FEMA-298, 10/92

Code Compatibility Report

Appendices C, D, E, and F

Federal Emergency Management Agency
Federal Insurance Administration

10/92
Volume 3 of 3

APPENDIX C

COMPARISON BETWEEN THE ICBO UNIFORM CODES AND THE NFIP STANDARDS AND TECHNICAL GUIDELINES

TABLE OF CONTENTS

TABLE OF CONTENTS

(Continued)

ICBO UNIFORM BUILDING CODE (U.B.C.) COMPARISON

NFIP Flood-Resistant Design Standards (44 CFR 59.1, 60.3 and 60.6)

CFR 59.1	U.B.C.	Analysis
Appurtenant Structure	None.	CFR 59.1 has a definition of a structure that is accessory to the insured structure on the same parcel of land. The U.B.C. has no such definition and does not make a distinction between one structure and another on a parcel of land.
Recommendation:	None.	

CFR 59.1	U.B.C.	Analysis
Base Flood	Appendix Chapter 23, Division IV.	CFR 59.1 has a definition of the flood to be used in the design of structures within areas under the authority of the National Flood Insurance Program (NFIP). The U.B.C. has a definition for the elevation that a base flood may reach and is in fact the same design flood.
Recommendation:	None.	

CFR 59.1	U.B.C.	Analysis
Basement	Sec. 403.	CFR 59.1 has a definition of basement stating that the floor of a building below ground level on all sides is a basement. The U.B.C. defines a basement as a floor level below the first story of a building except that a building having only one floor level shall be classified as a basement unless that floor level qualifies as a first story.
Recommendation:	None.	

CFR 59.1	U.B.C.	Analysis
Breakaway Wall	Appendix Chapter 23, Division IV.	CFR 59.1 defines a breakaway wall as a wall, not a part of the structural support of the building and intended to collapse under specific lateral load forces. The Uniform Building Code indirectly defines a breakaway wall as one being below the base flood elevation and designed to breakaway under high tides or wave action without causing damage to the structural system, given specific design criteria.
Recommendation:	None.	

NFIP Flood-Resistant Design Standards (44 CFR 59.1, 60.3 and 60.6)

CFR 59.1	U.B.C.	Analysis
Building (See Structure)	Sec. 403 Sec. 420.	See analysis of "structure."

Recommendation: See the recommendation of "structure."

CFR 59.1	U.B.C.	Analysis
Critical Feature	None.	CFR 59.1 defines a critical feature as one that is integral and readily identifiable part of a flood protection system without which the flood protection would be compromised. The U.B.C. considers all elements of a building to be important.

Recommendation: None.

CFR 59.1	U.B.C.	Analysis
Development	Sec. 402 Appendix Chapter 70.	CFR 59.1 defines development as any change to improved or unimproved property which includes, but is not limited to building structures, grading, mining, etc. The Uniform Building Code has a definition of alteration, which is any change, addition or modification in construction or occupancy. The U.B.C. also regulates grading on a site, but does not include mining or other such exploratory or other drilling.

Recommendation: The U.B.C. is not intended to regulate mining, dredging, drilling operations or the storage of equipment or materials whereas CFR 59.1 is intended to do so. Therefore, no change is recommended.

ICBO UNIFORM BUILDING CODE (U.B.C.) COMPARISON

NFIP Flood-Resistant Design Standards (44 CFR 59.1, 60.3 and 60.6)

CFR 59.1	U.B.C.	Analysis
Elevated Building	Appendix Chapter 23, Division IV.	CFR 59.1 defines elevated building differently in different zones. In Zones A-130 through D, the top of the elevated floor must be above the BFE. In Zones V-130, VE or V, the bottom of the lowest horizontal structure member must be elevated above the BFE. CFR 59.1 also goes as far as to say that fill or solid foundation perimeter walls may be used to elevate the building above the BFE provided that it facilitates the unimpeded movement of flood waters in or around the building in A Zones. The U.B.C. requires that a building located within flood-hazard Zone A shall have its lowest floor at or above the BFE. Any means of elevating the building within the A Zone is acceptable provided unimpeded flood water flow around the building or through the building is allowed. In V Zones, these buildings must be elevated on piles or columns.

Recommendation: None.

CFR 59.1	U.B.C.	Analysis
Existing Construction	Sec. 403.	CFR 59.1 defines existing construction as those structures which started construction prior to the effective date of the FIRM or before January 1, 1975. The U.B.C. defines an existing building as one that was erected or completed prior to the adoption of the Uniform Building Code or for one which a legal building permit was issued.

Recommendation: The definition in CFR 59.1 and the U.B.C.'s definition are for two totally different purposes and both are valid. Therefore, no recommendation.

CFR 59.1	U.B.C.	Analysis
Existing Structures	Sec. 403.	See analysis of "Existing Construction."

Recommendation: See recommendation of "Existing Construction."

ICBO UNIFORM BUILDING CODE (U.B.C.) COMPARISON

NFIP Flood-Resistant Design Standards (44 CFR 59.1, 60.3 and 60.6)

CFR 59.1	U.B.C.	Analysis
Flood	Appendix Chapter 23, Division IV.	The definition found in CFR 59.1 not only includes complete or partial inundation of normally dry land by inland or title waters, but also mud slides and the erosion of land along a coast or shoreline. The U.B.C. refers to a flood-plain management ordinance that is a separate document.
Recommendation:	None.	

CFR 59.1	U.B.C.	Analysis
Flood Plain or Flood Prone Area	Appendix Chapter 23, Division IV.	CFR 59.1 defines flood-plain or flood-prone area as any land susceptible to a flooding event. The Uniform Building Code refers to the flood-hazard map as published by an approved agency and adopted by the jurisdiction.
Recommendation:	None.	

CFR 59.1	U.B.C.	Analysis
Lowest Floor	Appendix Chapter 23, Division IV.	CFR 59.1's definition is the lowest floor of an enclosed area, including basement, with the exception of unfinished flood-resistant parking, building access or storage areas that are not in violation of applicable non-elevation design requirements. The U.B.C. makes reference to the lowest floor in any building, including basements, with the exception of enclosures used for building access, exits, foyers, storage and parking garages, provided they meet the enclosure requirements found in Appendix Chapter 23.
Recommendation:	None.	

CFR 59.1	U.B.C.	Analysis
Manufactured Home	None.	CFR 59.1 defines a manufactured home as a transportable structure when it is attached to the required utilities, but not including a recreational vehicle. The U.B.C. has no such definition.
Recommendation:	The U.B.C. relies on the discretion of the building official in approving such structures. However, a reference to an approved national standard or other such document could make the approval much easier.	

NFIP Flood-Resistant Design Standards (44 CFR 59.1, 60.3 and 60.6)

CFR 59.1	U.B.C.	Analysis
One-Hundred-Year Flood	Appendix Chapter 23, Division IV.	See analysis of "Base Flood."

Recommendation: See recommendation of "Base Flood."

CFR 59.1	U.B.C.	Analysis
Storm Cellar	None.	CFR 59.1 defines a storm cellar as a space used to temporarily accommodate occupants of a structure above in an emergency due to severe wind activity. The U.B.C. has no such definition.

Recommendation: The U.B.C. does not intend to require a storm cellar for every building in areas subject to severe winds. Therefore, no recommendation.

CFR 59.1	U.B.C.	Analysis
Structure	Sec. 403 Sec. 420.	CFR 59.1 defines a structure as a walled and roofed building and includes tanks for flood plain management purposes, but not for insurance coverage purposes. The U.B.C. has two related definitions, one for building and the other for structure. A building, according to the U.B.C., is any structure used or intended for supporting or sheltering any use or occupancy. A structure is any artificially built-up piece of work, built or constructed, in some definite manner.

Recommendation: Since the U.B.C. and CFR 59.1 have different purposes, no recommendation is required.

CFR 59.1	U.B.C.	Analysis
Substantial Improvement	Chapter 1 Sec. 402.	CFR 59.1 defines substantial improvement as an improvement whose cost equals or exceeds fifty percent of the market value of the structure with exception given to work repairing health, sanitary or safety code violations or alterations to historic structures. The Uniform Building Code considers a substantial improvements as any work requiring a permit as defined in the code.

Recommendation: Both of these definitions serve different purposes. Therefore, no recommendation is required.

ICBO UNIFORM BUILDING CODE (U.B.C.) COMPARISON

NFIP Flood-Resistant Design Standards (44 CFR 59.1, 60.3 and 60.6)

CFR 60.3	U.B.C.	Analysis
(b) (8) Manufactured Home Installation	Appendix Chapter 23, Division IV.	CFR 60.3 requires that all manufactured homes installed in A Zones be placed in such a way as to minimize flood damage and that they must be elevated and anchored to resist flotation, collapse or lateral movement. The Uniform Building Code requires that these structures, if they are located in any flood zone, shall meet the applicable elevation requirements and anchorage and tie-down requirements as stated in this appendix chapter.
Recommendation:	None.	

CFR 60.3	U.B.C.	Analysis
(c) (2) Elevation for Residential Structures	Appendix Chapter 23, Division IV.	CFR 60.3 requires that all new residential structures and substantial improvements within A Zones have their lowest floor elevated to or above the base flood elevation. The Uniform Building Code requires that all buildings erected within an A Zone have their lowest floor, including basement floors, located at or above the base flood elevation.
Recommendation:	None.	

CFR 60.3	U.B.C.	Analysis
(c) (3) Elevation of Non-Residential Structures	Appendix Chapter 23, Division IV.	CFR 60.3 requires that all new non-residential structures and substantial improvements of same within A Zones have their lowest floor elevated to or above the base flood elevation or be designed with hydrostatic and hydrodynamic loads and buoyancy forces under consideration. The Uniform Building Code requires that all buildings within an A Zone have their lowest floor, including basement floors, located at or above the base flood elevation. Any approved enclosed space below the base flood elevation would have to be designed to automatically equalize the pressure of the waters acting upon any exterior wall surface.
Recommendation:	None.	

NFIP Flood-Resistant Design Standards (44 CFR 59.1, 60.3 and 60.6)

CFR 60.3	U.B.C.	Analysis
(c) (5) Flood Openings	Appendix Chapter 23, Division IV.	CFR 60.3 requires that all new construction or substantial improvements that have approved, fully enclosed areas below the base flood elevation be designed in such a manner as to automatically equalize hydrostatic flood forces on the exterior walls with some specific design criteria. The U.B.C. requires that any approved enclosed spaces below the base flood elevation shall be designed in such a manner as to automatically equalize the lateral pressure of waters acting on any exterior wall surfaces with specific design criteria.

