from horizontal and uplift loads due to wind and water as does BOCA. Concrete and brick piers shall be used when elevating 1-1/2 to 6' off the ground. BOCA requires that plain concrete piers be constructed in accordance with ACI 318. If steel shells are used, the thickness shall be a minimum of 1/4" thick. BOCA also states dewatering specifications.

Recommendation: None

FEMA-54	BOCA Code	Analysis
P. 77 Piers	1205.0 1203.0	FEMA states that footings shall be poured in place or rest on the soil if the proper soil conditions exist. The footing size is a function of the soil bearing load capacity. BOCA uses design conditions for analysis of placement and size. In addition BOCA requires that soils testing be done prior to the addition of a footing.

Recommendation: FEMA should require a geotechnical report to ensure sufficient load bearing capacity of the soil.

FEMA-54	BOCA Code	Analysis
P. 79 Shear Walls and Floor Diaphragms	1109.4	FEMA requires that shear walls be used in parallel to brace against low-medium velocity flooding. Floor diaphragms should be aligned to resist horizontal forces. Flood areas should include additional bracing for wind and rain conditions . FEMA also cites design guide "Design and Construction Manual for Residential Buildings in Coastal High Hazard Areas". BOCA requires that all buildings in flood hazard zones be designed to resist the hydrodynamic forces which occur in the area.

Recommendation: None

FEMA-54	BOCA Code	Analysis
Pgs. 84 and 85 Pier Foundation Connections	1703.2.11	FEMA allows the piers to be attached to the floor by metal straps and bolts and offers diagrams describing the uses of piers. FEMA prescribes embedment of 12" for concrete piers and 16" for masonry piers. BOCA designates 8" embedment for concrete piers and 15" for masonry. The BOCA code also prescribes 2 anchor bolts be placed from the end. FEMA and BOCA require embedment which differs slightly.

Recommendation: This is a minor conflict, which if necessary, would require FEMA to conduct an evaluation of the relevant standards to determine if a "correct" embedment can be ascertained.

FEMA-54	BOCA Code	Analysis
P. 88 Concrete and Wood Flooring Systems	1703.2.4.1	FEMA requires that all members be tied and secured. Ends of beams shall rest or bend not less than 4 inches or be supported by metal stirrups or hangers. BOCA requires that metal connector straps shall be used for every other joist and wall studs shall be anchored.

Recommendation: None

FEMA-54	BOCA Code	Analysis
P. 92 Related Design Considerations	2202.1 2101.6.8 2101.6.3.4	FEMA requires glass windows to be protected from wind and changes in pressure. FEMA states that utilities should also be protected or elevated and sanitary systems should be designed to alleviate discharge due to flooding. BOCA does not require glass protection but relies on properly designed glass for the specified loads. BOCA also acknowledges utility protection/elevation and the need for properly designed sewage systems. See also Analysis of BOCA National Mechanical Code.

Recommendation: None

FEMA-54	BOCA Code	Analysis
P.93 Building Materials	1701.1 1703.2.6 1702.5.2.3 (Supp.) 1702.6.3 1801.4 1802.3 1503.3.2 1506.6.3 2106.6.6	FEMA identifies that preservative treatment is required for wood, steel requires corrosion protection, admixtures are required for concrete to improve freeze-thaw and strength. FEMA does not provide specific recommendations to achieve the desired results but rather includes names and addresses of associations to be contacted for guidance. See BOCA analysis to FEMA-54 Wood, Steel, Concrete and Masonry and FEMA-55 Sections 4.1.2 and 4.2.1.4.

Recommendation: See FEMA-54 Wood, Steel, Concrete, and Masonry and FEMA-55 Sections 4.1.2 and 4.2.1.4.

FEMA-54	BOCA Code	Analysis
Pgs. 94 and 95 Wood, Steel, Concrete and Masonry	1802.3 1702.6	BOCA requires that pressure treated wood shall conform with standards AWPA C1, C2 and C9 and AWPB-FDN. Preservatives to conform to AWPA P1, P2, P5, P8 and P9. Section 1802.3 states that steel shall be protected for exterior use with a shop or field coat to prevent corrosion. FEMA states that steel shall be protected for exterior use with a shop or field coat to prevent corrosion.
Admixtures	1502.6	BOCA requires that admixtures, if used, shall follow requirements of ACI 318, ASTM C260, ASTM C618 and ASTM C989 depending on the type used. FEMA does not include requirements for the use of admixtures.
	1503.1	BOCA cites that concrete shall be proportioned to provide the average compressive strength as prescribed by ACI 318, not less than 2500 psi. FEMA does not include the standard.
	1401.11	Mortar shall comply with the requirements of ASTM C270. FEMA states that wood shall be treated to resist fungus, insects, bacteria and rot. In addition the treatment must be designed to keep water out. Steel should be painted and bolts should be galvanized. Concrete and masonry units should have surface treatments and should also include additives.

Recommendation: See FEMA-55 Section 4.1.2. Also, FEMA should consider referencing the applicable standards for wood preservatives, concrete, and masonry.

FEMA-54	BOCA Code	Analysis
Pgs. 95 and 96 Insulation	928.0	BOCA states that when insulation is installed specific flame spread ratings and smoke developed ratings are required to be adhered to. A vapor retarder shall be installed on the warm side of the building having a performance not exceeding 1. FEMA requires insulation exposed to flood conditions to be impermeable and able to withstand submersion.

Recommendation: None

FEMA-54	BOCA Code	Analysis
Pgs. 113-115 Glossary	1109.4	Hydrodynamic loads in Zones A and V shall be incorporated into the design of these buildings and structures. FEMA defined all the flood zones in relation to 100 year floor. Hydrodynamic and hydrostatic loads are described without the use of equations.

Recommendation: None

FEMA-54	BOCA Code	Analysis
Pgs. 125 and 135 Performance Criteria	1102.1 1109.3 1109.4	BOCA relies upon the design calculations for all components of the structures. FEMA defined design loads, soil loads citing that each case should be dealt with individually and specifically approved by the code official.

Recommendation: None

Coastal Construction Manual (FEMA-55)

FEMA-55		BOCA Code	Analysis
4.1	Environmental forces	2101.6.1 1109.4	No differences

Recommendation: None

FEMA-55		BOCA Code	Analysis
4.1.1	Wind	1112.0	Both FEMA and BOCA follow ANSI A58.1-1982. FEMA-55 requires an importance factor of 1.11 for all structures while BOCA's factor reflects ANSI A58.1 and requires a 1.05 factor for non-essential facilities (i.e., offices, residential) and buildings of assembly with less than 300 people.

Recommendation: The provisions are compatible for certain types of buildings such as assembly buildings and essential facilities (hospitals, fire station, etc.) It is recommended that FEMA-55 revise its importance factor to correlate with ANSI A58.1-1.05 for all buildings other than essential facilities and assembly buildings with less than 300 occupants.

FEMA-55		BOCA Code	Analysis
4.1.2	Salt air, moisture and wind-driven rain	1801.4 1802.3	BOCA and FEMA require structural steel work and formed steel members to be corrosion protected but BOCA does not specifically address connectors.
		1701.1 1703.2.6 1704.1.1	BOCA references NFoPA NDS which requires galvanized sheet for metal plate connector joints (8.10.3). BOCA requires galvanized steel connections when the frame is more than one story in height and the studs are not continuous from the sill to the roof. FEMA requires all connections to be corrosion resistant.
		1702.5.2.3 (Supp)	Preservative treated wood fastener requirements similar.
		2103.3.10	Flashing requirements similar.
		1402.6	FEMA acknowledges the effects of salt laden air on mortar but does not provide types of mortar which are acceptable. BOCA also does not prescribe specific masonry mortar types for masonry exposed to salt laden air.
		2102.5	BOCA requires that exterior walls of alternative materials be weather-resistant but does not mention corrosion resistance.

FEMA-55	BOCA Code	Analysis
4.1.2 (cont.)	1503.3.2 1506.6.3	FEMA acknowledges the effects of concrete exposed to salt laden air but does not provide criteria. BOCA prescribes minimum concrete properties (w/c, f'c) for concrete exposed to sea water. BOCA and FEMA require increased concrete cover to reinforcement but neither stipulates the increase.
	2101.6.6	BOCA includes a general performance regulation which requires "All buildings ... shall be constructed with materials resistant to flood damage...".

Recommendation: Both codes acknowledge the effects salt laden air and moisture have on building components. FEMA and BOCA require corrosion resistant fasteners for pressure treated wood but neither provide definitive criteria for masonry or concrete. It is recommended that FEMA include a general provision to address moisture protection and BOCA revise its current text. Suggested language is: Construction materials, including connections, shall be resistant to water damage such that conditions of corrosion, deterioration or decay will not occur.

FEMA-55	BOCA Code	Analysis
4.1.3 Water, waves & debris	1109.4	FEMA and BOCA require the structures to resist the imposed loads. BOCA does not include design considerations for a 300 lb. object (debris) impacting the structure which is included in FEMA.

Recommendation: None. After consultation with FEMA, it was determined that a revision to the BOCA code would be premature given the provision has yet to be incorporated into NFIP.

FEMA-55	BOCA Code	Analysis
4.1.4 Effects of forces on higher & larger structures	1109.4 1112.0 108.1 2101.6.11.3	FEMA indicates applicability to residential structures up to 22 feet above grade. BOCA requirements would be applicable to all building types which are properly designed to withstand the water and wind forces. FEMA recommends the use of a qualified architect or engineer for design (with no mention of zone) while BOCA relies on state statutes and regulations to determine if a registered architect or engineer is required to do the design. BOCA does, however, require an engineer's or architect's design for the foundation design and breakaway enclosures for buildings in high hazard zone. (Zone V).

Recommendation: Registration laws for engineers and architects vary from state to state and FEMA should acknowledge these laws. Additionally, the requirements for professional registration (V-zones) should be coordinated between NFIP and FEMA-55.

FEMA-55		BOCA Code	Analysis
4.2	Construction Materials	None	FEMA acknowledges the benefits/drawbacks of different construction materials. BOCA does not provide recommendations as to the appropriate type of material to be used.

Recommendation: None

FEMA-55		BOCA Code	Analysis
4.2.1	Wood	-	-
4.2.1.1	Piling	1213.0 1214.0 1219.0 2101.6.4.3	No differences

Recommendation: None

FEMA-55		BOCA Code	Analysis
4.2.1.2	Main supporting members (beams)	1701.1 1702.6 2106.6.6	FEMA provides limited direction for the design of structural beams. BOCA references NFoPA NDS for the design of wood structures with structural design required to meet the design loads.

Recommendation: None

FEMA-55		BOCA Code	Analysis
4.2.1.3	Other wood construction members	2106.6	FEMA does not require floor joists, studs, plates, etc., to be preservative treated. BOCA requires all construction materials for structures in flood hazard zones to be resistant to water damage.

Recommendation: Main supporting members are critical to the structural integrity of a building but so are joists and other structural elements. It is not clear why FEMA only requires certain structural elements to be preservative treated. FEMA should revise its' criteria to include a requirement for pressure preservative treatment for all structural members subject to flooding.

FEMA-55	BOCA Code	Analysis
4.2.1.4 Wood preservatives	2106.6.6 1702.6.3 1219.2	FEMA requires wood to be pressure preservative treated but does not provide criteria. BOCA requires pressure preservative treatment in accordance with AWPA C2 and C9 for above grade construction and AWPA C3, and AWPB MP1, MP2, MP4 for timber piles.

Recommendation: FEMA should consider referencing the appropriate standards.

FEMA-55	BOCA Code	Analysis
4.2.2 Masonry materials and concrete	1402.6 1503.3.2 1506.6.3	See comments to FEMA Section 4.1.2

Recommendation: See FEMA Section 4.1.2.

FEMA-55	BOCA Code	Analysis
4.2.3 Metals	-	-
4.2.3.1 Aluminum	1901.1	FEMA recommends a 0.7 mil. anodizing finish and/or vinyl finish for aluminum elements such as doors, windows, gutters and flashings. BOCA references AA-SAS30 and AA-ASM35 for aluminum used for structural purposes. No similar requirements.

Recommendation: See FEMA Section 4.1.2

FEMA-55	BOCA Code	Analysis
4.2.3.2 Steel	1801.4 1802.3 1702.5.2.3 (Supp)	FEMA recommends the use of hot-dipped galvanizing for structural steel and the use of stainless steel. FEMA recommends regular inspection and maintenance of metal parts. BOCA requires hot-dipped galvanized for fasteners used for preservative treated wood. BOCA requires steel members to be painted or provided with an approved corrosion resistant coating. No regular inspection parameters are stipulated in BOCA.

Recommendation: See FEMA Section 4.1.2.

FEMA-55	BOCA Code	Analysis
4.2.3.3 Dissimilar metals	None	FEMA recommends that the use of dissimilar metals be avoided due to the potential for rapid corrosion.

Recommendation: This issue is one of providing materials which are not subject to corrosion. See FEMA Section 4.1.2.

FEMA-55		BOCA Code	Analysis
4.3	Design details	-	-
4.3.1	Foundations	1215.0 1217.0 1218.0 1219.0	FEMA cites advantages of different foundation systems and typical design approaches. BOCA does not provide recommendations for the appropriate type of foundation pile but rather provides criteria to be used to design the pile.

Recommendation: None

FEMA-55		BOCA Code	Analysis
4.3.1.1	Soil conditions	1201.1 1202.1 1201.3 1213.1	FEMA provides rules of thumb for evaluating soil conditions and cites the advantages and disadvantages of one soil type over another. FEMA includes a design table of pile capacities for 4 different soil types and includes common foundation scenarios. BOCA requires a foundation analysis to determine the soil capacity for pile foundations. Presumptive bearing values used for spread footings are provided in BOCA which range from 2,000-12,000 psf for the different soils listed. BOCA relies on a designed system to determine the structural acceptability of the building foundation supported by the soil.

Recommendation: FEMA should require a geotechnical report to ensure sufficient load bearing capacity of the soil.

FEMA-55	BOCA Code	Analysis
4.3.1.2 Piles Pile selection	1219.0 1218.0	FEMA recommends minimum timber pile sizes and cites the advantages of square vs. round piles. FEMA recommends concrete piles when higher capacity or longer lengths are needed. BOCA does not stipulate minimum timber pile sizes but rather relies on a design. BOCA specifies a minimum lateral dimension for precast concrete piles of 10". BOCA relies on a designed system to support the loads.
Pile embedment	1213.0 1214.0 2101.6.4.3	FEMA cites the effects pile embedment has on the structural capacity of the pile. FEMA provides recommended pile penetrations. BOCA does not stipulate minimum pile embedments, but rather relies on a design. BOCA requires pile embedment to consider scouring in high hazard zones (V Zone) only.
Pile installation	1215.0 1219.0	FEMA provides details of typical methods to install piles. BOCA does not prescribe the installation details for piles with the exception of cast-in-place concrete piles.

Recommendation: FEMA requires scour around piles to be evaluated for all pile installations while BOCA specifically cites scour for V Zones. It is recommended that BOCA include text for A Zones similar to that for V Zones relative to scour.

FEMA-55	BOCA Code	Analysis
4.3.1.3 Posts	None	FEMA recommends that wood posts should not be used in V Zones or A Zones subject to wave/scour. BOCA does not stipulate that wood posts should not be used but rather relies on a designed system.

Recommendation: It seems overly restrictive to preclude the use of a building material. If adequately designed, wood posts should be considered acceptable. It is recommended that FEMA relax their recommendation of material types in favor of a designed system of material of the designer's choice when such materials can be shown to be suitable for their intended use.

FEMA-55	BOCA Code	Analysis
4.3.1.4 Piers	1212.0 1205.1 1209.0	FEMA recommends minimum footing sizes and embedment depth. BOCA does not prescribe minimum footing sizes, depth, or reinforcement but rather relies on a designed system.

Recommendation: None

FEMA-55	BOCA Code	Analysis
4.3.2 Framing	None	FEMA for information only.

Recommendation: None

FEMA-55	BOCA Code	Analysis
4.3.2.1 Framing methods	None	FEMA cites the different types of wood framing methods and the benefits associated with one system over another. BOCA does not address the different types of construction (platform vs. pole) nor does it acknowledge the benefits associated with one over the other. BOCA relies on a designed system.

Recommendation: None

FEMA-55	BOCA Code	Analysis
4.3.2.2 Beams	None	FEMA cites the different types of wood beams (i.e, solid, built-up, glulam), preferred orientation (i.e., parallel to flow), and splice locations. BOCA does not prescribe any requirements for the beams but rather relies on a designed system.

Recommendation: None

FEMA-55	BOCA Code	Analysis
4.3.2.3 Joists and rafters	1703.2.9.2	FEMA recommends cross bridging for all floor joists located in the velocity zone. FEMA and BOCA require bridging on 8 centers. BOCA also requires bridging at the supports if adequate lateral support is not provided. For Use Group R-2 (i.e., apartments) and R-3 (single family or multiple single family) dwellings, bridging is only required when the joist depth exceeds 12" or the live load exceeds 40 psf.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
4.3.2.4 Subflooring	1702.1 Appendix C	FEMA recommends either 1x4 or 1x6 boards laid diagonally over joists or exterior type plywood following the guidelines of APA "Plywood Construction Guide". BOCA includes floor sheathing tables. FEMA stipulates an exterior glue for plywood while BOCA requires exterior, waterproof type plywood in all exterior uses, but allows either interior type, moisture-resistant type, or exterior type in interior applications and does not stipulate glue between layers for plywood. FEMA stipulates annular ring nails or deformed shank nails while BOCA's recommended fastening schedule (Appendix C) permits common nails.

Recommendation: See FEMA-55 Section 4.1.2 and FEMA 88-2.

FEMA-55	BOCA Codes	Analysis
4.3.2.5 Studs	1703.2.2 1703.2.3 Table 1702.1.2.5	FEMA acknowledges the common use of 2x4 or 2x6 wood studs at 16" o.c. and the increased use of metal studs configured similarly to wood studs. BOCA does not prescribe wall material, but requires that bearing walls be designed to provide adequate support for the materials and to provide for transfer of all lateral loads to the foundation. BOCA permits 24" stud spacing for bearing walls and 48" stud spacing for non-bearing walls. Other maximum stud spacings are given dependent on the plywood sheathing panel span rating. Also, a single top plate may be used only if specific requirements are met.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
4.3.2.6 Wall Sheathing	2103.3 1703.2.8 Table 1702.1.2.5	FEMA cites plywood as the typical sheathing material and prescribes exterior grade plywood of at least 15/32" or 3/4" thick. BOCA requires wall sheathing of any approved material. Plywood sheathing is required to be at least 5/16" thick. Appendix C Attachment and fastening requirements are similar.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
4.3.2.7 Wall Bracing	1703.2.5	BOCA and FEMA require wall bracing but neither specifies a particular method to be used. BOCA permits plywood sheathing, let-in bracing or any other approved equivalent whereas FEMA recommends plywood.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
4.3.2.8 Roof Details Roof Trusses Roof Construction	1702.1.2.1	The BOCA codes gives maximum span of roof sheathing allowed. Similar provisions are absent from FEMA.
	1703.2.10 1703.2.10.1	FEMA indicates typical considerations for roof design. BOCA requires that rafter spans comply with NFoPA Span Tables for Joists and Rafters and that plate connected roof trusses be designed in accordance with TPI Design Specifications for Metal Plate Connected Wood Truss and NFoPA NDS. Trusses must also be braced. Roof deck sheathing must be constructed of an approved material.
	1110.4	BOCA requires that flat roofs be designed to support the maximum possible depth of water assuming all means of roof drainage are blocked while FEMA does not include a similar requirement.
	1102.1	FEMA cites benefits of one roof configuration over another. BOCA does not acknowledge the benefits of one roof configuration (gable, hip, etc.) over another, but rather relies on the roof configuration to be designed to the appropriate loading conditions (i.e., wind, snow, and ponding). BOCA provides specific design provisions for roof overhangs.

Recommendation: FEMA should consider including design tables for roof sheathing and also ponding provisions for the roof design. Alternatively, FEMA could reference the model codes for roof sheathing design tables.

FEMA-55	BOCA Codes	Analysis
4.3.3 Foundation Bracing	1213.4 1213.6	BOCA requires that all piles be designed such that lateral stability is provided in all directions. BOCA does not require bracing for the length of pile above grade (regardless of the height) but rather stipulates that the pile is to be designed as a column to withstand the vertical (compression or uplift) and lateral (water/wind) loads. Bracing (knee braces, trusses, shear walls) would be considered as a design option but is not mandated. FEMA recommends bracing the piles but does not guarantee that this measure alone will make the structure storm resistant. 1109.4 BOCA requires that buildings located in flood-hazard and high hazard zones be designed to resist all hydrodynamic forces. 2101.6.4.3 BOCA requires that all buildings located in high hazard zones be supported on pilings or columns and be adequately anchored to such.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
4.3.3.1 Knee Braces	1213.4 1213.6	FEMA recommends that piles be braced. BOCA requires bracing of all piles but does not specify a particular method.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
4.3.3.2 Grade Beams	1213.4 1213.6 2101.6.3.2 2101.6.4.3	FEMA recommends the use of grade beams. BOCA permits but does not require the use of grade beams.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
4.3.3.3 Truss Bracing	1213.4 1213.6	FEMA prescribes the use of truss bracing systems when the structure is elevated about 10' or more above grade. BOCA requires sufficient bracing but does not specify a particular method.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
4.3.3.4 Shear Walls	2101.6.3.3 2101.6.4.2	FEMA acknowledges the use of shear walls. BOCA does not allow walls which structurally support the building to be located below the base flood elevation in high hazard zones.

Recommendation: FEMA should revise their provisions to include the prohibition of shear walls and other walls which are part of the structural frame below the BFE in V-zones.

FEMA-55	BOCA Codes	Analysis
4.3.4 Connections	2101.6.3.2 1701.1 1102.1	No significant difference.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
4.3.4.1 Roof to Wall	1112.2 1112.3 1701.1 2101.6.3.2	Appendix C BOCA requires that all structural members and connections be of sufficient size or capacity to meet or exceed the forces exerted upon them. ANSI A58.1 (ASCE 7) is used as a referenced standard. BOCA does not include provisions for positive connection from the ridge line through interior stud walls to the foundation. FEMA determines the wind uplift force from its own tables and states that toe-nailing alone may not provide a sufficient connection.

Recommendation: It is recommended that FEMA reference the design values of ANSI A58.1-1982.

FEMA-55	BOCA Codes	Analysis
4.3.4.2. Wall to Floor Joist	1112.2 1112.3 1701.1 2101.6.3.2	BOCA requires connections of sufficient size and strength be provided. FEMA prescribes that plywood sheathing be well anchored from the top plate of the stud wall to the floor joists and band beams below.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
4.3.4.3 Floor Joist to Floor Beam	1112.2 1112.3 1701.1 2101.6.3.2	Appendix C FEMA recommends the use of either metal or wood connections to anchor joist to beams. BOCA uses the performance oriented language and requires that all connections be of sufficient size and capacity. The recommended fastening schedule (Appendix C) acknowledges 3 toe nails as a connection, however, this would be required to be confirmed by design.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
4.3.4.4 Floor Beam to Pile, Post, or Pier	1701.1 2101.6.3.2	FEMA recommends that wood piles be notched no more than 50% of the original bearing area. BOCA relies on a designed system in accordance with accepted engineering practice and NFoPA NDS which is the referenced standard for wood construction. The flood-resistant construction provisions of Section 2101.6 require the structural system to be anchored but this design is left to the designer. BOCA, however does include prescriptive requirements for permitted boring, cutting and notching (1703.2.1), bearing (1703.2.4) and anchorage of sill plates (1703.2.11). BOCA requires a 15" embedment of anchor bolts into grouted masonry while FEMA stipulates 16".

Recommendation: FEMA should reference the design standard for wood, namely, NFoPA NDS-1986 with 1987 revisions and 1988 Supplement - Design Values for Wood Construction.

FEMA-55	BOCA Codes	Analysis
4.3.5 Breakaway Walls	2101.6.3.3 2101.6.4.2 2101.6.11.3	BOCA's requirements for enclosures below the base flood elevation are a function of the flood hazard zone (A vs V). Flood hazard Zone A structures with enclosed spaces are not required to have breakaway construction but are required to have a minimum amount of openings such that the space is designed to equalize the hydrostatic forces on the exterior by allowing the entry and exit of flood waters. Flood hazard Zone V structures are permitted to have enclosed spaces provided the walls and partitions are not part of the structural support of the building and are designed and constructed to breakaway or collapse.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
4.3.5.1 Breakaway Wall Designs Screening Lattice Wood Stud Walls Metal Stud Walls Masonry Walls	2101.6.3.3 2101.6.4.2 107.4	BOCA requires that non-bearing walls below the BFE in flood-hazard zones (A Zones) be equipped with sufficient openings to allow for entry and exit of fluid waters. FEMA does not differentiate between these type walls in Type A and Type V Zones. Also, FEMA states (p 4-45) that reinforced masonry walls, due to their "loading resistance" creates an unusual condition and therefore should be designed by a professional engineer or architect. This may be misleading in that all walls in V-zones require a design and not just based on construction material.FEMA regulations provide design considerations for designing breakaway walls. BOCA requires an engineer or architect to design the system (V-zones).

Recommendation: See recommendation to 44 CFR 60.3 (e)(5). Also, FEMA may wish to clarify that break-away walls are allowed in A-zones provided the opening criteria is met. This would also be a viable option under the alternate approval provisions of BOCA.

FEMA-55	BOCA Codes	Analysis
4.3.5.2 Design Considerations for Breakaway Walls Connections Working/Ultimate Strength of Fastener Distribution of Wall Loads Bracing Considerations	1109.3 1109.4 1112.0	No difference.
	2101.6.4.2 2101.6.3.3	BOCA requires openings in non-structural solid walls below the BFE for buildings located in flood-hazard (A Zones). FEMA does not have different recommendations for applications in A-Zones and V-Zones. BOCA does not stipulate the breakaway force design criteria while FEMA stipulates 20 psf unless the wind force exceeds this value. If the wind pressure exceeds this value, FEMA requires the enclosure below the base flood elevation to be designed to withstand the wind forces. BOCA does not include provisions for "wave runup" or recommended foundation configurations. FEMA expands on the distribution of wind and water loads below the BFE and recommends design procedures to be followed. BOCA does not promote one design method over another but requires that all load conditions be evaluated and designed for by a registered professional engineer or architect. See also FEMA Section 4.3.5.

Recommendation: See recommendation for 44 CFR 60.3 (e)(5).

FEMA-55	BOCA Codes	Analysis
4.3.6 Utilities	2101.6.5 2101.6.8	FEMA does not allow electrical distribution panels below the BFE. BOCA does allow placement of electrical components below the BFE as long as they are adequately protected and the provisions of NFiPA 70 are met. BOCA requires HVAC systems be protected from the entrance and accumulation of water. FEMA prescribes that duct work be sloped and have emergency openings to allow drainage of accumulated water.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
4.3.7 Wind and Storm Protection of Interior	2202.1	BOCA requires windows to be designed in accordance with the wind loads of ANSI A58.1-1982 for the loads associated wit components and cladding. BOCA does not require protective window coverings.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
4.3.7.1 Window Selection	2202.1	FEMA recommends that individual panel widths be limited to three feet and the maximum open wall area (doors and windows) be 30%. BOCA does not limit the size of glazed panels as long as they can withstand the wind design pressures. BOCA only limits door and window percentages due to fire hazards and not wind considerations.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
4.3.7.2 Operable Shutters	2202.1	FEMA strongly recommends some type of storm protection for glazed openings. BOCA does not require this type of window covering but rather relies on the window to be designed for the wind load for the location in question.

Recommendation: FEMA should determine the appropriate performance criteria for the shutters and stipulate when and what type of shutters are required. This could then be considered by BOCA.

FEMA-55	BOCA Codes	Analysis
4.3.7.3 Gable and Eave Vents	709.1	BOCA has minimum size requirements for vents in enclosed roof spaces. FEMA identifies attic ventilation as an important feature. FEMA also mentions that many standard ventilation products are inadequate for coastal locations with wind-driven rain.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
4.3.7.4 Roofing Material	2303.0 2304.0 2305.0	Both FEMA and BOCA acknowledge the effects rain may have on roof systems and require some type of roof covering. However, FEMA does not provide specific material types. BOCA requires all roofs to be covered with approved coverings which will resist wind and rain. In addition to asphalt shingles, BOCA acknowledges the use of asbestos cement, clay or cement tile, metal, slate, wood and wood shakes. BOCA provides prescriptive installation requirements which address underlayment, fasteners, and permitted roof slopes. BOCA requires installation in accordance with approved manufacturer's installation instructions.
	2306.0	BOCA requires that flashing be installed at all roof openings, gutters, intersections of wall and roof and at change in roof slope or direction. FEMA does not identify specific flashing locations.

Recommendation: FEMA should stipulate the locations which require flashing.

FEMA-55	BOCA Codes	Analysis
4.3.8 Maintenance	Property Maintenance	See Analysis of BOCA National Property Maintenance Code.
	1702.6.6	No significant difference.
	1802.3.2	FEMA recommends that exposed steel be hot-dipped galvanized BOCA requires exposed steel to be protected from exposure i not fabricated from approved corrosion-resistant or galvanizec steel.
		FEMA recommends that the underside of raised building: (beams and joists) be covered with sheathing. BOCA leaves the specifics of the design up to the architect/engineer.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
5.1 General Design Considerations - Ground Level Obstructions	2101.6.3.3 2101.6.4.2	Both FEMA and BOCA do not Permit occupied spaces below the base flood elevation.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
5.1 General Design Considerations -CorrosionProtection	1503.3.5 1506.6.3	No significant difference.

Recommendation: None

FEMA-55		BOCA Codes	Analysis
5.1	General Design -Wind Considerations	1109.3 1109.4 1112.0	No significant difference.

Recommendation: None

FEMA-55		BOCA Codes	Analysis
5.2	Foundations - Piles	1213.10 1213.0-1221.0	BOCA allows piles of any approved materials. The materials and installation methods must comply with specific code requirements.

Recommendation: None

FEMA-55		BOCA Codes	Analysis
5.2	Foundations - Other Foundations	1205.0 - 1212.0	FEMA recommends that "strip" foundations be aligned perpendicular to the shoreline. BOCA requires footing design to be in accordance with the appropriate standard (AWPA C2 or C3, ACI 318) and does not require a specific orientation.

Recommendation: FEMA should consider referencing applicable standards for footing designs.

FEMA-55		BOCA Codes	Analysis
5.3	Slabs at Grade	1502.0-1506.0 1509.0	FEMA recognizes a difference between essential (structural) and non-essential (non structural) slab on grade. BOCA permits a minimum slab thickness of 3 1/2 inches and requires a vapor barrier under most installations. BOCA also references ACI 318 concerning the materials, design and installation of concrete.

Recommendation: FEMA should consider referencing ACI 318 for slab on grade design.

FEMA-55		BOCA Codes	Analysis
5.3	Grade Beams	1213.6	No significant difference.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
5.4 Superstructure	1102.0 1305.0	FEMA provides a discussion of the basic elements of low-to-mid size and high rise construction (design loads, piles, pile caps columns, beams, and shear walls). BOCA has no prescriptive requirements for the type of construction materials used in a structure. BOCA does not indicate a benefit of one materia over another but requires that all structures be designed for th appropriate loading conditions (wind, hydrostatic, hydrodynamic, etc.)
	2101.6.6	BOCA requires that buildings in high-flood or high-hazard zones be constructed of materials resistant to flood damage using construction methods to minimize flood damage.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
5.5 Elevated Floors	1102.0 1305.0	FEMA cites reinforced concrete and precast concrete as typical systems used for floor construction. BOCA does not require a specific method of construction nor the use of specific materials. BOCA requires that all structural components, connections and system be designed for the forces exerted upon them.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
5.6 Exterior walls	1102.0 1305.0	See FEMA-55 Section 5.5 comment.
	2101.6.3.3 2101.6.4.2	No difference
	None	FEMA requests that all fasteners be determined by the designer and not left to the discretion of the installer. FEMA recommends that manufacturer's installation standards and appropriate safety factors be applied to powder-activated fasteners used with concrete. BOCA does not stipulate responsibility or standards for these types of fasteners.

Recommendation: None

FEMA-55		BOCA Codes	Analysis
5.7	Recommendations Use of a Design Professional	108.1 2101.6.11.2 2101.6.11.3 2101.6.3.3	FEMA recommends an experienced design professional to be responsible for mid-and high-rise design. BOCA requires all design for new construction work, alteration repair, expansion, addition or modification work involving the practice of professional architecture or engineering be prepared by registered professional architects or engineers as certified by the state in which the project is to be located. All plans, specifications and computations must be signed and sealed by the responsible engineer or architect.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
Appendix A - Design Tables Figure A-1 Number of Piles Required Table A-1 Downward Loads per Pile Table A-2 Horizontal Wind Loads per Pile Table A-3 Minimum Embedment Depth of Piles Table A-4 Maximum Unbraced Height of Piles Supporting Breakaway Walls Table A-4.1 Maximum Unbraced Height of Piles Table A-5 Uplift Loads per Foot of Wall Table A-6 Uplift Loads per Pile Table A-7 Capacity of bolt of Floor Beam Connections Table A-8 Concrete Masonry Unit Piers Table A-9 Concrete Piers Figure A-2 Concrete Pier Cross Section Figure A-3 Grade Beams and Slabs Table A-10 Fastener Capacities in Shear Table A-11 Fastener Schedule for Breakaway Walls	1102.0 1109.3 1109.4 2101.6.3.2 2101.6.4.3	FEMA provides loading and design tables to assist in the design of coastal construction. Appendices D and E provide raw calculations and computer programs from which the values in Appendix A were derived. BOCA does not contain design and loading tables by which to design a structure. The performance language of the code states the minimum design requirements that must be met by the design professional. BOCA references many standards (ACI 318, ANSI A58.1, NFoPA NDS, etc.) that shall be used in the design of a building.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
Appendix B -Bracing B.1 Knee Bracing B.2 Truss Bracing B.2.1 Diagonals B.2.1.1 Lumber Diagonals B.2.1.2 Threadbar Diagonals B.2.2 Struts B.3 Grade Beams Table B-1 Horizontal Water Loads per pile Table B-2 Loads of Transverse Truss Members Table B-3 Allowable Loads for Single 2-by-8 Diagonals Table B-4 Allowable Loads for Single 3-by-8 Diagonals	1102.0 1109.3 1109.4 1213.6 2101.6.3.2 2101.6.4.3	FEMA provides further discussion of bracing options and loading tables to assist in the design of coastal construction. BOCA does not prescribe specific methods or procedures to follow in designing structural bracing. The performance oriented language of the code requires that all structural members and connections be designed to withstand the forces exerted upon them. BOCA references national standards (ACI 318, ANSI A58.1, NFoPA NDS etc.) to aid the designer.

Recommendation: None

FEMA-55	BOCA Codes	Analysis
Appendix D - Design Equations and Procedures D.1 Procedure A-1: Downward Loads per Pile D.2 Procedure A-2: Horizontal Wind Loads per Pile D.3 Procedure A-3: Minimum embedment Depth of Piles D.4 Procedure A-4: Maximum Unbraced Height of Piles D.5 Procedure A-4.1: Maximum Unbraced Height of Piles Supporting Breakaway Walls D.6 Procedure A-5: Uplift Loads per Foot of Walls D.7 Procedure A-6" Uplift Loads per Pile D.8 Procedure B-1: Horizontal Water Loads per Pile D.9 Procedure B-2: Loads Transferred to Foundation Truss Members	1102.0 1109.3 1109.4 1213.0 2101.6.3.2 2101.6.4.3	FEMA compiles a series of basic design equations and procedures to follow in the design of coastal construction. All values found in Appendix A were derived from these equations based on the assumptions stated. These equations may be used for design in unique situations where the general assumptions do not hold true. Being a performance oriented code, BOCA does not prescribe specific design equations and procedures. Rather, the code requires that all structural members and connection be designed to withstand the forces exerted upon them. BOCA references many national standards to guide the designer in measuring the code compliance of structures.

Recommendation: FEMA should require a geotechnical report to ensure sufficient load bearing capacity of the soil.

FEMA-55	BOCA Codes	Analysis
Appendix G - Sample Coastal Construction Code		FEMA incorporates the discussions, insights and recommendations found in Chapters 1 through 5 into enforceable code language. This sample code is intended as a base which local jurisdictions may amend to create their own coastal construction code as a supplement to the governing building code.
2. Purpose	100.0 2101.6	No difference.
3. Scope	100.2	FEMA applies only to new construction, additions to and improvements of single family, duplex, and multi-family residential structures.
4. Definitions	201.0	FEMA defines terms relative to flood provisions (i.e. base flood, dead load, etc) which are compatible with the application in BOCA. However, BOCA does not define all the terms listed in FEMA.
5. Elevation Standards	2101.6.3.1 2101.6.3.3 2101.6.4.1 2101.6.4.2	No differences
6. Determination of Loading Forces	1100.1	BOCA does not prescribe specific design procedures. BOCA identifies minimum performance requirements of a structure.
6.1 Water Loads 6.2 Wind Loads	1109.3 1109.4 1112.0	
7. Foundation Standards	1100.1 2101.6.3 2101.6.4 1205.0 - 1220.0	FEMA does not allow the use of spread footings and fill for structural support purposes.
7.1 Pile Foundation Design	1100.1 1213.0-1220.0	BOCA does not prescribe a specific method of pile design.
7.2 Column Foundation Design	1212.0	BOCA does not prescribe a specific method of pier design.
8. Anchoring Standards	2101.6.3.2	No difference

Recommendation: None

FEMA-55	BOCA Codes	Analysis
8.1 Connectors and Fasteners	Appendix C	FEMA does not permit toe-nailing as a principal method of connection. All metal connectors and fasteners are to be galvanized.
8.2 Beam to Pile Connectors		Refer to FEMA 55 Section 4.3.4.4 analysis.
8.3 Floor and Deck Connectors		Refer to FEMA 55 Section 4.3.4.3 and 4.3.2.4 analysis.
8.4 Exterior Wall Connection		Refer to FEMA 55 Section 4.3.2.2 and 4.3.2.6 analysis.
8.5 Ceiling Joist/Rafter Connections		Refer to FEMA 55 Section 4.3.2.8 analysis.
8.6 Projecting Members	None	BOCA does not restrict the size of the eaves or other overhangs.
9. Roof Sheathing	2303.1 2304.0 2305.0	FEMA requires roof sheathing at least 15.32 inch thick. All attaching devices shall be corrosion resistant material. FEMA prescribes that roof be sloped as steeply as practicable.
10. Protection of Openings		Refer to FEMA-55 Section 4.3.7.1 and 4.3.7.2.
11. Use of Space Below the Lowest Elevated Floor	2101.6.3.3 2101.6.4.2	BOCA does not prescribe specific design procedures for breakaway walls.
11.1 Breakaway Wall Design Standards		Relocate to FEMA 55 Section 4.3.5, 4.3.5.1 and 4.3.5.2 analysis.
11.2 Certification of Breakaway Walls		Relocate to FEMA 55 Section 4.3.5, 4.3.5.1 and 4.3.5.2 analysis.
12. Utilities		Relocate to FEMA 55 Section 4.3.6 analysis.
13. Certification Requirements	1102.2	Refer to FEMA 55 Section 5.7 analysis.
14. Reference Documents		BOCA references ANSI A58.1-1982 as does FEMA.

Recommendation: None

Manufactured Homes Installation in Flood Hazard Areas (FEMA-85)

FEMA-85		BOCA Codes	Analysis
Chapter III	Elevation on Fill (p.19)	1201.0 1202.0 1203.0	FEMA has prescriptive requirements on the use of fill material to raise the elevation of the manufactured home. However, Section (e)(6) of 44 CFR 60.3 prohibits the use of structural fill in V zones. The requirements address the use of fill under various floodwater conditions and include site preparation and fill placement. BOCA requires that the bearing value of soils is established through testing.
		2101.6.3.2 2101.6.4.3 2101.6.11.2 2101.6.11.3	BOCA requires that a registered professional architect or engineer provide plans and specifications indicating that the proposed foundation design will adequately resist any loads caused by flooding which may cause flotation, collapse, or permanent lateral movement of the structure, or which will scour or erode the soil material. FEMA limits the use of fills for elevating the manufactured home to areas where the floodwater velocity will not exceed 10 feet per second (fps). BOCA does not address maximum floodwater velocity.

Recommendation: FEMA-85 and 44 CFR 60.3 require coordination relative to the use of structural fill.

FEMA-85		BOCA Codes	Analysis
Chapter III	Elevated Foundations Piers (p.22)	1205.1 1212.0	FEMA states that the use of piers is inappropriate in areas subject to floodwater velocity. FEMA's requirements are specification oriented. FEMA limits pier height to 10 times least horizontal dimension; BOCA states maximum of 12 times least dimension for other than single family structures and light structures. BOCA would rely on a designed system in accordance with the referenced standards.

Recommendation: This is a minor conflict, which, if necessary would require FEMA to conduct an evaluation of the relevant standards to determine a "correct" maximum pier height.

FEMA-85		BOCA Codes	Analysis
Chapter III	Posts (p.23)	1207.2 2101.6.3.2 2101.6.4.3	FEMA states some general requirements for the use of wood, steel, or concrete posts. BOCA says pole buildings shall be designed in an approved manner. The provisions of BOCA are not geared to any specific type of structure but rather structures in general. Poles shall be treated accordingly to AWPA C2 or C4 for decay resistance.

Recommendation: None

FEMA-85		BOCA Codes	Analysis
Chapter III	Piles (p.25)	1213.0 1214.0 1215.0 1216.0 1217.0 1218.0 1219.0 1220.0 1221.0 2101.6.4.3	FEMA states that the use of piles is appropriate in areas having high floodwater velocities. Details are given on how to drive the pile and how to increase lateral force resistance. BOCA provides design and driving requirements for different types of piles.

Recommendation: None

FEMA-85		BOCA Codes	Analysis
Chapter III	Horizontal Beams (p.26)	1102.1	FEMA and BOCA both require that the loads associated with the manufactured home are safely transferred to the foundation system.

Recommendation: None

FEMA-85		BOCA Codes	Analysis
Chapter III	Bracing Elevated Foundations (P. 26)	1102.1 1213.4 1213.6	Both FEMA and BOCA require bracing to resist lateral loads.

Recommendation: None

FEMA-85		BOCA Codes	Analysis
Chapter III	Perimeter Enclosure (p.27)	2101.6.3.3 2101.6.4.2 2101.7.1.1	FEMA requires that the skirting around the manufactured home be designed to yield under the forces of floodwaters and not transfer loads to the foundation, BOCA requires the same.

Recommendation: None

FEMA-85		BOCA Codes	Analysis
Chapter 23	Anchoring (P.28)	620.3.1 1109.3 1109.4 1112.0 2101.6.3.2 2101.6.7	FEMA expounds on the various methods available to anchor a Manufactured home so it can resist wind forces. BOCA relies upon the design and certification by an architect or engineer without specifying specific methods.

Recommendation: None

FEMA-85		BOCA Codes	Analysis
Chapter IV A	Flood Forces and Their Application	1102.0 - 1104.0 1106.0 - 1107.0 1104.3 - 1109.4 1111.0 - 1115.0	FEMA provides overviews of specific engineering calculations used to determine the hydrostatic and hydrodynamic forces including impact from debris and scour due to moving floodwater. Roof live load and wind load maps of the United States are also included. BOCA relies upon a professional engineer or architect to design the structure to support all applicable loads in accordance with acceptable engineering practice. FEMA provides a roof load and wind zone map. The snow loads indicated in FEMA are higher than BOCA and the wind load map is also different from BOCA. BOCA's maps are based on ANSI A58-1 - 1982 (ASCE 7).

Recommendation: FEMA should update their wind and snow load maps to the latest currently published by ASCE.

FEMA-85		BOCA Codes	Analysis
Chapter IV B	Evaluation of Elevated Foundations	108.1 Article 11	FEMA discussed the application of design loads to manufactured housing foundation systems. BOCA relies upon the registered engineer or architect to design the structure to resist all required design loads for all structures.
		1201.0 1202.0 1203.0	FEMA discusses the bearing values associates with various soils. BOCA contains similar information.
		108.1 1212.0 1406.0	FEMA specifies pier dimensions and location of reinforcement bars for acceptable pier design for various design considerations BOCA relies upon a system designed by a registered architect or engineer in accordance with the code and its referenced standards.
		108.1 1213.0 1214.0 1801.0	FEMA provides information necessary for the design of pile foundations to provide support for manufactured homes, and also states that a registered professional engineer should design the pile foundation under certain circumstances. BOCA relies upon an engineered design, but also provides details on pile-driving, spacing, splicing, etc.

Recommendation: None. The differences between FEMA and BOCA are related to the specification or performance nature FEMA and BOCA respectively.

FEMA-85	BOCA Codes	Analysis
Chapter IV C Bracing Support and Connections for Elevated Foundations	108.1 1213.6 1214.1 1214.6	FEMA provides design requirements and formulas for determining the size and location of lateral bracing and horizontal support beams for posts and piles. BOCA requires that all bracing methods be designed by an engineer or architect.
	108.1 1102.1 1109.5 1113.11 1303.1 1701.1	FEMA provides design information for all connections. BOCA relies upon an engineered system using materials which have the necessary properties and dimensions to support all loads.

Recommendation: None

FEMA-85	BOCA Codes	Analysis
Chapter IV D Additional Design Considerations	801.1 805.2 2101.6.8	FEMA indicates that an access and egress path must be provided to allow evacuation and rescue. BOCA's general egress requirements address maintenance of exits, however, BOCA specifically permits portions of the means of egress to be below the base flood elevation which would probably render the exit unusable.

Recommendation: It is not clear how the recommendations found in FEMA would be implemented relative to providing a means of evacuation and/or rescue during a flood event. In all likelihood, compliance with these recommendations would preclude a structure from being built in an area prone to flooding.

FEMA-85	BOCA Codes	Analysis
Appendix D	108.1 Article 12	FEMA provides formulas and equations for calculating loads for the design of structural members. BOCA relies upon a design and supporting calculations prepared by a registered professional engineer or architect, and references nationally recognized standards to be used for the design of structural members made of specific materials.

Recommendation: None. It is presumed that the registered engineer or architect will rely upon accepted engineering practice as does FEMA.

FEMA-85	BOCA Codes	Analysis
Appendix E	108.1 620.3 2101.6.3.2 2101.6.4.3 2101.6.7	FEMA provides design information for determining the necessary anchorage for a manufactured home to resist buoyancy and drag forces cause by flooding. BOCA relies on a design and supporting calculations prepared by a registered professional engineer or architect.

Recommendation: None. It is presumed that the registered engineer or architect will rely upon accepted engineering practice as does FEMA.

Floodproofing Non-Residential Structures (FEMA-102)

FEMA-102	BOCA Codes	Analysis
Chapter I E. Contingent Floodproofing Measures	107.4 108.1 2101.6.3.4 2101.6.4.2	FEMA discusses the possibility of utilizing specific contingent floodproofing measures. BOCA permits the use of such contingent floodproofing measures as flood shields and watertight doors for buildings in A Zones only.

Recommendation: None

FEMA-102	BOCA Code	Analysis
Chapter I F. Types of Contingent Measures	107.4 108.1 2101.6.3.3 2101.6.3.4 2101.6.11.2	FEMA addresses the use of flood shields, watertight doors, and moveable floodwalls. BOCA permits these types of devices to be used in Flood-Hazard (A-Zones), but not in high-hazard (V Zones).

Recommendation: None

FEMA-102	BOCA Codes	Analysis
Chapter III Floodproofing Design Permanent and Contingent Measures B. Elevation on Fill	1201.0 1202.0 1203.0	FEMA has prescriptive requirements for the use of fill material to raise the elevation of the manufactured home. However, Section (e)(6) of 44 CFR 60.3 prohibits the use of structural fill in V zones. The requirements address the use of fill under various floodwater conditions and include site preparation and fill placement. BOCA requires the bearing value of soils to be established through testing.
	1224.0 2101.6.3.2 2101.6.3.4 2101.6.4.3 2101.6.6 2101.6.11.2 2101.6.11.3	BOCA requires that a registered professional architect or engineer provide plans and specifications indicating that the proposed foundation design will adequately resist any loads caused by flooding which may cause flotation, collapse, leakage, or permanent lateral movement of the structure, or which will scour or erode the soil material. FEMA limits the use of fills for elevating the manufactured home to areas where the floodwater velocity will not exceed 10 feet per second (fps). BOCA does not address maximum floodwater velocity.

Recommendation: FEMA-102 and 44 CFR 60.3 require coordination relative to the use of structural fill.

FEMA-102	BOCA Codes	Analysis
Chapter III C. Elevation on Posts, Piles, Piers, or Walls	1207.2 1406.0 1801.0 2101.6.3.7 2101.6.4.3 2101.6.6	FEMA states some general requirements for the use of wood, steel, or concrete posts. BOCA says pole buildings shall be designed in an approved manner. Poles shall be treated accordingly to AWPA C2 or C4 for decay resistance.

Recommendation: FEMA should include a reference to the appropriate reference standard for pressure preservative treatment of wood.

FEMA-102	BOCA Codes	Analysis
Piles	1213.0 1214.0 1215.0 1216.0 1217.0 1218.0 1219.0 1220.0 1221.0 1702.6 1802.3 2101.6.4.3 2101.6.6	FEMA states that the use of piles is appropriate in areas having high floodwater velocities. Details are given on how to drive the pile and how to increase lateral force resistance. BOCA provides design and driving requirements for different materials and types of piles. BOCA relies upon material standards for pile materials.

Recommendation: None

FEMA-102	BOCA Codes	Analysis
Piers and Walls	1205.0 1209.0 1212.0 2101.6.6	FEMA provides specifications for the minimum dimensions of piers. BOCA specifies material standards and relies on an engineered design for piers.

Recommendation: None

FEMA-102	BOCA Codes	Analysis
Bracing	1102.1 1213.4 1213.6 2101.6.6	FEMA specifies materials for bracing. BOCA requires bracing to be part of the engineered design.

Recommendation: None

FEMA-102	BOCA Codes	Analysis
Maintenance	2101.6.6 2101.6.9	FEMA requires that regular maintenance be performed o specific materials used for elevating structures. BOCA state that after a flood, the structure is permitted to be repaired to its original state and must always be inspected to obtain its certificate of occupancy.

Recommendation: FEMA should evaluate how the provisions in FEMA-102 correlate with the NFIP requirements relative to "substantial improvement".

FEMA-102	BOCA Codes	Analysis
Chapter III D. Waterproof Construction	108.1	FEMA provides design aids but requires a design professional t accomplish the design. BOCA requires design by a registere professional engineer or architect.
Wall Strength	108.1 2101.6 Article 14 Article 15	FEMA discusses the general principles involved with designin a masonry or concrete wall to resist flood loads, but defers to a registered professional engineer or architect for the actual design, just as BOCA does.

Recommendation: None

FEMA-102	BOCA Codes	Analysis
Floor Strength and Structural Stability	108.1 Article 15	FEMA states that cast-in-place concrete is the only materia which can adequately resist hydrostatic uplift pressures. BOCA relies upon a system designed by a registered professional engineer or architect.

Recommendation: None

FEMA-102	BOCA Codes	Analysis
Counteracting of Hydrostatic Forces	108.1 1224.2.1 1224.3 1224.4 1224.5 Article 15	FEMA and BOCA address subsoil drainage as a method of reducing hydrostatic uplift pressure. FEMA also provide outlines of other methods such as the use of impervious cutoffs pressure relief systems, and anchorage to reduce hydrostatic uplift pressures. BOCA specifies none of the above but relies upon a system designed by a registered professional engineer or architect.

Recommendation: None

FEMA-102	BOCA Codes	Analysis
Waterproofing	107.4 108.1 1224.4.2 Article 14 Article 15	FEMA addresses the use of impervious concrete, sealants and membranes. BOCA specifies membrane protection for the wall and an approved method for joints and penetrations, but the method is subject to approval by the code official.

Recommendation: None

FEMA-102	BOCA Codes	Analysis
Watertight Cores	107.4 108.1	FEMA includes this method of protection as an alternative to waterproofing the exterior walls. BOCA does not directly address this method of waterproofing.

Recommendation: None

FEMA-102	BOCA Codes	Analysis
Closures and Flood Shields	108.1 2101.6.3.4	FEMA provides details for construction, testing and storing effective flood shields and closures. BOCA permits such flood shields and closures to be used in flood hazard zones (A Zones) only, and they must be designed by a registered professional engineer or architect.

Recommendation: None

FEMA-102	BOCA Codes	Analysis
Floodwall Design	108.1 2101.6.6 Article 14 Article 15	FEMA provides the engineering basis for designing a stable floodwall. BOCA relies upon a registered professional engineer or architect to design the floodwall.

Recommendation: None

FEMA-102	BOCA Codes	Analysis
Floodwall Maintenance	Property Maintenance	See Analysis to BOCA Property Maintenance Code.

Recommendation: None

FEMA-102	BOCA Codes	Analysis
Chapter IV C Floodproofing Utilities	2101.6.5 2101.6.8	The requirements of FEMA and BOCA are similar. FEMA describes prescriptive approaches to protecting utilities, and BOCA relies upon the design of a professional engineer or architect to achieve the desired results.

Recommendation: None

FEMA-102	BOCA Codes	Analysis
Appendix B Glossary	Article 2	BOCA does not contain the terms in Appendix B of FEMA, with the exception of "backflow preventer" and "structure", BOCA's definition of "backflow preventer" is similar to FEMA but FEMA defines "structure" as a walled and roofed building (or tank) and BOCA's definition is "that which is built or constructed."

Recommendation: None

FEMA-102	BOCA Codes	Analysis
Appendix D Floodproofing Performance Criteria B. Design Loads	1102.0 1109.3 1109.4 2101.6.1 2101.6.3.2 2101.6.4.3 2101.6.6 2101.6.11	FEMA describes in detail the loads on a structure caused by floodwaters. BOCA provides information for determining the appropriate snow, live, wind, and seismic loads, but does not address the calculation of floodwater loads.

Recommendation: FEMA should provide data for determining floodwater depth and velocity for use in hydrostatic and hydrodynamic load calculations. If no such data exists, a research effort should be undertaken to establish such data as the basis to develop specific hydrodynamic design loads for incorporation into the model codes.

FEMA-102	BOCA Codes	Analysis
Appendix D Performance Criteria	Article 11 2101.6.3.2 2101.6.4.3 2101.6.5 2101.6.6 2101.6.8 2101.6.11	FEMA addresses load combinations and construction techniques, as well as designing for the effects of floodwaters. FEMA requires that continuous lighting and operation of other emergency equipment be made available in some structures during and after a flood. FEMA provides specific performance criteria for all building systems, BOCA relies upon a design prepared by a registered professional engineer or architect. BOCA stipulates that the equipment must be above the BFE or if below, than it must be designed to resist the flood waters and remain operational. Both FEMA and BOCA require the sanitary sewer system to be designed to prevent sewage from discharging during a flood.

Recommendation: None

Design Manual for Retrofitting Flood Prone Structures (FEMA-114)

FEMA-114	BOCA Codes	Analysis
3.5 Elevation Onto Extended Foundation System	1112.3. 1113.4 1109.3 1206.1 2101.6.3.2 2101.6.4.3	FEMA states that footings and foundations shall be able to withstand the loading due to flooding. This may necessitate the existing foundation to be upgraded. The foundation should be vented with 1 square inch of opening for every square foot of floor area of the enclosure. Foundations shall also have a rodent barrier, extended backfill and in some cases, breakaway walls. FEMA does not differentiate between the A-zone requirements and V-zone requirements. BOCA states that foundations shall be designed for all loads imposed on the foundation. Section 1109.3 states that all foundations and footings subjected to water pressure shall be designed for a uniform distributed uplift equal to the full hydrostatic pressure.

Recommendation: FEMA requires a revision to clarify when openings to equalize flood waters are required (A zones) versus breakaway walls (V zones).

FEMA-114	BOCA Codes	Analysis
3.12 Technical Design Criteria - Extended Wall Foundations	1109.4 1500.1	FEMA requires walls to be extended to provide the necessary resistance to flood waters impacting elevated walls. Bonding of extensions to existing walls requires a clean wall surface which is free from dirt, debris and loose particles. Hydrostatic and hydrodynamic impact and dead loads shall be considered. BOCA Section 1500.1 BOCA references the concrete standard, ACI 318 and 1109.4 requires elevated structures and components to be designed to resist hydrodynamic forces in A or V Zones.

Recommendation: None

FEMA-114	BOCA Codes	Analysis
3.13 Technical Design Criteria - Anchorage of Superstructure to Foundation	2101.6.3.2 2101.6.4.3 1703.2.11	Anchor bolts of a 1/2" diameter with a maximum spacing of 4 feet and an embedment depth of 18" are required by FEMA. BOCA's embedment depths are 8" (concrete) and 15" (grouted masonry). The total reaction force due to hydrostatic, hydrodynamic and/or impact loads must be transferred through anchor bolts into the supporting system. FEMA permits expansion anchors as a equivalent means of anchorage. BOCA includes performance criteria which requires the anchors to resist floatation, collapse or lateral movement. However, BOCA's anchorage provision for wood specifies that the anchorage must resist wind uplift and the maximum spacing is 8 feet.

Recommendation: BOCA should revise the provisions of Section 1703.2.11 to reference the design as being capable of resisting both uplift and lateral forces due to flooding (and wind). See also FEMA-54 - Pier Foundation Connections.

FEMA-114	BOCA Codes	Analysis
3.14 Technical Design Criteria - Open Foundations	1212.0 1213.0	FEMA defines piers as vertical structural members with a height to least-lateral dimension of less than 3. Columns, defined by FEMA, have a height to least lateral dimension of 3 or more. Piles are defined as long slender structural members embedded to support loading. BOCA does not define the terms and the height to the thickness ratios prescribed by BOCA for piers are used to design the structural element in accordance with the referenced concrete or masonry standard.

Recommendation: None. Differences between FEMA and BOCA text are due to prescriptive requirements versus performance requirements which result in comparable levels of performance.

FEMA-114		BOCA Codes	Analysis
6.1, 6.2, 6.3	Floodwalls	1201.1 1203.1 1109.4	FEMA specifies that a floodwall is to be designed based on the type of flooding expected, erosion potential, possible obstructions and impact on flooding of adjacent property. Accordingly, closures must be constructed and drainage shall be provided for. Also, FEMA states that floodwalls shall have a water collection system and the soil should be evaluated for it's ability to support the loads imposed and seepage. BOCA also requires a soil test and does not specifically state floodwalls as an option but relies on a designed system to resist the loads.

Recommendation: None

FEMA-114	BOCA Codes	Analysis
6.5 Technical Design Criteria	1109.4 1102.1	Building Code Requirements for Concrete Masonry Structures & ACI 531-70 are listed as standards in FEMA. This section also includes many design considerations for the design of floodwalls. BOCA relies on the 1988 edition of ACI 530 and does not provide specifics but rather relies on a designed system to withstand the loads.

Recommendation: FEMA should update to the latest referenced standard for masonry - ACI 530/ASCE 5-88.

FEMA-114	BOCA Codes	Analysis
7.1 and 7.2 Closures	1109.3 1109.4 1223.1	FEMA cites that closures (temporary or permanent) are used for openings such as doors and windows. BOCA Sections 1109.3, 1109.4 and 1223.1 require buildings to be constructed in areas where flooding occurs to resist the hydrostatic and hydrodynamic loadings but does not require prescriptive requirements for the openings.

Recommendation: None

FEMA-114	BOCA Codes	Analysis
7.3 Low Profile Permanent Closures	1109.3 1109.4 1223.1 1224.4	FEMA requires that permanent floodwalls be built to protec various openings in the building. These floodwalls shall be buil of brick or concrete and be constructed tight to the structure. Sealants may also be required for seepage. BOCA states that the walls exposed to possible hydrostatic pressure condition: shall be waterproofed with two-ply hot-mopped felts not les: than 6 mil. polyvinyl chloride, 40 mil polymer modified asphalt, 6 mil polyethylene or an approved material. BOCA does not require closures for the openings but if provided, the design o: the wall would be based on the hydrostatic and hydrodynami(forces in accordance with accepted engineering principles.

Recommendation: None

FEMA-114	BOCA Codes	Analysis
7.4 Closure materials and Construction	1109.3 1223.1 1109.4 1224.4	FEMA requires that the construction of closures for openings are required to resist the flood pressures incurred. The closure should be made watertight through the use of neoprene and rubber. See Section 7.3 for BOCA analysis.

Recommendation: None

FEMA-114	BOCA Codes	Analysis
7.6 Technical Design Criteria	1109.3 1223.1 1109.4	FEMA stipulates that the closure must resist hydrostatic, hydrodynamic and impact loading. Formulas for stress and strain are provided. In addition the Plywood Design Specification was cited as a reference. See Section 7.3 for BOCA analysis.

Recommendation: None

FEMA-114	BOCA Codes	Analysis
8.1 and 8.2 Sealants	1224.0 1109.4	FEMA states that based on an investigation from the U.S. Army Corps. of Engineers, buildings may tend to float or structural elements buckle if constructed of brick or masonry and the flood depth is 2-3 feet. Impact loads caused from debris should also be considered in addition to uplift loading. BOCA does not identify potential problem scenarios but rather relies on a designed system.

Recommendation: None

FEMA-114	BOCA Code	Analysis
8.3 Sealing Techniques	1306.1 1224.0 1109.4	FEMA describes the proper construction for waterproofing brick faced walls. FEMA also describes the possible uses of polyurethanes. Drainage systems are also described. BOCA does not provide any sealing techniques but rather relies on a designed system.

Recommendation: None

FEMA-114	BOCA Codes	Analysis
8.4 Closures	1109.3 1109.4 1224.0	FEMA states that closures used for retrofitting typically include a waterproofing gasket in conjunction with a reinforced door jamb. Shields can also be used for windows. BOCA does not provide prescriptive methods for constructing closures but rather relies on a designed system.

Recommendation: None

FEMA-114	BOCA Codes	Analysis
8.5 Design details	1109.3 1109.4 1224.0	FEMA cites studies of the performance of block walls under hydrostatic pressure and indicates the need for a structural engineer to design the system. Again BOCA requires all designs to be done through accepted engineering practice.

Recommendation: None

FEMA-114	BOCA Codes	Analysis
8.7 Technical Design Criteria	1224.5.2 1202.0 1222.0 1500.0	FEMA states that existing basements may require additional reinforcing when subjected to the forces of soil and water. Foundation walls consisting of concrete shall conform to the requirements of ACI 318. Anchorage of the foundation as well as drainage systems should be analyzed by an engineer. BOCA requires foundation walls to be designed to resist the imposed loads and also references ACI 318.

Recommendation: None

FEMA-114	BOCA Codes	Analysis
9.1, 9.2, 9.3, 9.4 Protection of Utilities	2101.6.5	Both BOCA and FEMA discuss precautions required to prevent damage to utilities such as gas and electrical service. Such techniques include installation of utility connections above the flood level. Utilities within the building basement may be shielded with floodwalls or suspended from platforms.

Recommendation: None

FEMA-114	BOCA Codes	Analysis
9.5 Utility Relocations to Existing Space	2101.6.5	FEMA states that relocation of the utilities is another option which the homeowner may take. This would also be an option under BOCA but is not stated as such.

Recommendation: None

FEMA-114	BOCA Codes	Analysis
9.6 Utility Relocations to New Space	2101.6.5	FEMA indicates that utilities may be stored in an elevated room if there is not an area within the residence which is available. This would also be an option under BOCA as well but is not stated as such.

Recommendation: None

FEMA-114	BOCA Code	Analysis
10.4 Floating Structures	None	FEMA identifies a unique type of structural approach to floodproofing - a floating structure. This structure is permitted to rise and fall with the floodwaters but is restrained from lateral movement. Utility connections are made with flexible connections. BOCA does not indicate provisions for this type of structure but as a performance code, this would be permitted as approved by the code official.

Recommendation: None

FEMA-114	BOCA Code	Analysis
Appendix C Forces	1109.4	FEMA provides design equations for hydrostatic pressure, buoyancy, hydrodynamic pressure, etc., coupled with examples. BOCA relies on a design system in accordance with accepted engineering principles.

Recommendation: None

Alluvial Fans: Hazards and Management (FEMA-165)

FEMA-165		BOCA Code	Analysis
P.10 #6	Windows and Doors	2101.6.4 2101.6.4.2	FEMA recommends that windows and doors not be used on the uphill side of the structure; but if they are, they should be reinforced to strengthen resistance against debris and hydrodynamic forces. BOCA does not contain specific requirements for alluvial fan flooding, but this type of flooding is usually included in high-hazard zones (V Zones). BOCA requires that spaces below the base flood elevation are not used for human occupancy and must be constructed to allow the walls and partitions to break away under the forces of wind and water loads.

Recommendation: BOCA does not currently address flooding due to alluvial fans, per se, which occurs mostly at the base of mountain fronts in the Western United States (as stated on page 1 of FEMA-165). Because alluvial fan flooding has not been shown to be a relevant problem in areas governed by BOCA, it is recommended that no change be made to the National Codes.

MCRB	BOCA Code	Analysis
III.A.1 Unreinforced block	1109.3 1009.4 1222.0 Article 14	FEMA provides a general description of unreinforced masonry basement walls (8"-10" thick) and also recommends they only b used for "minimal loadings." BOCA includes requirements fo these walls (mortar, minimum thickness, etc.), references ACI 530/ASCE-88, and requires a system designed to resist imposed loads.

Recommendation: FEMA should reference the masonry design standard, ACI 530/ASCE-88 and should reconsider its recommendation that masonry be used only for "minimal loadings" when the system is properly designed.

MCRB	BOCA Code	Analysis
III.A.2 Reinforced and grouted block	1109.3 1109.4 1222.0 Article 14	FEMA provides a general description of reinforced masonr basement walls. See Analysis to MCRB III.A.1.

Recommendation: See MCRB Section III.A.1.

MCRB	BOCA Code	Analysis
III.A.3 Unreinforced concrete	1109.3 1109.4 1222.0 Article 15	FEMA provides a general description of unreinforced concrete basement walls (8"). BOCA includes requirements for these walls (f'_c, admixtures, placing, etc.), references ACI 318.1-89 and requires a designed system.

Recommendation: FEMA should reference the plain concrete design standard, ACI 318.1-89.

MCRB	BOCA Code	Analysis
III.A.4 Reinforced concrete	1109.3 1109.4 1222.0 Article 15	See Analysis to MCRB III.A.3. Additionally, BOCA references ACI 318-89.

Recommendation: FEMA should reference the reinforced concrete design standard, ACI 318-89.

MCRB	BOCA Code	Analysis
III.A.5 Stone,cribbing and planking	1109.3 1109.4 1222.2.4	FEMA acknowledges the past use of rubble stone but does not provide criteria for use. BOCA requires a designed system.

Recommendation: None

MCRB	BOCA Code	Analysis
III.A.6 Treated wood foundations	1109.3 1109.4 1207.3	FEMA indicates a lack of data for wood foundations under flooded conditions. BOCA references NFoPA TR7 for wood foundation systems.

Recommendation: FEMA should review the referenced standard NFoPA TR7-87 to determine applicability to flooded conditions.

MCRB	BOCA Code	Analysis
III.A.7 Variations of foundations	1109.3 1109.4 1222.0 Article 14 Article 15	FEMA summarizes the differences/benefit of partially reinforced masonry, unreinforced masonry, plain concrete and reinforced concrete. BOCA requires a designed system.

Recommendation: None

MCRB	BOCA Code	Analysis
III.A.8 Excavation and backfilling	1109.5 1201.1 1202.1 1205.1 1206.1 1206.2	FEMA provides general guidelines for excavation and backfilling. Both FEMA and BOCA require the foundation to be below the frost depth and the soil to be capable of supporting the loads.

Recommendation: None

MCRB	BOCA Code	Analysis
III.A.9 Formwork	1505.0	Both FEMA and BOCA require the formwork to be designed and constructed to withstand the imposed loads and to prevent leakage of cement paste.

Recommendation: None

MCRB	BOCA Code	Analysis
III.B.1 Basement slab	1109.3 1509.1	FEMA cites a 4" concrete slab thickness for basement slabs and acknowledges the use of 3" and less. FEMA also cites the use (but does not mandate) wire mesh. BOCA requires a 3½" slab thickness with no requirement for mesh but would require the slab thickness to be verified as adequate if subjected to hydrostatic pressures.

Recommendation: None

MCRB	BOCA Code	Analysis
III.B.2 Structural basement slab	1109.3 1509.1	FEMA requires a 6 inch slab with rebar for "undrained systems" and 4 inch slab with wire mesh for "drained systems." BOCA does not include requirements for a "drained" versus "undrained" systems but rather relies on a designed system to resist hydrostatic loads.

Recommendation: None

MCRB	BOCA Code	Analysis
III.B.3 Footing	1109.3 1109.4 1206.1 1209.3	FEMA cites a typical wall footing as 8 by 16 inches and stipulates a depth below frost. BOCA requires a minimum 6 inches thickness for single family houses with the width based on the allowable bearing pressure. BOCA's 6 inch minimum would require the footing thickness to be verified as adequate if subjected to hydrostatic pressures. BOCA also requires a depth below frost.

Recommendation: None

MCRB	BOCA Code	Analysis
III.B.4 Underdrain system (sumps and pumps)	1109.3 1109.4 1224.0	FEMA cites the benefits of a "gravel collector" adjacent to the bottom of the foundation wall but does not require drain tile. FEMA states that tile, if used, should be 4"-6" in diameter with open joints or perforated pipe. FEMA requires an adequate outlet (sump, sewer, gravity, etc.). BOCA requires a ground water table investigation. If hydrostatic pressure will not occur, BOCA requires "dampproofing" and cites dampproofing materials and the need for a foundation drain. If hydrostatic pressure exists, BOCA requires "waterproofing" and cites waterproofing materials. It should be noted that in flood prone areas, BOCA requires the residential basement to be above the BFE if used for human occupancy and therefore the provisions for dampproofing and waterproofing are only intended to abate the hazards of ground water.

Recommendation: The FEMA MCRB Manual discusses the design and construction of residential basement walls subjected to hydrostatic and hydrodynamic loads (i.e. below the BFE). The BOCA code does not permit the water-resistant design option for residential structures with floors usable for human occupancy below the BFE-this option is acceptable for all uses except residential. FEMA NFIP 44 CFR 60.3 (c)(2) also requires "residential structures...(including basements) to be elevated to or above the base flood level..."-unless a variance is granted in accordance with NFIP 44 CFR 60.6. Therefore, FEMA should clarify the use of the MCRB with respect to residential basements used as occupiable spaces.

MCRB	BOCA Code	Analysis
III.B.5.a Ground surface slope-site investigation	1224.2	FEMA and BOCA require an evaluation of the ground water table.

Recommendation: None

MCRB	BOCA Code	Analysis
III.B.5.b Grading and surface drainage	1224.8	FEMA requires the grade to be sloped 6 inches in 10 feet from the basement wall and splash blocks (3 feet) to direct rain water from downspouts. BOCA also requires drainage from the foundation but does not prescribe the slope or details.

Recommendation: None

MCRB	BOCA Code	Analysis
III.B.6 Seepage quantities	1224.5.3	FEMA contains a typical flow analysis procedure to size the sump and pump. BOCA requires the drainage system to discharge into an approved system but does not provide a basis for the design. See also Analysis of BOCA National Plumbing Code.

Recommendation: None

MCRB	BOCA Code	Analysis
III.B.7.a Penetrations	1224.4.3 2101.6.5 2101.6.8	FEMA requires penetrations to be pressure sealed and utility services (except water and sanitary sewer) to enter the house above the BFE. BOCA requires service utilities to be above the BFE or protected and capable of resisting the imposed loads. See also Analysis of BOCA National Plumbing Code.

Recommendation: None

MCRB	BOCA Code	Analysis
III.B.7.b Cracks and joints	Article 15	FEMA states problems of concrete cracking due to shrinkage and areas of stress concentrations. FEMA contains recommendations to reduce cracking: limiting slump, types of aggregate, placement, consolidation, air entraining admixtures, curing, reinforcement, and joints (control, isolation and construction). BOCA relies on a reference to ACI 318-89, and referenced standards for cement and aggregate (see Analysis to FEMA-54, pages 94-95). BOCA prescribes f'_c, air entrainment for freeze thaw only, mixing requirements, curing requirements, concrete acceptance criteria, cover to reinforcement, etc. BOCA does not include requirements for control or isolation joints - this is left up to the designer.

Recommendation: FEMA should consider referencing the applicable standards for concrete.

MCRB	BOCA Code	Analysis
III.B.7.c Waterproofing	None	See Analysis to Sections III.B.4 and III.B.6

Recommendation: None

MCRB	BOCA Code	Analysis
III.B.8 Plumbing subsystems	2101.6.5 2101.6.8	FEMA recommends a sump pump size. FEMA and BOCA require plumbing materials to be capable of resisting the loads and require back flow prevention. See Analysis to BOCA National Plumbing Code.

Recommendation: None

MCRB	BOCA Code	Analysis
III.B.9 Anchorage	1109.3 1109.4 2101.6.3.2	FEMA provides an example for determining the forces due to flood waters and requires the structure to resist such forces. BOCA also requires adequate anchorage but provides no example.

Recommendation: See MCRB Section V.B.1.

MCRB	BOCA Code	Analysis
III.B.10 Concrete construction practices	1504.0	Both FEMA and BOCA provide requirements for placement of concrete although FEMA's provisions are more in general terms while BOCA provides definitive specific requirements.

Recommendation: See MCRB Section III.B.7b

MCRB	BOCA Code	Analysis
III.B.11 Block construction practices	Article 14	FEMA provides general requirements for masonry construction while BOCA references ACI-530/ASCE 5. Both FEMA and BOCA require either type M or type S mortar.

Recommendation: See MCRB Section III.A.1.

MCRB	BOCA Code	Analysis
III.C.1.a-l.d Soil loads	1109.3 1109.4 1201.1	FEMA provides guidelines for soil classification (sand, silt, clay) to determine lateral pressures and includes a design example. FEMA also acknowledges expansive soils, permeability and saturation of soil but provides no criteria. BOCA only requires a soils report to determine the properties of the soil in order for the designer to anticipate the conditions of use and design accordingly.

Recommendation: None

MCRB	BOCA Code	Analysis
III.C.1.e Erosion	1224.8	FEMA addresses the use of vegetation and proper drainage to avoid erosion. BOCA also requires measures to be taken to prevent soil erosion but does not provide criteria.

Recommendation: None

MCRB	BOCA Code	Analysis
III.C.1.f Backfill	1109.1 1201.1 1222.2.2	FEMA discusses the different types of soil materials - clays, cohesionless soils, and cohesive soils as they relate to lateral earth pressures. FEMA provides presumptive design equivalent fluid weights for different soil types. BOCA requires soil testing and the test results to be used in the determination of the appropriate equivalent fluid weight. It should be noted that the empirical foundation wall requirements in BOCA are based on a maximum equivalent fluid weight of 30 pcf.

Recommendation: None

MCRB	BOCA Code	Analysis
III.C.2 Water table	None	FEMA relates the water table to soil stresses.

Recommendation: None

MCRB	BOCA Code	Analysis
III.C.3 Superstructure loads and buoyancy	1102.1 1104.1 1106.0 1107.0 1109.3 1110.0 1111.0	FEMA provides a design example to calculate the gravity load of the dwelling on the supporting soil (superstructure and basement) and compares this load to the force of buoyancy due to the water table. This is used to determine the anchorage requirements for buoyancy. BOCA does not provide examples but rather relies on a designed system. Upon cursory review of the FEMA design example, it would be considered unconservative to include live loads (10 psf first floor) in the buoyancy calculations due to the fact that these loads may not always be present which may lead to an unconservative anchorage design.

Recommendation: FEMA should review the calculations relative to the inclusion of live load in buoyancy considerations.

MCRB	BOCA Code	Analysis
III.C.4.d Flood velocity	1109.4	FEMA and BOCA require flood velocity waters to be considered in the design.

Recommendation: None

MCRB	BOCA Code	Analysis
III.C.4.e Sediment	2101.6.5 2101.6.6	FEMA cites the problems caused to contents and equipment due to flood water-deposited sediment. BOCA requires placement of mechanical and electrical systems above the BFE or to be protected. BOCA includes a general requirement for buildings to be constructed of materials resistant to flood damage.

Recommendation: None

MCRB	BOCA Code	Analysis
III.C.4.f Rate of rise	1102.1 1109.3 11009.4 2101.6.3.2	FEMA recommends that rate-of-rise information be considered in the design. BOCA does not specifically acknowledge this consideration but this would fall under the general requirement for a design to resist flooding.

Recommendation: None

MCRB	BOCA Code	Analysis
III.C.4.g Hydraulic relations	1102.1 1109.3 1109.4 2101.6.3.2	FEMA cites design considerations of flood water velocity, erosion, sediment, depth, and watershed hydrology. BOCA does not specifically acknowledge these considerations but this would fall under the general requirements for a design to resist flooding.

Recommendation: FEMA should study the conditions of flood water velocity, erosion, sediment, depth, and watershed hydrology in order to provide a comprehensive set of requirements for inclusion in ASCE 7.

MCRB	BOCA Code	Analysis
III.C.5 Debris, wind, impact, snow, ice, and other live loads	Article 11 2101.6	FEMA states that the designs indicated in the manual would not be effected by conditions of "wind, snow, ice and other live loads", but debris and impact may be severe. The manual does not address debris considerations. BOCA requires all structures to be evaluated for all loading conditions.

Recommendation: The basis for FEMA's assertion that loads other than impact and debris will not "appreciably alter the designs recommended" requires substantiation. Additionally, the manual takes the position that debris is not considered but other documents such as FEMA-54 (pages 69-70) and FEMA-55 (Section 4.1.3) require this type of loading to be evaluated. FEMA needs to clarify the effect this has on the use of the manual.

MCRB	BOCA Code	Analysis
V.A.2.a Building model, dimensions and loading	1223.2	FEMA presents a classic model of equivalent fluid design as applied to foundation walls. BOCA requires that walls be designed to resist the pressure of the retained material.

Recommendation: None

MCRB	BOCA Code	Analysis
V.A.2.b Structural analysis model	1223.2	FEMA presents a calculation method for calculating the lateral load capacity of a residential basement wall. BOCA requires calculations without specifying the method of calculation.

Recommendation: None

MCRB	BOCA Code	Analysis
V.A.2.c Structural plain concrete	1222.2.2 1223.2	FEMA presents tabular values for plain concrete basement walls. BOCA provides a prescriptive method for sizing basement foundation walls of plain concrete for unbalanced heights up to 7'-0" with a maximum equivalent fluid pressure of 30 pcf, beyond either parameter walls must be designed by structural analysis.

Recommendation: None

MCRB	BOCA Code	Analysis
V.A.2.d Reinforced concrete	1223.2 1500.1	FEMA presents tabular values for ultimate strength design of reinforced concrete basement walls. BOCA requires walls to be designed to resist the imposed loads. BOCA requires structural members of reinforced concrete to be designed in accordance with ACI 318.

Recommendation: See MCRB Section III.A.4

MCRB	BOCA Code	Analysis
V.A.2.e Plain masonry block	1222.2.2 1223.2 1400.2	FEMA provides a calculation method and design values drawn from the 1970 UBC and NCMA TEK 34 respectively. BOCA prescribes the size of a masonry basement wall with up to 7' of unbalanced height and 30 pcf maximum equivalent fluid pressure. Beyond those parameters Section 1223.2 requires calculations based on masonry design stresses in accordance with ACI 530.

Recommendation: See MCRB Section III.A.1.

MCRB	BOCA Code	Analysis
V.A.2.f Reinforced masonry block	1223.2 1400.2	FEMA provides a calculation method and design values for reinforced masonry block walls. BOCA requires such walls to be designed to resist the imposed loads and relies on design stresses contained in the referenced standard, ACI 530.