Recommendation: None.

CFR 60.3	U.B.C.	Analysis
(c) (4) Piling Certification	Appendix Chapter 23, Division IV.	CFR 60.3 requires that any new construction or substantial improvement in V Zones be elevated on pilings and columns so that the bottom of the lowest horizontal structural member of the lowest floor is elevated to or above the base flood level with specific design criteria and requires certification of the design by a professional engineer or architect. The Uniform Building Code requires that any new structure or addition in V Zones be elevated on pilings or columns so that the bottom of the lowest horizontal structural member of the lowest floor is elevated at or above the base flood elevation with specific design criteria and requires that the design be by a professional engineer or architect.

Recommendation: None.

CFR 60.3	U.B.C.	Analysis
(e) (5) Breakaway Walls	Appendix Chapter 23, Division IV.	CFR 60.3 requires that any approved enclosed space below the lowest floor in V Zones be enclosed with nonsupporting breakaway walls that are designed given the specific design criteria found within. The Uniform Building Code requires that any walls or partitions used to enclose any approved space below the base flood elevation be enclosed by breakaway walls designed to specific criteria.

Recommendation: None.

NFIP Flood-Resistant Design Standards (44 CFR 59.1, 60.3 and 60.6)

CFR 60.3	U.B.C.	Analysis
(e) (6) Fill	Appendix Chapter 23, Division IV.	CFR 60.3 prohibits the use of fill for structural support of any buildings within V Zones. The Uniform Building Code only allows fill in A Zones and not in any V Zones.

Recommendation: None.

CFR 60.6	U.B.C.	Analysis
(c) (2) (i) Flood-proof Walls	Appendix Chapter 23, Division IV	CFR 60.3 requires that any residential basement in an addition or substantial improvement that is located in an A1-30, AH, AO or AE zone be watertight and designed to resist hydrostatic and hydrodynamic loads and buoyancy effects. The U.B.C. requires that basements in other than residential uses below the BFE be impermeable to the passage of water and designed to resist hydrostatic and hydrodynamic loads.

Recommendation: None, since floodproofing of basements is allowed only in communities that have been granted an exception by FEMA.

CFR 60.6	U.B.C.	Analysis
(c) (2) (ii) Basement Top Floor Elevation	Appendix Chapter 23 Division IV	CFR 60.3 requires that the top floor of any residential basement be located no lower than 5 feet below the BFE. The U.B.C. allows basements in other than residential buildings to be located at any depth below the BFE provided they are designed to be impermeable to water and resistant to hydrostatic and hydrodynamic loads.

Recommendation: See recommendation of CFR 60.6 (c) (2) (i).

CFR 60.6	U.B.C.	Analysis
(c) (2) (iii) Fill	None	CFR 60.6 requires that the area surrounding exterior walls below the BFE be protected with sloped fill to or above the BFE. The U.B.C. has no such provision.

Recommendation: If the basement is designed to be impermeable to water and to resist hydrostatic and hydrodynamic loads, then additional protection is not necessary. Therefore, no recommendation.

ICBO UNIFORM BUILDING CODE (U.B.C.) COMPARISON

NFIP Flood-Resistant Design Standards (44 CFR 59.1, 60.3 and 60.6)

CFR 60.6	U.B.C.	Analysis
(c) (2) (iv) Use of a Registered Professional	Sec. 302 (b) Appendix Chapter 23, Division IV	Both CFR 60.6 and the U.B.C. require the use of a registered professional for the design of such basements.

Recommendation: None.

CFR 60.6	U.B.C.	Analysis
(c) (2) (v) Building Inspection	Sec. 305.	Both CFR 60.6 and the U.B.C. require the inspection of the construction of such basements to verify they are constructed to the approved plans.

Recommendation: None.

FEMA-55	U.B.C.	Analysis
4.1-Environmental Forces	Sec. 2308 (e) Sec. 2390 Sec. 2393 (a).	FEMA-55 recommends a flood-risk analysis for the design of a structure in coastal areas. The provisions found in the U.B.C. require that the design of a structure subject to a flooding risk reduces the risk of damage due to such a hazard prior to receiving a building permit.

Recommendation: None.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
4.1.1-Wind	Sec. 2311-2321 Figure No. 23-1 Tables Nos. 23-F G, and H, Appendix Chapters 24 and 25.	FEMA-55 refers to recommendations found in the Minimum Design Loads for Buildings and Other Structures (ANSI 58-1-1982) document and other model codes for the basic wind design of structures. Figure 4-1, the basic wind speed map, is identical to U.B.C. Figure No. 23-1 as both are based upon the ANSI document. The U.B.C. prescribes specific wind design procedures that are dependent upon the building site as well as the design of the structure. The U.B.C. also includes prescriptive design requirements and construction details for masonry and light-frame construction in areas subject to a basic wind speed of 80 to 110 miles per hour.

Recommendation: FEMA-55 should reference the latest edition of the Minimum Design Loads for Buildings and other structures published by the American Society of Civil Engineers (ASCE 7-88, formerly ANSI 58.1) as this document contains the most recent developments and is being used as evidence for recent code changes.

FEMA-55	U.B.C.	Analysis
4.1.2-Corrosion Protection	Sec. 1708 Sec. 2510 Sec. 2516 (g) and (j) Sec. 2604 (c) and (d) Sec. 2908 (i) Sec. 2909 (a) Sec. 3003 Sec. 3202 Sec. 3208 Chapter 32 Tables Sec. 4706 Appendix Chapters 27 and 25. U.P.C.: Sec. 315.	FEMA-55 recommends that the elements of a buildings be protected from the corrosive environment associated with coastal construction. It also recommends that a potential waterway path into a structure be identified and sealed. The U.B.C. has specific provisions for the protection of exterior assemblies and materials used that are exposed to such an environment. The Uniform Plumbing Code requires that all piping exposed to a corrosive environment be protected in an approved manner.

Recommendation: It is recommended that FEMA-55 address roofing and other exterior assemblies in more detail.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
4.1.3- Water Force Data	Appendix Chapter 23 Sec. 2390 Sec. 2396.	FEMA-55 recommends that structures located in coastal environments be designed with the forces of water, waves and debris considered. This document sets a specific impact loading criteria and a design load based upon an accumulation of debris. The Uniform Building Code requires the same type of structural analysis which is based upon well-established engineering principles for these environments.

Recommendation: None.

FEMA-55	U.B.C.	Analysis
4.1.4- Higher Structures	Appendix Chapter 23 Sec. 2390 Sec. 2396.	FEMA-55 discusses the forces on tall or large structures, requiring an appropriate structural analysis considering wind and water action. The Uniform Building Code does not make a distinction between tall or large structures and all others.

Recommendation: Both are compatible, as they are based upon sound, well-established engineering principles.

FEMA-55	U.B.C.	Analysis
4.2- Materials	Chapters 24, 25, 26, 27 and 28.	FEMA-55 discusses the use of wood, steel and concrete and makes general recommendations as to their protection in a corrosive environment. The Uniform Building requires that any material used be adequately protected against corrosion.

Recommendation: None.

FEMA-55	U.B.C.	Analysis
4.2.1.1- Wood Pilings	Sec. 2501 (a), 4 Sec. 2504 (b) Sec. 2516 (c) 1 Table No. 25-E Sec. 2909 (a).	FEMA-55 briefly discusses the use of wood pilings as foundation system. The Uniform Building Code requires wood pilings to meet specific design criteria and has established standards for the preparation of wood piles.

Recommendation: None.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
4.2.1.2- Wood Beams	Sec. 2303 (a) Sec. 2516 (c) 8 and 11 Appendix Chapter 23 Sec. 2393 (d).	FEMA-55 discusses, in general terms, the use of wood beams and their protection from a corrosive environment. The Uniform Building Code allows the use of any structurally adequate beam and requires adequate protection from the same environment.

Recommendation: None.

FEMA-55	U.B.C.	Analysis
4.2.1.3- Other Wood Members	Sec. 2516 (c) 3, 4, 5, 8, 9, and 11 Appendix Chapter 23 Sec. 2393 (d).	FEMA-55 states that other wood structural members are not required to be preservative treated. The Uniform Building Code requires that such members which are exposed to weather or corrosive conditions be preservative treated.

Recommendation: FEMA-55 and the Uniform Building Code are in direct conflict, with the Uniform Building Code requiring protection of all exposed members and FEMA-55 allowing unprotected members. It is recommended that FEMA-55 include the protection of all members that are exposed to these conditions.

FEMA-55	U.B.C.	Analysis:
4.2.1.4- Preservatives	Sec. 2501 (a) Sec. 2516 (c).	FEMA-55 discusses, in general terms, the use of wood preservatives in corrosive environments. The U.B.C. has specific requirements for the use of wood preservatives and has standards for the preservatives to meet.

Recommendation: FEMA-55 should recommend that the wood preservatives meet the approved standards within the jurisdiction where the project is located.

FEMA-55	U.B.C.	Analysis
4.2.2- Masonry	Chapters 23 and 26 Appendix Chapter 23, Division IV.	FEMA-55 has a brief paragraph on the use of masonry and concrete in corrosive environments. The U.B.C. has specific design requirements for concrete on corrosive environments but does not address masonry in similar situations.

Recommendation: The U.B.C. should discuss the use of masonry in corrosive environments.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
4.2.3.1-Aluminum	Chapter 28 Appendix Chapter 23.	FEMA-55 discusses the protection of aluminum trim, windows, etc. in corrosive environments. The U.B.C. does not address the use of these types of aluminum products in corrosive situations.

Recommendation: The U.B.C. should address the protection of all materials exposed to corrosive environments in Appendix Chapter 23.

FEMA-55	U.B.C.	Analysis
4.2.3.2-Steel	Chapter 27 Sec. 2510.	FEMA-55 discusses the protection of exposed steel in corrosive environments and recommends regular inspection and maintenance of same. The U.B.C. does not discuss the protection of steel members.

Recommendation: See recommendation for Section 4.2.3.1.

FEMA-55	U.B.C.	Analysis
4.2.3.3-Dissimilar Materials	Sec. 2804 (c).	FEMA-55 discusses dissimilar materials in general terms and recommends against their use, unless their safety has been verified. The U.B.C. requires that such materials be separated from each other and provides a standard for the separation.

Recommendation: None.