Recommendation: See MCRB Section III.A.1.

MCRB	BOCA Code	Analysis
V.A.2.g Flood waters above grade	1109.3 1223.2	FEMA contains an analysis of lateral loads imposed by floor water above grade level in addition to soil loads. BOCA requires the design to the resist loads, which specifically include hydrostatic loads due to flooding. See Analysis to MCRB Section III.B.4.

Recommendation: None

MCRB	BOCA Code	Analysis
V.A.2.h Slab thickness	1109.3 1223.2	FEMA provides an analysis of the slab thickness necessary to resist buoyancy loads. BOCA requires design to resist hydrostatic loads.

Recommendation: FEMA presents an oversimplified view that a 6 inch thick reinforced slab is adequate (rebar size and placement not described). FEMA should either provide a series of prescriptive design solutions for a broad range of conditions or simply require structural calculations in accordance with the current edition of ACI 318-89.

MCRB	BOCA Code	Analysis
V.A.2.i Structural slab design	1500.1	FEMA provides a derivation of a structural floor slab design to resist hydrostatic loads. BOCA references ACI 318-89 for structural slab design.

Recommendation: See MCRB Section III.A.4.

MCRB	BOCA Code	Analysis
V.B.1 Weir level load	1109.3 1224.4	FEMA assumes maximum head of 5 ft. above floor elevation on basement walls. BOCA requires that structural components resist all hydrostatic loads. See Analysis to MCRB Section III.B.4.

Recommendation: FEMA should provide a comprehensive list of hydrostatic design loads for inclusion in ASCE 7.

MCRB	BOCA Code	Analysis
V.B.2 Buoyancy	1109.3 1224.4	FEMA discusses the 5 ft. maximum assumed head as a "practical cut-off." BOCA simply requires design to resist anticipated buoyancy loads for each specific project under consideration. See Analysis to MCRB Section III.B.4.

Recommendation: See MCRB Section V.B.1

MCRB	BOCA Code	Analysis
V.B.3 Slab bending	1109.3 1500.1	FEMA describes the assumption that the span length of the slab is limited to ½ the width of the house. BOCA requires a slab design in accordance with ACI 318-89 to resist imposed loads.

Recommendation: See MCRB Section III.A.4.

MCRB	BOCA Code	Analysis
V.B.4 Wall loads	1109.3	FEMA states that a hydrostatic load is assumed to be acting on walls. BOCA requires walls to be designed to resist all hydrostatic loads. See Analysis to MCRB Section III.B.4.

Recommendation: None

MCRB	BOCA Code	Analysis
V.B.5 Water infiltration protection	1224.4	FEMA states the need to prevent water infiltration in basements. See Analysis to MCRB Section III.B.4.

Recommendation: None

MCRB	BOCA Code	Analysis
V.B.5.a Drained or sump system	1224.5 1224.6 1224.7	FEMA discusses the drained system. BOCA provides requirements for subsoil drainage systems, foundation drainage, placement of backfill and site grading. See Analysis to MCRB Section III.B.4.

Recommendation: None

MCRB	BOCA Code	Analysis
V.B.5.b Undrained or barge system	1109.3 1224.4	FEMA describes details of water-tight basement construction. BOCA requires proper structural design, penetration protection, and use of waterproofing materials. See Analysis to MCRB Section III.B.4.

Recommendation: None

MCRB	BOCA Code	Analysis
VII. Allowable bearing pressures	1201.3	Both FEMA and BOCA provide presumptive soil bearing values.

Recommendation: None

MCRB	BOCA Code	Analysis
VII. Allowable soil pressures beneath footings	1201.1 1201.3 1202.1	FEMA provides soil pressures as a function of footing design and surcharge. BOCA provides presumptive bearing values or requires soil testing to determine the actual bearing values.

Recommendation: None

MCRB	BOCA Code	Analysis
VIII.A.2.a Soil and water loading	1222.2.2	FEMA provides a table containing the weight of saturated soil types. BOCA states where equivalent fluid weight of soils exceeds 30 pcf, foundation walls shall be designed by analysis.

Recommendation: None

MCRB	BOCA Code	Analysis
VIII.A.2.c Waterproofing systems	1224.4 1224.5 1224.6 1224.7	FEMA illustrates drained and undrained systems. BOCA contains provisions for either system. See Analysis to MCRB Section III.B.4.

Recommendation: None

MCRB	BOCA Code	Analysis
VIII.A.2.d Wall design	1109.3 1224.4.2	FEMA illustrates the design of a reinforced masonry block wall. BOCA requires basement walls to be designed to resist hydrostatic loads. See Analysis to MCRB Section III.B.4.

Recommendation: None

MCRB	BOCA Code	Analysis
VIII.A.2.e Slab design	1224.4.1	FEMA illustrates slab design. BOCA requires floors to be designed and constructed to resist hydrostatic loads.

Recommendation: None

MCRB	BOCA Code	Analysis
VIII.B. Acceptable wall designs	1222.2.2	FEMA provides "design curves" for various wall types which allow the determination of the allowable height of hydrostatic loading. BOCA requires walls to be designed to resist the pressure of the retained saturated soil.

Recommendation: None

MCRB	BOCA Code	Analysis
VIII.B.1 Structural plain concrete wall	1222.2.2	FEMA provides "design curves" for unreinforced concrete walls. BOCA requires walls to be designed to resist imposed loading in accordance with ACI 318.1-89.

Recommendation: See MCRB Section III.A.3.

MCRB	BOCA Code	Analysis
VIII.B.2 Reinforced concrete wall	1500.1	FEMA provides "design curves" for reinforced concrete walls. BOCA requires design in accordance with ACI 318.

Recommendation: See MCRB Section III.A.4.

MCRB	BOCA Code	Analysis
VIII.B.3 Unreinforced masonry block wall	1400.3	FEMA provides "design curves" for unreinforced concrete masonry walls. BOCA references ACI 530.

Recommendation: See MCRB Section III.A.1

MCRB	BOCA Code	Analysis
VIII.B.4 Reinforced masonry block walls	1400.2	FEMA provides "design curves" for reinforced concrete masonry walls. BOCA references ACI 530.

Recommendation: See MCRB Section III.A.2.

MCRB	BOCA Code	Analysis
VIII.B.5 Buoyancy wall	1109.3 1224.4.2	FEMA provides illustrative examples of walls designed to brace the basement floor slab against hydrostatic loads. BOCA requires the slab to be designed to resist such loads, which could include consideration of the mitigating effects of such supplemental structural elements. See Analysis MCRB Section III.B.4.

Recommendation: None

MCRB	BOCA Code	Analysis
VIII.C. Reinforced concrete slab	1224.4.1	FEMA provides "design curves" for undrained system floor slabs. BOCA requires design for imposed loads.

Recommendation: None

MCRB	BOCA Code	Analysis
VIII.D.1 Control joints	1224.4.3	FEMA provides details of wall and floor control joints. BOCA requires all joints and penetrations to be water tight. Control joints (if any) are located at the discretion of the designer.

Recommendation: None

MCRB	BOCA Code	Analysis
VIII.D.2 Sump pump underdrain	1224.5.3	FEMA provides details of typical underslab drainage sump details. BOCA requires an approved drainage system complying with the BOCA National Plumbing Code. See Analysis to BOCA National Plumbing Code.

Recommendation: None

MCRB	BOCA Code	Analysis
VIII.D.3.a Waterproofed undrained slab and wall system	1109.3 1224.4	FEMA provides illustrations of design details of undrained basement wall and floor systems. BOCA requires waterproofing and design to resist imposed hydrostatic loads. See Analysis to MCRB Section III.B.4.

Recommendation: None

MCRB	BOCA Code	Analysis
VIII.D.3.b Waterproofed drained slab and wall system	1224.5	FEMA provides illustrative details of drained slab and wall systems. BOCA requires dampproofing in conjunction with subsoil drainage systems. See Analysis to MCRB Section III.B.4

Recommendation: None

MCRB	BOCA Code	Analysis
VIII.D.3.c Slab/wall footing juncture	2101.6.3.2	FEMA provides details of connections between slabs, footings and walls. BOCA requires structural systems to be designed connected and anchored to resist flotation, collapse, or lateral movement.

Recommendation: None

MCRB	BOCA Code	Analysis
Hydraulic/Hydrologic Manual		
I.B.4 Flood Velocity	1109.4	FEMA offers an analytical method for computing velocity loads on structures based on a wind load analogy. BOCA requires design to resist hydrodynamic loads.

Recommendation: FEMA should develop a table of hydrodynamic loads for inclusion into ASCE 7.

MCRB	BOCA Code	Analysis
Hydraulic/Hydrologic Manual		
I.B.5 Sediment	2101.6.6 2101.6.5	See Analysis to MCRB Section III.C.4.e.

Recommendation: None

Technical Standards Bulletin (FEMA 85-1)

FEMA 85-1	BOCA Code	Analysis
Intentional internal flooding	2101.6.3.2 2101.6.3.3	BOCA & FEMA both provide for evaluation of pressure by allowing for the entry and exit of flood waters.

Recommendation: None

FEMA 85-1	BOCA Code	Analysis
Protection goals	2101.6.3.3	BOCA provides for the equalization of hydrodynamic forces and protection of mechanical and electrical systems and water resistant materials, as does FEMA. FEMA also speaks to protection of contents which are outside the scope of the BOCA Codes.

Recommendation: None

FEMA 85-1	BOCA Code	Analysis
Structural features	2101.6.3.2 2101.6.3.3 2101.6.5 2101.6.6	In addition to the above, BOCA provides for foundation anchorage to resist flood loads. FEMA considers all the above as well as referencing specific materials which can be accepted under their text.

Recommendation: None

FEMA 85-1	BOCA Code	Analysis
Building activity and use	2101.6.3.3	BOCA limits spaces below base flood elevation to uses not involving human occupancy. FEMA says to consider the use of such spaces carefully as they are designed to be flooded.

Recommendation: None

FEMA 85-1	BOCA Code	Analysis
Foundations	2101.6.3.2 1109.4	BOCA requires foundations to be designed to resist hydrodynamic and buoyancy forces, as does FEMA.

Recommendation: None

FEMA 85-1	BOCA Code	Analysis
Cavity wall construction	1109.4 2101.4 2101.6.6	BOCA requires design to resist hydrodynamic loads. FEMA requires careful detailing of wall assemblies to mitigate effects of flooding.

Recommendation: None

FEMA 85-1	BOCA Code	Analysis
Solid wall construction	1109.4 2101.4 2101.6	Same as above, except FEMA emphasizes surface deterioration due to freeze-thaw action on porous surfaces.

Recommendation: None

FEMA 85-1	BOCA Code	Analysis
Interior walls	1109.4 2101.4 2101.6	Same as above

Recommendation: None

FEMA 85-1	BOCA Code	Analysis
Interior wall finishes	2101.6.3.3 2101.6.6	BOCA makes no explicit provision to evaluate finishes intended to be periodically submerged. FEMA requires finishes to withstand immersion for 160 hours without damage.

Recommendation: Add performance based text to Section 2101.6.6 to reflect the FEMA requirement.

FEMA 85-1	BOCA Code	Analysis
Floors	2101.6.3.3 2101.6.6	Same as above

Recommendation: None. The preceding recommendation will provide the needed correlation.

FEMA 85-1	BOCA Code	Analysis
Ceilings & Roofs	2101.6.3.2 2101.6.3.3	FEMA requires water-resistant finishes, relief vents and anchorage of the roof structure. BOCA does not provide specifically for relief venting of air trapped by rising flood waters, but general provisions of 2101.6.3.2 require design to resist all structural loads and stresses resulting from flooding.

Recommendation: None

FEMA 85-1	BOCA Code	Analysis
Building Envelope Penetrations	2101.6.3.3 2101.6.6	FEMA requires materials to resist flooding and high humidity Additionally, FEMA addresses needs for protective screens o impact resistant glazing and vents in multiple glazed windows. BOCA provides general, performance based text in 2101.6.6 which speaks to the overall issue.

Recommendation: None

FEMA 85-1	BOCA Code	Analysis
Electrical System	2101.6.5 2700.3	FEMA essentially desires that the portion of the electrical system subject to flooding be designed for same. BOCA references th National Electrical Code which, in turn, provides detailed requirements for "wet locations."

Recommendation: None

FEMA 85-1	BOCA Code	Analysis
HVAC	2101.6.5	FEMA requires HVAC equipment to be elevated above the base flood level as does BOCA. BOCA also requires the duct insulation to be elevated above the base flood elevation. See also Analysis of BOCA National Mechanical Code.

Recommendation: None

Technical Standards Bulletin (FEMA 85-2)

FEMA 85-2	BOCA Code	Analysis
Flood Forces	1109.3 1109.4 2101.6.3.2 2101.6.3.4	FEMA addresses hydrostatic, hydrodynamic & buoyancy forces, as does BOCA.

Recommendation: None

FEMA 85-2	BOCA Code	Analysis
Openings Design Criteria	2106.3.3 107.4	FEMA requires two openings with a total area not less than 1 square inch for every square foot of enclosed area subject to flooding to equalize pressure as does BOCA. FEMA and BOCA would also permit an approved alternative design. BOCA also requires the design to be performed by a registered professional architect or engineer.

Recommendation: None

Technical Standards Bulletins (FEMA-85-3)

FEMA 85-3	BOCA Code	Analysis
Wind and Water Forces	1109.4 1112.0 2101.6.4.2	FEMA references ANSI A58.1, 1982 for wind loads. BOCA references ASCE 7, 1982, the same document by another name FEMA requires break-away walls to resist wind loads but fail in response to combined wind and hydrodynamic loading. BOCA requires all structures to resist such loads except for coastal high-hazard zones where break-away walls are permitted.

Recommendation: Modify Section 1109.4, "Hydrodynamic loads" to reference Section 2101.6.4.2.

FEMA 85-3	BOCA Code	Analysis
Design Approach	1109.4	FEMA provides specific criteria for evaluating "break-away" walls. BOCA requires structural elements be designed to resist hydrodynamic loads except in coastal high-hazard flood zones where break-away walls are required to resist wind loads but not wind and water loads acting simultaneously.

Recommendation: See above

FEMA 85-3	BOCA Code	Analysis
Design Considerations	108.1 1109.4 1213.1 1213.4 1213.5 1213.6 1214.6 1400.2 1400.3 1401.11 1702.1 1703.2 1802.1 2101.6.4.2 2101.6.4.3	FEMA addresses the materials and connectors used in break-away walls and provides specific details. FEMA also addresses the effects of "scour" on embedment depth for piles, use of grade beams and orientation of floor beams/joists relative to direction of force from wave action as well as bracing of piles, as does BOCA. BOCA provides for the structural analysis of all structural elements including break-away walls, but does not provide for specifics of break-away wall action or design, relying on professional certification of the adequacy of such designs.

Recommendation: See recommendation for Wind and Water Forces. Additionally, please note that the 8th sentence under "Masonry walls" in 85-3 is probably incorrect for most conditions. This sentence states "Once the pins fail, the wall will cantilever with the reinforcing bars at the bottom of the wall, providing additional resistance to failure until the wall's capacity is reached." What is more likely, is that a load sufficient to cause the failure, in shear, at connecting pins at the top of the wall, can be expected to result in an immediate failure, in bending, at the bottom. We therefore recommended this statement be deleted or modified.

Technical Standards Bulletin (FEMA 88-1)

FEMA 88-1	BOCA Code	Analysis
Wind design standards & the NFIP	1112.3.1 1113.0 2101.6.1 2101.6.3.1 2101.6.4.1 2101.6.4.3 2101.6.4.2	FEMA restricts construction in areas subject to 100 year flood (1 percent chance per year). FEMA requires elevation of the lowest horizontal structural member above base flood elevation in coastal high-hazard flood zones. FEMA requires consideration of the simultaneous effect of wind and water loads in such areas, relying on ANSI A58.1, 1982 to determine wind loads. BOCA is consistent with these provisions. FEMA does not address the resistance of structures to seismic loads. BOCA requires seismic loading appropriate to geographical location to be considered.

Recommendation: None

Technical Standards Bulletin (FEMA 88-2)

FEMA 88-2	BOCA Code	Analysis
Flood Resistant Materials	2101.6 2101.6.6	FEMA provides for the review of all permits for construction in a flood zone as well as requirements for flood resistant construction, so does BOCA. FEMA defines "flood resistant material" and provides a preliminary list of materials classified as to their perceived resistance to the effects of flooding. BOCA addresses this material evaluation by referencing applicable material standards for certain construction materials.

Recommendation: FEMA should conduct the necessary research to indicate in 88-2 which of the materials referenced by Section 2101.6.6 of the BOCA National will "withstand direct and prolonged contact with flood waters without sustaining significant damage. The criteria by which significant damage is assessed is especially important to establish. Such information can then provide a technical basis for proposed changes to the model codes which will establish a regulatory basis for requiring flood damage resistant material. Modify 2101.6.6 to add a performance criterion for flood resistant materials such as referenced under "What Constitutes Flood Damage Resistant Material" in 88-2.

Technical Standards Bulletin (FEMA 88-3)

FEMA 88-3	BOCA Code	Analysis
Lower area obstructions	2101.6.4.1 2101.6.4.2 2101.6.4.3 2101.6.11.3	FEMA prohibits elements of the structure located below the BFE except for slabs, pile caps, and bracing and except as specifically analyzed and certified by a professional engineer or architect. BOCA is entirely consistent with these provisions.

Recommendation: None

FEMA 88-3	BOCA Code	Analysis
Obstructions outside the perimeter of the coastal building	2101.6.4.2 2101.6.4.3	FEMA discusses the effect of potential obstructions adjacent to buildings on the hydrodynamic loads which such buildings must be designed to resist. BOCA simply limits such adjacent structures to incidental storage of portable or mobile items readily moved in the event of a storm. BOCA requires piles to be adequately embedded to resist combined water and wind loads despite scour of soil strata surrounding the piling.

Recommendation: None

FEMA 88-3	BOCA Code	Analysis
Obstructions attached to but outside the building perimeter	2101.6.3.1	FEMA states that any "construction item" such as a swimming pool, deck, or accessory structure attached to a coastal building must be above the BFE or constructed with non-supporting break-away walls. BOCA permits only means of egress, incidental storage and parking to be located below the BFE. Attached structures must either be incidental storage readily moved in the event of a storm or constructed of break-away walls and partitions.

Recommendation: None

Technical Standards Bulletin (FEMA 88-4)

FEMA 88-4	BOCA Code	Analysis
Protection of elevator equipment in flood hazard areas	2101.6.5	FEMA recommends that elevator equipment be located above the BFE or be water-resistant. Further, elevators should be interlocked to ensure that the cab automatically stays above floo water. BOCA requires all mechanical/electrical equipment to b placed above the BFE or protected to prevent water entering the equipment or system during floods up to the BFE.

Recommendation: Add a subsection to 2606.2 "Emergency operation of elevators" to require elevators to automaticall move to a predetermined level above the BFE in the event of flooding.

Technical Standards Bulletin (90-2)

FEMA 90-2	BOCA Code	Analysis
NFIP requirements for below grade parking garages in flood hazard areas	2101.6.3.4 2101.6.4	FEMA generally does not permit below grade garages in flood hazard areas. Below grade parking is not permitted in V-zones. Similarly, floodproofing is not permitted in V-zones. Below grade parking is permitted in A-zones for non-residential buildings provided the building is floodproofed to the BFE. FEMA permits enclosed parking areas under residential and non-residential structures elevated on piers or piles as long as enclosing walls are designed as break-away walls. BOCA likewise does not permit residential uses below the BFE, but specifically does provide for garages. BOCA prescribes the options of flood proofing or break-away walls.

Recommendation: None

Technical Standards Bulletin (90-3)

FEMA 90-3	BOCA Code	Analysis
Non-residential flood-proofing certification requirements of the National Flood Insurance Program	1109.3 1109.4 2101.6.1.1 2101.6.3.1 2101.6.3.2 2101.6.3.4 2101.6.3.5 2101.6.5 2101.6.6 2101.6.8 2101.6.11	FEMA requires flood zones to be determined by the flood insurance rate map. FEMA permits flood proofing of non-residential uses only. Such structures must resist hydrostatic and hydrodynamic loads which are specified. FEMA requires protection of utilities (plumbing, mechanical, electrical). Professional certification is required. BOCA is consistent with these requirements.

Recommendation: None

Technical Standards Bulletin (90-4)

FEMA 90-4	BOCA Code	Analysis
Installation of manufactured homes in special flood hazard areas	120.4 620.3.1 2101.6 2101.6.3.2 2101.6.4.3 2101.6.5 2101.6.7 2101.6.9	FEMA requires manufactured (mobile) homes to be placed so that the lowest floor is either above the BFE, or placed on 36" piers (above grade), or in an existing park. FEMA describes various foundation/anchorage methods and speaks to soil bearing capacity and proper embedment of piles to resist scour. FEMA requires that any encroachments into a floodway be certified that such encroachment would not raise the BFE. Such provisions which prescribe acceptable land use are outside the scope of the BOCA Code. BOCA requires manufactured housing to be designed and built to resist the same flood forces as site built, which does not provide for 36" piers and/or placement below the BFE for residential occupancies..

Recommendation: To create separate and conflicting performance requirements for factory-built structures simply because they are not constructed on-site is contrary to BOCA's code development history and resulting policy on this matter. Therefore, no recommendation is made to carry FEMA's separate treatment of manufactured housing into BOCA code text. Recommendation is made however, to revise BOCA Code Section 620.3.1 to refer to flood forces and/or reference Section 2101.6.7 of the BOCA Code.

BOCA NATIONAL FIRE PREVENTION CODE COMPARISON

FEMA-54	BOCA Codes	Analysis
P. 93 Building Materials	F-2806.4 F-2806.8	FEMA identifies that corrosion protection is required for structures constructed of steel. BOCA requires corrosion protection and also includes the reference standards (STI stiP; or ULC S603.1-M) for protection of underground tanks.

Recommendation: See BOCA National Building Code Comparison recommendation to FEMA-54 - Building materials.

FEMA-102	BOCA Codes	Analysis
Appendix D Part (6d)	F-2806.4	FEMA requires fuel tanks to be above the design flood level or anchored and protected to resist floodwater (buoyancy, velocity and impact) forces. The anchorage system must have a safety factor of 1.5 against flotation. BOCA requires anchorage to resist hydrodynamic and hydrostatic forces also.

Recommendation: None

44 CFR 59.1, 60.3 and 60.6, FEMA-55, 85, 114, 165, Manual for the Construction of Residential Basements in Non-Coastal Flood Environments and the Technical Standards Bulletins do not include provisions which require correlation with the BOCA National Fire Prevention Code

Elevated Residential Structures (FEMA-54)

FEMA-54	BOCA Code	Analysis
P. 93 Utilities and Mechanical equipment	M-301.1.2 M-305.4 M-703.1 M-805.6 M-806.2 M-906.4 M-907.2	BOCA provides for flood-proofing of plenums, underground ducts, piping, underground tanks and fuel oil equipment. FEMA requires HVAC equipment to be elevated above base flood level as does BOCA. See also analysis to BOCA National Plumbing Code.

Recommendation: None

Manufactured Home Installation in Flood Hazard Areas (FEMA-85)

FEMA-85	BOCA Code	Analysis
Chapter IV Additional Design Considerations	M-405.1 M-703.1 M-805.6 M-806.2 M-906.4 M-907.2	Both FEMA and BOCA require that mechanical and plumbing systems be protected from exposure to floodwaters or designed to resist floodwater forces.

Recommendation: None

Technical Standards Bulletins (FEMA 85-1)

FEMA-85-1	BOCA Code	Analysis
HVAC	M-301.1.2 M-305.4 M-703.1 M-805.6 M-806.2 M-906.4 M-907.2	BOCA provides for flood-proofing of plenums, underground ducts, piping, underground tanks and fuel oil equipment. FEMA requires HVAC equipment to be elevated above base flood level as does BOCA. BOCA does not provide for "pop-out-panels" to allow pressures to equalize in ducts subject to flooding, requiring instead prohibition against water entering or accumulating in the system.

Recommendation: None

44 CFR 59.1, 60.3 and 60.6, FEMA-55, 102, 114, 165 and Manual for the Construction of Residential Basements in Non-Coastal Flood Environments do not include provisions which require correlation with the BOCA National Mechanical Code

BOCA NATIONAL PLUMBING CODE COMPARISON

Elevated Residential Structures (FEMA-54)

FEMA-54	BOCA Code	Analysis
P. 93 Utilities and Mechanical Equipment	P-308.6 P-500.6 P-602.6 P-1106.3 P-1502.3 P-1604.8 P-1604.9 P-1605.1	FEMA states that sanitary sewer and on-site waste disposa systems should be designed to prevent sewage or waste from discharging during a flood or tank from becoming buoyant BOCA contains general performance criteria which mandate protection for all piping, tanks and equipment.

Recommendation: None

Manufactured Home Installation in Flood Hazard Areas (FEMA-85)

FEMA-85	BOCA Code	Analysis
Chapter IV D Additional Design Considerations	P-308.6 P-500.6 P-602.6 P-1502.3 P-1604.8 P-1604.9 P-1605.1	FEMA states that waterproofing joints and connections and using backflow preventers for all piping beneath the design flood level may be necessary, and to consult local codes. BOCA requires that all piping and joints be designed to resist hydrostatic and hydrodynamic forces. Wells for potable water must have covers and casings which are located 1 foot above the base flood elevation or are sealed to resist flood forces.

Recommendation: None

Floodproofing Non-residential Structures (FEMA-102)

FEMA-102	BOCA Code	Analysis
Chapter IV C Floodproofing Utilities	P-308.6 P-500.6 P-602.6 P-1106.3 P-1502.3 P-1604.8 P-1604.9 P-1605.1	FEMA states that waterproofing joints and connections and using backflow preventers for all piping beneath the design flood level may be necessary, and to consult local codes. BOCA requires that all piping joints be designed to resist hydrostatic and hydrodynamic forces. Wells for potable water must have covers and casings which are located 1 foot above the base flood elevation or are sealed to resist flood forces.

Recommendation: None

FEMA-102	BOCA Code	Analysis
Appendix D Performance Criteria	P-308.6 P-500.6 P-602.6 P-1106.3 P-1502.3 P-1604.8 P-1604.9 P-1605.1	FEMA states that sanitary sewer and on-site waste disposal systems should be designed to prevent sewage or waste from discharging during a flood. Systems that must remain in operation during a flood should be provided with a holding tank to accommodate 150% of the demand. Potable water supplies should be designed to prevent contamination from floodwater. Backflow prevention should be provided for potable water lines and storm and sanitary sewer lines. BOCA requires all piping and joints to be designed to resist hydrostatic and hydrodynamic flood forces. Requirements are similar for wells used to provide potable water.

Recommendation: None

Manual for the Construction of Residential Basements in Non-Coastal Flood Environments (MCRB)

MCRB	BOCA Code	Analysis
III.B.5.b Grading and Surface Drainage	P-801.1	FEMA requires the grade to be sloped 6 inches in 10 feet from the basement wall and splash blocks (3 feet) to direct rain water from downspouts. BOCA also requires drainage from the foundation but does not prescribe the slope or details.

Recommendation: None

MCRB	BOCA Code	Analysis
III.B.6 Seepage quantities	P-804.2 P-804.3	FEMA contains a typical flow analysis procedure to size the pump and sump. BOCA requires a designed system with input from the sump pump manufacturer.

Recommendation: None

MCRB	BOCA Code	Analysis
III.B.7a Penetrations	P-308.1 P-308.6 P-309.1 P-500.6 P-602.6 P-1502.3	FEMA requires penetrations to be pressure sealed and utility services (except water and sanitary sewer) to enter the house above the BFE. BOCA requires sleeved penetrations with approved caulking. BOCA requires the piping to be capable of resisting the imposed loads.

Recommendation: None

MCRB	BOCA Code	Analysis
III.B.8 Plumbing subsystems	P-308.6 P-309.1 P-500.6 P-602.6 P-804.2 P-804.3 P-1003.2 P-1502.3	FEMA requires backflow valves at sanitary sewer outlets while BOCA requires that all piping and joints be designed to resist hydrostatic and hydrodynamic forces. BOCA's requirement for backwater valves is not a function of flood prone areas but rather a general requirement for backwater valves to be installed where fixtures are subject to backflow from the public sewer.

Recommendation: None

MCRB	BOCA Code	Analysis
VIII.D.2 Sump pump and underdrain	P-804.2 P-804.3	See MCRB Section III.B.6.

Recommendation: None

44 CFR 59.1, 60.3 and 60.6 FEMA-55, 114, 165 and the Technical Standards Bulletins do not include provisions which require correlation with the BOCA National Plumbing Code.

BOCA NATIONAL PROPERTY MAINTENANCE CODE COMPARISON

Coastal Construction Manual (FEMA-55)

FEMA-55	BOCA Code	Analysis
4.3.8 Maintenance	PM-302.0 PM-302.1 PM-302.3 PM-601.4	Both FEMA and the BOCA National Property Maintenance Code require structural members to be maintained free of deterioration, exterior walls and roof to be weatherproof, chimneys to be in good repair, windows to be free of cracks, and mechanical equipment to be maintained in safe working condition. BOCA does not require yearly inspections (as does NFIP) but rather provides the code official with the authorization to inspect when deemed appropriate.

Recommendation: None.

Floodproofing Non-Residential Structures (FEMA-102)

FEMA-102	BOCA Code	Analysis
Floodwall Maintenance	PM-302.3	Both FEMA and BOCA require that structural members be maintained to properly resist the design loads.

Recommendation: None

44 CFR 59.1, 60.3 and 60.6, FEMA-54, 85, 114, 165, Manual for the Construction of Residential Basements in Non-Coastal Flood Environments, and the Technical Standards Bulletins do not include provisions which require correlation with the BOCA National Property Maintenance Code.

APPENDIX B

COMPARISON BETWEEN THE SBCCI STANDARD CODES
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STANDARD BUILDING CODE (SBC) COMPARISON

NFIP (Regulations for Floodplain Management and Flood Hazard Identification) (44 CFR 59.1, 60.3, and 60.6)

59.1 - Definitions

NFIP	SBC	Analysis
Appurtenant Structure Base Flood Breakaway Wall Critical Feature Development Elevated Structure Existing Construction Existing Structures Flood Floodplain or Flood-Prone Area Lowest Floor Manufactured Home 100-year Flood Storm Cellar Substantial Improvement	1209	NFIP contains definitions which only apply to floodplain management. SBC does not address floodplain management. This is addressed in the SBCCI Standard for Floodplain Management.

Recommendation: None since NFIP addresses only flood-prone areas.

NFIP	SBC	Analysis
Basement Building Structure	202	The definitions of "basement" are compatible. The definitions of "building/structure" are similar but NFIP requires the building to have walls and a roof while SBC only requires the building to be used for sheltering its occupancy.

Recommendation: None since NFIP only applies to "enclosed" buildings.

60.3 - Floodplain Management Criteria for Flood-Prone Areas

NFIP	SBC	Analysis
60.3(b)(8) Manufactured Home Installations	H105.3	NFIP requires manufactured homes to be installed to resist flotation, collapse, and lateral movement to minimize flood damage in addition to anchoring requirements for wind. SBC requires only anchorage for wind.

Recommendation: None since SBC does not address flotation as a force. Appendix H should reference the SBCCI Standard for Floodplain Management.

NFIP	SBC	Analysis
60.3(c)(2) Elevation for Residential Structures	N/A	NFIP requires the lowest floor of residential structures to be elevated to or above the base flood level in A-zones. SBC does not address floodplain management. This is addressed in 602.1, 604.2, and 800 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

NFIP	SBC	Analysis
60.3(c)(3) Elevation for Non-Residential Structures; Flood-Proof Walls for Non-Residential Structures	N/A	NFIP requires the lowest floor of non-residential structures to be elevated to or above the base flood level or flood-proof the structure that is below the base flood level. SBC does not address floodplain management. This is addressed in 602.1 and 604.4 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

NFIP	SBC	Analysis
60.3(c)(5) Flood Openings		NFIP requires fully enclosed areas below the lowest floor, other than basements, to be provided with flood openings to equalize hydrostatic flood forces. SBC does not address floodplain management. This is addressed in 602.2 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

NFIP	SBC	Analysis
60.3(e)(4) Pilings	N/A	NFIP requires structures in V-zones to be elevated to or above the base flood level and anchored to resist flotation, collapse, and lateral movement due to the effects of wind and water loads acting simultaneously. SBC does not address Floodplain Management. This is addressed in 801.1 and 801.3 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

NFIP	SBC	Analysis
60.3(e)(5) Breakaway Walls	N/A	NFIP requires areas below the lowest floor to be free of obstruction or constructed with nonsupporting breakaway walls, open wood lattice, or insect screening intended to collapse under wind and water loads. SBC does not address Floodplain Management. This is addressed in 801.4 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

NFIP	SBC	Analysis
60.3(e)(6) Fill	N/A	NFIP prohibits the use of fill material to support building within flood-prone areas. SBC does not address floodplain management. This is addressed in 801.5 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

60.6 – Variances and Exceptions

NFIP	SBC	Analysis
60.6(c)(2)(i) Floodproof Walls 60.6(c)(2)(ii) Basement Top of Floor Elevation 60.6(c)(2)(iii) Fill 60.6(c)(2)(iv) Use of a Registered Professional 60.6(c)(2)(v) Building Inspection	N/A	NFIP requires the basement area, together with utilities and sanitary facilities, below the floodproofed design level, to be watertight with walls that are impermeable to the passage of water without human intervention. NFIP permits the basement floor to be up to five feet below the elevation of the base flood. NFIP permits the area surrounding the structure to be protected by fill material to or above the elevation of the base flood. NFIP requires the floodproofing measures to be certified by a registered professional engineer or architect. NFIP requires the authority having jurisdiction to verify that the provisions of the standards are satisfied. SBC does not address floodplain management. This is addressed in Chapter 4, 600.1, 604.2, 800.2, 801.5, 900.3, and 900.4 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

Elevated Residential Structures (FEMA 54)

FEMA 54	SBC	Analysis
Posts (Page 68)	N/A	FEMA 54 addresses the use of wood, concrete, or steel posts as the foundation to elevate residential structures. General commentary is made about installation, handling, and lateral resistance. SBC does not address post foundations but does address pile foundations in 1303 through 1311 and contains specific requirements for eight types of piles. Pile foundations are covered on pages 72-75 of FEMA 54.

Recommendation: FEMA 54 should combine post foundations and pile foundations into one section with more prescriptive requirements.

FEMA 54	SBC	Analysis
Post Embedment (Pages 68-70)	N/A	FEMA 54 provides general requirements for hole depth, end bearing, hole size, and backfilling of posts. SBC does not address post foundations but does address pile foundations in 1303 through 1311 and contains specific requirements for eight types of piles. Pile foundations are covered on pages 73-75 of FEMA 54.

Recommendation: FEMA 54 should combine post foundations and pile foundations into one section with more prescriptive requirements.

FEMA 54	SBC	Analysis
Post Anchorage (Page 71)	N/A	FEMA 54 provides general requirements for anchorage of post foundations. SBC does not address post foundations but does address pile foundations in 1303 through 1311 and contains specific requirements for eight types of piles. Pile foundations are covered on pages 72-75 of FEMA 54.

Recommendation: FEMA 54 should combine post foundations and pile foundations into one section with more prescriptive requirements.

FEMA 54	SBC	Analysis
Piers (Page 75)	N/A	FEMA 54 describes the suitability of pier foundations and types of pier foundations which are suitable for the flood areas with low velocity and minimal erosion. SBC does not address suitability of any type of foundation system.

Recommendation: None.

FEMA 54	SBC	Analysis
Brick and Concrete Masonry Piers (Pages 75, 76)	1405.6 1702.2.1	FEMA 54 provides minimum reinforcing, minimum dimensional requirements, maximum height, spacing, and recommended shape. FEMA 54 requires the piers to be filled with concrete. SBC bases the height on least dimension and whether the pier is filled with concrete or not. SBC does not require reinforcing. FEMA permits the maximum spacing to be 8 ft or 12 ft. SBC permits only 8 ft unless an engineering analysis is performed. Sections 1405.6 and 1702.2.1 of SBC is for conventional construction with light loads and locations in noncoastal areas.

Recommendation: FEMA 54 and SBC are in general agreement, however FEMA 54 provides more detailed requirements. FEMA 54 should provide reason for 12 ft spacing of piers in the direction parallel to the floor joists.

FEMA 54	SBC	Analysis
Concrete Piers (Page 77)	Chapter 13	FEMA 54 provides a general description and discussion of poured-in-place concrete piers. FEMA 54 and SBC requires foundations to be based on a structural analysis.

Recommendation: None since both basically require the foundation to be based on a structural analysis.

FEMA 54	SBC	Analysis
Pier Footings (Page 77)	1302.4	Both FEMA 54 and SBC require the footing sizes to be based on the properties of the soil.

Recommendation: None.

FEMA 54	SBC	Analysis
Shear Walls and Floor Diaphragms (Page 79)	1201	FEMA 54 addresses the use of plywood shear walls and floor diaphragm to brace piles or post foundations. SBC requires the structure to be of sufficient strength to support the loads and forces encountered.

Recommendation: FEMA 54 should address the use of shear walls and floor diaphragms as a method of bracing but should permit the building designer to choose the method.

FEMA 54	SBC	Analysis
Pier Foundation Connection (Pages 84, 85)	1201, 1408.3, 1706.1	FEMA 54 addresses anchorage of platform framing construction to pier foundations. SBC requires the structure to be of sufficient strength to support the loads and forces encountered. SBC addresses continuous wall foundations and not pier foundation anchorage. Sections 1408.3 and 1706.1 of the SBC is for conventional construction with light loads and locations in noncoastal areas.

Recommendation: FEMA 54 should provide wind load values or forces for which the anchorage is adequate.

FEMA 54	SBC	Analysis
Floor Beams (Page 86, Paragraph 2)	1706.2, 1705.1	FEMA 54 provides a general discussion of built up floor beams, (nailing, location of splices, and size.) SBC provides more detail for nailing and location of splices. Chapter 17 of the SBC is for light frame conventional construction having light loads and located in noncoastal areas.

Recommendation: FEMA 54 should provide better nailing and splice location requirements.

FEMA 54	SBC	Analysis
Cantilevers (Pages 86, 87)	1701.2	FEMA 54 describes a cantilevered beam with general discussion of why cantilevers are used. FEMA 54 provides a "rule of thumb" for the length of the cantilever. SBC requires the design of wood members to conform to good engineering practice. Chapter 17 of the SBC is for light frame conventional construction having light loads and located in noncoastal areas.

Recommendation: FEMA 54 should delete the "rule of thumb" or add better guidance for the design of the cantilever.

FEMA 54	SBC	Analysis
Floor Beam to Floor Joist Connection (Page 88)	1201, 1701.2	FEMA 54 requires positive connection between the floor joists and floor beams with a general discussion of the connection and connectors. SBC requires the design of the wood members and their fastenings to conform to good engineering practice. Chapter 17 of the SBC is for light frame conventional construction having light loads and located in noncoastal areas.

Recommendation: None.

FEMA 54	SBC	Analysis
Figure 4.48, Protective Utility Shaft (Page 92)	N/A	FEMA 54 requires protection of utility connections. SBC does not address utilities. This is addressed in 602.5 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 54	SBC	Analysis
Mechanical Equipment (Page 93, Paragraph 2)	N/A	FEMA 54 requires the mechanical equipment to be elevated above the expected floodwaters. SBC does not address mechanical equipment. This is addressed in 602.5 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 54	SBC	Analysis
Septic Tanks (Page 93, Paragraph 3)	N/A	FEMA 54 requires septic tanks to be floodproofed to prevent the tank from rising out of the ground as well as to prevent against discharge of effluent. SBC does not address septic tanks. This is addressed in 602.7 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 54	SBC	Analysis
Building Materials (Pages 93, 94)	N/A	FEMA 54 requires protection of the building materials which may be exposed to floodwaters. SBC does not address exposure to flood waters.

Recommendation: None.

FEMA 54	SBC	Analysis
Wood (Page 94)	1703	FEMA 54 requires wood exposed to the elements to be preservative treated. SBC requires the wood to be "naturally durable wood" or "preservative-treated wood."