FEMA-55	U.B.C.	Analysis
4.3.1-Foundations	Sec. 2908-2910 Appendix Chapter 23, Division IV.	FEMA-55 briefly discusses different foundation systems. The U.B.C. provides specific design requirements for different foundation systems and requires the use of piles or columns in V zones.

Recommendation: FEMA-55 should recommend the use of only piles or columns in Coastal High Hazard Zones.

ICBO UNIFORM BUILDING CODE (U.B.C.) COMPARISON

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
4.3.1.1- Soil Conditions	Sec. 2904-2906 Table No. 29-B.	FEMA-55 discusses, in general terms, soils conditions at the site and gives some general rules of thumb for the identification. The U.B.C. has specific requirements for the classification of soil.

Recommendation: FEMA-55 should recommend the use of a licensed engineer for the classification of the soil.

FEMA-55	U.B.C.	Analysis
4.3.1.2- Piles	Sec. 2908-2910 Appendix Chapter 23, Division IV.	FEMA-55 discusses the use of piles as the foundation and gives some minimum design recommendations. The U.B.C. requires the use of piles or columns in V zones but requires their design to be justified by structural calculations.

Recommendation: FEMA-55 should recommend that the sizing of the piles is done by a licensed engineer or architect or provide a reference to a document that does require such certification.

FEMA-55	U.B.C.	Analysis
4.3.1.3- Wood Posts	Appendix Chapter 23, Division IV.	FEMA-55 does not recommend the use of wood posts in either flood hazard zone. The U.B.C. requires that in V zones only piles or columns shall be used, all other zones may have any type of designed foundation system.

Recommendation: FEMA-55 should allow the use of wood posts in A zones provided the foundation system is designed by a licensed engineer or architect.

FEMA-55	U.B.C.	Analysis
4.3.1.4- Masonry Piers	Sec. 2907 and 2910 Appendix Chapter, Division IV.	FEMA-55 discusses the use of piers as a foundation system and provides some design criteria. The U.B.C. provides design criteria that is to be used by a licensed engineer or architect.

Recommendation: FEMA-55 should recommend that a licensed engineer or architect design the pier foundation or provide a reference to a document that requires such certification.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
4.3.2.1- Framing	Chapter 23 Chapter 25 Appendix Chapter 23, Division IV.	FEMA-55 discusses the use platform framing in flood-prone environments. The U.B.C. does not address this specific type of framing but instead requires any such design to be based on well-established engineering principles.

Recommendation: FEMA-55 should recommend that the design of this type of framing system be done by a licensed engineer or architect or provide a reference to a document that requires such certification, since these areas may also be subject to other lateral forces.

FEMA-55	U.B.C.	Analysis
4.3.2.2- Floor Beams	Chapter 23 Chapter 25 Appendix Chapter 23, Division IV.	FEMA-55 discusses the orientation and sizing of floor beams that are exposed. The U.B.C. requires that floor beams be designed by a licensed engineer or architect taking under consideration all loads that it may support.

Recommendation: See the recommendation for 4.3.2.1.

FEMA-55	U.B.C.	Analysis
4.3.2.3- Joists and Rafters	Chapter 23 Chapter 25 Appendix Chapter 23, Division IV.	FEMA-55 discusses types of joists and rafters. The U.B.C. has specific design criteria for such members.

Recommendation: None.

FEMA-55	U.B.C.	Analysis
4.3.2.4- Subflooring	Chapter 23 Chapter 24 Appendix Chapter 23, Division IV.	FEMA-55 discusses subflooring in flood-prone areas. The U.B.C. has specific design criteria for subflooring.

Recommendation: None.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
4.3.2.5- Studs	Chapter 23 Chapter 25 Appendix Chapter 23, Division IV.	FEMA-55 briefly discusses the types of studs used. The U.B.C. has specific design criteria for stud walls.

Recommendation: None.

FEMA-55	U.B.C.	Analysis
4.3.2.6- Wall Sheathing	Chapter 23 Chapter 25 Appendix Chapter 23, Division IV.	FEMA-55 discusses wall sheathing and gives some design criteria. The U.B.C. has specific deign criteria for wall sheathing.

Recommendation: FEMA-55 should recommend that an licensed engineer or architect design the wall sheathing as other lateral loads may govern.

FEMA-55	U.B.C.	Analysis
4.3.2.7- Wall Bracing	Chapter 23 Chapter 25 Appendix Chapter 23, Division IV.	FEMA-55 discusses different types of wall bracing. The U.B.C. has specific design criteria for wall bracing.

Recommendation: None.

FEMA-55	U.B.C.	Analysis
4.3.2.8- Roof	Chapter 23 Chapter 25 Appendix Chapter 23, Division IV.	FEMA-55 discusses different types of roof construction. The U.B.C. has specific design criteria for any type of roof.

Recommendation: None.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
4.3.3- Foundation Bracing	Sec. 2908 and 2910 Appendix Chapter 23, Division IV.	FEMA-55 discusses the use of foundation braces as an effective lateral force resisting system. The U.B.C.requires interconnection for all types of piles, unless proven that another system is adequate.

Recommendation: FEMA-55 should recommend that a licensed engineer or architect design these braces and the rest of the foundation system.

FEMA-55	U.B.C.	Analysis
4.3.3.1- Knee Bracing	Sec. 2908 and 2910 Appendix Chapter 23, Division IV.	FEMA-55 discusses the use of knee bracing and gives some design criteria. The U.B.C. requires that pile foundations be designed for lateral forces.

Recommendation: None.

FEMA-55	U.B.C.	Analysis
4.3.3.2- Grade Beams	Sec. 2908 and 2910 Appendix Chapter 23, Division IV.	FEMA-55 recommends the use of grade beams to restrain a pile foundation. The U.B.C. requires interconnection of all pile foundation systems or another equivalent form of restraint.

Recommendation: FEMA-55 should recognize other methods of foundation restraint.

FEMA-55	U.B.C.	Analysis
4.3.3.3- Truss Bracing	Sec. 2908 and 2910 Appendix Chapter 23, Division IV Appendix Chapter 24 Appendix Chapter 25.	FEMA-55 recommends a more substantial pile bracing system when the structure is 10 feet or more above grade or is subject to hurricane force winds. The U.B.C. requires that all foundation systems be designed with all lateral loads considered and provides specific connection details for structures in areas subject to high winds.

Recommendation: None.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
4.3.3.4- Shear Walls	Chapter 24 Chapter 26 Chapter 26 Appendix Chapter 23, Division IV Appendix Chapter 24 Appendix Chapter 25.	FEMA-55 discusses the use of shear walls to resist wind forces. The U.B.C. requires that the lateral resisting system of a structure be designed with all lateral loads under consideration.

Recommendation: FEMA-55 seems to recommend the use of reinforced concrete and reinforced masonry as the only acceptable means of resisting wind loads. FEMA-55 should also consider the use of wood shear walls as an acceptable method of resisting wind and water loads.

FEMA-55	U.B.C.	Analysis
4.3.4- Connections	Chapter 23 Sec. 2510 Sec. 2516-17, Appendix Chapter 23, Division IV Appendix Chapter 24 Appendix Chapter 25.	FEMA-55 recommends that extra care is given to the design and detailing of all connections in a structure. The U.B.C. requires that all connections be designed for the loads incurred by the structure.

Recommendation: None.

FEMA-55	U.B.C.	Analysis
4.3.4.1- Roof to Wall	Chapter 23 Sec. 2510 Sec. 2516 and 2517 Appendix Chapter 23, Division IV Appendix Chapter 24 Appendix Chapter 25.	See analysis of 4.3.4.

Recommendation: None.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
4.3.4.2- Wall to Floor	Chapter 23 Sec. 2510 Sec. 2516 and 2517 Appendix Chapter 23, Division IV Appendix Chapter 24 Appendix Chapter 25.	See analysis of 4.3.4.
Recommendation:	None.	

FEMA-55	U.B.C.	Analysis
4.3.4.3- Floor Joist to Beam	Chapter 23 Sec. 2510 Sec. 2516 and 2517 Appendix Chapter 23, Division IV Appendix Chapter 24 Appendix Chapter 25.	See analysis of 4.3.4.
Recommendation:	None.	

FEMA-55	U.B.C.	Analysis
4.3.4.4- Floor Beam to Pile	Chapter 23 Sec. 2510 Sec. 2516 and 2517 Appendix Chapter 23, Division IV Appendix Chapter 24 Appendix Chapter 25.	See analysis of 4.3.4
Recommendation:	None.	

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
4.3.5- Breakaway Walls	Appendix Chapter 23, Division IV.	FEMA-55 recommends that any sheltered space beneath an elevated structure be enclosed by breakaway walls and gives examples of same. The U.B.C. requires that any enclosing walls beneath an elevated structure be designed and constructed as a breakaway wall.
Recommendation:	None.	

FEMA-55	U.B.C.	Analysis
4.3.5.1- Types of Walls	Appendix Chapter 23, Division IV.	FEMA-55 discusses different types of breakaway walls. The U.B.C. requires that any breakaway wall be designed for specific loads.
Recommendation:	None.	

FEMA-55	U.B.C.	Analysis
4.3.5.2- Design of Breakaway Walls	Appendix Chapter 23, Division IV.	FEMA-55 discusses the design of breakaway walls. The U.B.C. requires that any breakaway wall be designed for specific loads.
Recommendation:	None.	

FEMA-55	U.B.C.	Analysis
4.3.6- Utilities	Appendix Chapter 23, Division IV U.P.C.: Sec. 315 (e).	FEMA-55 discusses the protection of utilities in the "Coastal High Hazard" zone. The U.B.C. requires that utilities be protected in both the flood hazard zones.
Recommendation:	FEMA-55 should also include the protection of utilities in the "A" flood hazard zone as they subject to similar forces as found on the Coastal High Hazard zone.	

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
4.3.7- 4.3.7.1 4.3.7.2 4.3.7.3 4.3.7.4- Protection of the Interior	Sec. 1708 Sec. 2516 Sec. 3201 Sec. 3205 Sec. 4205 Appendix Chapter 23, Division IV.	FEMA-55 discusses the protection of the interior of a structure from wind and water action. The U.B.C. requires that openings below the base flood elevation (BFE) be protected and that exterior assemblies provide a weather-resistive barrier.

Recommendation: The U.B.C. should also address the protection of openings above the BFE from wind and water action.

FEMA-55	U.B.C.	Analysis
4.3.8- Maintenance	Sec. 104 (d).	FEMA-55 recommends regular inspection and maintenance of pilings, exposed connections, exposed protective devices and utilities. The U.B.C. requires that the owner or owner's designate maintain the structure and all devices and safeguards required by code in a safe and sanitary condition.