Recommendation: FEMA 54 should include "naturally durable wood."

FEMA 54	SBC	Analysis
Steel (Pages 94, 95)	1503	FEMA 54 addresses the need for galvanization of steel exposed to the elements to prevent corrosion. SBC requires all structural members of cold-formed steel to be protected against corrosion with an acceptable shop coat of paint, enamel, or other approved protection.

Recommendation: None.

FEMA 54	SBC	Analysis
Concrete and Masonry (Page 95)	Chapter 14 Chapter 16	FEMA 54 addresses the need to increase the durability of reinforced concrete and masonry by the use of chemical additives and coatings. SBC does not address increase of durability but requires compliance with the appropriate ANSI, ASTM, ACI, and NCMA standards.

Recommendation: **None.**

FEMA 54	SBC	Analysis
Insulation (Pages 95, 96)	N/A	FEMA 54 addresses the need for insulation on the exposed floor of an elevated residence. SBC does not address insulation. This is addressed in the CABO Model Energy Code.

Recommendation: None.

FEMA 54	SBC	Analysis
Glossary (Pages 113-115)	1209	FEMA 54 contains definitions of terms which are relevant to floodplain management. SBC references the SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 54	SBC	Analysis
Performance Criteria (Page 125-135)	Chapter 12	FEMA 54 addresses performance criteria used to design buildings to withstand the design flood (1) without causing unacceptable risks to its occupants or to adjacent property owners, (2) without causing unacceptable health hazards to its occupants, or (3) without sustaining damage of unacceptable magnitude. SBC requires every building to be of sufficient strength to support the loads and forces encountered, without exceeding in any of the structural elements, the stresses prescribed in the Code.

Recommendation: FEMA 54 should include snow and seismic loads. The use of the phrases "unacceptable risks", "unacceptable health hazards", and "unacceptable magnitude" are too subjective.

STANDARD BUILDING CODE (SBC) COMPARISON

Coastal Construction Manual (FEMA 55)

FEMA 55	SBC	Analysis
4.1 Flood Frequency (Page 4-1, Paragraph 4)	1209	FEMA 55 addresses the wave crest elevation that would be present during the base (100 year) flood. SBC does not address floodplain management. SBC references SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 55	SBC	Analysis
4.1.1 Wind (Page 4-1, Paragraph 6 & 7 Page 4-2, Figure 4-1, Page 4-3, Paragraph 2 & 3, Page 4-6)	1205	FEMA 55 references the procedures of ANSI A58.1-1982 for design with particular emphasis placed on elevation of the roof above grade and high wind pressures at the corners of the house, at and under roof eaves, and at the peak of the roof. SBC permits ASCE 7-1988 (formerly ANSI A58.1-1982) to determine the wind forces but also provides the actual velocity pressure (psf), use factors, and coefficients to address the higher wind pressures at the corners, at and under roof eaves, and at the peak of the roof.

Recommendation: FEMA 55 should update reference to ASCE 7-1988.

FEMA 55	SBC	Analysis
4.1.2 Salt Air, Moisture, and Wind-Driven Rain (Pages 4-7, 4-8)	1703	FEMA 55 provides general discussion of the hazards of salt air, moisture, and wind-driven rain on wood, bolts, nails, and connectors. SBC requires wood subject to damage from decay and termites to be naturally durable or pressure treated. Chapter 17 of the SBC is for light frame conventional construction having light loads and located in noncoastal areas.

Recommendation: SBC should address corrosion.

FEMA 55	SBC	Analysis
4.1.3 Water, Waves, and Debris (Page 4-8, Paragraph 4)	1201	FEMA 55 addresses the impact loads exerted on the piles as the result in the movement of debris (fences, porches, stairs, utility poles, etc.) FEMA 55 has provided for the collision of a 300 pound object moving at surface water velocity and decelerating over a maximum distance of 0.5 ft. SBC requires the building to be of sufficient strength to support the loads and forces encountered without exceeding in any of its structural elements, the stresses prescribed in the Code. SBC also requires the structural system to be able to sustain local damage or failure with the overall structure remaining stable.

Recommendation: None since both address the issue of damage only from different directions: FEMA - prescriptive, SBC - performance.

FEMA 55	SBC	Analysis
4.1.4 Effects of Forces on Higher and Larger Structures (Page 4-9)	1201, 1205	FEMA 55 discusses the higher wind forces, uplift and overturning with respect to the height of the building. SBC requires buildings to be of sufficient strength to support the loads and forces encountered. 1205 of SBC provides velocity pressures (psf) and coefficients which address the height of the building above grade.

Recommendation: FEMA 55 should provide velocity pressures (psf) for varied wind speeds and building height.

FEMA 55	SBC	Analysis
4.2 Construction Materials (Page 4-9)	Chapters 13, 15, 16 and 17	FEMA 55 provides a general discussion of the types of construction materials (wood, steel, concrete) and their use in the coastal environment. SBC provides requirements for the use of these materials in any environment. Chapter 17 of the SBC is for light frame conventional construction having light loads and located in noncoastal areas.

Recommendation: None.

FEMA 55	SBC	Analysis
4.2.1.1 Pilings (Wood) (Pages 4-9, 4-10)	1309	FEMA 55 provides general comments on the use of wood pilings (species and decay resistance). SBC addresses the ASTM standard, preservative treatment, and allowable stresses for round timber piles.

Recommendation: FEMA 55 should provide additional information such as ASTM standard preservative treatment and allowable stresses of timber piles.

FEMA 55	SBC	Analysis
4.2.1.2 Main Supporting Members (Beams, Wood) (Page 4-10)	1706.2 Table 1705.1	Both FEMA 55 and SBC address the use of built-up beams and girders. FEMA 55 provides general nailing requirements and splice location. SBC provides specific nailing requirements and splice location. Chapter 17 of the SBC is for light frame conventional construction having light loads and located in noncoastal areas.

Recommendation: FEMA 55 should provide more specific nailing and splice details.

FEMA 55	SBC	Analysis
4.2.1.3 Other Wood Construction Members (Page 4-10)	1703.1.1.3	FEMA 55 does not require preservative treatment of miscellaneous wood members but highly recommends it. SBC requires wood subject to decay to be a naturally durable species resistant or pressure treated.

Recommendation: None.

FEMA 55	SBC	Analysis
4.2.1.4 Wood Preservatives (Page 4-10)	1701.4.6	FEMA 55 requires wood members to be treated to resist insect infestation, dry rot, decay fungi, and the effects of exposure to salt air and water and provides general discussions of wood preservatives. SBC requires wood which is subject to decay and termites to be preservative treated and provides a list of AWPA standards.

Recommendation: FEMA 55 should list some of the AWPA standards.

FEMA 55	SBC	Analysis
4.2.2 Masonry Materials and Concrete (Page 4-11)	Chapter 14 Chapter 16	FEMA 55 addresses the general use of masonry and concrete in the coastal environment. SBC provides reference to ASTM, ACI, and NCMA standards along with mixing, placing, formwork, embedded items, details of reinforcing, etc.

Recommendation: FEMA 55 should add references to ACI 318 and ACI/ASCE 530.

FEMA 55	SBC	Analysis
4.2.3.1 Aluminum (Page 4-11)	Chapter 28	FEMA 55 addresses the problem of corrosion of aluminum in the coastal environment. SBC addresses the use of aluminum structurally in buildings and references aluminum standards.

Recommendation: None.

FEMA 55	SBC	Analysis
4.2.3.2 Steel (Page 4-11)	Chapter 15	FEMA 55 addresses the problem of corrosion of unprotected steel shapes and anchoring devices (nails, bolts, etc.) and the need for regular inspection, maintenance, and replacement of corroded metal parts. SBC requires the design of steel construction to comply with the appropriate standards. SBC does not address corrosion in coastal environments.

Recommendation: SBC should address corrosion protection in coastal areas.

FEMA 55	SBC	Analysis
4.2.3.3 Dissimilar Metals (Page 4-11)	N/A	FEMA 55 addresses the corrosion which occurs when dissimilar metals are placed in contact with each other (brass screws and aluminum frame). SBC does not address dissimilar metals.

Recommendation: None.

FEMA 55	SBC	Analysis
4.3.1 Foundations (Design Details) (Pages 4-11, 4-12)	Chapter 13	FEMA 55 recommends foundation types which are suitable for supporting elevated structures in coastal high hazard areas. SBC permits any type of foundation provided it is designed. This is addressed in 801.1 of the SBCCI Standard for Floodplain Management.

Recommendation: None since FEMA 55 is "prescriptive" and SBC is "performance" oriented.

FEMA 55	SBC	Analysis
4.3.1.1 Soil Conditions (Pages 4-12, 4-13)	1302.2, 1302.3	Both FEMA 55 and SBC address the need to determine the quality of the soil for foundation purposes. FEMA 55 provides commentary type information also.

Recommendation: None.

FEMA 55	SBC	Analysis
4.3.1.2 Piles (Pages 4-13 to 4-18)	1303, 1304	FEMA 55 provides general information on types of piles, the need for sufficient pile embedment, and methods of pile installation. SBC requires a foundation investigation and report which will include recommended pile type, driving criteria, installation procedures, pile load test requirements, durability of pile materials, and designation of bearing strata.

Recommendation: FEMA 55 should emphasize that type of pile, pile depth, and method of installation should be based on the soils investigation.

FEMA 55	SBC	Analysis
4.3.1.3 Posts (Wood) (Page 4-18)	N/A	FEMA 55 explains that wood posts are not recommended in areas subject to wave forces and/or scour and erosion. SBC does not address post foundations but does address pile foundations in 1303-1311.

Recommendation: FEMA 55 should combine post foundations and pile into one section with more prescriptive requirements.

FEMA 55	SBC	Analysis
4.3.1.4 Piers (Pages 4-18 to 4-20)	1201 1405.6	FEMA 55 addresses the use of piers to elevate structures and the need for reinforcing and anchorage to the footing in V zones and coastal A zones. FEMA 55 also provides general construction guidelines. SBC requires that an appropriate structural analysis be performed for the piers. SBC provides maximum height to the least dimension ratio for unreinforced masonry piers.

Recommendation: FEMA 55 should clarify that the reinforcing, footing size, and grade beam size should be based on the design forces.

FEMA 55	SBC	Analysis
4.3.2.1 Framing Methods (Pages 4-20, 4-21)	1701.2.5 1706 1707.4	Both FEMA 55 and SBC address platform framing and pole construction. FEMA 55 addresses pole construction and provides commentary on the types of construction. Chapter 17 of the SBC is for light frame conventional construction having light loads and located in noncoastal areas.

Recommendation: None.

FEMA 55	SBC	Analysis
4.3.2.2 Beams (Pages 4-21, 4-22)	1706.2 Table 1705.1	FEMA 55 addresses the preferable direction of floor beams to reduce the impact force of the storm water. FEMA 55 and SBC address built-up beams and solid members. FEMA 55 mentions "glulam" beams. SBC provides nailing requirements for the built-up members. Chapter 17 of the SBC is for light frame conventional construction having light loads and located in noncoastal areas.

Recommendation: FEMA 55 should provide nailing requirements for built-up members.

FEMA 55	SBC	Analysis
4.3.2.3 Joists and Rafters (Page 4-22)	1706.3	The title of the section in FEMA 55 is joists and rafters but rafters are not addressed. FEMA 55 describes manufactured wooden I-beams, recommends cross bridging for all floor joists located in the V-zone, and describes typical cross bridging methods. SBC does not address manufactured wooden I-beams and only requires bridging or blocking if the depth to thickness ratio exceeds six or the design live load in excess of 40 psf. Chapter 17 of the SBC is for light frame conventional construction having light loads and located in noncoastal areas.

Recommendation: FEMA 55 should delete the reference to rafters or add information on rafters.

FEMA 55	SBC	Analysis
4.3.2.4 Subflooring (Pages 4-22, 4-23)	1706.6	Both FEMA 55 and SBC permit the use of lumber and plywood subflooring. SBC also permits the use of particleboard subfloors. FEMA 55 recommends the use of plywood with exterior glue and annular ring nails or deformed shank nails. FEMA 55 recommends nailing and gluing of plywood with tongue-and-groove joints to avoid the need for blocking and to produce a stronger diaphragm. SBC permits the use of common, annular, or spiral thread nails with no mention of gluing. SBC provides minimum thickness, span of subfloor, and nail spacing. Chapter 17 of the SBC is for light frame conventional construction having light loads and located in noncoastal areas.

Recommendation: The provisions are compatible. FEMA 55 should provide some recommended nail spacing and spans.

FEMA 55	SBC	Analysis
4.3.2.5 Studs (Page 4-23)	1707.1.1 1707.1.2	FEMA 55 recognizes that 2x4 wood studs at 16 inches on center are commonly used and permits 2x6 wood studs and metal studs. SBC addresses the use of wood studs based on lateral unsupported stud height, spacing of studs, and number of stories. Chapter 17 of the SBC is for light frame conventional construction having light loads and located in noncoastal areas.

Recommendation: FEMA 55 should address sizing of studs including number of stories which the stud supports or limits for the use of 2x4 studs.

FEMA 55	SBC	Analysis
4.3.2.6 Wall Sheathing (Page 4-23)	1707.2, 1201.1	FEMA 55 provides the minimum thickness and nail spacing for plywood wall sheathing for two cases 1) structures elevated not more than 10 ft and 2) structures elevated more than 10 ft above grade. SBC lists approved methods of wall bracing and requires the structure to be designed for the loads and forces encountered. Chapter 17 of the SBC is for light frame conventional construction having light loads and located in noncoastal areas.

Recommendation: FEMA 55 should provide additional information addressing the wind speed in addition to height above grade.

FEMA 55	SBC	Analysis
4.3.2.7 Wall Bracing (Page 4-24)	1707.2, 1201.1	Both FEMA 55 and SBC permit the use of let-in diagonal wood bracing, diagonal boards, and plywood. SBC also permits particleboard, fiberboard, and gypsum sheathing. SBC also requires the structure to be designed for the loads and forces encountered. Chapter 17 of the SBC is for light frame conventional construction having light loads and located in noncoastal areas.

Recommendation: FEMA 55 should combine 4.3.2.6 Wall Sheathing and 4.3.2.7 Wall Bracing into one section and address the design requirements for the wall bracing method chosen.

FEMA 55	SBC	Analysis
4.3.2.8 Roof Details (Pages 4-24 to 4-27)	N/A	FEMA 55 discusses the use of trusses, gable roofs, hip roofs, flat roofs, gambrel roofs, roof overhangs and porches and their performance in high wind conditions. SBC does not provide details or discuss performance of specific designs.

Recommendation: None.

FEMA 55	SBC	Analysis
4.3.3 Foundation Bracing (Pages 4-27 to 4-29)	1201.1 1303	FEMA 55 addresses the need for bracing wood foundation piles. SBC requires the wood foundation system to be designed for the loads and forces encountered.

Recommendation: None.

FEMA 55	SBC	Analysis
4.3.3.1 Knee Braces (Page 4-29)	1201.1 1303	FEMA 55 recommends the use of knee braces for wood foundation piles even though bracing may not be needed. SBC requires the wood foundation piles to be designed for the loads and forces encountered.

Recommendation: FEMA 55 should emphasize that the wood foundation piles should be designed for the additional moment introduced into the pile from the knee brace.

FEMA 55	SBC	Analysis
4.3.3.2 Grade Beams (Pages 4-29, 4-30)	1201.1 1303	FEMA 55 emphasizes the need for lateral support of the piles at the ground line. SBC requires the piles to be designed for the loads and forces encountered.

Recommendation: FEMA 55 should emphasize the need to design the grade beams to assure that they are actually providing lateral support of piles.

FEMA 55	SBC	Analysis
4.3.3.3 Truss Bracing (Pages 4-30, 4-31)	1201.1 1303	FEMA 55 recommends the use of truss bracing of the piles when the structure is 10 ft or more above grade and the design wind speed is 100 mph or greater. SBC requires the piles to be designed for the loads and forces encountered.

Recommendation: FEMA 55 should emphasize the need to design the bracing members.

FEMA 55	SBC	Analysis
4.3.3.4 Shear Walls (Page 4-31)	1201.1	FEMA 55 addresses only reinforced concrete or reinforced masonry shear walls. SBC requires the structure to be designed for the loads and forces encountered.

Recommendation: FEMA 55 should address wood shear walls for wood pile foundations.

FEMA 55	SBC	Analysis
4.3.4 Connections 4.3.4.1 Roof to Wall 4.3.4.2 Wall to Floor Joists 4.3.4.3 Floor Joist to Floor Beam (Pages 4-31 to 4-35)	1201.1	FEMA 55 provides commentary type language for connections but does require the anchorage to be sufficient to withstand the anticipated forces. FEMA 55 provides commentary type language for roof to wall, wall to floor joist, and floor joist to floor beam connection and requires the connections to be designed in high wind speed areas. SBC requires the structure to be designed for the loads and forces encountered.

Recommendation: None since both FEMA 55 and SBC require sufficient connection.

FEMA 55	SBC	Analysis
4.3.4.4 Floor Beam to Pile, Post, or Pier (Pages 4-35 to 4-40)	1201.1	FEMA 55 provides commentary type language and typical details for floor beams to pile, post, or pier connections, but permits other methods provided they are designed. SBC requires the structure to be for the loads and forces encountered.

Recommendation: FEMA 55 should provide some design values or wind speeds for which the connections are appropriate.

FEMA 55	SBC	Analysis
4.3.5 Breakaway Walls 4.3.5.1 Breakaway Wall Designs 4.3.5.2 Design Considerations for Breakaway Walls (Pages 4-41 to 4-49)	N/A	FEMA 55 permits breakaway walls to enclose the space below the lowest elevated floor and provides commentary type language for different types of breakaway walls. FEMA 55 provides breakaway wall designs and details for screening, lattice, wood stud walls, metal stud walls, and masonry walls. FEMA 55 provides the design process for breakaway walls and commentary type language for wind forces, water forces, working/ultimate strength of fasteners, distribution of wall loads, and bracing considerations for breakaway walls. SBC does not address breakaway walls. This is addressed in 801.4 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 55	SBC	Analysis
4.3.6 Utilities (Pages 4-50 to 4-52)	N/A	FEMA 55 requires the protection of utilities from the potential damage from flooding and wave impact. SBC does not address utilities. This is addressed in 602.5 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 55	SBC	Analysis
4.3.7 Wind and Storm Protection of Interior (Page 4-52)	N/A	FEMA 55 provides commentary on the need to protect the buildings from glass breakage in order to prevent water damage. SBC does not address glass breakage; it requires the windows to be designed as components and cladding or be considered an "opening."

Recommendation: None.

FEMA 55	SBC	Analysis
4.3.7.1 Window Selection (Pages 4-52, 4-53)	1205	FEMA addresses the importance of window selection to reduce water infiltration. SBC requires the windows to be designed as components and cladding or be considered an "opening." SBC does not address water infiltration.

Recommendation: FEMA 55 should address the design of the windows for the wind load pressures.

FEMA 55	SBC	Analysis
4.3.7.2 Operable Shutters (Pages 4-53, 4-54)	1205	FEMA 55 addresses the need for shutters to protect against wave and wind action. SBC requires the windows to be designed as components and cladding or be considered an "opening." SBC does not address the use of shutters.

Recommendation: FEMA should address the need to design the shutters for the wind load pressures.

FEMA 55	SBC	Analysis
4.3.7.3 Gable and Eave Vents (Page 4-54)	1205.1 1708.7	FEMA 55 addresses the vulnerability of vents to wind and wind-driven rain and emphasizes the importance for the careful selection of attic ventilators in order to assure that they will withstand the wind loads. SBC requires ventilation of the attic space based on a ratio of free ventilating area. SBC requires parts of the building to be designed to withstand the appropriate wind loads. Chapter 17 of the SBC is for light frame conventional construction having light loads and located in noncoastal areas.

Recommendation: None since FEMA 55 and SBC both require the design of the vents to withstand the appropriate wind loads.

FEMA 55	SBC	Analysis
4.3.7.4 Roofing Materials (Page 4-54)	1205.1	FEMA 55 emphasizes the need to use self-sealing, heavyweight shingles to avoid the possible loss of roofing material in high winds. SBC requires all parts of the building to be designed to withstand the appropriate wind loads.

Recommendation: FEMA 55 should emphasize the need to have a roof covering designed to withstand the uplift from the wind. SBC should emphasize that the roof covering should be designed to 1205.

FEMA 55	SBC	Analysis
4.3.8 Maintenance (Pages 4-54, 4-55)	N/A	FEMA 55 emphasizes the need for maintenance of all parts of buildings exposed to the coastal environment because of the accelerated deterioration. SBC does not address maintenance but does require repairs or rehabilitation to comply with the requirements of the SBC for new construction.

Recommendation: None.

FEMA 55	SBC	Analysis
5.1 General Design Considerations (Pages 5-1, 5-2)	1201.1 1607.6.3	FEMA 55 prohibits enclosure for habitation below BFE mid-rise and high-rise structures in coastal high hazard areas. SBC does not address this issue. This is addressed in 602.3 of the SBCCI Standard for Floodplain Management. FEMA 55 and SBC require thicker concrete cover over reinforcing steel to provide added corrosion protection of the reinforcing steel in corrosive environments or severe exposure conditions. SBC requires compliance with ACI 318 and the minimum cover in 1607.6. FEMA 55 addresses the need to design for wind and water forces. SBC requires the structure to be sufficient to support the loads and forces encountered.

Recommendation: FEMA 55 should address snow and seismic loads.

FEMA 55	SBC	Analysis
5.2 Foundations (Page 5-2)	1303	FEMA 55 emphasizes the need for pile foundations that are embedded deeply to provide a safety margin against scour. FEMA 55 lists the common types of piles as precast/prestressed concrete, cast-in-place concrete, steel, and timber. FEMA 55 shows a typical pile/pile cap/column/grade beam detail. FEMA 55 permits strip footings and mat foundations in zones of reduced velocity and wave action. SBC does not address scour. SBC requires foundations to be designed and installed on the basis of a foundation investigation. SBC provides standards for all of the types of piles listed in FEMA 55.

Recommendation: None.

FEMA 55	SBC	Analysis
5.3 Slabs at Grade (Pages 5-3, 5-4)	1303, 1608	FEMA 55 suggests that slabs supported on soil are thin (minimum of 4 inches thick) with minimal reinforcing in the form of welded wire fabric and are expected to be lost in the event of a storm. SBC requires the minimum thickness of 3 1/2 inches and does not require welded wire fabric. FEMA 55 also addresses the use of designed slabs and grade beams to laterally support the pile foundation system. SBC permits the engineer to design the foundation system.

Recommendation: The minimum slab thickness in FEMA 55 should be changed to 3 1/2 inches and delete the requirement for welded wire fabric.

FEMA 55	SBC	Analysis
5.4 Superstructure (Pages 5-4 to 5-7)	N/A	FEMA 55 provides commentary type language and typical details of the superstructure of a building. This includes columns, beams, slabs, and shear walls. SBC is a performance code and not a commentary.

Recommendation: None.

FEMA 55	SBC	Analysis
5.5 Elevated Floors (Pages 5-7, 5-8)	Chapter 16	FEMA 55 provides commentary type language for elevated concrete floors. FEMA 55 addresses one-way and two-way slabs, perimeter beams, and the transfer of lateral forces to the pile foundation. SBC requires structural members of reinforced concrete to be designed and constructed in accordance with Chapter 16 and ACI 318.

Recommendation: None.

FEMA 55	SBC	Analysis
5.6 Exterior Wall Systems (Pages 5-8, 5-9)	1201.1	FEMA 55 provides commentary type language on exterior wall systems of masonry or metal studs and the fastening method of the walls. FEMA 55 and SBC require that the walls be designed to resist the lateral forces encountered.

Recommendation: None since both requires the walls to be designed for the lateral forces encountered; however, FEMA 55 should address seismic loads.

FEMA 55	SBC	Analysis
5.7 Recommendations (Page 5-9)	103.2.3	FEMA 55 requires mid-rise and high-rise structures to be designed by a "design professional." SBC requires a "design professional" to design all structures three stories or more high and structures 5000 sq ft or more in area.

Recommendation: None since both require a design professional.

FEMA 55	SBC	Analysis
Appendix A Design Tables Figure A-1 number of piles required Table A-1 downward loads per pile Table A-2 horizontal wind loads per pile in 80 mph winds Table A-3 minimum embedment depth of piles Table A-4 maximum unbraced height of piles in 80 mph winds and flood forces Table A-4.1 maximum unbraced height of piles supporting breakaway walls Table A-5 uplift loads per foot of wall in 80 mph winds Table A-6 uplift loads per pile in 80 mph winds Table A-7 capacity per bolt of floor beam connections Table A-8 concrete masonry unit piers Table A-9 concrete piers Figure A-2 concrete pier cross section Figure A-3 grade beams and slabs Table A-10 fastener capacities in shear Table A-11 fastener schedule for breakaway walls (Pages A-1 to A-47)	Chapters 12, 13, 14, 15, 16, and 17	FEMA 55 provides design tables. SBC is a performance code and not a specification type code. Chapter 17 of the SBC is for light frame conventional construction having light loads and located in noncoastal areas.

Recommendation: None.

FEMA 55	SBC	Analysis
Appendix B - Bracing B.1 knee bracing B.2 truss bracing B.2.1 diagonals B.2.1.1 lumber diagonals B.2.1.2 threadbar diagonals B.2.2 struts B.3 grade beams Table B-1 horizontal water loads per pile in 80 mph winds Table B-2 loads of transverse truss members Table B-3 allowable loads for single 2x8 diagonals Table B-4 allowable loads for single 3x8 diagonals (Pages B-1 to B-15)	Chapters 12, 13, 14, 15, 16, and 17	FEMA provides various recommendations and details for bracing methods. SBC is a performance code and not a specification type of code. Chapter 17 of the SBC is for light frame conventional construction having light loads and located in noncoastal areas.

Recommendation: None.

FEMA 55	SBC	Analysis
Appendix D - Design Equations and Procedures D.1 Procedure A-1: downward loads per pile D.2 Procedure A-2: horizontal wind loads per pile D.3 Procedure A-3: minimum embedment depth of piles D.4 Procedure A-4: maximum unbraced height of piles D.5 Procedure A-4.1: maximum unbraced height of piles supporting breakaway walls D.6 Procedure A-5: uplift loads per foot of walls D.7 Procedure A-6: uplift loads per pile D.8 Procedure B-1: horizontal water loads per pile D.9 Procedure B-2: loads transferred to foundation truss members (Pages D-1 to D-32)	N/A	FEMA 55 contains design equations and procedures which are needed to evaluate individual designs. SBC is a performance code with design being based on good engineering practice.

Recommendation: None.

FEMA 55	SBC	Analysis
G-2. Purpose (Page G-1)	101.2	FEMA 55 states that the purpose of the Coastal Code is to provide minimum standards for the design and construction of residential structures in Coastal High Hazard Areas and where wave action can be expected. SBC is declared remedial and is intended to secure the beneficial interests and purposes of the Code which are public safety, health and general welfare.

Recommendation: None since the intent of both FEMA 55 and SBC is to provide minimum requirements for structures.

FEMA 55	SBC	Analysis
G-3. Scope (Page G-2)	101.3 101.5	Both FEMA 55 and SBC apply to new construction and improvements or additions to existing structures. FEMA 55 permits improvements up to 49% of the market value of the structure without compliance with the Coastal Construction Code but the SBC requires all improvements to comply with the Code.

Recommendation: Since market value is a variable based on location, economy, etc., FEMA should require compliance for all improvements since noncompliance of any part of the structure makes the entire structure out of compliance.

FEMA 55	SBC	Analysis
G-4. Definitions (Pages G-2, G-3)	202	FEMA 55 contains only definitions which are related to coastal construction. SBC contains definitions which are applicable to all types of structures and occupancies in any location. Dead load, grade, live load, and structure have similar definitions.

Recommendation: None.

FEMA 55	SBC	Analysis
G-5. Elevation Standards. (Page G-3)	N/A	FEMA 55 prohibits new construction or substantial improvements from being seaward of an established setback line and requires it to be elevated above the BFE. SBC does not prohibit construction in any location. This is addressed in 801.6 of the SBCCI Standard for Floodplain Management.

Recommendation: None since these types of requirements are local specific and should addressed on the local level.

FEMA 55	SBC	Analysis
G-6. Determination of Loading Forces G-6.1 Water Loads G-6.2 Wind Loads (Page G-3)	1201.1 1205	Both FEMA 55 and SBC require the structure to be of sufficient strength to support the loads and forces encountered. FEMA 55 references ANSI A58.1-1982 for the wind load provisions. SBC contains a basic wind speed map, use factors, velocity pressures, and coefficients for wind design. SBC also permits wind design based on ASCE 7-88.

Recommendation: FEMA 55 should update reference to ASCE 7-88.

FEMA 55	SBC	Analysis
G-7. Foundation Standards (Page G-4)	Chapter 12 Chapter 13	Both FEMA 55 and SBC require the foundations to be designed to support the loads and forces encountered.

Recommendation: FEMA 55 should address snow and seismic loads.

FEMA 55	SBC	Analysis
G-7.1 Pile Foundation Design (Pages G-4, G-5)	Chapter 12 Chapter 13	FEMA 55 requires the pile spacing to pile diameter ratio to not be less than 8:1 with a maximum spacing of 12 ft while SBC requires the minimum center to center spacing of piles to be not less than twice the average diameter of a round pile nor less than 1 3/4 times the diagonal dimension of a rectangular pile. FEMA 55 provides minimum embedment of foundation piles based on mean sea level and BFE while SBC requires embedment to be based on a foundation investigation. Both FEMA 55 and SBC requires the piles to be analyzed as a column for the unsupported length. FEMA 55 provides dimensional criteria for round and square wood piles. SBC references the appropriate ASTM standard. FEMA 55 requires the minimum compressive strength of the concrete for reinforced concrete piles to be 5000 psi while SBC requires only 4000 psi. The reinforcement requirements for reinforced concrete piles are the same for both FEMA 55 and SBC. FEMA 55 lists three methods of pile installation. FEMA 55 provides commentary type language for methods of bracing piles to resist the horizontal forces while SBC requires the piles to be designed for the horizontal forces which are encountered.

Recommendation: FEMA 55 should emphasize that pile spacing and embedment should be based on the foundation investigation. FEMA 55 should reduce the minimum compressive strength of the concrete for reinforced concrete piles to 4000 psi, since 4000 psi has been a building code requirement since 1980.

FEMA 55	SBC	Analysis
G-7.2 Column Foundation Design (Page G-5)	1201.1 Chapter 13 1405.6	FEMA 55 requires reinforcing of masonry piers or poured-in-place concrete piers. SBC requires piers to be designed for the forces encountered.

Recommendation: None.

FEMA 55	SBC	Analysis
G-8. Anchoring Standards (Page G-5)	1201.1	FEMA 55 requires anchorage to prevent flotation, collapse, or permanent lateral movement during the base flood concurrent with the 100 year design wind velocity. SBC requires every structure to support the loads and forces encountered. SBC does not address flotation. This is addressed in 601.1 and 801.1 of the SBCCI Standard for Floodplain Management.

Recommendation: FEMA 55 should address snow and seismic loads.

FEMA 55	SBC	Analysis
G-8.1 Connector and Fasteners (Page G-5)	1201.1	Both FEMA 55 and SBC require the connectors to support the loads and forces encountered. FEMA 55 does not permit toe nailing. FEMA 55 requires metal connectors and fasteners to have corrosion protection.

Recommendation: FEMA 55 should not prohibit toe nailing if the connection is adequate for the calculated loads. SBC should address corrosion protection of metal connectors.

FEMA 55	SBC	Analysis
G-8.2 Beam to Pile Connections (Pages G-5, G-6)	1201.1	FEMA 55 provides prescriptive requirements for the beam to pile connection. SBC requires the structure to support the loads and forces encountered.

Recommendation: FEMA 55 should permit the designer to design the connection.

FEMA 55	SBC	Analysis
G-8.3 Floor to Deck Connections (Page G-6)	1201.1 Chapter 17	FEMA 55 provides prescriptive requirements for the connection of floor joists to floor beam/girders, cross bridging, subflooring, and attic flooring. SBC permits connections to be designed and subflooring to any material permitted by Chapter 17. Chapter 17 of the SBC is for light frame conventional construction having light loads and located in noncoastal areas.

Recommendation: FEMA 55 should permit the designer the leeway to meet performance requirements.

FEMA 55	SBC	Analysis
G-8.4 Exterior Wall Connections (Page G-6)	1201.1 Chapter 17	FEMA 55 provides prescriptive requirements for the exterior wall connection. SBC permits the designer to design the exterior wall connection. Chapter 17 of the SBC is for light frame conventional construction having light loads and located in noncoastal areas.

Recommendation: FEMA 55 should permit the designer the leeway to meet performance requirements.

FEMA 55	SBC	Analysis
G-8.5 Ceiling Joist/Rafter Connections (Page G-6)	1201.1 1708	Both FEMA 55 and SBC requires a continuous tie across the building and the joist and rafters securely fastened at their intersection. FEMA 55 requires metal or wood connectors at alternate ceiling joist/rafter connections to the wall top plate and blocking in gable roofs. Chapter 17 of the SBC is for light frame conventional construction having light loads and located in noncoastal areas.

Recommendation: FEMA 55 should permit the designer to design the connection.

FEMA 55	SBC	Analysis
G-8.6 Projecting Members (Page G-6)	1201.1	Both FEMA 55 and SBC require cantilevers and projecting members to be designed to support the loads and forces encountered.

Recommendation: None.

FEMA 55	SBC	Analysis
G-9. Roof Sheathing (Pages G-6, G-7)	1708	FEMA 55 requires the roof sheathing to be a minimum of 15/32 inch thick plywood. SBC also permits particleboard of 3/8 inch thickness. FEMA 55 requires corrosion resistant fasteners and the application of waterproof industrial adhesive to all bearing surfaces of plywood used in the sheathing of corners, gable end, or roof overhang. FEMA 55 also provides commentary type language addressing the roof slopes and construction at points of discontinuity of the roofing surface. Chapter 17 of the SBC is for light frame conventional construction having light loads and located in noncoastal areas.

Recommendation: FEMA 55 should permit particleboard roof sheathing provided it is of the appropriate strength.

FEMA 55	SBC	Analysis
G-10. Protection of Openings (Page G-7)	1205.1.4 2703.3	Both FEMA 55 and SBC require exterior openings to be designed to withstand the appropriate wind loads.

Recommendation: None.

FEMA 55	SBC	Analysis
G-11. Use of Space Below the Lowest Elevated Floor (Page G-7)	N/A	FEMA 55 prohibits the use of the space below the BFE to be used for any other purpose than parking storage or building access. SBC does not prohibit the use of the space below the elevated floor. This is addressed in 602.3 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 55	SBC	Analysis
G-11.1 Breakaway Wall Design Standards (Page G-7)	N/A	FEMA 55 provides the design requirements for breakaway walls. SBC does not address breakaway walls. This is addressed in 801.4 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 55	SBC	Analysis
G-11.2 Certification of Breakaway Walls (Pages G-7, G-8)	N/A	FEMA 55 permits breakaway walls which are designed with a wall strength in excess in that permitted in 11.1 provided the design profession certifies that the wall will fail under water loads less than those that would occur during the base flood and the elevated portion of the building will not be subject to damage due to the effects of wind and water loads acting simultaneously. SBC does not address breakaway walls. This is addressed in 801.4 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 55	SBC	Analysis
G-12. Utilities (Page G-8)	N/A	FEMA 55 requires the utilities to be elevated above the BFE and backflow valves for sanitary sewer and storm drainage systems which have openings below the BFE. SBC does not address utilities. This is addressed in 602.5 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 55	SBC	Analysis
G-13. Certification Requirements (Page G-8)	103.2.3	FEMA 55 requires new and substantial improvements to be designed by a registered professional engineer or architect. SBC requires design by a professional engineer or architect for all group A, E, and I occupancies, structures three stories or more high, and structures 5000 sq ft or more in area. This is addressed in 401.3 and 801.7 of the SBCCI Standard for Floodplain Management.

Recommendation: FEMA 55 should provide parameters for which sections 7 and 8 are appropriate (wind load, height above grade, etc.).

FEMA 55	SBC	Analysis
G-14. Reference Documents (Page G-8)	Chapter 3	FEMA 55 references ANSI A58.1-1982, Shore Protection Manual by the Department of the Army, and the Coastal Construction Manual by FEMA. SBC does not reference any of these documents.

Recommendation: FEMA 55 should update reference to ASCE 7-88.

Manufactured Home Installation In Flood Hazard Areas (FEMA 85)

Chapter III Elevation and Anchoring Techniques

FEMA 85	SBC	Analysis
Elevation and Anchoring Techniques (Page 19)	N/A	FEMA 85 provides general techniques which are used to elevate a manufactured home in riverine or coastal flooding areas. SBC does not provide techniques but does provide performance requirements for piers, piles, and foundations. This is addressed in 600, 601, 603, and 604 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 85	SBC	Analysis
Elevation on Fill (Pages 19-20)	Chapter 13	FEMA 85 provides commentary and prescriptive type language on the use of earth fill to elevate a manufactured home. FEMA 85 prohibits the use of fill material in areas subject to floodwaters having a velocity greater than 10 fps and where it will constrict the flow of floodwaters and cause increased flood elevations or velocity. SBC requires foundations to be built on undisturbed or properly compacted fill material. SBC does address floodplain management. This is addressed in 603.3 and 801.5 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 85	SBC	Analysis
Elevated Foundations (Pages 21-28)	Chapter 13 H105	FEMA 85 addresses structural techniques, such as piers, posts, piles and similar structural arrangements, to elevate a manufactured home above the flood level. FEMA 85 provides prescriptive requirements for these structural techniques while SBC provides performance type of requirements. Both FEMA 85 and SBC requires the foundation to be designed for the anticipated forces. SBC has prescriptive requirements in H105 for piers up to 80 inches in height. SBC has prescriptive requirements in 1405.6 similar to FEMA 85 for masonry piers. SBC does not address post foundations.

Recommendation: None.

FEMA 85	SBC	Analysis
Anchoring (Pages 29-31)	1201.1 H105.3	Both FEMA 85 and SBC require tie-down and anchoring systems to resist the lateral and uplift forces resulting from wind. FEMA 85 provides commentary type language and descriptive details. SBC contains minimum number of ties and anchors based on the length of manufactured home.

Recommendation: FEMA 85 should address minimum number of ties and anchors.

FEMA 85	SBC	Analysis
Design of Elevated Foundations (Page 33)	Chapter 12	FEMA 85 presents an overview of flood-induced loads, tables of calculated forces, governing design equations and specific technical information which can be used to determine an appropriate elevated design for a manufactured home with the manufactured home complying with HUD's Manufactured Home Construction Safety Standards. The wind loads and snow loads in FEMA 85 and SBC are very different.

Recommendation: FEMA 85 and HUD's MHCSS should update the wind and snow loads to ASCE 7-88. FEMA 85 should address seismic loads.

FEMA 85	SBC	Analysis
A. Flood Forces and Their Application (Pages 34-45)	Chapter 12	FEMA 85 addresses the hydrostatic forces, lateral forces, buoyancy forces, hydrodynamic forces, impact forces due to water-borne objects, and scour. SBC does not address "water forces" but does require every structure to be of sufficient strength to support the loads and forces encountered.

Recommendation: None.

FEMA 85	SBC	Analysis
B. Evaluation of Elevated Foundations (Pages 45-58)	Chapter 12	FEMA 85 provides commentary type language in addition to actual design tables and details. SBC is a performance code and does not provide design tables and details. SBC requires every structure to be of sufficient strength to support the loads and forces encountered and permits the designer to choose the technique.

Recommendation: None.

FEMA 85	SBC	Analysis
C. Bracing Support and Connections for Elevated Foundations (Pages 58-68)	Chapter 12	FEMA 85 provides design procedures, tables, and details needed to design bracing and connections. SBC is a performance code and requires the structure to be of sufficient strength to support the loads and forces encountered.

Recommendation: None.