Recommendation: None.

FEMA-55	U.B.C.	Analysis
5.1- General Design	Sec. 2311 and 2321 Appendix Chapter 23.	FEMA-55 discusses the lateral design criteria for larger structures. The U.B.C. requires a lateral analysis of all buildings with no distinction in the size of the building.

Recommendation: FEMA-55 recognizes that wind loads may govern in large structures, but should recommend that all lateral loads be considered in the design of all structures.

FEMA-55	U.B.C.	Analysis
5.2- Foundations	Sec. 2907 and 2910 Appendix Chapter 23, Division IV.	FEMA-55 discusses the types of foundations used on larger structures. The U.B.C. requires that all foundations be designed for the loads they support.

Recommendation: None.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
5.3- Slabs-on-grade	Sec. 2623 Sec. 2908 (b).	FEMA-55 briefly discusses the different uses of slabs-on-grade. The U.B.C. prescribes specific design criteria for the different uses of slabs-on-grades.

Recommendation: None.

FEMA-55	U.B.C.	Analysis
5.4- Superstructure	Chapter 23 Chapter 24 Chapter 26 Chapter 27.	FEMA-55 discusses some types of structural systems found in larger buildings. The U.B.C. requires that the structural system used be designed according to specific criteria.

Recommendation: None.

FEMA-55	U.B.C.	Analysis
5.5- Elevated Floors	Chapter 26 Chapter 27.	FEMA-55 briefly discusses the use of reinforced concrete floors in larger structures. The U.B.C. requires that any floors used in larger structures be designed to meet specific criteria.

Recommendation: FEMA-55 should also discuss composite floor systems as these are prevalent in high-rise construction.

FEMA-55	U.B.C.	Analysis
5.6- Exterior Walls	Sec. 2309 and 2321 Appendix Chapter 24 Appendix Chapter 25.	FEMA-55 briefly discusses the types of exterior wall systems and their connections. The U.B.C. require that any exterior wall system used meet specific design criteria.

Recommendation: None.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
5.7- Professionals	Sec. 302 (b) Appendix Chapter 23, Division IV.	FEMA-55 recommends the use of design professionals in the design and construction of larger structures in areas subject to wind and water action. The U.B.C. requires a licensed engineer or architect for the design of such buildings.

Recommendation: None.

FEMA-55	U.B.C.	Analysis
Figure No. A-1 Number of Piles	Sec. 302 (b) Chapter 23 Chapter 29 Appendix Chapter 23, Division IV.	FEMA-55 recommends a certain number of piles which is dependent upon the dimensions of the supported structure. The U.B.C. requires that an engineer or architect design the piling system based on the applied loads and soil conditions.

Recommendation: FEMA-55 should recommend that a licensed engineer or architect design the piling system or provide a reference to a document that does require such certification rather than provide specific design criteria for all situations. Also, FEMA-55 should consider the soil conditions at the site when making design recommendations.

FEMA-55	U.B.C.	Analysis
Table No. A-1 Vertical Loads on Piles	Sec. 302 (b) Chapter 23 Chapter 29 Appendix Chapter 23, Division IV.	FEMA-55 provides design loads for typical one- and two-story houses which leads to a recommended pile embedment depth. The U.B.C. requires that an engineer or architect design the piling system based on the applied loads and soil conditions.

Recommendation: See the recommendation for Figure No. A-1.

FEMA-55	U.B.C.	Analysis
Table No. A-2 Horizontal Wind Load per Pile	Sec. 302 (b) Chapter 23 Chapter 29 Appendix Chapter 23, Division IV.	FEMA-55 provides wind design loads for typical one- and two-story houses which leads to the design of the bracing of the piles. The U.B.C. requires that an engineer or architect design the piling system based on the applied loads and soil conditions.

Recommendation: See the recommendation for Figure No. A-1.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
Table No. A-3 Minimum Pile Embedment	Sec. 302 (b) Chapter 23 Chapter 29 Appendix Chapter 23, Division IV.	FEMA-55 provides the minimum embedment length of piles based on the loads provided. The U.B.C. requires that an engineer or architect design the piling system based on the applied loads and soil conditions.

Recommendation: See the recommendation for Figure No. A-1.

FEMA-55	U.B.C.	Analysis
Table No. A-4 Maximum Unbraced Pile Height	Sec. 302 (b) Chapter 23 Chapter 29 Appendix Chapter 23, Division IV.	FEMA-55 provides a table of the maximum unbraced pile heights. The U.B.C. requires that an engineer or architect design the piling system based on the applied loads and soil conditions.

Recommendation: See the recommendation for Figure No. A-1.

FEMA-55	U.B.C.	Analysis
Table No. A-4.1 Maximum Unbraced Pile Heights Supporting Breakaway Walls	Sec. 302 (b) Chapter 23 Chapter 29 Appendix Chapter 23, Division IV.	FEMA-55 provides a table of the maximum unbraced pile heights that support breakaway walls. The U.B.C. requires that an engineer or architect design the piling system based on the applied loads and soil conditions.

Recommendation: See the recommendation for Figure No. A-1.

FEMA-55	U.B.C.	Analysis
Table No. A-5 Uplift Loads per Foot of Wall	Sec. 302 (b) Chapter 23 Chapter 29 Appendix Chapter 23, Division IV.	FEMA-55 provides wind loads that are to be used in the design of the connections between floors. The Uniform Building Code requires that an engineer or architect design the lateral resisting system based on the applied loads.

Recommendation: See the recommendation for Figure No. A-1.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
Table No. A-6 Uplift Loads per Pile	Sec. 302 (b) Chapter 23 Chapter 29 Appendix Chapter 23, Division IV.	FEMA-55 provides a table of loads to be used in the design of the connection of the floor beams to the piles. The Uniform Building Code requires that an engineer or architect design the lateral resisting system based on the applied loads.

Recommendation: See the recommendation for Figure No. A-1.

FEMA-55	U.B.C.	Analysis
Table No. A-7 Bolt Capacity of Floor Beam Connections	Table No. 26-E Sec. 2510 Table No. 25-F.	FEMA-55 provides bolt capacities based on the type of connection. The U.B.C. provides design loads based on the material in which the bolts are used.

Recommendation: FEMA-55 should also base their design tables on the materials used along with the connection requirements.

FEMA-55	U.B.C.	Analysis
Table No. A-8 Concrete Masonry Piers	Sec. 2303 Chapter 24 Appendix Chapter 24.	FEMA-55 provides recommended reinforcing requirements for areas subject to high winds. The Uniform Building Code requires that an engineer or architect design these concrete masonry piers for any horizontal loads that it may be subjected to.

Recommendation: FEMA-55 should require that an engineer or architect design all concrete masonry piers or provide a reference to a document that does require such certification rather than providing prescriptive reinforcing requirements.

FEMA-55	U.B.C.	Analysis
Table No. A-9 Concrete Piers	Sec. 2303 Chapter 26	FEMA-55 provides prescriptive reinforcing requirements for structures that are subject to high winds. The Uniform Building Code requires that an engineer or architect design such structures with all loads taken into account.

Recommendation: FEMA-55 should require that an engineer or architect design all concrete piers based on the loads generated by such winds rather that provide prescriptive reinforcing requirements or provide a reference to a document that does require such certification.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
Figure No. A-2 Concrete Pier Cross Section	Sec. 2303 Chapter 26	FEMA-55 provides two diagrams of recommended locations for the reinforcing steel. Also, FEMA-55 recommends the use of No. 3 ties at 16 inches on center as the shear reinforcement for the concrete pier. The U.B.C. requires that all concrete piers be designed for both flexure and shear stresses.

Recommendation: FEMA-55 should recommend that a licensed engineer or architect design the concrete pier rather than provide specific design recommendations for all situations or provide a reference to a document that does require such certification.

FEMA-55	U.B.C.	Analysis
Figure No. A-3 Grade Beams and Slabs	Sec. 2303 Chapter 26	FEMA-55 provides a diagram for the recommended location of the steel reinforcing in grade beams and other specific design criteria. Also, this figure contains specific reinforcing requirements for slabs located in areas subject to these conditions. The Uniform Building Code requires such structural members be designed by a licensed engineer or architect based on the applied loads and conditions of the site.

Recommendation: FEMA-55 should recommend that a licensed engineer or architect should design such members based on the applied loads and site conditions.

FEMA-55	U.B.C.	Analysis
Table No. A-10 Fastener Capacities in Shear	Sec. 2303 Tables Nos. 24-D-1 and 24-D-2 Table No. 24-E Tables Nos. 25-F, G, H, J, K, O, Q.	FEMA-55 provides specific shear capacities for nails, screws and dowel pins. The Uniform Building Code provides specific criteria for the design of all fasteners.

Recommendation: FEMA-55 should recommend the use of the shear capacity requirements in the building code of that project's jurisdiction.

FEMA-55	U.B.C.	Analysis
Table No. 11-A Fasteners for Breakaway Walls	Sec. 2303 Appendix Chapter 23, Division IV.	FEMA-55 provides specific design criteria for the fasteners for breakaway walls. The Uniform Building Code requires that these breakaway walls be designed in accordance with specific loading criteria.

Recommendation: None.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
Appendix B Bracing	Sec. 2303 Sec. 2908 and 2910 Appendix Chapter 23, Division IV.	FEMA-55 discusses the use of pile bracing. The U.B.C. requires that a lateral resisting pile system be designed with wind loads, water and wave action under consideration.

Recommendation: FEMA-55 should recommend the use of an engineer or architect in the design of such a foundation system or provide a reference to a document that does require such certification.

FEMA-55	U.B.C.	Analysis
B.1 Knee Bracing	Sec. 2303 Sec. 2908 and 2910 Appendix Chapter 23, Division IV.	FEMA-55 discusses the use of knee braces and the detailing of same. The Uniform Building Code requires that such connections and braces be designed by a licensed engineer or architect with wind, water and wave action under consideration.

Recommendation: FEMA-55 should recognize the use of other forms of bracing as well as requiring the use of a licensed engineer or architect in the design of such a system or provide a reference to a document that does require such certification.

FEMA-55	U.B.C.	Analysis
B.2 Truss Bracing	Sec. 2303 Sec. 2908 and 2910 Appendix Chapter 23, Division IV.	FEMA-55 recommends that truss bracing be designed per the following sections. The U.B.C. requires that such a bracing system be designed by a licensed engineer or architect.

Recommendation: FEMA-55 should require the use of a licensed engineer or architect to design such a bracing system or provide a reference to a document that does require such certification.

FEMA-55	U.B.C.	Analysis
B.2.1 Diagonals	Sec. 2303 Sec. 2908 and 2910 Appendix Chapter 23, Division IV.	FEMA-55 discusses, in general terms, the use of diagonals as a bracing element and gives some specific design examples. The U.B.C., on the other hand, relies on a design by a licensed engineer or architect rather than specific design criteria.

Recommendation: FEMA-55 should rely on the design of a licensed engineer or architect or provide a reference to a document that does require such certification rather than providing specific design criteria.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
B.2.1.1 Lumber Diagonals	Sec. 2303 Chapter 25 Sec. 2908 and 2910 Appendix Chapter 23, Division IV.	FEMA-55 gives specific design criteria and examples for all conditions. The U.B.C. requires a design by a licensed engineer or architect given the site conditions.

Recommendation: FEMA-55 should rely more on the design of a licensed engineer or architect rather than give specific design criteria.

FEMA-55	U.B.C.	Analysis
B.2.1.2 Thread Bar Diagonals	Sec. 2303 Chapter 27 Sec. 2908 and 2910 Appendix Chapter 23, Division IV.	FEMA-55 gives recommendations for specific manufactured product as the use of a thread bar diagonal. The Uniform Building Code requires that these diagonals be designed by a licensed engineer or architect based on the applied loads and site conditions.

Recommendation: FEMA-55 should not recommend a specific manufacturer and should rely on the design of a licensed engineer or architect or provide a reference to a document that does require such certification.

FEMA-55	U.B.C.	Analysis
B.2.2 Struts	Sec. 2303 Chapter 25 Sec. 2908 and 2910 Appendix Chapter 23, Division IV.	FEMA-55 provides specific design criteria for struts and makes specific manufacturer recommendations. The U.B.C. relies on a design by a licensed engineer or architect based on the implied loads and site conditions.

Recommendation: See recommendation of B.2.1.2.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
B.3 Grade Beams	Sec. 2303 Chapter 26 Sec. 2908 and 2910 Appendix Chapter 23, Division IV.	FEMA-55 discusses the at-grade supports of a piling system by certain materials. The U.B.C. requires such a design to be by a licensed engineer or architect based on the applied loads and site conditions.

Recommendation: FEMA-55 should rely upon the design of a licensed engineer or architect or provide a reference to a document that does require such certification.

FEMA-55	U.B.C.	Analysis
D.1 Procedure A-1 Downward Loads per Pile	Chapter 23 Sec. 2908-2910.	FEMA-55 provides a simplistic approach to calculating the downward loads per pile. It also assumes certain dead and live loads without providing justification for the figures. The U.B.C. requires that the engineer or architect base the design dead and live loads on the use of the structure. Also, the load per pile is based on the tributary area supported by the pile and a reduction is given for any group action that may be used in the system.

Recommendation: FEMA-55 should indicate that this is a design example only and not a procedure to be used for every situation that may arise.

FEMA-55	U.B.C.	Analysis
D.2 Procedure A-2 Wind Loads per Pile	Chapter 23 Sec. 2908-2910.	FEMA-55 provides a simplistic procedure for the calculation of the wind loads per pile given a specific design situation. The U.B.C. provides two methods, normal force method and projected area method for calculating the wind loads on any given building. It also provides the means for calculating loads generated at roof eaves, ridges, overhangs and also on miscellaneous structures and provides criteria for calculating the loads on leeward elements.

Recommendation: See the recommendation for D.1, Procedure A-1.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
D.3 Procedure A-3 Minimum Embedment of Piles	Sec. 2908-2910.	FEMA-55 gives the design procedure for two types of piles in two different types of soil. These procedures come up with an embedment length for two different diameters of these piles based on the soils equations provided therein. The Uniform Building Code relies on the investigation of a soils engineer and subsequent recommendations for the minimum embedment depth of piles.

Recommendation: FEMA-55 should recommend that a soils engineer by consulted and a soils report be undertaken for each specific site as the soil conditions vary from site to site.

FEMA-55	U.B.C.	Analysis
D.4 Procedure A-4 Maximum Unbraced Pile Height	Sec. 2908-2910 Appendix Chapter 23, Division IV.	FEMA-55 provides design equations for the calculation of moments due to wave, current, debris impact and wind forces which ultimately leads to the allowable bending moment of piles and then to the maximum unbraced pile height. The Uniform Building Code requires that the structural system be designed in accordance with well established engineering principles with hydrodynamic and hydrostatic loads being considered and requires that the required loading be established by an investigation of the conditions at the site.

Recommendation: FEMA-55 should indicate the source of the equations used for the forces calculated.

FEMA-55	U.B.C.	Analysis
D.5 Procedure A-4.1 Maximum Unbraced Height for Piles Supporting Breakaway Walls	Sec. 2908-2910 Appendix Chapter 23, Division IV.	FEMA-55 provides a means of calculating the unbraced height for piles that support breakaway walls. The Uniform Building Code requires that the structural system be designed in accordance with well established engineering principles with hydrodynamic and hydrostatic loads being considered. The required loading should be established by an investigation of the conditions at the job site or by approved national standards.

Recommendation: See the recommendation for D.4, Procedure A-4.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
D.6 Procedure A-5 Wall Uplift Loads	Chapter 23.	FEMA-55 provides an example of a method of calculating wind generated uplift loads in the walls of a building given specific design criteria. The U.B.C. requires that a licensed engineer or architect consider all of the loads generated by wind forces, including uplift forces, in the design of the structure.

Recommendation: FEMA-55 should recommend the use of a licensed engineer or architect in the design of such structures and should indicate that this is a design example that may not be appropriate for all situations.

FEMA-55	U.B.C.	Analysis
D.7 Procedure A-6 Pile Uplift Loads	Chapter 23.	FEMA-55 provides an example of a method of calculating the uplift loads generated by wind forces per pile. The U.B.C. requires that a licensed engineer or architect design the piling system for wind generated uplift loads depending on the design of the structure and the site conditions.

Recommendation: FEMA-55 should require that a licensed engineer or architect design the structure with all loads under consideration or provide a reference to a document that does require such certification. It should also indicate that this is a design example which may not be appropriate for all situations.

FEMA-55	U.B.C.	Analysis
D.8 Procedure B-1 Horizontal Water Loads per Pile	Appendix Chapter 23, Division IV.	FEMA-55 provides a method of calculating lateral loads due to wave, current drag, debris impact forces on each pile. The Uniform Building Code requires that the piling be designed in accordance with well established engineering principles and with hydrodynamic and hydrostatic loads under consideration. The required loading should be established by an investigation of the site conditions or approved national standards.

Recommendation: FEMA-55 should require that a licensed engineer or architect consider these forces in the design of the building or provide a reference to a document that does require such certification.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
D.9 Procedure B-2 Loads Transferred to the Foundation Truss Members	Chapter 23 Appendix Chapter 23, Division IV.	FEMA-55 has a brief description of a procedure to evaluate any loads resulting from lateral forces which may be transferred to horizontal or diagonal bracing members. The U.B.C. requires that a complete load path be identified and designed for both lateral and vertical loads.

Recommendation: See the recommendation for D.8.

FEMA-55	U.B.C.	Analysis
Appendix G.2 Purpose	Sec. 102.	FEMA-55 recommends that this sample Coastal Construction Code supplement the local building code with the more restrictive requirements governing. The purpose of the U.B.C. is to provide minimum standards for the protection of property and public welfare for all buildings within the local jurisdiction.

Recommendation: None.

FEMA-55	U.B.C.	Analysis
Appendix G.3 Scope	Sec. 103.	Scope of FEMA-55 includes only residential structures, both large and small and the additions thereto, even though Chapter 5 in the Coastal Construction Manual addresses larger structures which seems to include both commercial and industrial buildings. The scope of the U.B.C., on the other hand, includes all buildings and miscellaneous structures within the authority of the local building official.

Recommendation: FEMA-55 should include, within the sample Coastal Construction Code, any other uses which may be subjected to these kinds of conditions.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
Appendix G.4 Definitions	Chapter 4 Chapter 23 Appendix Chapter 23, Division IV.	The definitions found in the sample Coastal Construction Code in FEMA-55 are strictly related to the design of structures subject to flood, wave and wind actions. Half of the definitions in FEMA-55 are located in the U.B.C. and most of those are compatible with the Uniform Building Code. However, the definition of "grade" is in conflict with U.B.C. The other definitions located in FEMA-55 are indirectly referenced in the U.B.C. by way of a reference to approved national standards.

Recommendation: FEMA-55 should develop language that correlates the definition of "grade" with the U.B.C., such as replacing the term "adjoining" with a specific distance at which point the measurement is taken.

FEMA-55	U.B.C.	Analysis
Appendix G.5 Elevation Standards	Appendix Chapter 23, Division IV.	FEMA-55 has a provision in this section where a setback can be established, where within same, no new construction or substantial improvements are allowed. Also, all new construction or substantial improvements in this provision must have their lowest horizontal structural member supporting the elevated floor at or above the base flood elevation. The U.B.C. does not establish a setback where construction is not allowed. It requires that all new construction or improvements have the lowest horizontal structural member at or above base flood elevation.

Recommendation: None.

FEMA-55	U.B.C.	Analysis
Appendix G.6 Loading Forces	Chapter 23 Appendix Chapter 23, Division IV.	FEMA-55 recommends that the structural design in coastal high-hazard areas consider the effects the wind and water loads acting simultaneous during a base flood on all building components. The U.B.C. states that the structural system shall be designed in accordance with well established engineering principles with hydrodynamic and hydrostatic loads under consideration and that the required loading shall be established by an investigation of the conditions at the site or approved national standards.

Recommendation: None.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
Appendix G.6.1 Water Loads	Appendix Chapter 23, Division IV.	FEMA-55 states that the structural design shall take horizontal water loads under consideration and shall consider specific forces of waves and other forces in the analysis. The U.B.C. requires that the structural system shall be designed in accordance with well established engineering principles and with hydrodynamic and hydrostatic loads under consideration and that the loading shall be established by an investigation of the site conditions or approved national standards.

Recommendation: None.

FEMA-55	U.B.C.	Analysis
Appendix G.6.2 Wind Loads	Chapter 23 Appendix Chapters 24 and 25.	FEMA-55 recommends that all buildings be designed to resist wind load pressures based on ANSI Standard A 58.1-1982. The Uniform Building Code requires that all buildings be designed and detailed to resist the forces due to wind pressures and includes a number of the provisions from the ANSI Standard.