FEMA 85	SBC	Analysis
D. Additional Design Considerations (Pages 68-70)	N/A	FEMA 85 addresses the setup (jacking), utility service, mechanical systems, and access/egress during flooding around the manufactured home. SBC does not address these issues.

Recommendation: None.

FEMA 85	SBC	Analysis
Appendix D - Calculational Procedures for Elevated Foundation Design (Pages 89-97)	N/A	FEMA 85 contains actual design procedures and formulas which were used as a basis of the manual. SBC is a performance code and does not contain engineering analysis procedures.

Recommendation: None.

FEMA 85	SBC	Analysis
Appendix E - Buoyancy and Drag Forces (Pages 99-101)	Chapter 12	FEMA 85 addresses the forces from buoyancy and drag caused by the floodwaters. FEMA 85 contains design tables for vertical tie forces based on home width and water depth. SBC does not address flood water forces but does require the structure to have sufficient strength to support the loads and forces encountered.

Recommendation: None.

Floodproofing Non-Residential Structures (FEMA 102)

Chapter I Introduction

FEMA 102	SBC	Analysis
I.E. Contingent Floodproofing Measures I.F.1 Flood Shields I.F.2 Watertight Doors I.F.3 Movable Floodwalls (Pages 8-13)	N/A	FEMA 102 addresses the use of contingent floodproofing measures that require some type of installation, activation, or other preparation immediately prior to the occurrence of a flood. These measures include flood shields, watertight doors, and moveable floodwalls. SBC does not address floodproofing. This is addressed in Chapter 9 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

Chapter III Floodproofing Design Permanent and Contingent Measures

FEMA 102	SBC	Analysis
III.B. Elevation on Fill (Pages 37-38)	N/A	FEMA 102 addresses the use of fill material to elevate the building to protect it from flood damages. FEMA 102 contains commentary type language on the design and maintenance of the fill material. SBC does not address floodplain management. Floodplain management is addressed in the SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 102	SBC	Analysis
III.C.2 Posts (Pages 39-40)	Chapter 13	FEMA 102 addresses the elevation of the structure on "post" foundations by showing details and design charts. SBC does not address post foundations but does address pile foundations.

Recommendation: FEMA 102 should combine post foundations and pile foundations into one section.

FEMA 102	SBC	Analysis
III.C.3 Piles (Pages 40-44)	Chapter 13	FEMA 102 provides commentary type language describing the general length, maximum design load, application, advantages, disadvantages, typical elevation, and typical cross section. SBC requires pile foundations to be designed and installed on the basis of a foundation investigation and report.

Recommendation: FEMA 102 should emphasize that the length and maximum design load is based on the foundation investigation and report.

FEMA 102	SBC	Analysis
III.C.4 Piers and Walls (Pages 43-46)	1405.6	Both FEMA 102 and SBC limit the height of filled masonry piers to a maximum of ten times their smallest dimension. FEMA 102 provides details of a brick pier, reinforced concrete masonry pier, and reinforced concrete pier, along with commentary type language.

Recommendation: None.

FEMA 102	SBC	Analysis
Table III-1 Minimum Requirements for Reinforced Piers (Page 46)	1405.6 1411	FEMA 102 provides the minimum pier size, minimum footing size, pier spacing, and useful elevation range but does not contain the reinforcing requirements. SBC references ACI/ASCE 530 for reinforced masonry.

Recommendation: FEMA 102 should clarify the soil bearing capacity was used for the minimum footing size and the design loads used for the minimum pier size.

FEMA 102	SBC	Analysis
III.C.6 Maintenance (Page 47)	N/A	FEMA 102 addresses the need to perform maintenance on posts, piles, piers or wall based on the frequency of the flooding. SBC does not address maintenance of foundations.

Recommendation: None.

FEMA 102	SBC	Analysis
III.D Waterproof Construction III.D.1 Introduction III.D.2 Wall Strength (Pages 48-51)	N/A	FEMA 102 addresses floodproofing of a structure to prevent floodwaters from reaching its interior. SBC does not address floodproofing. This is addressed in 401.2 and Chapter 9 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 102	SBC	Analysis
III.D.3 Floor Strength and Structural Stability III.D.4 Counteracting of Hydrostatic Forces (Pages 51-54)	1312	FEMA 102 addresses floodproofing of a structure by the use of a concrete slab or impervious cutoffs, or subsurface drainage to resist the hydrostatic uplift pressures. SBC does not address floodproofing. This is addressed in 401.2 and Chapter 9 of the SBCCI Standard for Floodplain Management. SBC addresses waterproofing of enclosed spaces below finished ground level when hydrostatic pressure conditions exist.

Recommendation: None.

FEMA 102	SBC	Analysis
III.D.5 Waterproofing (Pages 55-58)	1312	FEMA 102 addresses techniques of waterproofing concrete and masonry walls by the use of high-quality concrete, sealant materials, and/or impermeable membranes. SBC addresses waterproofing by the use of a "waterproofing" material. FEMA 102's waterproofing is to protect the interior from floodwaters while SBC's waterproofing is to protect the interior from groundwater conditions. Floodproofing is addressed in 401.2 and Chapter 9 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 102	SBC	Analysis
III.D.6 Watertight Cores (Pages 58-59)	N/A	FEMA 102 addresses the technique of creating a "watertight core" around expensive items which are located together in a small part of the building when it is not feasible to waterproof the exterior walls. SBC does not address watertight cores.

Recommendation: None.

FEMA 102	SBC	Analysis
III.D.7 Closures and Flood Shields (Pages 60-72)	N/A	FEMA 102 addresses the use of closures and flood shields to protect against floodwater intrusion into the structure. SBC does not address floodproofing.

Recommendation: None.

FEMA 102	SBC	Analysis
III.E. Floodwalls and Levees III.E.5 Floodwall Design (Pages 80-85)	Chapter 12	FEMA 102 provides commentary type language on different types of floodwalls (permanent floodwalls, gravity walls, cantilever walls, and movable walls). SBC does not specifically address floodwalls but does require every structure to be of sufficient strength to support the loads and forces encountered.

Recommendation: None.

FEMA 102	SBC	Analysis
III.E.7 Floodwall Maintenance (Page 88)	N/A	FEMA 102 addresses the need to annually inspect floodwalls. SBC does not address the need for inspection of existing structures.

Recommendation: None.

FEMA 102	SBC	Analysis
IV. Other Floodproofing Measures IV.C. Floodproofing Utilities (Pages 99-104)	N/A	FEMA 102 addresses methods to prevent flood damage to exterior utilities. SBC does not address utilities or floodproofing. This is addressed in 602.5 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 102	SBC	Analysis
Appendix B Glossary (Pages 161-166)	202	FEMA 102 contains definitions addressing floodplain management. SBC does not address floodplain management. Floodplain management is addressed in the SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 102	SBC	Analysis
Appendix D Floodproofing Performance Criteria Appendix D.B Design Loads (Pages 182-186)	Chapter 12	FEMA 102 lists the type of loads which the floodproofed structure may be subjected. SBC requires the structure to be of sufficient strength to support the loads and forces encountered.

Recommendation: None since both FEMA 102 and SBC require the structure to be designed for the loads and forces encountered. SBC should address hydrostatic, hydrodynamic, and buoyance forces in floodplain areas.

FEMA 102	SBC	Analysis
Appendix D Floodproofing Performance Criteria Appendix D.C Performance Criteria (Pages 187-193)	N/A	FEMA 102 contains performance criteria which represents the objectives that should be achieved in the design of floodproofed non-residential structures and service systems. SBC does not address floodplain management. Floodplain management is addressed in the SBCCI Standard for Floodplain Management. SBC is a performance code.

Recommendation: None since both FEMA 102 and SBC address performance.

Retrofitting Flood-Prone Residential Structures (FEMA 114)

FEMA 114	SBC	Analysis
3.5 Elevation Onto Extended Foundation Walls (Pages 46-49)	101.5 Chapter 12 Chapter 13	FEMA 114 addresses the method of elevating the structure by increasing the foundation wall height. When this is done, consideration must be taken for the additional load imposed on the footings and the foundation wall. SBC requires alterations to comply with the Code. SBC requires the structure to be of sufficient strength to support the loads and forces encountered. SBC does not address floodplain management. Floodplain management is addressed in SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 114	SBC	Analysis
3.12 Technical Design Criteria Extended Wall Foundations (Pages 61-63)	1201.1	Both FEMA 114 and SBC require the foundation system with the increased foundation wall height to be of sufficient strength to support the loads and forces encountered.

Recommendation: None.

FEMA 114	SBC	Analysis
3.13 Technical Design Criteria Anchorage of Superstructure to Foundation (Pages 63-67)	1201.1 Chapter 17	FEMA 114 provides design details for the anchorage of the superstructure to the foundation system. SBC is a performance code and does not provide design details.

Recommendation: None.

FEMA 114	SBC	Analysis
3.14 Technical Design Criteria Open Foundations (Pages 67-68)	1201.1 Chapter 13	FEMA 114 describes three types of open foundation systems (piers, columns, or piles) and requires them to be designed for the loads encountered. SBC also addresses piers, columns, or piles and requires them to be designed for the loads and forces encountered.

Recommendation: FEMA 114 should address seismic loads.

FEMA 114	SBC	Analysis
6.2 Considerations (Floodwalls) (Pages 111-114)	1201.1	FEMA 114 addresses the use of floodwalls to protect structures from flooding and emphasizes that tremendous forces are created by high water levels and velocities. SBC does not address floodwalls but does require structures to be designed for the loads and forces encountered.

Recommendation: SBC should address hydrostatic, hydrodynamic and buoyance forces in floodplain areas.

FEMA 114	SBC	Analysis
6.3 Construction Techniques and Materials (Floodwalls) (Pages 115-119)	N/A	FEMA 114 addresses techniques and types of materials for the construction of floodwalls. SBC does not address floodwalls or floodplain management. Floodplain management is addressed in the SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 114	SBC	Analysis
6.5 Technical Design Criteria (Floodwalls) (Pages 121-129)	Chapters 12, 13, 14, 15 and 16	FEMA 114 contains design criteria for floodwall design which addresses materials, soils, loads, overturning resistance, sliding resistance, and actual foundation dimensions. SBC is a performance code which requires structures to be designed to withstand the loads and forces encountered. SBC provides reference to material specifications in the materials chapters.

Recommendation: None.

FEMA 114	SBC	Analysis
7.2 Considerations (Closures) (Pages 133-134)	N/A	FEMA 114 addresses the use of closures (covering openings such as doors, windows, driveways, etc.) to act as shields to keep water away from the residence or entering the residence. SBC does not address floodplain management. Floodplain management is addressed in SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 114	SBC	Analysis
7.3 Low Profile Permanent Closures 7.4 Closure Materials and Construction 7.6 Technical Design Criteria (Closures) (Pages 133-142)	N/A	FEMA 114 addresses the use of closures (covering openings such as doors, windows, driveways, etc.) to act as shields to keep water away from the residence or entering the residence. SBC does not address floodplain management. Floodplain management is addressed in SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 114	SBC	Analysis
8.2 Considerations (Sealants) 8.3 Sealing Techniques 8.4 Closures (Sealants) 8.5 Design Details (Sealants) 8.7 Technical Design Criteria (Sealants) (Pages 145-156)	N/A	FEMA 114 addresses the sealing, making watertight, or dry floodproofing of the structure to prevent the entry of water during low level flooding. SBC does not address floodplain management. Floodplain management is addressed in the SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 114	SBC	Analysis
9.4 Permanent Protective Measures (Utilities) 9.5 Utility Relocations to Existing Space 9.6 Utility Relocations to New Spaces (Pages 160-165)	N/A	FEMA 114 addresses permanent protection of a structure's utility system. SBC does not address utilities. This is addressed in 602.4 and 602.5 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

FEMA 114	SBC	Analysis
9.8 Storage Tank Anchorage (Page 166)	N/A	FEMA 114 addresses the need for proper anchorage of tanks to prevent their flotation from the buoyancy forces. SBC does not address buoyancy forces.

Recommendation: None.

FEMA 114	SBC	Analysis
10.4 Floating Structures (Pages 176-177)	N/A	FEMA 114 permits "floating structures" as a method of floodproofing. SBC does not address "floating structures."

Recommendation: None.

FEMA 114	SBC	Analysis
Appendix C - Forces (Pages 197-207)	Chapter 12	FEMA 114 addresses hydrostatic loads, hydrodynamic loads, impact loads, and wind loads. FEMA 114 also provides definitions, application and methodology for design. SBC requires design for all forces encountered but does not provide methodology. Section 900.4 of the SBCCI Standard for Floodplain Management addresses hydrostatic and hydrodynamic loads.

Recommendation: FEMA 114 should update the wind speed maps to the latest editions and address snow and seismic loads. SBC should address hydrostatic, hydrodynamic, and buoyancy forces in floodplain areas.

Alluvial Fans: Hazards and Management (FEMA 165)

FEMA 165	SBC	Analysis
Windows and Doors (Page 10)	N/A	FEMA 165 prohibits openings on the uphill side of the structure to prevent debris and flood water from entering the building. SBC does not prohibit the location of openings except for fire protection requirements. SBC does not address floodplain management. Floodplain Management is addressed in the SBCCI Standard for Floodplain Management.

Recommendation: None.

STANDARD BUILDING CODE (SBC) COMPARISON

Manual for the Construction of Residential Basements in Non-Coastal Flood Environs (MCRB)

Chapter III Basement Construction

A. Construction Types - Walls

MCRB	SBC	Analysis
III. A.1 Unreinforced Block (Page 13)	1302.6.2 1403.6 1404 1405	MCRB provides commentary type language for minimum thickness, lack of reinforcing, and the lack of resistance to lateral pressures. SBC provides minimum thickness of foundation walls based on type of wall construction and depth of unbalanced fill.

Recommendation: None.

MCRB	SBC	Analysis
III.A.2 Reinforced and Grouted Block (Pages 13, 14)	1302.6.2 1410 1411	MCRB provides commentary and prescriptive type language for minimum thickness, vertical and horizontal reinforcing, bond beam, and the capacity to resistant lateral loads. SBC provides minimum thickness, specification for mortar and grout, construction requirements for both low-lift and high-lift grouted construction, etc. SBC requires reinforced masonry to conform to the provisions of ANSI A41.2 or ACI/ASCE 530.

Recommendation: MCRB should reference ANSI A41.2 and ACI/ASCE 530.

MCRB	SBC	Analysis
III.A.3 Structural Plain Concrete (Page 14)	1302.6.2 1601.1.2 1603.2	MCRB provides commentary and prescriptive type language for minimum thickness, lack of reinforcing, minimum compressive strength, and limits on resistance to lateral pressure. SBC provides minimum thickness of foundation walls based on type of wall construction and depth of unbalanced fill.

Recommendation: None.

MCRB	SBC	Analysis
III.A.4 Reinforced Concrete (Pages 14, 15)	1601.1.1	MCRB provides commentary and prescriptive type of language for minimum thickness, reinforcing, and ability to resist lateral loads. SBC requires structural members of reinforced concrete to be designed in accordance with ACI 318.

Recommendation: MCRB should reference ACI 318.

MCRB	SBC	Analysis
III.A.5 Cut Stone, Rubble Stone, and Cribbing and Planking. (Page 15)	1402.5 1403.2 1407.5	MCRB provides commentary type language and will not consider them any further because they are not commonplace. SBC provides minimal requirements such as minimum compressive strength, minimum thickness, etc.

Recommendation: None.

MCRB	SBC	Analysis
III.A.6 Treated Wood Foundations (Page 15)	1302.8	MCRB explains that sufficient research is not available on treated wood foundations under flooded condition,s therefore, they are not included in the MCRB. SBC requires wood foundations to comply with the provisions of NFoPA Technical Report No. 7.

Recommendation: None.

MCRB	SBC	Analysis
III.A.7 Variations (Pages 15, 16)	N/A	MCRB provides commentary type language for partially reinforced masonry, unreinforced masonry, reinforced masonry, structural plain concrete, and reinforced cast-in-place concrete walls. SBC does not provide commentary language.

Recommendation: None.

MCRB	SBC	Analysis
III.A.8 Excavation and Backfilling (Pages 16-18)	1302.1.1 1302.1.3 1302.1.5 1302.3 1312.4 1608	Both MCRB and SBC require all organic material to be removed from the foundation excavation, the footings to be built on undisturbed or properly compacted soil, the bottom of the footing to be below the depth of frost penetration, foundations on expansive soils to be a mat or raft foundation, and backfill to be placed in lifts and compacted in a manner which does not damage the waterproofing or foundation wall.

Recommendation: None.

MCRB	SBC	Analysis
III.A.9 Formwork (Pages 18, 19)	1606.1 1606.2.4	Both MCRB and SBC require the forms to be substantial and sufficiently tight to prevent leakage of mortar, properly braced to maintain position, and removed in such a manner as not to damage the concrete.

Recommendation: None.

B. Other Construction Features.

MCRB	SBC	Analysis
III.B.1 Basement Slab (Page 19)	1608	MCRB states that basement slabs are typically between 3 and 4 inches thick, with and without steel wire reinforcement. SBC requires a minimum slab thickness of 3 1/2 inches and does not require wire reinforcement.

Recommendation: None.

MCRB	SBC	Analysis
III.B.2 Structural Basement Slab (Pages 19, 20)	1601.1.1 1608	MCRB provides commentary type language on the use of a structural basement slab to resist water pressures up to 5 feet above the bottom of the slab for an "undrained system" and a conventional slab for a "drained system." SBC requires structural members of reinforced concrete to be designed and constructed in accordance with ACI 318. SBC requires the thickness of floor slabs to be a minimum of 3 1/2 inches thick.

Recommendation: None.

MCRB	SBC	Analysis
III.B.3 Footing (Foundation) (Page 20)	1302.1.3 1302.4.2	Both MCRB and SBC require the bottom of the footing to be below the depth of frost penetration. MCRB provides a "typical" size of a footing. SBC is a performance code and does not provide any minimum footing size.

Recommendation: None.

MCRB	SBC	Analysis
III.B.4 Underdrain System-Sumps and Pumps (Pages 20-23)	1312.1 1312.2	Both MCRB and SBC require waterproofing where hydrostatic pressure conditions exist, however MCRB contains commentary type language. MCRB also addresses the use of a sump pump in addition to the waterproofing.

Recommendation: None.

MCRB	SBC	Analysis
III.B.5a Grand Surface Slope - Site Investigation (Pages 23, 24)	N/A	MCRB provides commentary type language addressing site investigation of the soil to determine the drainage method needed to maintain a dry basement.

Recommendation: None.

MCRB	SBC	Analysis
III.B.5b Ground Surface Slope - Grading and Surface Drainage (Pages 24, 25)	1302.1.6 1302.1.7	Both MCRB and SBC require the finish grade to slope away from the foundation for drainage. Both MCRB and SBC require provisions to be made to prevent soil erosion and divert water away from the foundation.

Recommendation: None.

MCRB	SBC	Analysis
III.B.6 Seepage Quantities (Pages 25-31)	N/A	MCRB provides a "flow net analysis" to determine if the drainage system is feasible. SBC is a performance code and does not provide sample calculations.

Recommendation: None.

MCRB	SBC	Analysis
III.B.7a Penetrations, Cracks, Joints, and "Waterproofing" - Utility Openings (Page 31)	1312.2.4	Both MCRB and SBC require penetrations through walls to be watertight.

Recommendation: None.

MCRB	SBC	Analysis
III.B.7b Penetrations, Cracks, Joints, and "Waterproofing" - Techniques that Lessen Cracking in Concrete (Pages 31-34)	N/A	MCRB provides commentary type language addressing crack control. SBC is a performance code and does not provide commentary.

Recommendation: None.

MCRB	SBC	Analysis
III.B.7c Penetrations, Cracks, Joints, and "Waterproofing" - "Waterproofing" Basements (Pages 34, 35)	1312.1 1312.2	Both MCRB and SBC address waterproofing. MCRB addresses the use of drains, sumps, and pumps. SBC addresses the use of "waterproofing" on the basement wall.

Recommendation: None.

MCRB	SBC	Analysis
III.B.8 Subsystems (Plumbing) (Pages 35, 36)	N/A	None. The SBC does not address plumbing.

Recommendation: None.

MCRB	SBC	Analysis
III.B.9 Anchorage (Pages 36, 37)	1408.3 1706.1	MCRB provides calculations to determine the anchorage requirements. MCRB requires a minimum of 1/2 inch anchor bolts spaced a maximum of 8 ft anchored into 2 block courses or 16 inches with a minimum of 2 bolts per plate. SBC requires a minimum of 1/2 inch anchor bolts spaced a maximum of 6 ft embedded at least 6 inches in concrete or 8 inches into masonry units.

Recommendation: The MCRB should be changed to comply with current model codes.

MCRB	SBC	Analysis
III.B.10 Some Concrete Construction Practices (Pages 37-46)	1602.6 1605 1607	Both MCRB and SBC contain provisions for handling and depositing concrete, consolidating concrete, cold weather considerations, additives placing reinforcement, etc. However, MCRB also contains commentary type language.

Recommendation: None.

MCRB	SBC	Analysis
III.B.11 Some Block Construction Practices (Pages 47-50)	Chapter 14	MCRB contains commentary type language addressing ways to improve the waterproofing quality of concrete masonry walls. SBC contains minimum requirements for all types of masonry construction.

Recommendation: None.

C. Loads

MCRB	SBC	Analysis
III.C.1 Soil III.C.1.a Sand, Silt, Clay III.C.1.b Expansive Soils III.C.1.c Permeability III.C.1.d Saturation (Pages 50-57)	1302.2 1302.3	MCRB contains commentary type language on soil types, expansive soils, permeability, and saturation. MCRB contains sample calculations for nonexpansive and expansive soils. SBC contains provisions for soils investigation and expansive soils.

Recommendation: None.

MCRB	SBC	Analysis
III.C.1 Soil III.C.1.e Erosion	1302.1.6	MCRB addresses methods of inhibiting erosion by soil treatment, seeding, and mulching. SBC requires provisions to be made to prevent soil erosion from roof runoff by directing water away from the foundation.

Recommendation: None.

MCRB	SBC	Analysis
III.C.1 Soil III.C.1.f Backfill Material Related to Lateral Pressures (Pages 58-63)	1312.4	MCRB provides commentary type language addressing lateral pressures exerted from backfill material. SBC simply requires the backfill material to be placed in such a manner so as not to damage the foundation wall.

Recommendation: None.

MCRB	SBC	Analysis
III.C.2 Water Table (Page 63)	N/A	None. The SBC does not address the water table.

Recommendation: None.

MCRB	SBC	Analysis
III.C.3 Superstructure Loads and Buoyancy (Pages 63-71)	N/A	MCRB contains sample calculations to determine the superstructure loads imposed by buoyancy. SBC is a performance code and does not provide sample calculations.

Recommendation: None.

MCRB	SBC	Analysis
III.C.4.d Flood Waters - Velocity (Pages 72, 73)	N/A	MCRB provides commentary type language addressing increased structural damage which may result from the high velocity of flood waters. SBC does not address flood waters.

Recommendation: None.

MCRB	SBC	Analysis
III.C.4.e Flood Waters - Sediment (Pages 73, 74)	N/A	MCRB provides commentary type language addressing flood water deposited sediment. SBC does not address sediment deposited by flood waters.

Recommendation: None.

MCRB	SBC	Analysis
III.C.4.f Flood Waters - Rate of Rise (Page 74)	N/A	MCRB provides commentary type language addressing the rate of rise of flood water causing unequal loading on basement walls which could cause damage to the wall. SBC does not address rate of rise of flood waters.

Recommendation: None.

MCRB	SBC	Analysis
III.C.4.g Flood Water - Hydraulic/ Hydrologic Relations (Pages 74, 75)	N/A	MCRB references a separate Hydraulic/Hydrologic manual which could be used to evaluate a site (i.e. for velocity of flood waters, erosion, sediment, flood water depth, and watershed hydrology).

Recommendation: None.

MCRB	SBC	Analysis
III.C.5 Debris, Wind, Impact, Snow, Ice, and Other Live Loads (Page 75)	Chapter 12	MCRB states that other than debris and impact loads; wind, snow, and ice are not considered to alter the designs in the MCRB. SBC requires every building to be of sufficient strength to support the loads and forces encountered.

Recommendation: MCRB should include wind, snow, and seismic loads.

Chapter V Basements in Floods

MCRB	SBC	Analysis
V.A. Structural Design/Analysis V.A.2. Designs, Methods, and Tables V.A.2.a Building Model, Dimensions, and Loading V.A.2.b Structural Analysis Model (Wall) V.A.2.c Structural Plain Concrete V.A.2.d Reinforced Concrete V.A.2.e Plain Masonry Block V.A.2.f Reinforced Masonry Block V.A.2.g Flood Waters Above Grade V.A.2.h Slab Thickness (Based on Bending) V.A.2.i Structural Slab Design (Ultimate Strength Design) (Pages 88-114)	N/A	MCRB contains sample structural calculations. MCRB refers to the UBC in V.A.2.e and V.A.2.f. SBC is a performance code and does not provide sample calculations.

Recommendation: MCRB should not reference a single model code. MCRB should reference only national consensus documents.

MCRB	SBC	Analysis
V.B. Soil/Water Load Philosophy V.B.1 Weir Level Load V.B.2 Buoyancy V.B.3 Slab Bending V.B.4 Wall Loads V.B.5 Clay vs. Sand or Drain and Sump vs. Sealed "Barge" V.B.5.a Drained or Sump System V.B.5.b Undrained or Barge System (Pages 114-126)	N/A	MCRB contains commentary type language addressing the design philosophy of the lateral pressures exerted by soil and/or water loadings. SBC is a performance code and does not contain commentary type language.

Recommendation: None.

VII Appendices

MCRB	SBC	Analysis
Appendix A - Soils Data Allowable Bearing Pressures (Page 164) Allowable Soil Pressures Beneath Footings (Page 166)	N/A	MCRB contains allowable bearing pressures for various soil types. SBC is a performance code. SBC relies on a soils report to determine the allowable bearing capacity.

Recommendation: None.

VIII. Builder's Guide

MCRB	SBC	Analysis
A. Introduction A.2.a Soil and Water Loading on Wall Cross-Section (Page 198) A.2.c "Waterproofing" Systems (Page 206) A.2.d Wall Design (Page 209) A.2.e Slab Design (Page 211) B. Acceptable Wall Designs B.1 Structural Plain Concrete (Unreinforced) B.2 Reinforced Concrete B.3 Unreinforced Masonry Block B.4 Reinforced Masonry Block B.5 Buoyancy Wall (Pages 212-239) C. Acceptable Slab Designs (Pages 240-246) D. Acceptable Control Joint Designs, Underdrain, "Waterproofing" and Seals D.1 Overview and Control Joints D.2 Sump, Pump, and Underdrain (for Drained System) D.3 "Waterproofing" and Seals D.3.a Undrained Slab and Wall System D.3.b Drained Slab and Wall System D.3.c Slab/Wall/Footing Juncture (Pages 247-262) *Recommendation:* None.	N/A	MCRB contains details and design charts for wall design, slab design, control joints, sumps, and/or waterproofing. SBC is a performance code and does not contain details or design charts.

MCRB	SBC	Analysis
Hydraulic/Hydrologic Manual I. Introduction I.B Flood Waters I.B.4 Velocity I.B.5 Sediment (Pages 7-9) *Recommendation:* None.	N/A	MCRB contains commentary type language addressing increased structural damage which may result from the high velocity of floodwaters and floodwater deposited sediment. SBC does not address floodwaters.

STANDARD BUILDING CODE (SBC) COMPARISON

Technical Standards Bulletin: Wet Floodproofing, No. 85-1

No. 85-1	SBC	Analysis
I. Definition (Page 1)	N/A	No. 85-1 provides a definition of wet floodproofing and explains the justification for this type of floodproofing. SBC does not address floodproofing. This is addressed in Chapter 9 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

No. 85-1	SBC	Analysis
II. Protection Goals (Page 2)	N/A	No. 85-1 explains that wet floodproofing consists of protection of the structure , protection of interior finishes, protection of mechanical and electrical systems, protection of major equipment and machinery, and protection of contents. SBC does not address floodproofing. This is addressed in Chapter 9 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

No. 85-1	SBC	Analysis
III.B. Structural Features (Pages 4-5)	N/A	No. 85-1 addresses the superstructure materials as far as durability, resistance to the deterioration caused by floodwaters, and water resistance. SBC does not address floodproofing. This is addressed in Chapter 9 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

No. 85-1	SBC	Analysis
III.C Building Activity and Use (Pages 5-6)	N/A	No. 85-1 addresses the need to determine the feasibility of wet floodproofing based on building activity and use. SBC does not address floodproofing. This is addressed in Chapter 9 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

No. 85-1	SBC	Analysis
IV.A.1 Foundations (Page 6)	N/A	No. 85-1 emphasizes the importance of the need to investigate the influence of hydrologic and hydraulic conditions on the foundation design when wet floodproofing is used. SBC does not address floodproofing. This is addressed in Chapter 9 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

No. 85-1	SBC	Analysis
IV.A.2 Cavity Wall Construction (Pages 6-7)	N/A	No. 85-1 addresses the need to drain the cavity space at a rate approximately equal to the flood rate. SBC does not address floodproofing. This is addressed in Chapter 9 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

No. 85-1	SBC	Analysis
IV.A.3 Solid Wall Construction (Pages 7-8)	N/A	No. 85-1 addresses the need for the interior and exterior wall cladding to be relatively impervious to prevent the intrusion of the floodwaters into the wall. SBC does not address floodproofing. This is addressed in Chapter 9 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

No. 85-1	SBC	Analysis
IV.A.4 Interior Walls (Page 8)	N/A	No. 85-1 emphasizes that the criteria for cavity wall and solid wall construction applies to interior walls. SBC does not address floodproofing. This is addressed in Chapter 9 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

No. 85-1	SBC	Analysis
IV.A.5 Interior Wall Finishes (Page 8)	N/A	No. 85-1 addresses the need for the interior finishes to be able to withstand inundation for a minimum of 160 hours without damage, not be subject to deterioration from chemicals in the floodwaters, and capable of being easily cleaned. SBC does not address floodproofing. This is addressed in Chapter 9 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

No. 85-1	SBC	Analysis
IV.A.6 Floors (Pages 8-9)	N/A	No. 85-1 addresses the need for floor systems to be capable of withstanding the hydrostatic pressure generated by a water level differential of two feet between the exterior and interior of the structure. SBC does not address floodproofing. This is addressed in Chapter 9 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

No. 85-1	SBC	Analysis
IV.A.7 Ceiling and Roofs (Page 9)	N/A	No. 85-1 addresses the need for the ceiling materials to be of a type to withstand prolonged exposure to moisture and humidity. SBC does not address floodproofing. This is addressed in Chapter 9 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

No. 85-1	SBC	Analysis
IV.A.8 Building Envelope Penetrations (Page 10)	N/A	No. 85-1 addresses the need for building penetrations (doors, louvers, vents, skylights, etc.) to be capable of resisting damage for a minimum of 160 hours of inundation, be essentially nonporous, and be conducive to easy cleaning. SBC does not address floodproofing. This is addressed in Chapter 9 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

No. 85-1	SBC	Analysis
IV.A.9 Electrical System (Pages 10-11)	N/A	No. 85-1 addresses the need to prevent vulnerable electrical components from coming in contact with the floodwaters. SBC does not address floodproofing. This is addressed in 602.5 and Chapter 9 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

No. 85-1	SBC	Analysis
IV.A.10 HVAC (Pages 11-12)	N/A	No. 85-1 emphasizes that the key protective measures for HVAC equipment is elevation and enclosure. SBC does not address protection of HVAC equipment from floodwaters. This is addressed in 602.5 and Chapter 9 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

STANDARD BUILDING CODE (SBC) COMPARISON

Technical Standards Bulletin: Foundation Wall Openings, No. 85-2

No. 85-2	SBC	Analysis
Flood Forces (Pages 1-3)	1201.1	No. 85-2 provides commentary type language on flood forces (hydrostatic and hydrodynamic pressure) and formulas to determine these pressures. SBC requires the structure to be of sufficient strength to support the loads and forces encountered (wind, water, seismic, snow).

Recommendation: No. 85-2 should address snow and seismic loads.

No. 85-2	SBC	Analysis
Openings Design Criteria (Pages 4-6)	1302.6.3	No. 85-2 provides the design criteria to size the openings needed to allow floodwaters into an enclosure for the purpose of equalizing hydrostatic pressures. SBC only addresses crawl space openings needed for ventilation. This is addressed in 602.2 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

STANDARD BUILDING CODE (SBC) COMPARISON

Technical Standards Bulletin: Breakaway Walls, No. 85-3

No. 85-3	SBC	Analysis
II. Wind and Water Forces (Pages 2-3)	1201.1 1205	No. 85-3 addresses wind and flood water loads. SBC requires every structure to be of sufficient strength to support the loads and forces encountered. SBC does not specifically address flood water forces but does address wind, snow, and seismic loads. No. 85-3 references the building codes or ANSI A58.1-1982 for information on wind loads. SBC references ASCE 7-88 in addition to providing a wind load map, velocity pressures and coefficients.

Recommendation: No. 85-3 should update reference to ASCE 7-88 and address snow and seismic loads.

No. 85-3	SBC	Analysis
III. Design Approach (Page 4)	1201.1	No. 85-3 requires the breakaway wall to be designed to withstand at least 10 psf but no more than 20 psf. SBC does not address breakaway walls. SBC requires the structure to be designed for the loads and forces encountered. Breakaway walls are addressed in 801.4 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

No. 85-3	SBC	Analysis
IV. Design Considerations (Pages 4-10)	N/A	No. 85-3 provides commentary type language and details for various types of breakaway walls. SBC does not address breakaway walls. SBC requires the structure to be designed for the loads and forces encountered. Breakaway walls are addressed in 801.4 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

STANDARD BUILDING CODE (SBC) COMPARISON

Technical Standards Bulletin: Wind Design Standards and the NFIP, No. 88-1

No. 88-1	SBC	Analysis
Pages 1-5	1201.1 1205	Both No. 88-1 and SBC address wind loads. No. 88-1 contains a reference to ANSI A58.1-1982. SBC references ASCE 7-88 in addition to containing a wind speed map, velocity pressure table, and coefficients for wind load design. SBC requires the structure to be of sufficient strength to support the loads and forces encountered.

Recommendation: No. 88-1 should update reference to ASCE 7-88 and address snow and seismic loads.

STANDARD BUILDING CODE (SBC) COMPARISON

Technical Standards Bulletin: Flood Resistant Materials, No. 88-2

No. 88-2	SBC	Analysis
Pages 1-7	N/A	No. 88-2 provides data and guidance to determine "materials resistant to flood damage" and how the material should be used to improve a structure's ability to withstand flooding. SBC does not address "flood resistant" materials. This is addressed in 602.4 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

STANDARD BUILDING CODE (SBC) COMPARISON

Technical Standards Bulletin: Free of Obstruction Requirement in Coastal High Hazard Areas, No. 88-3

No. 88-3	SBC	Analysis
Lower Area Obstructions (Pages 2-4)	1201.1	No. 88-3 prohibits the construction of anything; except breakaway walls, open wood latticework, or insect screening; beneath the lowest horizontal structural member in V zones. SBC does not prohibit construction provided it is of sufficient strength to support the loads or forces encountered. This is addressed in 602.3, 800.2 and 801.4 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

No. 88-3	SBC	Analysis
Obstructions Outside the Perimeter of the Coastal Building (Pages 4-6)	1201.1	No. 88-3 requires structures outside the perimeter of the coastal building to be anchored to resist flotation, collapse, and lateral movement due to the combined effects of wind and water loads. SBC requires structures to be of sufficient strength to support the loads and forces encountered. SBC does not address flotation. This is addressed in 801.1 of the SBCCI Standard for Floodplain Management.

Recommendation: None.

No. 88-3	SBC	Analysis
Obstructions Attached to But Outside the Building Perimeter (Page 6)	Chapter 1	No. 88-3 explains that anything attached to the building is considered part of the building and has to meet the same requirements as the building. SBC requires every building or structure to comply with the Code.

Recommendation: None.

STANDARD BUILDING CODE (SBC) COMPARISON

Technical Standards Bulletin: Protection of Elevator Equipment in Flood Hazard Areas, No. 88-4

No. 88-4	SBC	Analysis
Recommendations (Page 3)	N/A	No. 88-4 recommends that the elevator-related hydraulic equipment and elevator-related electrical equipment be located above the BFE. No. 88-4 recommends that electrical equipment that cannot be placed above the BFE to be of water resistant models. No. 88-4 recommends that the elevator cab automatically stay above flood waters by interlocking the controls with "float" switches in the elevator shaft. SBC does not address floodplain management. Floodplain management is addressed in the SBCCI Standard for Floodplain Management.

Recommendation: None.

STANDARD BUILDING CODE (SBC) COMPARISON

Technical Standards Bulletin: NFIP Requirements for Below Grade Parking Garages in Flood Hazard Areas, No. 90-2

No. 90-2	SBC	Analysis
Pages 1-4	N/A	No. 90-2 provides a summary of the National Flood Insurance Program (Regulations for Floodplain Management and Flood Hazard Identification) requirements for below grade parking garages in flood hazard areas. SBC does not address floodplain management. Floodplain Management is addressed in the SBCCI Standard for Floodplain Management.

Recommendation: None.

STANDARD BUILDING CODE (SBC) COMPARISON

Technical Standards Bulletin: Non-Residential Floodproofing Certification Requirements of the National Flood Insurance Program, No. 90-3

No. 90-3	SBC	Analysis
Pages 1-6	N/A	No. 90-3 provides a summary of the National Flood Insurance Program (Regulations for Floodplain Management and Flood Hazard Identification) requirements to obtain certification by floodproofing the non-residential structure. No. 90-3 also provides the forces that the structure would be subjected to when the structure is subjected to the base flood. SBC does not address floodplain management. Floodplain management is addressed in the SBCCI Standard for Floodplain Management.

Recommendation: None.

STANDARD BUILDING CODE (SBC) COMPARISON

Technical Standards Bulletin: Installation of Manufactured Homes in Special Flood Hazard Areas, No. 90-4

No. 90-4	SBC	Analysis
Pages 3-19	Appendix H	No. 90-4 provides a summary of the National Flood Insurance Program (Regulations for Floodplain Management and Flood Hazard Identification) requirements which affect the placement of manufactured homes in flood hazard areas. SBC addresses manufactured home tiedown requirements based on hurricane and nonhurricane zones. SBC does not address floodplain management. Floodplain management is addressed in the SBCCI Standard for Floodplain Management.

Recommendation: None.

STANDARD MECHANICAL CODE (SMC) COMPARISON

NFIP (Regulations for Floodplain Management and Flood Hazard Identification) (44 CFR 59.1, 60.3, and 60.6)

NFIP	SMC	Analysis
59.1 Definitions 60.3 Floodplain Management Criteria for Flood-Prone Areas	N/A	None. These sections of NFIP do not address mechanical equipment or its installation.

Recommendation: None.

60.6 – Variances and Exceptions

NFIP	SMC	Analysis
60.6(c)(2)(i) Flood-Proof Wall	302 303	NFIP requires the basement area, together with utilities and sanitary facilities below the floodproofed design level, to be watertight with walls that are impermeable to the passage of water without human intervention. The SMC allows underfloor installation but does not specify minimum elevations for equipment. This is addressed in 602.1.2, 602.5, and Chapter 9 of the SBCCI Standard for Floodplain Management.

Recommendation: The SMC should be revised to reference the SBCCI Standard for Floodplain Management.

NFIP	SMC	Analysis
60.6(c)(2)(ii) Basement Top of Floor Elevation 60.6(c)(2)(iii) Fill 60.6(c)(2)(iv) Use of a Registered Professional 60.6(c)(2)(v) Building Inspection	N/A	None. NFIP does not address mechanical equipment or its installation.

Recommendation: None.

STANDARD MECHANICAL CODE (SMC) COMPARISON

Elevated Residential Structures (FEMA 54)

FEMA 54	SMC	Analysis
Design and Construction Guidelines posts post embedment post anchorage piers brick and concrete masonry piers concrete piers pier footings shear walls and floor diaphragms pier foundation connections floor beams cantilevers floor joist to floor beam connection (Pages 68-88)	N/A	None. These sections of FEMA 54 do not address mechanical equipment or its installation.