Recommendation: FEMA-55 should include the latest edition of ANSI Standard A 58.1 which is now ASCE 7-88.

FEMA-55	U.B.C.	Analysis
Appendix G.7 Foundation Standards	Chapter 29 Appendix Chapter 23, Division IV.	FEMA-55 requires that all structures built in the coastal high-hazard area be designed and detailed to resist lateral forces due to wind and water pressures. The U.B.C. requires that all loads that the building might be subject to be taken into consideration in the structural calculations and designed appropriately.

Recommendation: None.

FEMA-55	U.B.C.	Analysis
Appendix G.7.1 Pile Foundation Design	Sec. 2908-2910 Appendix Chapter 23, Division IV.	FEMA-55 has some specific design criteria for pile foundations. The U.B.C. requires that the structural system, in this case the pile foundation, be designed in accordance with well established engineering principles and take into consideration hydrodynamic and hydrostatic loads. Also, the required loading and design shall be established by an investigation of the site conditions or approved national standards.

Recommendation: FEMA-55 should include a provision for soil investigations to determine the site soil conditions.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
Appendix G.7.2 Column Foundations	Chapters 24, 26 Appendix Chapter 23, Division IV.	FEMA-55 briefly discusses the use of masonry piers and poured-in-place concrete piers and requires that they be reinforced to resist both vertical and lateral loads and be interconnected. The Uniform Building Code has specific design criteria for such piers and also requires that they be interconnected.

Recommendation: None.

FEMA-55	U.B.C.	Analysis
Appendix G.8 Anchoring Standards	Appendix Chapter 23, Division IV Appendix Chapters 24 and 25.	FEMA-55 requires that the entire structural system be tied together to prevent flotation collapse or a permanent lateral movement due to a base flood event concurrent with the one-hundred-year design wind velocity. The U.B.C. requires that the structural system of a building or structure shall be tied together to resist the flotation, collapse, or permanent lateral movement due to loads to flooding equal to the base flood elevation. Another provision requires that the structure be designed and tied together to resist basic wind speeds from 80 to 110 miles per hour.

Recommendation: The U.B.C. should consider one-hundred-year design wind velocities concurrently with the base floor elevation forces.

FEMA-55	U.B.C.	Analysis
Appendix G.8.1 Connectors and Fasteners	Sec. 2510 Appendix Chapters 24 and 25.	FEMA-55 requires that these connections be adequate for the loads applied and also, if exposed, shall be protected against corrosion. The U.B.C. also requires that connections be adequate for the applied loads and also be corrosion resistant if exposed to a corrosive environment.

Recommendation: None.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
Appendix G.8.2 Beam to Pile Connections	Sec. 2510 Appendix Chapter 23, Division IV.	FEMA-55 has design requirements for specific beam to pile connections with no consideration for other possibly structural adequate connectors. The Uniform Building Code requires that these connections be designed by a licensed engineer or architect based on the applied loads, but does require that any connectors that are exposed to corrosive environments be protected.

Recommendation: FEMA-55 should allow for other structurally adequate connections.

FEMA-55	U.B.C.	Analysis
Appendix G.8.3 Floor and Deck Connections	Chapter 25.	FEMA-55 has specific design criteria for floor and deck connections in coastal high-hazard areas. The U.B.C. requires that a licensed engineer or architect design these connections for the applied loads and site conditions.

Recommendation: FEMA-55 should consider other structurally adequate materials than what is prescribed within their provisions provided a licensed engineer or architect verifies the adequacy.

FEMA-55	U.B.C.	Analysis
Appendix G.8.4 Exterior Wall Connections	Chapter 25.	FEMA-55 contains specific design criteria for exterior wall connections. The U.B.C. requires that exterior wall connections be designed and detailed by a licensed engineer or architect to support the applied loads.

Recommendation: FEMA-55 should recommend other types of designed exterior wall connections.

FEMA-55	U.B.C.	Analysis
Appendix G.8.5 Ceiling Joist and Rafter Connections	Sec. 2303 Sec. 2510 Appendix Chapter 23, Division IV.	FEMA-55 requires that the roof framing and ceiling be designed in such a manner as to provide a continuous tie across the rafters and that an adequate connection to the exterior walls be provided. The Uniform Building Code requires that these connections be designed by a licensed engineer or architect for the applied loads.

Recommendation: FEMA-55 should recognize other types of systems which may provide this continuous tie.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
Appendix G.8.6 Projecting Members	Chapter 23 Sec. 2510 Appendix Chapter 23, Division IV.	FEMA-55 gives design provisions for small overhangs and projecting members and requires that larger projecting members be designed by a licensed engineer or architect. The Uniform Building Code requires that all such projecting members be designed and detailed given the applied loads by a licensed engineer or architect.

Recommendation: FEMA-55 should require that all projecting members be designed by a licensed engineer or architect.

FEMA-55	U.B.C.	Analysis
Appendix G.8.9 Roof Sheathing	Chapter 23 Chapter 25 Chapter 32 Appendix Chapter 23, Division IV.	FEMA-55 has specific design criteria for roof sheathing on buildings in the coastal high-hazard areas and also for the design of roofs in these areas. The Uniform Building Code requires that roof sheathing be detailed in a manner that allows any design of roof if high winds and water forces are considered.

Recommendation: FEMA-55 should recognize other types of roofs if they are designed by a licensed engineer or architect.

FEMA-55	U.B.C.	Analysis
Appendix G.10 Protection of Openings	None.	FEMA-55 requires that exterior openings be designed and detailed to withstand high wind speeds and recommends additional protection such as storm shutters. The Uniform Building Code has no such provision.

Recommendation: The Uniform Building Code should address the protection of exterior openings from wind and water action that are above the base flood elevation.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
Appendix G.11 Use of Space Below the Lowest Elevated Floor	Appendix Chapter 23, Division IV.	FEMA-55 requires that all new construction and substantial improvements within the coastal high-hazard zone must have the space below the base flood elevation free of obstruction or constructed with breakaway walls. Enclosed space, may be used only for vehicular parking or access to the building. The U.B.C. requires that the space below the base flood elevation in coastal high-hazard zones be free of obstruction except that it allows the storage of portable or mobile items that can be moved in the event of a storm to be located below the lowest floor as well as stairs and entrances required to access the building.

Recommendation: FEMA-55 should not allow enclosed space for vehicular parking unless it is provided by breakaway walls and should recognize that portable or temporary storage of items can be located there.

FEMA-55	U.B.C.	Analysis
Appendix G.11.1 Breakaway Wall Design	Appendix Chapter 23, Division IV.	FEMA-55 requires that breakaway walls be designed for loads as designated by the jurisdiction and gives some design recommendations for the design of the piles that support the breakaway walls. The Uniform Building Code requires that breakaway walls be designed for specific criteria and includes these loads in the design of the pile system.

Recommendation: None.

FEMA-55	U.B.C.	Analysis
Appendix G.11.2 Certification of Breakaway Walls	Appendix Chapter 23, Division IV.	FEMA-55 allows the use of breakaway walls designed for greater loads than twenty pounds per square foot if designed by a licensed architect or engineer. The Uniform Building Code does not allow the use of breakaway walls that are designed above twenty pounds per square foot.

Recommendation: The Uniform Building Code should recognize that the design of breakaway walls with a higher loads considered may be appropriate under certain circumstances.

Coastal Construction Manual (FEMA-55)

FEMA-55	U.B.C.	Analysis
Appendix G.12 Utilities	Appendix Chapter 23, Division IV.	FEMA-55 requires that all machinery servicing the building be elevated at or above the base flood elevation (BFE) or that any system below the BFE be provided with protection from water penetration. The U.B.C. requires that new or replacement utilities that service the building be placed above the base flood elevation or protected against water penetration.

Recommendation: None.

FEMA-55	U.B.C.	Analysis
Appendix G.13 Certification	Sec. 2303 Appendix Chapter 23, Division IV.	FEMA-55 requires that all new or substantial improvements to residential buildings in coastal high-hazard zones either be designed by a licensed engineer or architect or certified as meeting standard accepted practices. The Uniform Building Code requires that all such structures be designed and detailed by a licensed engineer or architect.

Recommendation: FEMA-55 should require a design by a licensed engineer or architect or provide a reference to a document that does require such certification.

FEMA-55	U.B.C.	Analysis
Appendix G.14 Reference Documents	Chapter 23 Appendix Chapter 23, Division IV Appendix Chapters 24 and 25.	FEMA-55 lists the documents used in determining the design wind and water forces on structures and provides a reference to the Coastal Construction Manual. The U.B.C. provides specific criteria for wind and high-wind design or requires that such design of the structures meet approved national standards.

Recommendation: None.

Elevated Residential Structures (FEMA-54)

FEMA-54	U.B.C.	Analysis
Posts	Sec. 2908-2910 Appendix Chapter 23, Division IV.	FEMA-54 discusses, generally, the use and design of post foundations. The Uniform Building Code gives specific design criteria for such foundations.
Recommendation:	None.	

FEMA-54	U.B.C.	Analysis
Post Embedment	Sec. 2507 Sec. 2516 Sec. 2908-2910 Appendix Chapter 23, Division IV.	FEMA-54 discusses some general construction practices for post foundations. The Uniform Building Code requires a design by a licensed engineer or architect and provides specific design criteria for these foundations.
Recommendation:	FEMA-54 should recommend the use of a soils investigation report by a licensed soil engineer in the design of the foundation system.	

FEMA-54	U.B.C.	Analysis
Post Anchorage	Sec. 2510 Sec. 2910 Appendix Chapter 23, Division IV Appendix Chapter 25.	FEMA-54 recommends the anchorage of posts to the foundation. The U.B.C. requires that such connections be designed by a licensed engineer or architect with all applied loads considered.
Recommendation:	None.	

FEMA-54	U.B.C.	Analysis
Piers	Sec. 2403-2409 Sec. 2907 Appendix Chapter 23, Division IV.	FEMA-54 discusses, in general terms, pier foundations in areas subject to flood events. The Uniform Building Code has specific design criteria for pier foundations in these same areas.
Recommendation:	None.	

ICBO UNIFORM BUILDING CODE (U.B.C.) COMPARISON

Elevated Residential Structures (FEMA-54)

FEMA-54	U.B.C.	Analysis
Brick in Concrete Masonry Piers	Sec. 2403-2409 Sec. 2907 Appendix Chapter 23, Division IV.	FEMA-54 discusses, in general terms, the design of brick in concrete masonry piers and recommends that the long dimension of the pier be placed parallel to any anticipated flood flow. The Uniform Building Code has specific design criteria for the use these masonry pier foundations of brick in concrete in A Zones, but has no requirement for the placement of these piers parallel to any anticipated flood flow.
Recommendation:	None.	

FEMA-54	U.B.C.	Analysis
Concrete Piers	Chapter 26 Sec. 2907 Appendix Chapter 23, Division IV.	FEMA-54 discusses, in general terms, piers as a foundation system and gives recommendations as to their use. The Uniform Building Code has specific design criteria for concrete pier foundations given the applied loads and soil conditions.
Recommendation:	FEMA-54 should recommend the use of a soils engineer and soils investigation report in determining the best type of foundation.	

FEMA-54	U.B.C.	Analysis
Pier Footings	Chapter 29 Appendix Chapter 23, Division IV.	FEMA-54 discusses, in general terms, the sizing of pier footings in the foundation system and gives a recommendation that a soils engineer be consulted prior to the design of such a footing. The Uniform Building Code has specific design criteria for the design of the footings and embedment and requires a soils investigation.
Recommendation:	None.	

FEMA-54	U.B.C.	Analysis
Shear Walls and Diaphragms	Chapter 23 Chapter 24 Chapter 26 Appendix Chapter 23, Division IV Appendix Chapters 24 and 25.	FEMA-54 discusses, in general terms, the use of wood shear walls and wood floor diaphragms to transfer any horizontal forces to the foundation system. It does not recommend their use in coastal V Zones. The U.B.C. has specific design criteria for the use of shear walls as a bracing system and does not exclude the use of other materials such as masonry or concrete shear walls.
Recommendation:	None.	

Elevated Residential Structures (FEMA-54)

FEMA-54	U.B.C.	Analysis
Pier Foundation Connections	Sec. 2303 Sec. 2615 Sec. 2907.	FEMA-54 recommends certain pier foundation connections and gives some specific design criteria. The U.B.C. requires that these connections be designed by a licensed engineer or architect for the applied loads.

Recommendation: As these are very important connections, it is recommended that FEMA-54 recommend the use of a licensed engineer or architect in the design of these connections and that it should recognize that other connections may be more adequate for the same purpose.

FEMA-54	U.B.C.	Analysis
Floor Beams	Chapter 25.	FEMA-54 discusses, in general terms, the different sizes and types of floor beams used in construction of residential structures and gives some general design recommendations. The Uniform Building Code requires that floor beams be designed for the applied loads by a licensed engineer or architect and that they meet specific design criteria.

Recommendation: FEMA-54 should recommend that these members and any splices of some be designed by a licensed engineer or architect.

FEMA-54	U.B.C.	Analysis
Cantilevers	Chapter 25 Chapter 29.	FEMA-54 discusses, in general terms, the use of a cantilevered floor area to reduce the number of piles in the foundation system. The U.B.C. requires that a pile foundation system be design by a licensed engineer or architect for the applied loads.

Recommendation: None.

FEMA-54	U.B.C.	Analysis
Floor Joist/Floor Beam Connections	Chapter 25 Appendix Chapters 23, 24 and 25.	FEMA-54 recommends that a positive connection be developed between the first floor joists and the floor beams supporting them and discusses, in general terms, the usage of straps as the connection. The U.B.C. requires that approved anchors be installed to provide a continuous tie from the roof to the foundation system and that these connections be designed by a licensed engineer or architect.

Recommendation: FEMA-54 should recommend the use of a licensed engineer or architect in the design of a substantial connection.

Elevated Residential Structures (FEMA-54)

FEMA-54	U.B.C.	Analysis
Figure No. 4.48 Protected Utility Shaft	Appendix Chapter 23, Division IV. U.P.C.: Sec. 315 (e).	FEMA-54 provides a diagram of a recommended protective utility shaft. The Uniform Building Code requires that mechanical and electrical systems be either placed above the base flood elevation or protected to prevent any water from entering the system's components during a flood event.

Recommendation: None.

FEMA-54	U.B.C.	Analysis
Mechanical Equipment	Appendix Chapter 23, Division IV. U.P.C.: Sec. 315 (e).	FEMA-54 discusses the elevating of all mechanical equipment above the base flood elevation and the protection of same due to a flood event. The Uniform Building Code requires that all mechanical equipment either be placed above the base floor elevation or protected against a flood event.

Recommendation: None.

FEMA-54	U.B.C.	Analysis
Septic Tanks	Appendix Chapter 23, Division IV. U.P.C.: Sec. 315 (e).	FEMA-54 discusses the protection of septic tanks during a flood event. The Uniform Building Code requires that such equipment be protected to prevent water from entering or accumulating within the tank.

Recommendation: None.

FEMA-54	U.B.C.	Analysis
Building Materials	Chapters 24, 25, 26 Appendix Chapter 23, Division IV.	FEMA-54 discusses, in general terms, the protection of different types of building materials from a corrosive environment. The Uniform Building Code requires that materials in corrosive environments be protected in an approved manner.

Recommendation: FEMA-54 should not recommend that the designer use specific manufacturers or industrial groups for the protection of their products. The wording should be in general terms.

Elevated Residential Structures (FEMA-54)

FEMA-54	U.B.C.	Analysis
Wood	Chapter 25 Appendix Chapter 23, Division IV.	FEMA-54 discusses, in general terms, the treatment of wood to protect it against a corrosive environment. The Uniform Building Code requires that wood exposed to such environments be protected with an approved preservative treatment.

Recommendation: FEMA-54 should not recommend that a designer seek the guidance of a specific manufacturer of preservative in the guidelines. The terms should be more general.

FEMA-54	U.B.C.	Analysis
Steel	Chapter 1 Chapter 27 Appendix Chapter 23, Division IV.	FEMA-54 discusses the protection of steel structural members that are exposed to a corrosive environment. The U.B.C. does not have a specific requirement for the protection of steel. Rather, it requires that a structure be maintained in a safe condition which also has been interpreted as being protected from corrosive environments.

Recommendation: The U.B.C. should address the protection of steel structural elements specifically in Appendix Chapter 23, Division IV.

FEMA-54	U.B.C.	Analysis
Concrete and Masonry	Chapter 24 Chapter 26 Appendix Chapter 23, Division IV.	FEMA-54 discusses, in general terms, the use of chemical admixtures in surface treatments in the protection and strengthening of reinforced concrete and masonry block in corrosive environments. The Uniform Building Code has specific design criteria for the use of chemical admixtures in reinforced concrete and masonry construction.

Recommendation: FEMA-54 should not recommend a specific manufacturer for these products.

FEMA-54	U.B.C.	Analysis
Insulation	Sec. 1714 Appendix Chapter 23, Division IV.	FEMA-54 discusses, in general terms, the insulating of buildings. The Uniform Building Code requires that buildings are insulated per the requirements of the *Model Energy Code* and that such insulation meets specific design criteria.

Recommendation: None.

Elevated Residential Structures (FEMA-54)

FEMA-54	U.B.C.	Analysis
Glossary	Chapter 4 Appendix Chapter 23, Division IV.	FEMA-54 goes into much greater detail in defining the terms used in flood-resistant construction. The Uniform Building Code goes into much less detail in these definitions and only classifies the hazard zones into two zones, A Zones and V Zones.

Recommendation: None.

FEMA-54	U.B.C.	Analysis
Performance Criteria	Chapter 1 Chapter 4 Chapter 23 Chapter 29 Appendix Chapter 23, Division IV.	FEMA-54 identifies and defines loads which buildings may be subject to during a flood event and then provides three standards to which a building may be designed to. The U.B.C. has these different load definitions, however, the specific water loads and soil loads are left to the design of the engineer. Also, the U.B.C. has only one standard which the building can be designed to and that is the prescribed code requirements in this document.

Recommendation: None. Both documents serve different purposes.

Retrofitting Flood-Prone Residential Structures (FEMA-114)

FEMA-114	U.B.C.	Analysis
3.5 Foundation Walls	Chapter 23 Chapter 24 Chapter 26 Chapter 29 Appendix Chapter 23, Division IV.	FEMA-114 discusses the protection of a structure by elevating it above its original foundation and the various methods of achieving that. The Uniform Building Code provides design criteria for the design of such elevated structures. However, it is only required that these buildings be elevated above the BFE.

Recommendation: None.

FEMA-114	U.B.C.	Analysis
3.12 Extended Wall Foundations	Chapter 23 Chapter 24 Chapter 26 Chapter 29 Appendix Chapter 23, Division IV.	FEMA-114 discusses, in general terms, the design of extended reinforced concrete masonry and reinforced concrete extended wall foundations and provides some recommended construction practices as well as reference to Appendix C which provides a method for calculating the different loads that the building may be subject to. The Uniform Building Code provides specific design criteria for these types of foundations as well as standards of quality of the construction materials.

Recommendation: FEMA-114 should recognize that seismic forces may govern over wind loads in certain areas of the country and should recommend the use of a licensed engineer or architect in the design of such structures. FEMA-114 should also recognize the latest edition of all referenced standards within that portion of text.

FEMA-114	U.B.C.	Analysis
3.13 Anchorage of Super-Structured Foundation	Chapter 23 Sec. 2510 Chapter 29 Appendix Chapter 23, Division IV Appendix Chapters 24 and 25.	FEMA-114 provides a good discussion on the anchorage of exterior walls and floor diaphragms to the foundation system. Also, a number of details are provided to assist in the construction of such an anchor. The Uniform Building Code requires that these connections be provided and that a licensed engineer or architect design such connections given the applied loads on the building.

Recommendation: FEMA-114 should reference the latest edition of the ACI Standard 318.

Retrofitting Flood-Prone Residential Structures (FEMA-114)

FEMA-114	U.B.C.	Analysis
3.14 Open Foundations	Chapter 23 Chapter 24 Chapter 25 Chapter 26 Chapter 29 Appendix Chapter 23, Division IV Appendix Chapters 24 and 25.	FEMA-114 discusses, in general terms, the use of piers, columns and piles as a foundation system in flood-prone areas. The Uniform Building Code requires that piles or columns be used in V Zones only and gives specific design criteria for the use of same.

Recommendation: FEMA-114 should discuss the use of a soils engineer and soils report in determining the embedment length of piles and the soil-bearing pressure in flood-prone areas.