Recommendation: None.

FEMA 54	SMC	Analysis
Figure 4.48 Protective Utility Shaft (Page 92)	607 607.3.1.5	FEMA 54 requires fuel piping serving an elevated structure to be on the leeward side of post/columns or enclosed in a protective shaft. SMC requires piping to be supported and protected against physical damage.

Recommendation: None since both address the issue of damage only in different directions. FEMA - prescriptive SMC - performance.

FEMA 54	SMC	Analysis
Mechanical Equipment (Page 93, Paragraph 2)	302 303	FEMA 54 requires all mechanical equipment to be elevated above expected flood waters, with indoor components preferably installed in attics. The SMC allows attic installation but does not specify minimum elevations for equipment.

Recommendation: These sections of the SMC should be revised to reference the SBCCI Standard for Floodplain Management.

FEMA 54	SMC	Analysis
Mechanical Equipment (Page 93, Paragraph 2) Continued	Ch. 5 504.2	FEMA 54 requires air ductwork to have emergency openings at lowest elevations and a minimum slope on horizontal duct runs to allow drainage. The SMC requires that ducts be suitably protected when placed in locations where they may be subject to damage.

Recommendation: None since both address the issue of damage only in different directions. FEMA - prescriptive SMC - performance.

FEMA 54	SMC	Analysis
Septic Tanks (Page 93, Paragraph 3)	N/A	The SMC does not address septic tanks.

Recommendation: None.

FEMA 54	SMC	Analysis
Building Materials Wood Steel Concrete and Masonry (Pages 93-95)	N/A	None. These sections of FEMA 54 do not address mechanical equipment or its installation.

Recommendation: None.

FEMA 54	SMC	Analysis
Insulation (Pages 95, 96)	506 610	FEMA 54 requires underfloor exposed pipes to be insulated with impermeable or inexpensively replaced insulation. Inexpensive insulation is not defined in FEMA. The SMC requires air duct in nonconditioned areas to be insulated and piping to be insulated for personal protection and for condensation control. This is addressed in 602.4 and 602.5 of the SBCCI Standard for Floodplain Management.

Recommendation: Change FEMA 54 to address insulation of exposed ductwork.

FEMA 54	SMC	Analysis
Glossary (Pages 113-115)	N/A	None. The Glossary section of FEMA 54 does not address mechanical equipment or installation.

Recommendation: None.

FEMA 54	SMC	Analysis
Performance Criteria C.2 (1.3) "Protection Against Unnecessary Damage" (Page 134)	607, 607.3.1.5, 302, 303, Ch. 5, 504.2	See previous sections. This is only a recap.

Recommendation: None.

STANDARD MECHANICAL CODE (SMC) COMPARISON

Coastal Construction Manual (FEMA 55)

FEMA 55	SMC	Analysis
Chapter 4 -Structural Design Section 4.3.6 Utilities (Pages 4-50 to 4-52)	Ch. 3 607 607.3.1.5 302 303	FEMA 55 requires all mechanical equipment to be elevated above BFE, and fuel piping be on the leeward side of columns/piers or enclosed in shaft. The SMC allows attic installation of equipment, but does not specify minimum elevations for equipment. The SMC requires fuel piping to be supported and protected from physical damage.

Recommendation: (1) For equipment location - the SMC should be revised to reference the Standard for Floodplain Management (2) for fuel pipe protection - None both address the issue only in different directions. FEMA - prescriptive SMC - performance

FEMA 55	SMC	Analysis
Ch. 5 - Larger Structures (Pages 5-1 to 5-9) Appendix A - Design Tables (Pages A-1 to A-47) Appendix B - Bracing (Pages B-1 to B-15) Appendix D - Design Equation and Procedures (Pages D-1 to D-32)	N/A	None. These sections of FEMA 55 do not address mechanical equipment or its installation.

Recommendation: None.

FEMA 55	SMC	Analysis
Appendix G "Sample Coastal Construction Code" 12. Utilities (Page G-8)	302 303	FEMA 55 requires all mechanical equipment to be elevated above expected floodwaters. The SMC allows such installations, but does not specify minimum equipment elevations.

Recommendation: The SMC should be revised to reference the Standard for Floodplain Management.

STANDARD MECHANICAL CODE (SMC) COMPARISON

Manufactured Home Installation in Flood Hazard Areas (FEMA 85)

FEMA 85	SMC	Analysis
Chapter III Elevation and Anchoring Techniques (Pages 19-31) Chapter IV Design of Elevated Foundations (Pages 33-70) Appendix D Calculational Procedure for Elevated Foundation Design (Pages 89-97) Appendix E Buoyancy and Drag Forces (Pages 99-101)	N/A	None. These sections of FEMA do not address mechanical equipment or its installation.

Recommendation: None.

Floodproofing Non-Residential Structures (FEMA 102)

FEMA 102	SMC	Analysis
Ch. I Introduction (Pages 8-13) Ch. III Floodproofing Design Permanent & Contingent Measures (Pages 37-72, 80-88)	N/A	None. These sections of FEMA 102 do not address mechanical equipment or its installation.

Recommendation: None.

FEMA 102	SMC	Analysis
Ch. IV Other Floodproofing Measures C. Utilities (Pages 99-105)	302 303	FEMA 102 requires mechanical equipment to be elevated above BFE or "floodproofed". Floodproofing entails a watertight enclosure, with all penetrations into the building pressure sealed. The SMC allows such installations, with proper access and clearance to combustibles.
	308	FEMA 102 requires mechanical exhaust fans discharging below the BFE to be protected by flood shields. The SMC requires exhaust to discharge outdoors at a point where it will not cause a nuisance or 10 ft above a public walkway.

Recommendation: (1) Revise SMC to reference the Standard for Floodplain Management (2) Revise FEMA 102 to reference the locally adopted model code for installation clearances.

FEMA 102	SMC	Analysis
Appendix B "Glossary" (Pages 161-166) Appendix D "Floodproofing Performance Criteria" Parts B and D (Pages 182-193)	N/A	None. These sections of FEMA 102 do not address mechanical equipment or its installation.

Recommendation: None.

FEMA 102	SMC	Analysis
Appendix D "Floodproofing Performance Criteria" Part C "Performance Criteria" Criteria #6 Heating Air-Conditioning & Ventilation (A) Location (Page 192)	302 303	FEMA 102 requires that all mechanical equipment be installed above BFE, or be enclosed in water-tight rooms. The SMC allows elevated or enclosed installation but requires access and clearance to combustibles.

Recommendation: (1) Revise FEMA 102 to reference the local model codes for access and clearance. (2) Revise SMC to reference Standard for Floodplain Management

FEMA 102	SMC	Analysis
Appendix D "Floodproofing Performance Criteria" Part C "Performance Criteria" Criteria #6 Heating, Air-Conditioning and Ventilation (B) Heating and Air Conditioning (Page 192)	607	FEMA 102 requires that fuel systems below the BFE be equipped with automatic shutoff valves activated by rising water. The SMC would not require or prohibit such valves.
	306.2	FEMA 102 requires all heating equipment be vented to a level above BFE. SMC requires vent/chimney termination 3 ft above roof and 2 ft higher than any portion of the roof within 10 ft.

Recommendation: Revise SMC to reference Standard for Floodplain Management.

FEMA 102	SMC	Analysis
Appendix D "Floodproofing Performance Criteria" Part C "Performance Criteria" Criteria #6 Heating Air-Conditioning & Ventilation (c) Ventilation (Page 193)	307 308 Ch. 5	FEMA 102 requires all ductwork located below BFE to slope to drainage openings. The SMC does not require conditioned air ducts to slope.
	Ch. 5	FEMA 102 requires all ductwork located below BFE to be anchored against floodwaters. The SMC requires adequate support per SMACNA.
	510	FEMA 102 requires all penetrations of the building envelope by air ductwork to have a closure assembly. The SMC requires fire dampers at certain firewalls.

Recommendation: The SMC should be revised to reference Standard Floodplain Management.

FEMA 102	SMC	Analysis
Appendix D "Floodproofing Performance Criteria" Part C "Performance Criteria" Criteria #6 Heating Air-Conditioning & Ventilation (D) Fuel Tanks and Lines (Page 193)	607	FEMA 102 requires fuel tanks and lines to be located above BFE or anchored and protected from floodwater velocity/surge with a fact of safety of 1.5. The SMC allows installation of fuel storage tanks either inside or outside buildings but does not address uplift forces. The SMC states that the piping shall be protected from physical damage.

Recommendation: The SMC should reference tank location, uplift forces, and the Standard for Floodplain Management.

FEMA 102	SMC	Analysis
Appendix D "Floodproofing Performance Criteria Part C "Performance Criteria" Criteria #7 "Plumbing Systems" (Page 193)	N/A	None. This appendix of FEMA 102 does not address mechanical equipment on its installation.

Recommendation: None.

Retrofitting Flood-Prone Residential Structures (FEMA 114)

FEMA 114	SMC	Analysis
Ch. 3 Elevation (Pages 46-49, 61-68) Ch. 6 Floodwalls (Pages 111-129) Ch. 7 Closures (Pages 133-142) Ch. 8 Sealants (Pages 145-156)	N/A	None. These sections of FEMA 114 do not address mechanical equipment or its installation.

Recommendation: None.

FEMA 114	SMC	Analysis
Ch. 9 Protection of Utilities 9.4 Permanent Protective Measures (Pages 160-163)	Ch. 3	FEMA 114 requires utility connections to be above flood level, shielding for basement appliances, elevated installation for exterior appliances, suspension for underfloor equipment, and anchoring for fuel storage tanks. The SMC allows these types of installations but requires minimum clearances to combustibles and access which is ignored by FEMA 114.

Recommendation: (1) Change FEMA to reference locally adopted model codes for clearances to combustible materials and minimum access (2) change the SMC to reference the Standard for Floodplain Management.

FEMA 114	SMC	Analysis
Ch. 9 Protection of Utilities 9.5 Utility Relocation to Existing Space (Pages 163-164)	Ch. 3	FEMA 114 addresses relocation of mechanical equipment from the basement to upper levels or attics. The SMC allows attic or closet installation as an option, but specifies minimum clearances and access.

Recommendation: Section 9.5 of FEMA 114 should be revised to reference minimum clearances for heat producing appliances according to local model codes.

FEMA 114	SMC	Analysis
Ch. 9 Protection of Utilities 9.6 Utility Relocations to New Space (Pages 164, 165)	Ch. 3	FEMA 114 addresses relocation of mechanical equipment to a newly constructed space. The SMC allows equipment rooms, but specifies minimum clearances and access.

Recommendation: Section 9.6 of FEMA 114 should be revised to encourage obtaining a building permit for new construction/alterations. It should also reference model codes for minimum clearance to combustibles and access to equipment.

FEMA 114	SMC	Analysis
Ch. 9 Protection of Utilities 9.8 Storage Tank Anchorage (Page 166)	607	FEMA 114 requires anchorage of fuel storage tanks. The SMC allows installation of fuel storage tanks inside or outside structures, but does not specifically address uplift forces.

Recommendation: Revise the SMC to reference the Standard for Floodplain Management and add a section on fuel tank anchorage.

FEMA 114	SMC	Analysis
Chapter 10 Special Situations (Pages 176, 177) Appendix C Forces (Pages 197-207)	N/A	None. These sections of FEMA 114 do not address mechanical equipment or its installation.

Recommendation: None.

Alluvial Fans: Hazards and Management (FEMA 165)

FEMA 165	SMC	Analysis
Windows and Doors (Page 10)	N/A	None. This page of FEMA 165 does not address mechanical equipment or its installation.

Recommendation: None.

STANDARD MECHANICAL CODE (SMC) COMPARISON

Manual for the Construction of Residential Basements in Non-Coastal Flood Environs (MCRB)

MCRB	SMC	Analysis
Chapter III. Basement Construction (Pages 13-75) Chapter V. Basements in Floods (Pages 88-126) Chapter VII Appendix A – Soils Data (Pages 164, 166) Chapter VIII Builder's Guide (Pages 198, 206, 209, 211-262) Hydraulic/Hydrologic Manual (Pages 7-10) *Recommendation:* None.	N/A	None. MCRB does not address mechanical equipment or its installation.

STANDARD MECHANICAL CODE (SMC) COMPARISON

Technical Standards Bulletin: Wet Floodproofing, No. 85-1

No. 85-1	SMC	Analysis
Definition Protection Goals Considerations for Applicability (Pages 1-6)	N/A	None. These sections of No. 85-1 do not address mechanical equipment or its installation.

Recommendation: None.

No. 85-1	SMC	Analysis
IV. Guidelines for Implementation A.1 Foundations A.2 Cavity Wall Construction A.3 Solid Wall Construction A.4 Interior Walls A.5 Interior Wall Finishes A.6 Floors A.7 Ceilings and Roofs A.8 Building Envelope Penetrations A.9 Electrical Systems (Pages 6-11)	N/A	None. These sections of No. 85-1 do not address mechanical equipment or its installation.

Recommendation: None.

No. 85-1	SMC	Analysis
IV. Guidelines for Implementation 4.A.10 HVAC (Page 11)	302 303	No. 85-1 requires mechanical equipment to be elevated or enclosed for protection. The SMC allows enclosed installations, but does not specify minimum elevations for equipment.

Recommendation: The SMC should be revised to reference the Standard for Floodplain Management.

STANDARD MECHANICAL CODE (SMC) COMPARISON

Technical Standards Bulletin: Foundation Wall Openings, No. 85-2

No. 85-2	SMC	Analysis
Flood Forces (Pages 1-3)	N/A	None. This section of No. 85-2 does not address mechanical equipment or its installation.

Recommendation: None.

No. 85-2	SMC	Analysis
Openings Design Criteria (Pages 4-6)	302 303	No. 85-2 gives sizing criteria for foundation wall openings used to equalize hydrostatic pressures. The SMC addresses crawl space access opening size only where mechanical equipment is installed there. This section of FEMA really doesn't address mechanical equipment installation.

Recommendation: None.

STANDARD MECHANICAL CODE (SMC) COMPARISON

Technical Standards Bulletin: Breakaway Walls, No. 85-3

No. 85-3	SMC	Analysis
II. Wind and Water Forces III. Design Approach IV. Design Considerations (Pages 2-10)	N/A	None. These sections of No. 85-3 do not address mechanical equipment or its installation.

Recommendation: None.

STANDARD MECHANICAL CODE (SMC) COMPARISON

Technical Standards Bulletin: Wind Design Standards and the NFIP, No. 88-1

No. 88-1	SMC	Analysis
Pages 1-5	N/A	None. These pages of No. 88-1 do not address mechanical equipment or its installation.

Recommendation: None.

STANDARD MECHANICAL CODE (SMC) COMPARISON

Technical Standards Bulletin: Flood Resistant Materials, No. 88-2

No. 88-2	SMC	Analysis
Pages 1-7	N/A	None. These pages of No. 88-2 do not address mechanical equipment or its installation.

Recommendation: None.

STANDARD MECHANICAL CODE (SMC) COMPARISON

Technical Standards Bulletin: Free of Obstruction Requirement in Coastal High Hazard Areas, No. 88-3

No. 88-3	SMC	Analysis
Lower Area Obstructions Obstructions Outside the Perimeter of the Coastal Building Obstructions Attached to But Outside the Building Perimeter (Pages 2-6) *Recommendation:* None.	N/A	None. These pages of No. 88-3 do not address mechanical equipment or its installation.

STANDARD MECHANICAL CODE (SMC) COMPARISON

Technical Standards Bulletin: Protection of Elevator Equipment in Flood Hazard Areas, No. 88-4

No. 88-4	SMC	Analysis
Recommendation #1 Page 3	Ch. 3	No. 88-4 requires location of elevator equipment above base flood elevation. The SMC allows such installation but does not specify minimum equipment elevations.

Recommendation: Revise the SMC to reference the Standard for Floodplain Management.

Technical Standards Bulletin: NFIP Requirements for Below Grade Parking Garages in Flood Hazard Areas, No. 90-2

No. 90-2	SMC	Analysis
Pages 1-4	N/A	None. These pages of No. 90-2 do not address mechanical equipment or its installation.

Recommendation: None.

STANDARD MECHANICAL CODE (SMC) COMPARISON

Technical Standards Bulletin: Non-Residential Floodproofing Certification Requirements of the National Flood Insurance Program, No. 90-3

No. 90-3	SMC	Analysis
Section D-2 (Pages 1-6)	Ch. 3	No. 90-3 requires all utilities to be (1) Above BFE or (2) completely watertight, or (3) completely enclosed by the building's watertight walls. The SMC allows such installations but requires clearances and access to equipment.

Recommendation: Revise No. 90-3 to reference the local model codes for clearance to combustibles and access to equipment.

STANDARD MECHANICAL CODE (SMC) COMPARISON

Technical Standards Bulletin: Installation of Manufactured Homes in Special Flood Hazard Areas, No. 90-4

No. 90-4	SMC	Analysis
Pages 3-19	N/A	None. These sections of No. 90-4 do not address mechanical equipment or its installation.

Recommendation: None.

NFIP (Regulations for Floodplain Management and Flood Hazard Identification) (44 CFR 59.1, 60.3, and 60.6)

NFIP	SGC	Analysis
59.1 Definitions 60.3 Floodplain Management Criteria to Flood-Prone Areas	N/A	None. These sections of NFIP do not address gas-fired equipment.

Recommendation: None.

60.6 – Variances and Exceptions

NFIP	SGC	Analysis
60.6(c)(2)(i) Flood-proof Walls	Chapter 4	NFIP requires the basement area, together with utilities and sanitary facilities below the floodproofed design level, to be watertight with walls that are impermeable to the passage of water without human intervention. The SGC defers to the SMC for access and clearance, but does specify minimum combustion air and venting criteria. Utility location and floodproofing are addressed in 602.1.2, 602.5, and Chapter 9 of the SBCCI Standard for Floodplain Management.

Recommendation: The SGC should be revised to reference the SBCCI Standard for Floodplain Management.

NFIP	SGC	Analysis
60.6(c)(2)(ii) Basement Top of Floor Elevation 60.6(c)(2)(iii) Fill 60.6(c)(2)(iv) Use of a Registered Professional 60.6(c)(2)(v) Building Inspection	N/A	None. NFIP does not address gas-fired equipment.

Recommendation: None.

Elevated Residential Structures (FEMA 54)

FEMA 54	SGC	Analysis
Design and Construction Guidelines posts post embedment post anchorage piers brick and concrete masonry piers concrete piers pier footings shear walls and floor diaphragms pier foundation connections floor beams cantilevers floor joist to floor beam connection (Pages 68-88)	N/A	None. These sections of FEMA 54 do not address gas-fired equipment.

Recommendation: None.

FEMA 54	SGC	Analysis
Figure 4.48 Protective Utility Shaft (Page 92)	Ch. 3 308	FEMA 54 requires gas piping serving an elevated structure to be installed on the leeward side of post/columns or enclosed in a protective shaft. The SGC requires piping to be supported and allows a shaft enclosure.

Recommendation: The SGC should be revised to reference the Standard for Floodplain Management.

FEMA 54	SGC	Analysis
Mechanical Equipment (Page 93, Paragraph 2)	Ch. 4 402.4	FEMA 54 requires all gas-fired mechanical equipment to be elevated above expected flood waters with indoor components preferably installed in attic. The SGC defers to the SMC for access and clearance, but does specify minimum combustion air and venting criteria. Ductwork is covered in the SMC.

Recommendation: (1) Revise FEMA to caution that fuel-fired equipment must be installed to local codes (2) Revise SGC to reference the Standard for Floodplain Management.

FEMA 54	SGC	Analysis
Septic Tanks (Page 93, Paragraph 3)	N/A	None. The SGC does not address septic tanks.

Recommendation: None.

FEMA 54	SGC	Analysis
Building Materials Wood Steel Concrete and Masonry (Pages 93-95)	N/A	None. These sections of FEMA 54 do not address gas-fired mechanical equipment.

Recommendation: None.

FEMA 54	SGC	Analysis
Insulation (Pages 95, 96)	N/A	None. The SGC does not address insulation.

Recommendation: None.

FEMA 54	SGC	Analysis
Glossary (Pages 113-115)	N/A	None. The Glossary section of FEMA 54 does not address gas-fired mechanical equipment.

Recommendation: None.

FEMA 54	SGC	Analysis
Performance Criteria C. 2 (1.3) "Protection Against Unnecessary Damage" (Page 134)	Ch. 3, 308 Ch. 4, 402.4	See previous sections on FEMA 54. This is only a summary.

Recommendation: None.

STANDARD GAS CODE (SGC) COMPARISON

Coastal Construction Manual (FEMA 55)

FEMA 55	SGC	Analysis
Chapter 4 - Structural Design Section 4.3.6 Utilities (Pages 4-50 to 4-52)	Ch. 3, 308, Ch. 4, 402.4	FEMA 55 requires all gas-fired equipment to be elevated above expected flood water and gas piping to be installed on the leeward side of posts/columns or enclosed in shafts. The SGC defers to the SMC for access requirements, but does specify minimum combustion air and venting. The SGC requires piping to be supported and would allow the shaft.

Recommendation: (1) For elevation - revise the SGC to reference the Standard for Floodplain Management. (2) For fuel supply - revise FEMA to reference model codes for installation.

FEMA 55	SGC	Analysis
Ch. 5 Larger Structures (Pages 5-1 to 5-9) Appendix A Design Tables (Pages A-1 to A-47) Appendix B Bracing (Pages B-1 to B-15) Appendix D Design Equations and Procedures (Pages D-1 to D-32)	N/A	None. These sections of FEMA 55 do not address gas-fired mechanical equipment.

Recommendation: None.

FEMA 55	SGC	Analysis
Appendix G "Sample Coastal Construction Code" 12 Utilities (Page G-8)	Ch. 4	FEMA 55 requires all gas-fueled mechanical equipment to be elevated above flood waters. The SGC allows elevated installations but also requires minimum combustion air and venting criteria.

Recommendation: (1) Revise SGC to reference the Standard for Floodplain Management. (2) Revise FEMA 55 to reference local model codes for installation.

Manufactured Home Installation in Flood Hazard Areas (FEMA 85)

FEMA 85	SGC	Analysis
Chapter III Elevation and Anchoring Techniques (Pages 19-31) Chapter IV Design of Elevated Foundations (Pages 33-70) Appendix D Calculational Procedure for Elevated Foundation Design (Pages 89-97) Appendix E Buoyancy and Drag Forces (Pages 99-101)	N/A	None. These sections of FEMA 85 do not address gas-fired mechanical equipment.

Recommendation: None.

Floodproofing Non-Residential Structures (FEMA 102)

FEMA 102	SGC	Analysis
Ch. I Introduction (Pages 8-13) Ch. III Floodproofing Design Permanent & Contingent Measures (Pages 37-72, 80-88)	N/A	None. These sections of FEMA 102 do not address gas-fired mechanical equipment.

Recommendation: None.

FEMA 102	SGC	Analysis
Chapter IV Other Floodproofing Measures C. Utilities (Pages 99-105)	402 611	FEMA 102 requires gas-fired mechanical equipment to be elevated above "BFE" or "floodproofed." Floodproofing entails a watertight enclosure for equipment with all penetrations of the building envelope pressure sealed. The SGC allows equipment enclosure with proper access. Adequate combustion air and proper venting.
	611	FEMA 102 requires exterior gas natural draft vents below BFE to be protected by flood shields. The SGC allows very limited exterior venting.

Recommendation: (1) Revise the SGC to reference the Standard for Floodplain Management. (2) Revise FEMA 102 to reference the locally adopted model code for installation criteria.

FEMA 102	SGC	Analysis
Appendix B "Glossary" (Pages 161-166) Appendix D "Floodproofing Performance Criteria Parts B and D (Pages 182-192)	N/A	None. These sections of FEMA 102 do not address gas-fuel appliances.

Recommendation: None.

FEMA 102	SGC	Analysis
Appendix D "Floodproofing Performance Criteria Part C "Performance Criteria" Criteria #6 Heating Air-Conditioning and Ventilation (A) Location (Page 192)	Ch. 4 402.4	FEMA 102 requires that all gas-fired mechanical equipment be installed above BFE, or be enclosed in water-tight rooms. The SGC allows elevated or enclosed installation, but specifies minimum combustion air and venting.

Recommendation: (1) Revise SGC to reference Standard of Floodplain Management. (2) Revise FEMA to reference locally adopted model codes for installation requirements.

FEMA 102	SGC	Analysis
Appendix D "Floodproofing Performance Criteria" Part C "Performance Criteria" Criteria #6 Heating Air-Conditioning & Ventilation (B) Heating and Air Conditioning (Page 192)	Ch. 4 Ch. 5 Ch. 6 608.3	FEMA 102 requires that gas delivery systems installed below BFE be equipped with automatic shutoff valves, activated by rising water. The SGC would not require or prohibit such valves. FEMA 102 requires all gas heating equipment be vented to a level above BFE. The SGC requires natural draft gas vents to terminate at least 2 ft above roof and 2 ft above any portion of the roof within 10 ft.

Recommendation: Revise SGC to reference Standard of Floodplain Management.

FEMA 102	SGC	Analysis
Appendix D "Floodproofing Performance Criteria" Part C "Performance Criteria" Criteria #6 Heating Air-Conditioning & Ventilation (C) Ventilation (Page 193)	N/A	Ventilation ductwork is addressed in the SMC.

Recommendation: None.

FEMA 102	SGC	Analysis
Appendix D "Floodproofing Performance Criteria" Part C "Performance Criteria" Criteria #6 Heating Air-Conditioning & Ventilation (D) Fuel Tanks and Lines (Page 193)	Ch. 3 Ch. 9	FEMA 102 requires fuel storage tanks and lines to be located above BFE or anchored and protected against floodwaters by a factor of safety of 1.5. The SGC does not address uplift forces on storage tanks.

Recommendation: Revise SGC to reference Standard of Floodplain Management and address buoyancy forces on storage tanks.

FEMA 102	SGC	Analysis
Appendix D "Floodproofing Performance Criteria Part C "Performance Criteria" Criteria #7 "Plumbing Systems" (Page 193)	N/A	None. The SGC does not address plumbing.

Recommendation: None.

Retrofitting Flood-Prone Residential Structures (FEMA 114)

FEMA 114	SGC	Analysis
Ch. 3 Elevation (Pages 46-49, 61-68) Ch. 6 Floodwalls (Pages 111-129) Ch. 7 Closures (Pages 133-142) Ch. 8 Sealants (Pages 145-156)	N/A	None. These sections of FEMA 114 do not address gas-fired mechanical equipment.

Recommendation: None.

FEMA 114	SGC	Analysis
Ch. 9 Protection of Utilities 9.4 Permanent Protective Measures (Pages 160-163)	Ch. 4 Ch. 5	Section 9.4 of FEMA 114 requires utility connections to be above flood level, shielding for basement appliances, elevated exterior appliances, suspension for underfloor equipment and anchoring of fuel storage tanks. The SGC allows such installation but requires adequate combustion air and venting.

Recommendation: Revise SGC to reference the Standard for Floodplain Management.

FEMA 114	SGC	Analysis
Ch. 9 Protection of Utilities 9.5 Utility Relocation to Existing Space (Pages 163, 164)	Ch. 3, 4, 5 and 6	Section 9.5 of FEMA 114 addresses relocation of equipment from the basement to upper levels or attics. The SGC allows such installation but specifies minimum combustion air, venting and clearances.

Recommendation: FEMA 114 should be revised to reference readers to local model codes for other safety considerations.

FEMA 114	SGC	Analysis
Ch. 9 Protection of Utilities 9.6 Utility Relocation to New Space (Pages 164, 165)	Ch. 3, 4, 5, and 6	Section 9.6 of FEMA 114 addresses relocation of gas equipment to a newly constructed space. The SGC allows equipment rooms but specifies minimum combustion air, venting and fuel supply.

Recommendation: Section 9.6 of FEMA 114 should be revised to encourage obtaining of a building permit for new construction/alterations.

FEMA 114	SGC	Analysis
Ch. 9 Protection of Utilities 9.8 Storage Tank Anchorage (Page 166)	Ch. 3	Section 9.8 of FEMA 114 requires anchorage of fuel storage tanks. The SGC does not address uplift on LPG tanks.

Recommendation: Revise SGC to address uplift on LPG storage tanks.

FEMA 114	SGC	Analysis
Chapter 10 Special Situations (Pages 176, 177) Appendix C Forces (Pages 197-207)	N/A	None. These sections of FEMA 114 do not address gas-fired mechanical equipment.

Recommendation: None.

Alluvial Fans: Hazards and Management (FEMA 165)

FEMA 165	SGC	Analysis
Windows and Doors (Page 10)	N/A	None. FEMA 165 does not address gas-fired mechanical equipment.

Recommendation: None.

STANDARD GAS CODE (SGC) COMPARISON

Manual for the Construction of Residential Basements in Non-Coastal Flood Environs (MCRB)

MCRB	SGC	Analysis
Chapter III Basement Construction (Pages 13-75) Chapter V Basements in Floods (Pages 88-126) Chapter VII Appendix A-Soils Data (Pages 164, 166) Chapter VIII Builder's Guide (Pages 198, 206, 209, 211-262) Hydraulic/Hydrologic Manual (Pages 7-10)	N/A	None. MCRB does not address gas-fired equipment.

Recommendation: None.

STANDARD GAS CODE (SGC) COMPARISON

Technical Standards Bulletin: Wet Floodproofing, No. 85-1

No. 85-1	SGC	Analysis
Definition Protection Goals Considerations for Applicability (Pages 1-6)	N/A	None. These sections of No. 85-1 do not address gas-fired mechanical equipment.

Recommendation: None.

No. 85-1	SGC	Analysis
IV. Guidelines for Implementation A.1 Foundations A.2 Cavity Wall Construction A.3 Solid Wall Construction A.4 Interior Walls A.5 Interior Wall Finishes A.6 Floors A.7 Ceilings and Roofs A.8 Building Envelope Penetrations A.9 Electrical Systems (Pages 6-11)	N/A	None. These sections of No. 85-1 do not address gas-fired mechanical equipment.

Recommendation: None.

No. 85-1	SGC	Analysis
IV. Guidelines for Implementation A.10 HVAC (Page 11)	Ch. 4 Ch. 5	No. 85-1 requires gas-fired mechanical equipment to be elevated or enclosed for protection. The SGC allows enclosed installation but requires combustion air and clearances to combustible construction.

Recommendation: The SGC should be revised to reference the Standard for Floodplain Management.

STANDARD GAS CODE (SGC) COMPARISON

Technical Standards Bulletin: Foundation Wall Openings, No. 85-2

No. 85-2	SMC	Analysis
Flood Forces (Pages 1-3)	N/A	None. This section of No. 85-2 does not address gas-fired mechanical equipment.

Recommendation: None.

No. 85-2	SGC	Analysis
Openings Design Criteria (Pages 4-6)	402.8	No. 85-2 provides sizing criteria for foundation wall openings used to equalize hydrostatic pressures. The SGC addresses access to appliances, but defers sizes to the SMC. However, this section of No. 85-2 doesn't address equipment installation.

Recommendation: None.

STANDARD GAS CODE (SGC) COMPARISON

Technical Standards Bulletin: Breakaway Walls, No. 85-3

No. 85-3	SGC	Analysis
II. Wind and Water Forces III. Design Approach IV. Design Considerations (Pages 2-10)	N/A	None. These sections of No. 85-3 do not address gas-fired mechanical equipment.

Recommendation: None.

STANDARD GAS CODE (SGC) COMPARISON

Technical Standards Bulletin: Wind Design Standards and the NFIP, No. 88-1

No. 88-1	SMC	Analysis
Pages 1-5	N/A	None. These pages of No. 88-1 do not address gas-fired mechanical equipment.

Recommendation: None.

STANDARD GAS CODE (SGC) COMPARISON

Technical Standards Bulletin: Flood Resistant Materials, No. 88-2

No. 88-2	SGC	Analysis
Pages 1-7	N/A	None. These pages of No. 88-2 do not address gas-fired mechanical equipment.

Recommendation: None.

STANDARD GAS CODE (SGC) COMPARISON

Technical Standards Bulletin: Free of Obstruction Requirement in Coastal High Hazard Areas, No. 88-3

No. 88-3	SGC	Analysis
Lower Area Obstructions Obstructions Outside the Perimeter of the Coastal Building Obstructions Attached to But Outside the Building Perimeter (Pages 2-6)	N/A	None. These pages of No. 88-3 do not address gas-fired mechanical equipment.

Recommendation: None.

STANDARD GAS CODE (SGC) COMPARISON

Technical Standards Bulletin: Protection of Elevator Equipment in Flood Hazard Areas, No. 88-4

No. 88-4	SGC	Analysis
Recommendations (Page 3)	N/A	None. This page of No. 88-4 does not address gas-fired mechanical equipment.

Recommendation: None.

STANDARD GAS CODE (SGC) COMPARISON

Technical Standards Bulletin: NFIP Requirements for Below Grade Parking Garages in Flood Hazard Areas, No. 90-2

No. 90-2	SGC	Analysis
Pages 1-4	N/A	None. These pages of No. 90-2 do not address gas-fired mechanical equipment.

Recommendation: None.

STANDARD GAS CODE (SGC) COMPARISON

Technical Standards Bulletin: Non-Residential Floodproofing Certification Requirements of the National Flood Insurance Program, No. 90-3

No. 90-3	SGC	Analysis
Section D-2 (Pages 1-6)	Ch. 4 Ch. 5	No. 90-3 requires all utilities to be (1) above design flood or (2) completely enveloped by watertight building or (3) completely watertight. The SGC allows such installation but requires venting and combustion air.

Recommendation: Revise No. 90-3 to reference the local model code for venting and combustion air.

STANDARD GAS CODE (SGC) COMPARISON

Technical Standards Bulletin: Installation of Manufactured Homes in Special Flood Hazard Areas, No. 90-4

No. 90-4	SGC	Analysis
Pages 3-19	N/A	None. These pages of No. 90-4 do not address gas-fired mechanical equipment.

Recommendation: None.

STANDARD PLUMBING CODE (SPC) COMPARISON

NFIP (Regulations for Floodplain Management and Flood Hazard Identification) (44 CFR 59.1, 60.3, and 60.6)

NFIP	SPC	Analysis
59.1 Definitions 60.3 Floodplain Management Criteria to Flood-Prone Areas	N/A	None. NFIP does not address plumbing.

Recommendation: None.

60.6 – Variances and Exceptions

NFIP	SPC	Analysis
60.6(c)(2)(i) Flood-proof Walls	301.12 1204.1	NFIP requires the basement area, together with utilities and sanitary facilities below the floodproofed design level, to be watertight with walls that are impermeable to the passage of water without human intervention. The SPC prohibits deleterious discharge of sewage or other waste and requires the water distribution system to be protected against backflow. This is addressed in 602.1.2, 602.6, and 602.7, and Chapter 9 of the SBCCI Standard for Floodplain Management.

Recommendation: The SPC should be revised to reference the SBCCI Standard for Floodplain Management.

NFIP	SPC	Analysis
60.6(c)(2)(ii) Basement Top of Floor Elevation 60.6(c)(2)(iii) Fill 60.6(c)(2)(iv) Use of a Registered Professional 60.6(c)(2)(v) Building Inspection	N/A	None. NFIP does not address plumbing.

Recommendation: None.

Elevated Residential Structures (FEMA 54)

FEMA 54	SPC	Analysis
Design and Construction Guidelines posts post embedment post anchorage piers brick and concrete masonry piers concrete piers pier footings shear walls and floor diaphragms pier foundation connections floor beams cantilevers floor joist to floor beam connection (Pages 68-88)	N/A	None. These sections of FEMA 54 do not address plumbing.

Recommendation: None.

FEMA 54	SPC	Analysis
Figure 4.48 Protective Utility Shaft (Page 92)	407	FEMA 54 requires water and DWV piping serving an elevated structure to be attached to the leeward side of posts/columns or enclosed in a protective shaft. The SPC requires piping to be protected from physical damage.

Recommendation: The SPC should be revised to reference the Standard for Floodplain Management.

FEMA 54	SPC	Analysis
Mechanical Equipment (Page 93, Paragraph 2)	N/A	The SPC does not address mechanical equipment.

Recommendation: None.

FEMA 54	SPC	Analysis
Septic Tanks (Page 93, Paragraph 3)	Appendix E 301.12	FEMA 54 requires that septic tanks be floodproofed to stop floating and potential discharge of effluent. The SPC requires proper installation and prohibits deleterious discharge.

Recommendation: None since both approach the problem from different directions. FEMA - prescriptive SPC - performance. The SPC should be revised to reference the Standard for Floodplain Management.

FEMA 54	SPC	Analysis
Building Materials Wood Steel Concrete and Masonry (Pages 93-95) *Recommendation:* None.	N/A	None. These sections of FEMA 54 do not address plumbing.

FEMA 54	SPC	Analysis
Insulation (Pages 95, 96) *Recommendation:* None.	N/A	The SPC does not address insulation.

FEMA 54	SPC	Analysis
Glossary (Pages 113-115) *Recommendation:* None.	N/A	None. The Glossary section of FEMA 54 does not address plumbing.

FEMA 54	SPC	Analysis
Performance Criteria C. 2 (1.3) "Protection Against Unnecessary Damage" (Page 134) *Recommendation:* None.	407 Appendix E 301.12	See previous sections on FEMA 54. This is only a summary.

STANDARD PLUMBING CODE (SPC) COMPARISON

Coastal Construction Manual (FEMA 55)

FEMA 55	SPC	Analysis
Chapter 4 - Structural Design Section 4.3.6 Utilities (Pages 4-50 to 4-52)	407	FEMA 55 requires water and DWV piping serving elevated structures to be attached to the leeward side of posts/columns or enclosed in a protective shaft. The SPC requires piping be protected from physical damage.

Recommendation: The SPC should be revised to reference the Standard for Floodplain Management.

FEMA 55	SPC	Analysis
Ch. 5 Larger Structures (Pages 5-1 to 5-9) Appendix A Design Tables (Pages A-1 to A-47) Appendix B Bracing (Pages B-1 to B-15) Appendix D Design Equations and Procedures (Pages D-1 to D-32)	N/A	None. FEMA 55 does not address plumbing.

Recommendation: None.

FEMA 55	SPC	Analysis
Appendix G "Sample Coastal Construction Code" 12 Utilities (Page G-8)	301.10 808 Ch. 13	FEMA 55 requires sanitary sewer and storm drainage systems with openings below the BFE to have backflow valves where the lines pass through the building envelope. The SPC requires a backwater valve only where a drainage system may be subject to a backflow of sewage.

Recommendation: Revise the SPC to reference the Standard for Floodplain Management and include specific criteria for the isolation of these lines.

STANDARD PLUMBING CODE (SPC) COMPARISON

Manufactured Home Installation in Flood Hazard Areas (FEMA 85)

FEMA 85	SPC	Analysis
Chapter III Elevation and Anchoring Techniques (Pages 19-31) Chapter IV Design of Elevated Foundations (Pages 33-70) Appendix D Calculational Procedure for Elevated Foundation Design (Pages 89-97) Appendix E Buoyancy and Drag Forces (Pages 99-101)	N/A	None. FEMA 85 does not address plumbing.

Recommendation: None.

STANDARD PLUMBING CODE (SPC) COMPARISON

Floodproofing Non-Residential Structures (FEMA 102)

FEMA 102	SPC	Analysis
Ch. I Introduction (Pages 8-13) Ch. III Floodproofing Design Permanent & Contingent Measures (Pages 37-72, 80-88)	N/A	None. FEMA 102 does not address plumbing.

Recommendation: None.

FEMA 102	SPC	Analysis
Chapter IV Other Floodproofing Measures C. Utilities (Pages 99 - 105)	1302 1308	FEMA 102 requires that backwater valves be installed on the building sewer at a point where the piping is strong enough to resist the flood induced pressures. A backwater valve is usually a swing-check valve. As an alternate, all gravity sewer openings below the BFE may be routed to a sump, then pumped above BFE to the lowest entrance to the sewer (Figure IV-8). FEMA also requires wells to be equipped with a watertight casing that extends from one ft above grade to 25 ft below grade to minimize contamination. The SPC would allow the backwater valve, but would prohibit the sump in situations where gravity sewer is available. (1308.1) The SPC does not address well construction.

Recommendation: (1) Revise SPC to reference the Standard for Floodplain Management. (2) Revise SPC to allow sumps and ejectors for flood areas even where gravity drainage is available.

FEMA 102	SPC	Analysis
Appendix B "Glossary" (Pages 161-166) Appendix D "Floodproofing Performance Criteria Parts B and D (Pages 182-193)	N/A	None. These sections of FEMA 102 do not address plumbing.

Recommendation: None.

FEMA 102	SPC	Analysis
Appendix D "Floodproofing Performance Criteria Part C "Performance Criteria" Criteria #6 Heating Air-Conditioning and Ventilation (A) Location (Page 192)	N/A	None. The SPC does not address HVAC equipment.

Recommendation: None.

FEMA 102	SPC	Analysis
Appendix D "Floodproofing Performance Criteria" Part C "Performance Criteria" Criteria #7 "Plumbing Systems" (A) General (Page 193)	903 606.1	FEMA 102 requires that all plumbing system components below BFE should be designed to minimize loss of stability or tightness. The SPC requires fixtures to be securely anchored.

Recommendation: None.

FEMA 102	SPC	Analysis
Appendix D "Floodproofing Performance Criteria" Part C "Performance Criteria" Criteria #7 "Plumbing Systems" (B) Sanitary Sewer Systems (Page 193)	301.10 Ch. 13	FEMA 102 requires on-site sewage disposal systems to be designed to minimize floodwater effects. Sanitary sewer systems which must remain in operation during a flooding event should be designed with a sealed holding tank sized at 150% of anticipated demand. All vents should extend above BFE. The SPC does not prohibit holding tanks, but makes no provision to size the tank except for engineering. The SPC will allow, in limited instances, air admittance valves in lieu of venting termination above roof.

Recommendation: Revise SPC to reference Standard of Floodplain Management and to prohibit air admittance valves below BFE.

FEMA 102	SPC	Analysis
Appendix D "Floodproofing Performance Criteria" Part C "Performance Criteria" Criteria #7 "Plumbing Systems" (C) Water Supply Systems (Page 193)	1204	FEMA 102 requires that potable water supply systems be protected from contamination during flooding. The SPC requires protection of potable water.

Recommendation: The SPC should reference Standard of Floodplain Management.

FEMA 102	SPC	Analysis
Appendix D "Floodproofing Performance Criteria Part C "Performance Criteria" Criteria #7 "Plumbing Systems" (D) Backflow Prevention (Page 193)	301.10 Ch. 13	FEMA 102 requires backwater valves on storm drain, sewage and potable water supply lines installed at wells or building exits. The SPC allows such valves but only requires them for sewage backflow.

Recommendation: Revise the SPC to reference Standard of Floodplain Management.

Retrofitting Flood-Prone Residential Structures (FEMA 114)

FEMA 114	SPC	Analysis
Ch. 3 Elevation (Pages 46-49, 61-68) Ch. 6 Floodwalls (Pages 111-129) Ch. 7 Closures (Pages 133-142) Ch. 8 Sealants (Pages 145-156)	N/A	None. These sections of FEMA 114 do not address plumbing.

Recommendation: None.

FEMA 114	SPC	Analysis
Ch. 9 Protection of Utilities 9.4 Permanent Protective Measures (Pages 160-163)	N/A	None. This section of FEMA 114 does not address plumbing.

Recommendation: None.

FEMA 114	SPC	Analysis
Ch. 9 Protection of Utilities 9.5 Utility Relocation to Existing Space (Pages 163, 164)	N/A	None. This section of FEMA 114 does not address plumbing.

Recommendation: None.

FEMA 114	SPC	Analysis
Ch. 9 Protection of Utilities 9.6 Utility Relocation to New Space (Pages 164, 165)	N/A	None. This section of FEMA 114 does not address plumbing.

Recommendation: None.

FEMA 114	SPC	Analysis
Ch. 9 Protection of Utilities 9.8 Storage Tank Anchorage (Page 166)	N/A	None. This section of FEMA 114 does not address plumbing.

Recommendation: None.

FEMA 114	SPC	Analysis
Chapter 10 Special Situations (Pages 176, 177) Appendix C Forces (Pages 197-207)	N/A	None. These sections of FEMA 114 do not address plumbing.

Recommendation: None.

Alluvial Fans: Hazards and Management (FEMA 165)

FEMA 165	SPC	Analysis
Windows and Doors (Page 10)	N/A	None. FEMA 165 does not address plumbing.

Recommendation: None.

STANDARD PLUMBING CODE (SPC) COMPARISON

Manual for the Construction of Residential Basements in Non-Coastal Flood Environs (MCRB)

MCRB	SPC	Analysis
Chapter III Basement Construction (Pages 13-75) Chapter V Basements in Floods (Page 88-126) Chapter VII Appendix A - Soils Data (Pages 164, 166) Chapter VIII Builder's Guide (Pages 198, 206, 209, 211-262) Hydraulic/Hydrologic Manual (Pages 7-10)	301.12 1204.1	The majority of the MCRB does not address plumbing. However, III.B.8 does address plumbing materials, sewer systems, and potable water supply systems. MCRB requires gate valves on the sanitary sewer outlets from the house and the potable water supply system to be designed in such a manner to prevent contamination from flood waters. The SPC prohibits deleterious discharge of sewage or other waste and requires the water distribution system to be protected against backflow. This is addressed in 602.6 and 602.7 of the SBCCI Standard for Floodplain Management.

Recommendation: The SPC should be revised to reference the SBCCI Standard for Floodplain Management.

STANDARD PLUMBING CODE (SPC) COMPARISON

Technical Standards Bulletin: Wet Floodproofing Bulletin, No. 85-1

No. 85-1	SPC	Analysis
Definition Protection Goals Considerations for Applicability (Pages 1-6)	N/A	None. These sections of No. 85-1 do not address plumbing.

Recommendation: None.

No. 85-1	SPC	Analysis
IV. Guidelines for Implementation A.1 Foundations A.2 Cavity Wall Construction A.3 Solid Wall Construction A.4 Interior Walls A.5 Interior Wall Finishes A.6 Floors A.7 Ceilings and Roofs A.8 Building Envelope Penetrations A.9 Electrical Systems (Pages 6-11)	N/A	None. These sections of No. 85-1 do not address plumbing.

Recommendation: None.

No. 85-1	SPC	Analysis
IV. Guidelines for Implementation A.10 HVAC (Page 11)	N/A	None. The SPC doesn't address HVAC equipment.

Recommendation: None.

No. 85-1	SPC	Analysis
A.11 Plumbing and Water (Not in Scope) (Page 12)	Ch. 12 1204 301.10	No. 85-1 A.11 requires that interruptible water supply sources be protected from contamination by a check valve. The SPC does require backflow prevention. No. 85-1 requires a sealed holding tank for those disposal systems required to remain in operation during a flooding event. Sewage systems should have a manual valve or a backwater valve at building penetration. The SPC requires a backflow valve for sewage reversal only.

Recommendation: (1) Revise SPC to reference Standard for Floodplain Management; (2) Revise SPC to add a principle for flood plain areas.

STANDARD PLUMBING CODE (SPC) COMPARISON

Technical Standards Bulletin: Foundation Wall Openings, No. 85-2

No. 85-2	SMC	Analysis
Flood Forces (Pages 1-3)	N/A	None. This section of No. 85-2 does not address plumbing.

Recommendation: None.

No. 85-2	SPC	Analysis
Openings Design Criteria (Pages 4-6)	N/A	None. The SPC does not address equipment access or foundation wall openings.

Recommendation: None.

STANDARD PLUMBING CODE (SPC) COMPARISON

Technical Standards Bulletin: Breakaway Walls, No. 85-3

No. 85-3	SPC	Analysis
II. Wind and Water Forces III. Design Approach IV. Design Considerations (Pages 2-10)	N/A	None. No. 85-3 does not address plumbing.

Recommendation: None.

STANDARD PLUMBING CODE (SPC) COMPARISON

Technical Standards Bulletin: Wind Design Standards and the NFIP, No. 88-1

No. 88-1	SMC	Analysis
Pages 1-5	N/A	None. No. 88-1 does not address plumbing.

Recommendation: None.

STANDARD PLUMBING CODE (SPC) COMPARISON

Technical Standards Bulletin: Flood Resistant Materials, No. 88-2

No. 88-2	SPC	Analysis
Pages 1-7	N/A	None. No. 88-2 do not address plumbing.

Recommendation: None.

STANDARD PLUMBING CODE (SPC) COMPARISON

Technical Standards Bulletin: Free of Obstruction Requirement in Coastal High Hazard Areas, No. 88-3

No. 88-3	SPC	Analysis
Lower Area Obstructions Obstructions Outside the Perimeter of the Coastal Building Obstructions Attached to But Outside the Building Perimeter (Pages 2-6)	N/A	None. No. 88-3 does not address plumbing.

Recommendation: None.

STANDARD PLUMBING CODE (SPC) COMPARISON

Technical Standards Bulletin: Protection of Elevator Equipment in Flood Hazard Areas, No. 88-4

No. 88-4	SPC	Analysis
Recommendations (Page 3)	N/A	None. No. 88-4 does not address plumbing.

Recommendation: None.

STANDARD PLUMBING CODE (SPC) COMPARISON

Technical Standards Bulletin: NFIP Requirements for Below Grade Parking Garages in Flood Hazard Areas, No. 90-2

No. 90-2	SPC	Analysis
Pages 1-4	N/A	None. No. 90-2 do not address plumbing.

Recommendation: None.

STANDARD PLUMBING CODE (SPC) COMPARISON

Technical Standards Bulletin: Non-Residential Floodproofing Certification Requirements of the National Flood Insurance Program, No. 90-3

No. 90-3	SPC	Analysis
Section D-2 (Pages 1-6)	N/A	No. 90-3 requires all utilities to be (1) above design flood or (2) completely enclosed by the building's watertight walls or (3) be completely watertight. The SPC would not prohibit such installation, but only regulates size of space for setting fixtures.

Recommendation: Revise SPC to reference the Standard for Floodplain Management.

STANDARD PLUMBING CODE (SPC) COMPARISON

Technical Standards Bulletin: Installation of Manufactured Homes in Special Flood Hazard Areas, No. 90-4

No. 90-4	SPC	Analysis
Pages 3-19	N/A	None. No. 90-4 does not address plumbing.

Recommendation: None.

STANDARD FOR FLOODPLAIN MANAGEMENT (SFM;) COMPARISON

The Standard for Floodplain Management contains provisions which are unique to floodplain management and does not contain provisions for conventional construction contained in the Standard Codes.

NFIP (Regulations for Floodplain Management and Flood Hazard Identification) (44 CFR 59.1, 60.6, and 60.3)

59.1 – Definitions

NFIP	SFM	Analysis
Appurtenant Structure Critical Feature Storm Cellar	202	NFIP contains a definition of "appurtenant structure" and "critical feature" since it addresses requirements for flood insurance. NFIP contains a definition of a "storm cellar" which is used as a temporary shelter against severe tornado or similar wind storm activity. SFM does not contain these definitions since it does not address flood insurance or temporary shelters against wind storm activity.

Recommendation: None.

NFIP	SFM	Analysis
Base Flood Basement Breakaway Wall Building Development Elevated Building Existing Construction Flood Floodplain or Flood-Prone Area Lowest Floor Manufactured Home 100-year Flood Structure Substantial Improvement	202	The definitions in NFIP and SFM are compatible. NFIP's definition of "manufactured home" does not include a "recreational vehicle" while SFM includes "mobile homes, park trailers, travel trailers, and similar transportable structures placed on a site for 180 consecutive days or longer and intended to be improved property."

Recommendation: None.

60.3 - Floodplain Management Criteria for Flood-Prone Areas

NFIP	SFM	Analysis
60.3(b)(8) Manufactured Home Installation	603	Both NFIP and SFM are compatible however SFM does not permit the placement of a manufactured home within a designated floodway or coastal high hazard area.

Recommendation: In order to avoid confusion, NFIP and SFM should list the zone designation (A, AO, AH, VO, M, etc) along with the word description (floodway, coastal high hazard).

NFIP	SFM	Analysis
60.3(c)(2) Elevation for Residential Structures	602.1.1	Both NFIP and SFM require elevation of the lowest horizontal structural member of the lowest floor including basement to be elevated to or above the base flood level.

Recommendation: None.

NFIP	SFM	Analysis
60.3(c)(3) Elevation for Non-Residential Structures; Floodproof Walls for Non-Residential Structures	602.1.2	Both NFIP and SFM permit the structure to be constructed below the base flood elevation provided the structure is floodproofed up to the base flood level.

Recommendation: None.

NFIP	SFM	Analysis
60.3(c)(5) Flood Openings	602.2	Both NFIP and SFM require two openings in walls below the base flood elevation to allow the entry and exit of floodwaters to automatically equalize hydrostatic flood forces on the exterior walls.

Recommendation: None.

NFIP	SFM	Analysis
60.3(e)(4) Piling	801.1	Both NFIP and SFM requires the structure in a high coastal high hazard area to be elevated on pilings or columns and securely anchored to resist flotation, collapse, and permanent lateral movement due to the effects of wind and water loading.

Recommendation: None.

NFIP	SFM	Analysis
60.3(e)(5) Breakaway Walls	801.4	Both NFIP and SFM require areas below the lowest floor to be free of obstruction or constructed with nonsupporting breakaway walls, open wood lattice, or insect screening intended to collapse under wind and water loads.

Recommendation: None.

NFIP	SFM	Analysis
60.3(e)(6) Fill	801.5	Both NFIP and SFM prohibit the use of fill material for structural support in coastal high hazard areas.

Recommendation: None.

60.6 – Variances and Exceptions.

NFIP	SFM	Analysis
60.6(c)(2)(i) Floodproof Walls 60.6(c)(2)(iv) Use of a Registered Professional	900.3 900.4	Both NFIP and SFM require the basement area together with utilities and sanitary facilities below the floodproofed design level, to be watertight with walls that are impermeable to the passage of water without human intervention. The SFM does not permit floodproofing of walls below the flood level for residential structures. Both NFIP and SFM require the floodproofing measures to be certified by a registered professional engineer or architect.

Recommendation: None, since floodproofing of basements is allowed only in communities that have been granted an exception by FEMA.

NFIP	SFM	Analysis
60.6(c)(2)(ii) Basement Top of Floor Elevation 60.6(c)(2)(iii) Fill	600.1 604.2 604.3 800.2 801.5	NFIP permits the basement floor to be up to five feet below the elevation of the base flood. NFIP permits the area surrounding the structure to be protected by fill material to or above the elevation of the base flood. SFM requires the lowest floor to be located above the base flood elevation. SFM does not permit the use of fill material as a buffer from storm surge in coastal high hazard areas.

Recommendation: None.

NFIP	SFM	Analysis
60.6(c)(2)(v) Building Inspection	Chapter 4	Both NFIP and SFM require the authority having jurisdiction to verify that the provisions of the standard are satisfied.

Recommendation: None.

STANDARD FOR FLOODPLAIN MANAGEMENT (SFM) COMPARISON

The Standard for Floodplain Management contains provisions which are unique to floodplain management and does not contain provisions for conventional construction contained in the Standard Codes.

Elevated Residential Structures (FEMA 54)

FEMA 54	SFM	Analysis
Posts Post Embedment Post Anchorage (Pages 68-71)	801.1	FEMA 54 addresses the use of wood, concrete, or steel posts as the foundation to elevate residential structures. General commentary is made about installation, handling, and lateral resistance. SFM does not address post foundations but references Chapter 13 of the Standard Building Code for pile system design and installation.

Recommendation: FEMA 54 should combine post foundations and pile foundations into one section.

FEMA 54	SFM	Analysis
Piers Brick and Concrete Masonry Piers Concrete Piers Pier Footings Shear Walls and Floor Diaphragms (Pages 75-77, 79)	801.1	FEMA 54 describes the suitability of pier foundations and types of pier foundations suitable for flood areas with low velocity and minimal erosion. FEMA 54 provides minimum reinforcing, minimum dimensional requirements, maximum height, spacing, and recommended shape. FEMA 54 requires the piers to be filled with concrete. FEMA 54 provides a general description and discussion of poured-in-place concrete piers. FEMA 54 requires the footing sizes to be based on the properties of the soil. FEMA 54 addresses the use of plywood shear walls and floor diaphragms to brace piles or post foundations. SFM requires foundations to have adequate soil penetrations to resist the combined wave and wind loads to which they are subject. SFM does not address the actual requirements for the piers.

Recommendation: None.

FEMA 54	SFM	Analysis
Pier Foundation Connection (Pages 84, 85)	801.3	FEMA 54 addresses anchorage of platform framing construction to pier foundations. SFM requires all components including floor frames to be securely fastened and adequately interconnected to resist loads anticipated during flooding.

Recommendation: None.

FEMA 54	SFM	Analysis
Floor Beams Cantilevers (Pages 86, 87)	N/A	FEMA 54 provides a general discussion of built-up floor beams and cantilevered beams. FEMA 54 provides a "rule of thumb" for the length of cantilever. SFM does not address construction materials. Construction materials are addressed in the SBCCI Standard Building Code.

Recommendation: FEMA 54 should delete the "rule of thumb."

FEMA 54	SFM	Analysis
Floor Beam to Floor Joist Connection (Page 88)	801.3	FEMA 54 requires positive connection between the floor joists and floor beams. SFM requires all components of the building to be securely fastened and adequately interconnected to resist loads anticipated during flooding.

Recommendation: None.

FEMA 54	SFM	Analysis
Figure 4.48, Protective Utility Shaft (Page 92)	602.5	FEMA 54 and SFM require utility protection.

Recommendation: None.

FEMA 54	SFM	Analysis
Mechanical Equipment (Page 93, Paragraph 2)	602.5	Both FEMA 54 and SFM require the mechanical equipment to be designed and located so as to prevent water from entering the components.

Recommendation: None.

FEMA 54	SFM	Analysis
Septic Tanks (Page 93, Paragraph 3)	501.2 602.7	FEMA 54 requires septic tanks to be floodproofed to prevent the tank from rising out of the ground. FEMA 54 and SFM requires the tank to be designed to minimize or eliminate discharge of effluent into the floodwaters.

Recommendation: None. SFM should address buoyancy forces on tanks.

FEMA 54	SFM	Analysis
Building Materials Wood Steel Concrete and Masonry Insulation (Pages 93-96)	N/A	FEMA 54 addresses the need for preservative treatment, corrosion protection, and increased durability of building materials exposed to the elements and flood water. FEMA 54 addresses the need for insulation on the exposed floor of an elevated residence. SFM does not address building materials or insulation requirements. This is addressed in the CABO Model Energy Code.

Recommendation: None.

FEMA 54	SFM	Analysis
Glossary (Pages 113-115)	202	Both FEMA 54 and SFM contain some of the same definitions and some different definitions. The definitions are appropriate for each document.

Recommendation: None.

FEMA 54	SFM	Analysis
Performance Criteria (Pages 125-135)	401.3 801.3	FEMA 54 addresses performance criteria used to design buildings to withstand the design flood (1) without causing unacceptable risks to its occupants or to adjacent property owners, (2) without causing unacceptable health hazards to its occupants, or (3) without sustaining damage to unacceptable magnitude. SFM requires the building to be certified by a registered professional engineer or architect that it is designed to withstand velocity waters, wave action, and wind loadings. SFM requires all components to be securely fastened and adequately interconnected to resist the loads anticipated during flooding.

Recommendation: FEMA 54 should include performance criteria for snow and seismic loads. The use of the phrases "unacceptable risks", "unacceptable health hazards", and "unacceptable magnitude" are too subjective.

STANDARD FOR FLOODPLAIN MANAGEMENT (SFM) COMPARISON

The Standard for Floodplain Management contains provisions which are unique to floodplain management and does not contain provisions for conventional construction contained in the Standard Codes.

Coastal Construction Manual (FEMA 55)

FEMA 55	SFM	Analysis
4.1 Flood Frequency (Page 4-1, Paragraph 4)	801.1	Both FEMA 55 and SFM reference the base flood (100 year) as the water force for which the structure must be designed to resist.

Recommendation: None.

FEMA 55	SFM	Analysis
4.1.1 Wind (Page 4-1, Paragraphs 6 & 7 Page 4-2, Figure 4-1 Page 4-3, Paragraphs 2 & 3 Page 4-6)	801	FEMA 55 references the procedures of ANSI A58.1-1982 for design with particular emphasis placed on elevation of the roof above grade and high wind pressures at the corners of the house, at and under roof eaves, and at the peak of the roof. SFM references 1205 of the Standard Building for design wind loads. SBC permits ASCE 7-1988 (formerly ANSI A58.1-1982) in addition to the wind load provisions of 1205.

Recommendation: FEMA 55 should update its reference to ASCE 7-1988.

FEMA 55	SFM	Analysis
4.1.2 Salt Air, Moisture and Wind-Driven Rain (Pages 4-7, 4-8)	N/A	FEMA 55 provides general discussion of the hazards of salt air, moisture and wind driven rain on wood, bolts, rails, and connectors. SFM does not address decay or corrosion of building materials.

Recommendation: None.

FEMA 55	SFM	Analysis
4.1.3 Water, Waves, and Debris (Page 4-8, Paragraph 4)	401.3	FEMA 55 addresses the impact loads exerted on the piles as the result of the movement of debris, (fences, porches, stains, utility poles, etc.) FEMA 55 has provided for the collision of a 300 pound object moving at surface water velocity and decelerating over a maximum distance of 0.5 ft. SFM requires, in coastal high hazard areas, certification from a professional engineer or architect that the building is designed to withstand velocity waters, wave action, and wind loadings.

Recommendation: None since both address the issue of damage only from different directions: FEMA-prescriptive, SBC-performance.

FEMA 55	SFM	Analysis
4.1.4 Effects of Forces on Higher and Larger Structures (Page 4-9)	801.1	FEMA 55 discusses the higher wind forces, uplift and overturning with respect to the height of the building. SFM refers to 1205 of the Standard Building Code, which does address building height, for design wind load values.

Recommendation: FEMA 55 should provide velocity pressures (psf) for varied wind speeds and building height.

FEMA 55	SFM	Analysis
4.2 Construction Materials (Page 4-9)	N/A	FEMA 55 provides a general discussion of the types of construction materials (wood, steel, concrete) and their use in the coastal environment. SFM does not address construction materials.

Recommendation: None.

FEMA 55	SFM	Analysis
4.2.1.1 Pilings (Wood) (Pages 4-9, 4-10)	801.1	FEMA 55 provides general comments on the use of wood pilings (species and decay resistance). SFM refers to Chapter 13 of the Standard Building Code for pile design and installation.

Recommendation: None since neither FEMA 55 or SFM actually contains specifications for timber pilings.

FEMA 55	SFM	Analysis
4.2.1.2 Main Supporting Members (Beams, Wood) (Page 4-10)	401.3	FEMA 55 provides general nailing requirements and splice location. SFM requires the design to be certified that the building will withstand velocity waters, wave action, and wind loadings.

Recommendation: FEMA 55 should provide more specific parameters for which the stated nailing is appropriate.

FEMA 55	SFM	Analysis
4.2.1.3 Other Wood Construction Members (Page 4-10)	N/A	FEMA 55 does not require preservative treatment of miscellaneous wood members but highly recommends it. SFM does not address preservative treatment of wood.

Recommendation: None.

FEMA 55	SFM	Analysis
4.2.1.4 Wood Preservative (Page 4-10)	N/A	FEMA 55 requires wood members to be treated to resist insect infestation, dry rot, decay fungi, and the effects of exposure to salt air and water and provides general discussions of wood preservatives. SFM does not address preservative treatment.

Recommendation: None.

FEMA 55	SFM	Analysis
4.2.2 Masonry Materials and Concrete (Page 4-11)	N/A	FEMA 55 addresses the general use of masonry and concrete in the coastal environment. SFM does not address building materials.

Recommendation: None.

FEMA 55	SFM	Analysis
4.2.3.1 Aluminum (Page 4-11)	N/A	FEMA 55 addresses the problem of corrosion of aluminum in the coastal environment. SFM does not address corrosion on building materials.

Recommendation: None.

FEMA 55	SFM	Analysis
4.2.3.2 Steel (Page 4-11)	N/A	FEMA addresses the problem of corrosion of unprotected steel shapes and anchoring devices (nails, bolts, etc.) and the need for regular inspections, maintenance, and replacement of corroded metal parts. SFM does not address corrosion, regular inspection, maintenance, and replacement of corroded metal parts.

Recommendation: None.

FEMA 55	SFM	Analysis
4.2.3.3 Dissimilar Metals (Page 4-11)	N/A	FEMA 55 addresses the corrosion which occurs when dissimilar metals are placed in contact with each other. SFM does not address dissimilar metals.

Recommendation: None.

FEMA 55	SFM	Analysis
4.3.1 Foundations (Design Details) (Page 4-11, 4-12)	801.1	FEMA 55 recommends foundation types which are suitable for supporting elevated structures in coastal high hazard areas. SFM permits any type of foundation provided it is designed to resist the combined wave and wind loads which it is likely to be subjected.

Recommendation: None since FEMA 55 is "prescriptive" and SBC is "performance" oriented.

FEMA 55	SFM	Analysis
4.3.1.1 Soil Conditions (Pages 4-12, 4-13)	801.1	FEMA 55 addresses the need to determine the quality of the soil for foundation purposes. SFM refers to Chapter 13 of the Standard Building Code which requires a soils investigation for pile foundations.

Recommendation: None.

FEMA 55	SFM	Analysis
4.3.1.2 Piles (Pages 4-13 to 4-18)	801.1	FEMA 55 provides general information on types of piles, the need for sufficient pile embedment, and methods of pile installation. SFM refers to Chapter 13 of the Standard Building Code for pile system design and installation which requires a foundation investigation and report.

Recommendation: FEMA 55 should emphasize that the type of pile, pile depth, and method of installation should be based on the soils investigation.

FEMA 55	SFM	Analysis
4.3.1.3 Posts (Wood) (Page 4-18)	801.1	FEMA 55 explains that wood posts are recommended in areas subject to wave forces and/or scour and erosion. SFM refers to Chapter 13 of the Standard Building Code for pile system design and installation but does not address post foundations.

Recommendation: FEMA should combine post foundations and piles into one section with more prescriptive requirements.

FEMA 55	SFM	Analysis
4.3.1.4 Piers (Page 4-18 to 4-20)	801.1	FEMA 55 addresses the use of piers to elevate structures and the need for reinforcing and anchorage of the footings in V zones and coastal A zones. FEMA 55 also provides general construction guidelines. SFM requires the foundations to have adequate soil penetrations to resist the wave and wind loads to which they are likely to be subjected during a flood.

Recommendation: FEMA 55 should clarify that the reinforcing, footing size, and grade beam should be based on the design forces.

FEMA 55	SFM	Analysis
4.3.2.1 Framing Methods (Pages 4-20, 4-21)	N/A	FEMA 55 addresses platform framing and pole construction. SFM does not address any type of construction.

Recommendation: None.

FEMA 55	SFM	Analysis
4.3.2.2 Beams (Pages 4-21, 4-22)	N/A	FEMA 55 addresses the preferable direction of floor beams to reduce the impact force of the storm water. FEMA 55 addresses built-up and solid beams, and "glulam" beams. SFM does not address any type of construction.

Recommendation: None.

FEMA 55	SFM	Analysis
4.3.2.3 Joists and Rafters (Page 4-22)	N/A	The title of the section in FEMA 55 is joists and rafters but rafters are not addressed. FEMA 55 describes manufactured wooden I-beams, recommends cross bridging for all floor joists located in the V-zone, and describes typical cross bridging methods. SFM does not address joists and rafters.

Recommendation: FEMA 55 should delete the reference to rafters.

FEMA 55	SFM	Analysis
4.3.2.4 Subflooring (Pages 4-22, 4-23)	N/A	FEMA 55 addresses the use of lumber and plywood subflooring. SFM does not address subflooring.

Recommendation: None.

FEMA 55	SFM	Analysis
4.3.2.5 Studs (Page 4-23)	N/A	FEMA 55 recognizes that 2x4 wood studs at 16 inches on center are commonly used and permits 2x6 wood studs and metal studs. SFM does not address studs of any type.

Recommendation: None.

FEMA 55	SFM	Analysis
4.3.2.6 Wall Sheathing 4.3.2.7 Wall Bracing (Pages 4-23, 4-24)	801.1	FEMA 55 provides the minimum thickness and nail spacing for plywood wall sheathing and permits let-in diagonal wood bracing, diagonal boards, and plywood as wall bracing. SFM does not address types of wall sheathing or bracing but does require the design wind loading values to be based on 1205 of the Standard Building Code.

Recommendation: FEMA 55 should combine wall sheathing and wall bracing into one section and address the design requirements for the wall bracing method chosen.

FEMA 55	SFM	Analysis
4.3.2.8 Roof Details 4.3.3 Foundation Bracing 4.3.3.1 Knee Braces 4.3.3.2 Grade Beams 4.3.3.3 Truss Bracing 4.3.3.4 Shear Walls 4.3.4 Connections 4.3.4.1 Roof to Wall 4.3.4.2 Wall to Floor Joists 4.3.4.3 Floor Joist to Floor Beam 4.3.4.4 Floor Beam to Pile, Post, or Pier (Page 4-24 to 4-40)	801.1 801.3	FEMA 55 provides details and recommendations for roofs, bracing, shear walls, and connections. SFM does not address details but does require all buildings and structures to have all components securely fastened and adequately interconnected to resist the loads anticipated during flooding.

Recommendation: FEMA 55 should provide some design values or wind speeds for which the connections and details are appropriate.

FEMA 55	SFM	Analysis
4.3.5 Breakaway Walls 4.3.5.1 Breakaway Wall Designs 4.3.5.2 Design Considerations for Breakaway Walls (Page 4-41 to 4-49)	801.4	Both FEMA 55 and SFM permits breakaway walls to enclose the space below the lowest elevated floor and provides the design loading for the breakaway walls. FEMA 55 also provides commentary type language, breakaway wall designs, details, and design process for breakaway walls (screening, lattice, wood stud walls, metal stud walls and masonry walls.)

Recommendation: None although FEMA 55 provides commentary type language the requirements in FEMA 55 and SFM are compatible.

FEMA 55	SFM	Analysis
4.3.6 Utilities (Pages 4-50 to 4-52)	602.5	Both FEMA 55 and SFM require the utilities to be designed and located so as to be protected from inundation and to minimize the chance of impairment during flooding. FEMA 55 requires protection of utilities from the potential damage from wave impact.

Recommendation: FEMA 55 should address the potential damage from high winds in coastal areas.

FEMA 55	SFM	Analysis
4.3.7 Wind and Storm Protection of Interior 4.3.7.1 Window Selection 4.3.7.2 Operable Shutters (Pages 4-52 to 4-54)	N/A	FEMA 55 provides commentary type language on the need to protect the building from glass breakage to prevent water damage, the importance of window selection to reduce water infiltration, and the need for shutters to protect against wave and wind action. SFM does not address protection of openings.

Recommendation: None.

FEMA 55	SFM	Analysis
4.3.7.3 Gable and Eave Vents (Page 4-54)	801.3	FEMA 55 addresses the vulnerability of vents to wind and wind-driven rain and emphasizes the importance for the careful selection of attic ventilators in order to assure that they will withstand the wind loads. SFM does require all components to be securely fastened and interconnected to resist the loads anticipated during flooding.

Recommendation: None.

FEMA 55	SFM	Analysis
4.3.7.4 Roofing Materials (Page 4-54)	801.3	FEMA 55 emphasizes the need to use self-sealing, heavyweight shingles to avoid the possible loss of roofing materials in high winds. SFM requires all components including roofs and sheathing to be securely fastened and adequately interconnected to resist the loads anticipated during flooding.

Recommendation: None.

FEMA 55	SFM	Analysis
4.3.8 Maintenance (Pages 4-54, 4-55)	N/A	FEMA 55 emphasizes the need for maintenance of all parts of buildings exposed to coastal environment because of the accelerated deterioration. SFM does not address maintenance of building components.

Recommendation: None.

FEMA 55	SFM	Analysis
5.1 General Design Considerations (Pages 5-1, 5-2)	801	FEMA 55 prohibits enclosure for habitation at grade beneath mid-rise and high-rise structures. Nonessential enclosures such as entrances, lobbies, parking areas, and storage areas must have breakaway walls. SFM requires the space below the lowest floor either free of obstruction or constructed with breakaway walls. FEMA 55 requires thicker concrete cover over reinforcing steel to provide added corrosion protection of the reinforcing steel. SFM does not address corrosion protection. FEMA 55 addresses the need to design for wind and water forces. SFM requires the building to be anchored to resist flotation, collapse, and lateral movement due to the effects and water loading.

Recommendation: FEMA 55 should address snow and seismic loads.

FEMA 55	SFM	Analysis
5.2 Foundations (Page 5-2)	801.1	FEMA 55 emphasizes the need for pile foundations that are embedded deeply to provide a safety margin against scour. SFM refers to Chapter 13 of the Standard Building Code for pile system design and installation with emphasis on embedment depth to take into account reduced capacity caused by scour. SFM prohibits the use of mat or raft foundations where soil materials are subject to scour and erosion from wave velocity conditions. FEMA 55 permits strip footings and mat foundations in zones of reduced velocity and wave action. FEMA 55 lists common types of piles and shows typical pile/pile cap/column/grade beam details.

Recommendation: None.

FEMA 55	SFM	Analysis
5.3 Slabs at Grade (Pages 5-3, 5-4)	801.1	FEMA 55 requires the slab supported on the soil to be a minimum of 4 inches thick with minimal reinforcing in the form of welded wire fabric. SFM does not address minimum thickness of slabs at grade. FEMA 55 addresses the use of designed slabs and grade beams to laterally support the pile foundation system. SFM refers to Chapter 13 of the Standard Building Code for pile system design and installation.

Recommendation: None.

FEMA 55	SFM	Analysis
5.4 Superstructure 5.5 Elevated Floors (Pages 5-4 to 5-8)	N/A	FEMA 55 provides commentary type language and typical details of the superstructure of a building which includes columns, beams, slabs, and shear walls. FEMA 55 provides commentary type language for elevated concrete floors. SFM is a performance standard and not a commentary.

Recommendation: None.

FEMA 55	SFM	Analysis
5.6 Exterior Wall Systems (Pages 5-8, 5-9)	801.3	FEMA 55 provides commentary type language on exterior wall systems of masonry or metal studs and the fastening method of the walls. FEMA 55 requires the walls to be designed to resist the lateral forces encountered. SFM requires all components of the building to be securely fastened and adequately interconnected to resist the loads anticipated during flooding.

Recommendation: None since both require the walls to be designed for the lateral forces encountered, however FEMA 55 should address seismic loads.

FEMA 55	SFM	Analysis
5.7 Recommendations (Page 5-9)	401.3	FEMA 55 requires mid-rise and high-rise structures to be designed by a "design professional". SFM requires buildings in coastal high hazard areas to be certified that it is designed to withstand velocity waters, wave action, and wind loadings.

Recommendation: None since both require a design professional.

FEMA 55	SFM	Analysis
Appendix A Design Tables	401.3	FEMA 55 provides design tables. SFM is a performance standard and not a specification code.
Figure A-1 number of piles required	801	
Table A-1 downward loads per pile		
Table A-2 horizontal wind loads per pile in 80 mph winds		
Table A-3 minimum embedment depth of piles		
Table A-4 maximum unbraced height of piles in 80 mph winds and flood forces		
Table A-4.1 maximum unbraced height of piles supporting breakaway walls		
Table A-5 uplift loads per foot of wall in 80 mph winds		
Table A-6 uplift loads per pile in 80 mph winds		
Table A-7 capacity per bolt of floor beam connections		
Table A-8 concrete masonry unit piers		
Table A-9 concrete piers		
Figure A-2 concrete pier cross section		
Figure A-3 grade beams and slabs		
Table A-10 fastener capacities in shear		
Table A-11 fastener schedule for breakaway walls		
(Pages A-1 to A-47)		

Recommendation: None.

FEMA 55	SFM	Analysis
Appendix B - Bracing	401.3	FEMA 55 provides various recommendations and details for bracing methods. SFM is a performance standard and not a specification type code.
B.1 knee bracing	801	
B.2 truss bracing		
B.2.1 diagonals		
B.2.1.1 lumber diagonals		
B.2.1.2 threadbar diagonals		
B.2.2 struts		
B.3 grade beams		
Table B-1 horizontal water loads per pile in 80 mph winds		
Table B-2 loads of transverse truss members		
Table B-3 allowable loads for single 2x8 diagonals		
Table B-4 allowable loads for single 3x8 diagonals		
(Pages B-1 to B-15)		

Recommendation: None.

FEMA 55	SFM	Analysis
Appendix D - Design Equations and Procedures D.1 Procedure A-1: downward loads per pile D.2 Procedure A-2: horizontal wind loads per pile D.3 Procedure A-3: minimum embedment depth of piles D.4 Procedure A-4: maximum unbraced height of piles D.5 Procedure A-4.1: maximum unbraced height of piles supporting breakaway walls D.6 Procedure A-5: uplift loads per foot of walls D.7 Procedure A-6: uplift loads per pile D.8 Procedure B-1: horizontal water loads per pile D.9 Procedure B-2: loads transferred to foundation truss members (Pages D-1 to D-32)	N/A	FEMA 55 contains design equations and procedures which are needed to evaluate individual designs. SFM is a performance standard with design being based on good engineering practice.

Recommendation: None.

FEMA 55	SFM	Analysis
G-2 Purpose (Page G-1)	100.1	The purpose of both FEMA 55 and SFM is to minimize losses due to flood conditions in specific areas through the establishment of comprehensive regulations for floodplain management.

Recommendation: None.

FEMA 55	SFM	Analysis
G-3 Scope (Page G-2)	100.1 102.1	Both FEMA 55 and SFM apply to new construction and additions to existing structures.

Recommendation: None.

FEMA 55	SFM	Analysis
G-4 Definitions (Pages G-2, G-3)	202	The definition of base flood elevation, breakaway wall, and coastal high hazard area appear in both FEMA 55 and SFM. FEMA 55 contains design type definitions (dead load, live load, pile cluster, piling foundation, and uplift pressure.) SFM contains floodplain management type definitions (area of shallowing flooding, flood, flood hazard boundary map, flood insurance rate map, floodproofing, lowest floor, storm water detention, etc.)

Recommendation: None.

FEMA 55	SFM	Analysis
G-5 Elevation Standards (Page G-3)	600.1 602.1.1 800.2 801.1 801.6	FEMA 55 prohibits new construction or substantial improvements from being seaward of an established setback line and requires it to be elevated above the BFE. SFM requires the lowest portion of the horizontal members of the lowest floor to be elevated above the BFE and new construction be located landward of the reach of the mean high tide.

Recommendation: None.

FEMA 55	SFM	Analysis
G-6 Determination of Loading Forces G-6.1 Water Loads G-6.2 Wind Loads (Page G-3)	401.3 801.1	Both BEMA 55 and SFM require the structure to be designed to withstand velocity waters, wave action, and wind loadings. FEMA 55 references ANSI A58.1-1982 for the wind load provisions. SFM references 1205 of the Standard Building Code which contains a basic wind speed map, use factors, velocity pressures, and coefficients for wind design in addition to referencing ASCE 7-88.

Recommendation: FEMA 55 should update its reference ASCE 7-88.

FEMA 55	SFM	Analysis
G-7 Foundation Standards G-7.1 Pile Foundation Design G-7.2 Column Foundation Design (Pages G-4, G-5)	401.3 801.1	Both FEMA 55 and SFM require the foundations to be designed to resist the combined wave and wind loads which they are likely to be subjected during a flood. FEMA 55 contains minimum and maximum pile spacing, minimum embedment length, dimensional requirements for wood piles, minimum compressive strength for concrete piles, and methods of bracing piles. SFM refers to Chapter 13 for pile system design and installation.

Recommendation: None.

FEMA 55	SFM	Analysis
G-8 Anchoring Standards G-8.1 Connector and Fasteners G-8.2 Beam to Pile Connections G-8.3 Floor to Deck Connections G-8.4 Exterior Wall Connections G-8.5 Ceiling Joist/Rafter Connections G-8.6 Projecting Members (Pages G-5, G-6)	601.1 801.1 801.3	Both FEMA 55 and SFM all components to be securely fastened and adequately interconnected to resist the loads anticipated during flooding. FEMA 55 requires corrosion protection for connectors in exposed locations. SFM does not address corrosion protection.

Recommendation: SFM should address corrosion protection of metal connectors.

FEMA 55	SFM	Analysis
G-9 Roof Sheathing (Pages G-6, G-7)	801.3	FEMA 55 provides the minimum thickness of roof sheathing, requires corrosion resistant fasteners, requires the application of waterproof industrial adhesive to all bearing surfaces of plywood used in the sheathing of corners, gable end, or roof overhang, and provides commentary language addressing roof slopes. SFM requires all components including roofs and sheathing to be securely fastened and adequately interconnected to resist the loads anticipated during flooding.

Recommendation: None.

FEMA 55	SFM	Analysis
G-10 Protection of Openings (Page G-7)	801.1	FEMA 55 requires openings to be constructed to withstand loads due to the design windspeed. SFM does not address protection of openings. SFM refers to 1205 of the Standard Building Code which requires the openings to be designed as components and cladding.

Recommendation: None.

FEMA 55	SFM	Analysis
G-11 Use of Space Below the Lowest Elevated Floor G-11.1 Breakaway Wall Design Standards G-11.2 Certification of Breakaway Walls (Pages G-7, G-8)	801.4	Both FEMA 55 and SFM permits breakaway walls to enclose the space below the lowest elevated floor and provides the design loading for the breakaway walls.

Recommendation: None.

FEMA 55	SFM	Analysis
G-12 Utilities (Page G-8)	602.5	FEMA 55 requires the utilities to be elevated above the BFE and backflow valves for combined sanitary sewer and storm drainage systems which have openings below the BFE. SFM requires the utilities to be designed and located so as to be protected from flooding and to minimize the chance of impairment during flooding.

Recommendation: None.

FEMA 55	SFM	Analysis
G-13 Certification of Requirements (Page G-8)	401.3 801.7	FEMA 55 requires new and substantial improvements which do not comply with sections 7 and 8 of this Coastal Code to be designed by a registered professional engineer or architect. SFM requires certification from a registered professional engineer or architect that the building is designed to withstand velocity waters, wave action, and wind loadings.

Recommendation: FEMA 55 should provide parameters for which sections 7 and 8 are appropriate (wind load, height above grade, etc.)

FEMA 55	SFM	Analysis
G-14 Reference Documents (Page G-8)	Chapter 11	FEMA 55 references ANSI A58.1-1982 and Shore Protection Manual by the Department of the Army. SFM references FEMA 15, FEMA 54, FEMA 55, FEMA 85, FEMA 104, and EP 1165 2 314.

Recommendation: FEMA 55 should update reference to ASCE 7-88.

STANDARD FOR FLOODPLAIN MANAGEMENT (SFM) COMPARISON

The Standard for Floodplain Management contains provisions which are unique to floodplain management and does not contain provisions for conventional construction contained in the Standard Codes.

Manufactured Home Installation In Flood Hazard Areas (FEMA 85)

Chapter III Elevation and Anchoring Techniques

FEMA 85	SFM	Analysis
Elevation and Anchoring Techniques (Page 19)	600, 601, 603, 604	FEMA 85 provides general techniques which are used to elevate a manufactured home in riverine or coastal flooding areas. SFM requires the manufactured home to be elevated and anchored to resist flotation, collapse or lateral movement.

Recommendation: None since FEMA 85 contains prescriptive type requirements and SFM is a performance type standard.

FEMA 85	SFM	Analysis
Elevation on Fill (Pages 19-20).	600, 601, 603 801.5	FEMA 85 provides commentary and prescriptive type language on the use of earth fill to elevate a manufactured home. FEMA 85 prohibits the use of fill material in areas subject to floodwaters having a velocity greater than 10 fps and where it will constrict the flow of floodwaters and cause increased flood elevations or velocity. SFM requires the manufactured home to be elevated and anchored to resist flotation, collapse or lateral movement. SFM does not permit the placement of manufactured homes in designated floodway or coastal high hazard areas. SFM prohibits the use of fill material for structural support in coastal high hazard areas.

Recommendation: None since FEMA 85 contains prescriptive type requirements and SFM is a performance type standard.

FEMA 85	SFM	Analysis
Elevated Foundations (Pages 21-28)	600, 601, 603	FEMA 85 addresses structural techniques, such as piers, posts, piles, and similar structural arrangements to elevate a manufactured home above the flood level. FEMA 85 provides prescriptive requirements for these structural techniques. SFM requires the manufactured home to be elevated and anchored to resist flotation, collapse, or lateral movement.

Recommendation: None since FEMA 85 contains prescriptive requirements and SFM is a performance type standard.

FEMA 85	SFM	Analysis
Anchoring (Pages 29-31)	601, 603.1	Both FEMA 85 and SFM require the manufactured home to be anchored to resist flotation, collapse, or lateral movement. FEMA 85 provides commentary type language and descriptive details. The anchoring requirements of the SFM are in addition to the anchoring requirements provided in Appendix H of the Standard Building Code.

Recommendation: None since FEMA contains prescriptive type requirements and SFM is a performance type standard.

FEMA 85	SFM	Analysis
Chapter IV Design of Elevated Foundations (Pages 33-70)	601, 602.5, 603, 801.1	FEMA 85 presents an overview of flood-induced loads, tables of calculated forces, governing design equations, and specific technical information which can be used to determine an appropriate elevated design for a manufactured home with the manufactured home complying with HUD's MHCSS. FEMA 85 provides design procedures, tables, and details needed to design bracing and connections. SFM requires the manufactured home to be elevated and anchored to resist flotation, collapse or lateral movement. SFM references 1205 of the Standard Building Code for the design wind load values. FEMA 85 addresses the set-up (jacking), utility service, mechanical systems, and access/egress during flooding around the manufactured home. SFM requires the utilities to be designed and located so as to prevent water from entering the components to minimize the chance of impairment during flooding.

Recommendation: FEMA 85 and HUD's MHCSS should update its reference to wind and snow loads for ASCE 7-88.

FEMA 85	SFM	Analysis
Appendix D - Calculational Procedures for Elevated Foundations Design (Pages 89-97)	N/A	FEMA 85 contains actual design procedures and formulas which were used as a basis of the manual. SFM is a performance type standard and does not contain engineering analysis procedures.

Recommendation: None.

FEMA 85	SFM	Analysis
Appendix E - Buoyancy and Drag Forces (Pages 99-101)	603.1	FEMA 85 addresses the forces from buoyancy and drag caused by the flood waters. FEMA 85 contains design tables for vertical tie forces based on home width and water depth. SFM requires the home to be anchored to resist flotation, collapse, or lateral movement.

Recommendation: None since FEMA 85 contains prescriptive type requirements and SFM is a performance type standard.

STANDARD FOR FLOODPLAIN MANAGEMENT (SFM) COMPARISON

The Standard for Floodplain Management contains provisions which are unique to floodplain management and does not contain provisions for conventional construction contained in the Standard Codes.

Floodproofing Non-Residential Structure (FEMA 102)

FEMA 102	SFM	Analysis
Chapter I Introduction I.E. Contingent Floodproofing Measures I.F.1. Flood Shields I.F.2. Watertight Doors I.F.3. Moveable Floodwalls (Pages 8-13)	Chapter 9	FEMA 102 addresses the use of contingent floodproofing measures that require some type of installation, activation, or other preparation immediately prior to the occurrence of a flood. These measures include flood shields, watertight doors, and moveable floodwalls. SFM does not specifically address contingent floodproofing measures but addresses floodproofing measures in general (watertight doors, bulkheads, shutters, reinforcement of walls to resist water pressures, etc.)

Recommendation: None.

Chapter III Floodproofing Design Permanent and Contingent Measures

FEMA 102	SFM	Analysis
III.B. Elevation on Fill (Pages 37-38)	602 801	FEMA 102 addresses the use of fill material to elevate the building to protect it from flood damages. FEMA 102 contains commentary type language on the design and maintenance of the fill material. SFM requires buildings within the special flood hazard area to be elevated so that the lowest horizontal structural member is elevated above the base flood elevation, but does not address the method. SFM requires buildings within the coastal high hazard area to be elevated on piles and prohibits the building from being elevated on fill material so that the lowest horizontal structural member is elevated above the base flood elevation.

Recommendation: None since FEMA 102 and SFM require the building to be elevated.

FEMA 102	SFM	Analysis
III.C. Elevation on Posts, Piles, Piers, or Walls III.C.2. Posts III.C.3. Piles III.C.4. Piers and Walls Table III-1 Minimum Requirements for Reinforced Piers III.C.6. Maintenance (Pages 39-47)	801.1	FEMA 102 addresses the elevation of buildings on "post" foundations by showing details and design charts. FEMA 102 addresses the elevation of buildings on piles by describing the general length, maximum design load, application, advantages, disadvantages, typical elevation, and typical cross section. FEMA 102 provides details of piers (brick, reinforced concrete, reinforced masonry). FEMA 102 addresses the need to perform maintenance on posts, piles, piers, or walls based on the frequency of flooding. SFM requires buildings to be elevated on pilings or columns so that the lowest horizontal structural member is elevated above the base flood elevation. SFM references Chapter 13 of the Standard Building Code for pile system design and installation. SFM does not provide details. SFM does not address maintenance of the foundation system.

Recommendation: None since FEMA 102 contains prescriptive type requirements and SFM contains performance type requirements.

FEMA 102	SFM	Analysis
III.D. Waterproof Construction III.D.1 Introduction III.D.2 Wall Strength III.D.3 Floor Strength and Structural Stability III.D.4 Counteracting of Hydrostatic Forces III.D.5 Waterproofing III.D.6 Watertight Cores III.D.7 Closures and Flood Shields (Pages 48-72)	900.3 900.4	FEMA 102 addresses floodproofing of the building to prevent floodwaters from reaching the interior; the use of a concrete slab or impervious cutoffs, or subsurface drainage to resist the hydrostatic uplift pressures, the use of impermeable membranes, the use of "watertight cores" around expensive items which are located together and the use of closures and flood shields to protect against floodwater intrusion. SFM addresses the same techniques of floodproofing.

Recommendation: None.

FEMA 102	SFM	Analysis
III.E. Floodwalls and Levees III.E.5 Floodwall Design III.E.7 Floodwall Maintenance (Pages 80-85, 88)	900.4	FEMA 102 provides commentary type language on different types of floodwalls (permanent floodwalls, gravity walls, cantilever walls, and moveable walls) and annual inspection of the floodwalls. SFM permits the use of bulkheads as a form of floodproofing but does not address different types of bulkheads or annual inspection.

Recommendation: None since both FEMA 102 and SFM address floodwalls (bulkheads).

FEMA 102	SFM	Analysis
IV. Other Floodproofing Measures IV.C. Floodproofing Utilities (Pages 99-104)	602.5	Both FEMA 102 and SFM require utilities to be designed and located so as to prevent water from entering or accumulating within the components and to minimize the chance of impairment during flooding.

Recommendation: None.

FEMA 102	SFM	Analysis
Appendix B Glossary (Pages 161-166)	202	Both FEMA 102 and SFM contain some of the same definitions and some different definitions. The definitions are appropriate for each document.

Recommendation: None.

FEMA 102	SFM	Analysis
Appendix D Floodproofing Performance Criteria Appendix D.B Design Loads Appendix D.C Performance Criteria (Pages 182-193)	900.4	FEMA 102 provides a list of the types of loads (dead load, wind loads, floodwater loads, flood impact loads, soil loads, etc.). FEMA 102 contains performance criteria which represents the objectives that should be achieved in the design of floodproofed nonresidential structures and service systems. SFM requires the floodproofing measures to be designed consistent with the flood protection elevation for the particular area, flood velocities, durations, rate of rise, hydrostatic and hydrodynamic forces, and other factors associated with the base flood.

Recommendation: None since the final results are the same.

STANDARD FOR FLOODPLAIN MANAGEMENT (SFM) COMPARISON

The Standard for Floodplain Management contains provisions which are unique to floodplain management and does not contain provisions for conventional construction contained in the Standard Codes.

Retrofitting Flood-Prone Residential Structures (FEMA 114)

FEMA 114	SFM	Analysis
3.5 Elevation Onto Extended Foundation Walls (Pages 46-49)	602.1 801.1	FEMA 114 addresses the method of elevating the structure by increasing the foundation wall height. SFM requires the elevation of the lowest structural member of the lowest floor to be above the base flood level but does not specifically address "extended foundation walls."

Recommendation: None since both FEMA 114 and SFM address the need to have the lowest structural member of the lowest floor above the base flood level.

FEMA 114	SFM	Analysis
3.12 Technical Design Criteria Extended Wall Foundation (Pages 61-63)	601.1 801.1 801.3	FEMA 114 requires the foundation system with the increased foundation wall height to be of sufficient strength to support the loads and forces encountered. SFM does not specifically address "extended foundation walls" but does require the foundations to be adequate to resist the combined wave and wind loads to which they are likely to be subjected during a flood.

Recommendation: None.

FEMA 114	SFM	Analysis
3.13 Technical Design Criteria Anchorage of Superstructure to Foundation (Pages 63-67)	401.3 601.1 801.3	FEMA 114 provides design details for the anchorage of the superstructure to the foundation system. SFM requires the structural system to be designed, connected and anchored to prevent flotation, collapse and permanent lateral movement due to flooding.

Recommendation: None since FEMA 114 contains prescriptive type requirements and SFM contains performance type requirements.

FEMA 114	SFM	Analysis
3.14 Technical Design Criteria Open Foundations (Pages 67, 68)	801.1	FEMA 114 describes three types of open foundations (piers, columns, or piles) and requires them to be designed for the loads encountered. SFM requires the foundations to be adequate to resist the combined wave and wind loads to which they are likely to be subjected during a flood. SFM refers to Chapter 13 of the Standard Building Code for pile system design and installation.

Recommendation: FEMA 114 should address seismic loads.

FEMA 114	SFM	Analysis
Chapter 6 Floodwalls 6.2 Considerations 6.3 Construction Techniques and Materials 6.5 Technical Design Criteria (Pages 111-119, 121-129)	900.4	FEMA 114 addresses the use of floodwalls to protect structures from flooding and emphasizes that tremendous forces are created by high water levels and velocities, techniques and types of materials for the construction of floodwalls, and design criteria. SFM does not address construction materials or design criteria for floodwalls, but does require the floodproofing measures to be designed for the flood velocities, hydrostatic and hydrodynamic forces, and other factors associated with the base flood.

Recommendation: None.

FEMA 114	SFM	Analysis
Chapter 7 Closures 7.2 Considerations 7.3 Low Profile Permanent Closures 7.4 Closure Materials and Construction 7.6 Technical Design Criteria (Pages 133-142)	900.4	FEMA 114 addresses the use of closures (covering openings such as doors, windows, driveways, etc.) to act as shields to prevent water away from or entering residence. SFM addresses the use of watertight doors, bulkheads, and shutters, or similar methods of construction.

Recommendation: None.

FEMA 114	SFM	Analysis
Chapter 8 Sealants 8.2 Considerations 8.3 Sealing Techniques 8.4 Closures 8.5 Design Details 8.7 Technical Design Criteria (Pages 145-156)	900.3 900.4	FEMA 114 addresses the sealing, making watertight, or dry floodproofing of the structure to prevent the entry of water during low level flooding. SFM permits buildings, except residential, to be floodproofed with walls which are impermeable to the passage of water below the base flood level. SFM requires the floodproofing measures to be designed consistent with the flood protection elevation for the particular area, flood velocities, durations, rate of rise, hydrostatic and hydrodynamic forces and other factors associated with the base flood.

Recommendation: None, since floodproofing of basements is allowed only in communities that have been granted an exception by FEMA.

FEMA 114	SFM	Analysis
Chapter 9 Protection of Utilities 9.4 Permanent Protective Measures 9.5 Utility Relocations to Existing Space 9.6 Utility Relocations to New Space (Pages 160-165)	602.4 602.5	FEMA 114 addresses permanent protection of utilities by shielding or elevating the utility. SFM requires the utilities to be designed to prevent water from entering or accumulating with the components and to minimize the chance of impairment during flooding.

Recommendation: None.

FEMA 114	SFM	Analysis
9.8 Storage Tank Storage (Page 166)	N/A	FEMA 114 addresses the need for proper anchorage of tanks to prevent their flotation from the buoyancy forces. SFM does not address anchorage of storage tanks.

Recommendation: SFM should address anchorage of storage tanks.

FEMA 114	SFM	Analysis
10.4 Floating Structures (Pages 176-177)	N/A	FEMA 114 permits "floating structures" as a method of floodproofing. SFM does not address "floating structures."

Recommendation: None.

FEMA 114	SFM	Analysis
Appendix C - Forces (Pages 197-207)	401.3, 601.1, 801	FEMA 114 addresses hydrostatic loads, hydrodynamic loads, impact loads, and wind loads. FEMA 114 also provides definitions, application and methodology for design. SFM requires the design to be designed, connected and anchored to present flotation, collapse and permanent lateral movement due to the effects of wind and water forces. SFM refers to 1205 of the Standard Building Code for the design wind loading.

Recommendation: FEMA 114 should update the wind speed maps to the latest edition and address snow and seismic loads.

STANDARD FOR FLOODPLAIN MANAGEMENT (SFM) COMPARISON

The Standard for Floodplain Management contains provisions which are unique to floodplain management and does not contain provisions for conventional construction contained in the Standard Codes.

Alluvial Fans: Hazards and Management (FEMA 165)

FEMA 165	SFM	Analysis
Window and Doors (Page 10)	N/A	FEMA 165 prohibits openings on the uphill side of the structure to prevent debris and flood water from entering the building. SFM does not address the location of openings; however, it does address the installation of watertight doors, bulkheads, and shutters on similar methods of construction to floodproof the building.

Recommendation: None.

STANDARD FOR FLOODPLAIN MANAGEMENT (SFM) COMPARISON

The Standard for Floodplain Management contains provisions which are unique to floodplain management and does not contain provisions for conventional construction contained in the Standard Codes.

Manual for the Construction of Residential Basements in Non-Coastal Flood Environs (MCRB)

Chapter III Basement Construction

MCRB	SFM	Analysis
III.A. Construction Types-Walls (Pages 13-19)	N/A	MCRB provides commentary and prescriptive type language for minimum thickness, reinforcing, and resistance to lateral loads of masonry and concrete walls. MCRB also addresses stone and wood foundations, excavation and backfilling, and concrete formwork. SFM does not address types of wall construction. This is addressed in Chapters 13, 14, and 16 of the SBCCI Standard Building Code.

Recommendation: None.

B. Other Construction Features

MCRB	SFM	Analysis
III.B.1 Basement Slab III.B.2 Structural Basement Slab III.B.3 Footing (Foundation) III.B.4 Underdrain System - Sumps and Pumps III.B.5.a Ground Surface Slope - Site Investigation III.B.5.b Ground Surface Slope - Grading and Surface Drainage III.B.6 Seepage Quantities III.B.7.a Penetrations, Cracks, Joints, and "Waterproofing" - Utility III.B.7.b Penetrations, Cracks, Joints, and "Waterproofing" - Techniques that Lessen Cracking in Concrete (Pages 19-34)	N/A	MCRB contains commentary and prescriptive type language for basement slabs (minimum thickness and reinforcing), footing size, sumps and pumps, soils investigation, grading of lot, flow net analysis, penetrations through waterproofed walls, and crack control of concrete. This is addressed in Chapter 13 and 16 of the SBCCI Standard Building Code.

Recommendation: None.

MCRB	SFM	Analysis
III.B.7.c Penetrations, Cracks, Joints, and "Waterproofing" - "Waterproofing" Basements (Pages 34, 35)	Chapter 9	Both MCRB and SFM address "Waterproofing" as a method of protecting the basement of residential structures. SFM does not permit floodproofing of the basement of residential structures. Methods of waterproofing are addressed in 1312 of the SBCCI Standard Building Code.

Recommendation: None, since floodproofing of basements is allowed only in communities that have been granted an exception by FEMA.

MCRB	SFM	Analysis
III.B.8 Plumbing Subsystems (Pages 35, 36)	602.5 602.6 602.7	MCRB requires gate valves on the sanitary sewer outlets from the house and the potable water supply system to be designed in such a manner to prevent contamination from flood waters. SFM requires the plumbing systems to be designed and located to minimize the chance of impairment during flooding. SFM requires water supply systems to be designed to minimize infiltration of flood waters into the system and the sewage system to be designed to minimize discharge from the system into flood waters.

Recommendation: None.

MCRB	SFM	Analysis
III.B.9 Anchorage (Pages 36, 37)	601.1	MCRB provides calculations to determine the anchorage requirements. MCRB requires a minimum of 1/2 inch anchor bolts spaced a maximum of 8 ft anchored into 2 block courses or 16 inches with a minimum of 2 bolts per plate. SFM simply requires the structural systems to be designed, connected and anchored to prevent flotation, collapse, and permanent lateral movement due to flooding.

Recommendation: None.

MCRB	SFM	Analysis
III.B.10 Some Concrete Construction Practices III.B.11 Some Block Construction Practices III.C. Loads III.C.1 Soil III.C.2 Water Table (Pages 37-63)	N/A	MCRB contains commentary type language for handling and depositing concrete, consolidating concrete, cold weather considerations, additives, placing reinforcement, etc.; for improving the waterproofing quality of concrete masonry walls; for determination of soil types; for erosion control; for lateral pressures exerted from backfill material; and for the water table. SFM does not address construction practices, erosion control, soil types, or water table.

Recommendation: None.

MCRB	SFM	Analysis
III.C. Loads III.C.3 Superstructure Loads and Buoyancy III.C.4.d Flood Waters - Velocity III.C.4.e Flood Waters - Sediment III.C.4.f Flood Waters - Rate of Rise III.C.4.g Flood Waters - Hydraulic/ Hydrologic Relations (Pages 63-75)	601.1 900.3	MCRB contains sample calculations to determine the superstructure loads imposed by buoyancy. MCRB provides commentary type language addressing increased structural damage which may result from the high velocity of flood waters, floodwater deposited sediment, and the rate of rise of flood water causing unequal loading on basement walls. MCRB references a separate Hydraulic/Hydrologic manual which could be used to evaluate a site. SFM requires the structural systems to be designed, connected and anchored to prevent flotation, collapse and permanent lateral movement due to flooding. SFM requires the floodproofing measures to be designed consistent with the flood protection elevation for the particular area, flood velocities, durations, rate of rise, hydrostatic and hydrodynamic forces, and other factors associated with the base flood.

Recommendation: None.

MCRB	SFM	Analysis
III.C. Loads III.C.5 Debris, Wind Impact, Snow, Ice, and Other Live Loads. (Page 75)	601.1	MCRB states that other than debris and impact loads; wind, snow, and ice are not considered to alter the designs in the MCRB. SFM requires the structural system to be designed, connected and anchored to prevent flotation, collapse and permanent lateral movement due to flooding.

Recommendation: MCRB should include wind, snow, and seismic loads.

Chapter V Basements in Floods

MCRB	SFM	Analysis
A. Structural Design/Analysis A.2 Designs, Methods, and Tables A.2.a Building Model, Dimensions, and Loading A.2.b Structural Analysis Model (Wall) A.2.c Structural Plain Concrete A.2.d Reinforced Concrete A.2.e Plain Masonry Block A.2.f Reinforced Masonry Block A.2.g Flood Waters Above Grade A.2.h Slab Thickness (Based on Bending) A.2.i Structural Slab Design (Ultimate Strength Design) (Pages 88-114)	N/A	MCRB contains sample structural calculations. MCRB refers to the UBC in V.A.2.e and V.A.2.f. SFM does not provide sample calculations.

Recommendation: MCRB should not reference a single model code. MCRB should reference only national consensus documents.

MCRB	SFM	Analysis
B. Soil/Water Load Philosophy B.1 Weir Level Load B.2 Buoyancy B.3 Slab Bending B.4 Wall Loads B.5 Clay vs. Sand or Drain and Sump vs. Sealed "Barge" B.5.a Drained or Sump System B.5.b Undrained or Barge System (Pages 114-126)	N/A	MCRB contains commentary type language addressing the design philosophy of the lateral pressures exerted by soil and/or water loadings. SFM is not a commentary and does not address philosophy.

Recommendation: None.

VII. Appendices

MCRB	SFM	Analysis
Appendix A - Soils Data Allowable Bearing Pressures Allowable Soil Pressures Beneath Footings (Pages 164, 166)	N/A	MCRB contains allowable bearing pressures for various soil types. SFM is a performance code.

Recommendation: None.

MCRB	SFM	Analysis
VIII Builder's Guide A. Introduction A.2.a Soil and Water Loading on Wall Cross-Section (Page 198) A.2.c "Waterproofing" System (Page 206) A.2.d Wall Design (Page 209) A.2.e Slab Design (Page 211) B. Acceptable Wall Designs B.1 Structural Plain Concrete (Unreinforced) B.2 Reinforced Concrete B.3 Unreinforced Masonry Block B.4 Reinforced Masonry Block B.5 Buoyancy Wall (Pages 212-239) C. Acceptable Slab Designs (Pages 240-246) D. Acceptable Control Joint Design, Underdrain, and "Waterproofing" and Seals D.1 Overview and Control Joints D.2 Sump, Pump, and Underdrain (for Drained System) D.3 "Waterproofing" and Seals D.3.a Undrained Slab and Wall System D.3.b Drained Slab and Wall System D.3.c Slab/Wall/Footing Juncture (Pages 247-262)	N/A	MCRB contains details and design charts for wall design, slab design, control joints, sumps, and/or waterproofing. SFM is a performance code and does not contain details or design charts.

Recommendation: None.

MCRB	SFM	Analysis
Hydraulic/Hydrologic Manual I. Introduction I.B. Flood Waters I.B.4 Velocity I.B.5 Sediment (Pages 7-9)	601.1 900.3	MCRB contains commentary type language addressing increased structural damage which may result from the high velocity of floodwaters and floodwater deposited sediment. SFM is a performance code and does not contain commentary. SFM requires the structural systems to be designed, connected and anchored to prevent flotation, collapse and permanent lateral movement due to flooding. SFM requires the floodproofing measures to be designed consistent with the flood protection elevation for the particular area, flood velocities, durations, rate of rise, hydrostatic and hydrodynamic forces, and other factors associated with the base flood.

Recommendation: None.

STANDARD FOR FLOODPLAIN MANAGEMENT (SFM) COMPARISON

The Standard for Floodplain Management contains provisions which are unique to floodplain management and does not contain provisions for conventional construction contained in the Standard Codes.

Technical Standard Bulletin: Wet Floodproofing, No. 85-1

No. 85-1	SFM	Analysis
I. Definition (Page 1)	602.2	No. 85-1 provides a definition of wet floodproofing and explains the justification for this type of floodproofing. SFM does not address wet floodproofing but does address foundation wall openings to allow for the entry and exit of floodwaters to automatically equalize hydrostatic flood forces on exterior walls; however, only breakaway walls are permitted in coastal high hazard areas.

Recommendation: None.

No. 85-1	SFM	Analysis
II. Protection Goals (Page 2)	N/A	No. 85-1 explains that wet floodproofing consists of protection of the structure, protection of interior finishes, protection of mechanical and electrical systems, protection of major equipment and machinery, and protection of contents. SFM does not address wet floodproofing as a method of floodproofing.

Recommendation: None.

No. 85-1	SFM	Analysis
III.B. Structural Features (Pages 4, 5)	900.4	No. 85-1 addresses the superstructure materials as far as their durability, resistance to flood forces, resistance to the deterioration caused by floodwaters, and water resistance. SFM does not address building materials.

Recommendation: None.

No. 85-1	SFM	Analysis
III.C. Building Activity and Use (Page 5-6)	900.3	No. 85-1 addresses the need to determine the feasibility of wet floodproofing based on activity and use. SFM does not address wet floodproofing. SFM addresses the building when floodproofing walls below the base flood level is used.

Recommendation: None.

No. 85-1	SFM	Analysis
IV.A.1 Foundations (Page 6)	801.1 900.4	No. 85-1 emphasizes the importance of the need to investigate the influence of hydrologic and hydraulic conditions on the foundation design when wet floodproofing is used. SFM requires the floodproofing measures to be designed for the flood velocities, durations, rate of rise, hydrostatic and hydrodynamic forces, and other factors associated with the base flood.

Recommendation: None.

No. 85-1	SFM	Analysis
III.A.2 Cavity Wall Construction (Pages 6-7)	N/A	No. 85-1 addresses the need to drain the cavity space at a rate approximately equal to the flood rate. SFM does not address any specific type of construction.

Recommendation: None.

No. 85-1	SFM	Analysis
IV.A.3 Solid Wall Construction (Pages 7-8)	900.3	No. 85-1 addresses the need for the interior and exterior wall cladding to be relatively impervious to prevent the intrusion of the floodwaters into the wall. SFM requires walls below the base flood level to be substantially impermeable.

Recommendation: None.

No. 85-1	SFM	Analysis
IV.A.4 Interior Walls (Page 8)	N/A	No. 85-1 emphasizes that the criteria for cavity wall and solid wall construction applies to interior walls. See analysis for IV.A.2 and IV.A.3.

Recommendation: None.

No. 85-1	SFM	Analysis
IV.A.5 Interior Wall Finishes (Page 8)	N/A	No. 85-1 addresses the need for the interior finishes to be able to withstand inundation for a minimum of 160 hours without damage, not be subject to deterioration from chemicals in the floodwaters, and capable of being easily cleaned. SFM does not address wall finishes.

Recommendation: **None.**

No. 85-1	SFM	Analysis
IV.A.6 Floors (Pages 8-9)	900.4	No. 85-1 addresses the need for floor systems to be capable of withstanding the hydrostatic pressure generated by a water level differential of two feet between the exterior and interior of the structure. SFM requires the floodproofing measures to be designed for the flood velocities, durations, rate of rise, hydrostatic and hydrodynamic forces, and other factors associated with the base flood.

Recommendation: None.

No. 85-1	SFM	Analysis
IV.A.7 Ceiling and Roofs (Page 9)	N/A	No. 85-1 addresses the need for ceiling materials to be of a type to withstand prolonged exposure to moisture and humidity. SFM does not address exposure to moisture and humidity.

Recommendation: None.

No. 85-1	SFM	Analysis
IV.A.8 Building Envelope Penetrations (Page 10)	900.4	No. 85-1 addresses the need for building penetrations (doors, louvers, vents, skylights, etc.) to be capable of resisting damage for a minimum of 160 hours of inundation, be essentially nonporous, and be conducive to easy cleaning. SFM addresses the installation of watertight doors, bulkheads, and shutters or similar methods of construction. SFM does not address nonporous or easy cleaning material.

Recommendation: None.

No. 85-1	SFM	Analysis
IV.A.9 Electrical System IV.A.10 HVAC (Pages 10-12)	602.5 900.4	No. 85-1 addresses the need to prevent vulnerable electrical components from coming in contact with the floodwaters. No. 85-1 emphasizes that the key protective measures for HVAC equipment is elevation and enclosure. SFM requires all utilities to be designed and located so as to prevent water from entering or accumulating within the components and to minimize the chance of impairment during flooding.

Recommendation: None.

STANDARD FOR FLOODPLAIN MANAGEMENT (SFM) COMPARISON

The Standard for Floodplain Management contains provisions which are unique to floodplain management and does not contain provisions for conventional construction contained in the Standard Codes.

Technical Standards Bulletin: Foundation Wall Openings, No. 85-2

No. 85-2	SFM	Analysis
Flood Forces (Page 1-3)	401.3 801.1 900.3	No. 85-2 provides commentary type language on flood forces, (hydrostatic and hydrodynamic pressure) and formulas to determine these pressures. SFM requires the walls to be designed for the flood velocities, durations, rate of rise, hydrostatic and hydrodynamic forces and other factors associated with the base flood.

Recommendation: None.

No. 85-2	SFM	Analysis
Openings Design Criteria (Pages 4-6)	602.2	No. 85-2 provides design criteria to size the openings (1 sq inch of opening for 1 sq ft of floor area) needed to allow floodwaters in an enclosure for the purpose of equalizing hydrostatic pressures. SFM requires a minimum of two openings having a total net area of no less than 1 sq inch of opening for 1 sq ft of floor area.

Recommendation: None.

STANDARD FOR FLOODPLAIN MANAGEMENT (SFM) COMPARISON

The Standard for Floodplain Management contains provisions which are unique to floodplain management and does not contain provisions for conventional construction contained in the Standard Codes.

Technical Standards Bulletin: Breakaway Walls, No. 85-3

No. 85-3	SFM	Analysis
II. Wind and Water Forces (Pages 2-3)	401.3 801.1 801.3	No. 85-3 addresses wind loads and flood water loads. No. 85-3 references the building codes or ANSI A58.1-1982 for information on wind loads. SFM requires the building to be designed for the wave and wind loads. SFM refers to 1205 of the Standard Building Code for the design wind loads.

Recommendation: No. 85-3 should update reference to ASCE 7-88 and address snow and seismic loads.

No. 85-3	SFM	Analysis
III. Design Approach (Page 4)	801.4	Both No. 85-3 and SFM require the breakaway wall to be designed to withstand at least 10 psf but no more than 20 psf.

Recommendation: None.

No. 85-3	SFM	Analysis
IV. Design Considerations (Pages 4-10)	N/A	No. 85-3 provides commentary type language and details for various types of breakaway walls. SFM does not provide details.

Recommendation: None since No. 85-3 contains specification type requirements and SFM contains performance type requirements.

STANDARD FOR FLOODPLAIN MANAGEMENT (SFM) COMPARISON

The Standard for Floodplain Management contains provisions which are unique to floodplain management and does not contain provisions for conventional construction contained in the Standard Codes.

Technical Standards Bulletin: Wind Design Standards and the NFIP, No. 88-1

No. 88-1	SFM	Analysis
Pages 1-5	801.1	Both No. 88-1 and SFM address wind loads. No. 88-1 contains a reference to ANSI A58.1-1982. SFM references 1205 of the Standard Building Code which contains basic wind speed map, velocity pressure, and coefficients in addition to referencing ASCE 7-88.

Recommendation: No. 88-1 should update reference to ASCE 7-88 and address snow and seismic loads. Section 801.1 of the Standard for Floodplain Management should reference Chapter 12 instead of only 1205 (Wind) to include 1204 (Snow) and 1206 (Seismic).

STANDARD FOR FLOODPLAIN MANAGEMENT (SFM) COMPARISON

The Standard for Floodplain Management contains provisions which are unique to floodplain management and does not contain provisions for conventional construction contained in the Standard Codes.

Technical Standards Bulletin: Flood Resistant Materials, No. 88-2

No. 88-2	SFM	Analysis
Pages 1-7	N/A	No. 88-2 provides data and guidance to determine "materials resistant to flood damage" and how the material should be used to improve the structure's ability to withstand flooding. SFM does not address "flood resistant" materials.

Recommendation: None.

STANDARD FOR FLOODPLAIN MANAGEMENT (SFM) COMPARISON

The Standard for Floodplain Management contains provisions which are unique to floodplain management and does not contain provisions for conventional construction contained in the Standard Codes.

Technical Standards Bulletin: Free of Obstruction Requirements in Coastal High Hazard Areas, No. 88-3

No. 88-3	SFM	Analysis
Lower Area Obstruction (Pages 2-4)	801.4	Both No. 88-3 and SFM prohibits the construction of anything, except breakaway walls, open wood latticework, or insect screening, beneath the lowest horizontal structural member.

Recommendation: None.

No. 88-3	SFM	Analysis
Obstructions Outside the Perimeter of the Coastal Building (Pages 4-6)	401.3 801.1 801.3	No. 88-3 requires structures outside the perimeter of the coastal building to be anchored to resist flotation, collapse, and lateral movement due to the combined effects of wind and water. SFM requires "all structures" in the coastal high hazard area to be anchored to resist flotation, collapse, and permanent lateral movement due to the effects of wind and water loading.

Recommendation: None.

No. 88-3	SFM	Analysis
Obstructions Attached to But Outside the Building Perimeter (Page 6)	401.3 801.1 801.3	No. 88-3 explains that anything attached to the building is considered part of the building and has to meet the same requirements as the building. SFM requires all structures in the coastal high hazard area to be anchored to resist flotation, collapse, permanent lateral movement due to the effects of wind and water loading.

Recommendation: None.

STANDARD FOR FLOODPLAIN MANAGEMENT (SFM) COMPARISON

The Standard for Floodplain Management contains provisions which are unique to floodplain management and does not contain provisions for conventional construction contained in the Standard Codes.

Technical Standards Bulletin: Protection of Elevator Equipment in Flood Hazard Areas, No. 88-4

No. 88-4	SFM	Analysis
Recommendations (Page 3)	602.5 900.4	No. 88-4 recommends that the elevator-related hydraulic equipment and elevator-related electrical equipment be located above the BFE. No. 88-4 recommends that electrical equipment that cannot be placed above the BFE to be of water resistant models. No. 88-4 recommends that the elevator cab automatically stay above flood waters by interlocking the controls with "float" switches in the elevator shaft. SFM does not specifically address elevators but does require all utilities to be designed and located so as to prevent water from entering or accumulating within the components and to minimize the chance of impairment during flooding.

Recommendation: None.

STANDARD FOR FLOODPLAIN MANAGEMENT (SFM) COMPARISON

The Standard for Floodplain Management contains provisions which are unique to floodplain management and does not contain provisions for conventional construction contained in the Standard Codes.

Technical Standards Bulletin: NFIP Requirements for Below Grade Parking Garages in Flood Hazard Areas, No. 90-2.

No. 90-2	SFM	Analysis
Pages 1-4	602.3	No. 90-2 provides a summary of the National Flood Insurance Program (Regulations for Floodplain Management and Flood Hazard identification) requirements for below grade parking garages in flood hazard areas. Both No. 90-2 and SFM require the enclosed area below an elevated building to be used solely for parking of vehicles, limited storage of maintenance equipment used in connection with the premises, and access to the elevated living area.

Recommendation: None.

STANDARD FOR FLOODPLAIN MANAGEMENT (SFM) COMPARISON

The Standard for Floodplain Management contains provisions which are unique to floodplain management and does not contain provisions for conventional construction contained in the Standard Codes.

Technical Standards Bulletin: Non-Residential Floodproofing Certification Requirements of the National Flood Insurance Program, No. 90-3.

No. 90-3	SFM	Analysis
Pages 1-6	401.2	No. 90-3 provides a summary of the National Flood Insurance Program (Regulations for Floodplain Management and Flood Hazard Identification) requirements to obtain certification by floodproofing the non-residential structure. No. 90-3 also provides the forces that the structure would be subjected to when the structure is subjected to the base flood. SFM requires certification from a registered professional engineer or architect that the floodproofing is in accordance with the SFM when floodproofing is utilized on a non-residential building as specified in Chapter 9.

Recommendation: None.

STANDARD FOR FLOODPLAIN MANAGEMENT (SFM) COMPARISON

The Standard for Floodplain Management contains provisions which are unique to floodplain management and does not contain provisions for conventional construction contained in the Standard Codes.

Technical Standards Bulletin: Installation of Manufactured Homes in Special Flood Hazard Areas, No. 90-4.

No. 90-4	SFM	Analysis
Pages 3-19	603	No. 90-4 provides a summary of the National Flood Insurance Program (Regulations for Floodplain Management and Flood Hazard Identification) requirements which affect the placement of manufactured homes in flood hazard areas. SFM requires all manufactured homes located in a special flood hazard area to be elevated above the base flood elevation and anchored to resist flotation, collapse, or lateral movement in addition to the anchoring requirements provided in Appendix H of the Standard Building Code.

Recommendation: None.

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