FEMA-114	U.B.C.	Analysis
6.2 Flood Wall Considerations	None.	FEMA-114 discusses the use of flood walls in the protection of residential structures. The U.B.C. requires that such buildings are elevated above the base flood elevation and has no provisions for such retrofitting of existing residential structures.

Recommendation: It is recommended that the U.B.C. develop some provisions for the retrofitting of existing buildings or at least refer to approved national standards.

FEMA-114	U.B.C.	Analysis
6.3 Techniques and Materials	Chapter 23 Chapter 24 Chapter 26.	FEMA-114 discusses the different types of flood walls and the materials used in their construction. The U.B.C. provides specific design criteria for the materials used in walls.

Recommendation: None.

Retrofitting Flood-Prone Residential Structures (FEMA-114)

FEMA-114	U.B.C.	Analysis
6.5 Technical Design Criteria	Chapter 23 Chapter 24 Chapter 26 Chapter 29.	FEMA-114 discusses specific design criteria for the materials used in flood walls and provides specific references to ACI Standards. It also provides a good discussion of the adequacy of the soil at the site to bear the applied loads. The U.B.C. provides specific design criteria for the design of walls, and also, requires that a soils investigation be done under specific conditions.

Recommendation: FEMA-114 should recognize the authority of the local building codes, rather than recommend the use of standards which may not be recognized by the jurisdiction.

FEMA-114	U.B.C.	Analysis
7.2 Closure Considerations	Appendix Chapter 23, Division IV.	FEMA-114 discusses the closure of any openings in either flood walls or exterior walls of a building and recommends that a professional engineer be consulted for the design of such closures. The U.B.C. requires that openings below the base flood elevation shall be provided with water-tight closures designed to withstand the applied loads.

Recommendation: None.

FEMA-114	U.B.C.	Analysis
7.3 Low Profile Closures	Appendix Chapter 23, Division IV.	FEMA-114 discusses the use of low profile, permanent closures around openings which may be below grade. The U.B.C. requires that openings below the base flood elevation shall be provided with water-tight closures designed to withstand the applied loads.

Recommendation: None.

FEMA-114	U.B.C.	Analysis
7.4 Closure Materials and Construction	Chapter 23 Chapter 25 Chapter 27 Chapter 28 Appendix Chapter 23, Division IV.	FEMA-114 discusses the types of materials used in construction of the closures at openings in flood walls. The U.B.C. provides specific design criteria for the use of such materials under the applied loads.

Recommendation: None.

Retrofitting Flood-Prone Residential Structures (FEMA-114)

FEMA-114	U.B.C.	Analysis
7.6 Technical Design Criteria for Closures	Chapter 23 Chapter 25 Chapter 27 Chapter 28 Appendix Chapter 23, Division IV.	FEMA-114 provides a method for calculating potential flood forces. The U.B.C. recommends the use of well-established engineering principles and/or approved national standards and provides the allowable stresses for such materials used.

Recommendation: FEMA-114 should recognize the authority of the local building codes in determining the allowable stresses for such materials.

FEMA-114	U.B.C.	Analysis
8.2 Sealant Considerations	Sec. 1708 Appendix Chapter 23, Division IV.	FEMA-114 discusses the problem of sealing different types of walls from water penetration. The U.B.C. requires that such walls be designed to withstand hydrostatic and hydrodynamic loads during the occurrence of flooding, but not necessarily to resist the penetration of the water due to the flood event. It does, however, address the sealing of openings in walls below the base flood elevation.

Recommendation: Both the U.B.C. and FEMA-114 should develop some language to address acceptable water penetration.

FEMA-114	U.B.C.	Analysis
8.3 Sealing Techniques	Sec. 1708 Appendix Chapter 23, Division IV.	FEMA-114 discusses several techniques of sealing exterior walls that are exposed to waters due to a flood event. The U.B.C. has no such provision. The U.B.C. requires that the exterior walls be weatherproofed to protect the interior finish of the wall.

Recommendation: None.

FEMA-114	U.B.C.	Analysis
8.4 Closures	Appendix Chapter 23, Division IV.	FEMA-114 discusses a few sealing techniques for larger openings such as windows and doors. The U.B.C. requires that openings below the base flood elevation shall be provided with water-tight closures designed to withstand the applied loads.

Recommendation: None.

Retrofitting Flood-Prone Residential Structures (FEMA-114)

FEMA-114	U.B.C.	Analysis
8.5 Design Details	Appendix Chapter 23, Division IV.	FEMA-114 recommends that all walls subject to flood waters be designed for hydrodynamic, hydrostatic and impact loads due to the flood event. The U.B.C. also requires that such walls be designed to withstand the same applied loads.

Recommendation: None.

FEMA-114	U.B.C.	Analysis
8.7 Technical Design Criteria	Chapter 23 Chapter 24 Chapter 26 Chapter 27 Chapter 28 Chapter 29 Appendix Chapter 23, Division IV.	FEMA-114 discusses the use of the materials in the structural analysis of walls that are subject to hydrodynamic, hydrostatic and impact loads. The U.B.C. has specific design criteria for the use of such materials and requires that they are also designed for these same applied loads.

Recommendation: FEMA-114 should recognize the authority of the local building codes in the design of such walls and should only reference the latest edition of the ACI Standards as guidelines.

FEMA-114	U.B.C.	Analysis
9.4 Permanent Protective Measures of Utilities	Appendix Chapter 23, Division IV. U.P.C.: Sec. 315 (e).	FEMA-114 discusses a number of techniques of protecting utilities that may be subject to flood waters due to a flood event. The Uniform Building Code requires that electrical and mechanical equipment either be placed above the base flood elevation or protected to prevent water from entering or accumulating in the system due to a flood event.

Recommendation: None.

FEMA-114	U.B.C.	Analysis
9.5 Utility Relocations to Existing Space	Appendix Chapter 23, Division IV. U.P.C.: Sec. 315 (e).	FEMA-114 discusses methods of protecting different utilities from flood events using existing space within the structure. The U.B.C. just requires that new or replacement electrical and mechanical equipment be either placed above the base flood elevation or protected to prevent water from entering the system.

Recommendation: None.

Retrofitting Flood-Prone Residential Structures (FEMA-114)

FEMA-114	U.B.C.	Analysis
9.6 Utility Relocations to New Space	Appendix Chapter 23, Division IV. U.P.C.: Sec. 315 (e).	FEMA-114 discusses the protection of utilities by relocating them to new additions that are above or protected from the base flood event. The Uniform Building Code just requires that new or replacement electrical and mechanical equipment be either placed above the base flood elevation or protected to prevent water from entering the system.
Recommendation:	None.	

FEMA-114	U.B.C.	Analysis
9.8 Storage Tank Anchorage	None.	FEMA-114 discusses methods of anchoring fuel tanks in the event that the buoyant force may lift the tank during a flood event. The Uniform Building Code does not regulate such structures.
Recommendation:	None.	

FEMA-114	U.B.C.	Analysis
10.4 Floating Structures	None.	FEMA-114 discusses an unusual method of flood-proofing a structure by allowing it to rise or fall with the flood waters. The Uniform Building Code does not allow such a situation.
Recommendation:	None.	

FEMA-114	U.B.C.	Analysis
Appendix C Forces	Chapter 23 Appendix Chapter 23, Division IV.	FEMA-114 discusses the methods for calculating hydrostatic, hydrodynamic and impact loads as well as wind loads on the structures that may be subject to flood events. The Uniform Building Code makes reference to approved national standards and site conditions for hydrostatic, hydrodynamic and impact loads, but has a specific methodology for calculating wind loads.
Recommendation:	None.	

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

FEMA-102	U.B.C.	Analysis
E Contingent Flood Proofing Measures	Appendix Chapter 23, Division IV.	FEMA-102 discusses the different types of flood proofing measures and their advantages and disadvantages in this section. The Uniform Building Code only requires that openings below the base flood elevation be provided with watertight enclosures.
Recommendation:	None.	

FEMA-102	U.B.C.	Analysis
F.1 Flood Shields	Appendix Chapter 23, Division IV.	FEMA-102 discusses the advantages and disadvantages of using flood shields as a flood proofing method. The Uniform Building Code only requires that openings below the base flood elevation be provided with watertight closures.
Recommendation:	None.	

FEMA-102	U.B.C.	Analysis
F.2 Watertight Doors	Appendix Chapter 23, Division IV.	FEMA-102 discusses the advantages and disadvantages of using watertight doors as a method of flood proofing the openings in the structure. The Uniform Building Code only requires that openings below the base flood elevation be provided with watertight enclosures.
Recommendation:	None.	

FEMA-102	U.B.C.	Analysis
F.3 Moveable Flood Walls	Appendix Chapter 23, Division IV.	FEMA-102 discusses the advantages and disadvantages of using moveable flood walls as a method of flood proofing a structure. The Uniform Building Code only requires that openings below the base flood elevation be provided with watertight closures.
Recommendation:	None.	

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

FEMA-102	U.B.C.	Analysis
B Elevation Non-Fill	Chapter 29 Appendix Chapter 23, Division IV.	FEMA-102 discusses the use of fill material to elevate a structure above the base flood elevation and provides some design recommendations. The U.B.C. requires that fill can only be used as an elevation technique in the "A" Zones.

Recommendation: None.

FEMA-102	U.B.C.	Analysis
C.2 Posts	Appendix Chapter 23, Division IV.	FEMA-102 discusses the use of posts to elevate a structure above the base flood elevation. The U.B.C. requires that a building be elevated above the base flood elevation.

Recommendation: None.

FEMA-102	U.B.C.	Analysis
Figure No. III-7 Pile Characteristics and Pier Walls	Chapter 24 Chapter 29 Appendix Chapter 23, Division IV.	FEMA-102 discusses the general characteristics of piles and pier walls and their advantages and disadvantages. The Uniform Building Code provides specific design criteria for the design of piers and pier walls, but relies on the design of a licensed engineer or architect.

Recommendation: FEMA-102 should recommend that a licensed engineer or architect design the structure.

FEMA-102	U.B.C.	Analysis
Table No. III-1 Requirements for Reinforced Piers	Chapter 24 Chapter 26 Chapter 29 Appendix Chapter 23, Division IV.	Table No. III-1 of FEMA-102 gives some minimum design requirements for the construction of reinforced piers. The U.B.C. has specific design criteria for the use of reinforced piers and relies on the design of a licensed engineer or architect.

Recommendation: FEMA-102 should rely on the design of a licensed engineer or architect for the use of reinforced piers.

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

FEMA-102	U.B.C.	Analysis
C.6 Maintenance	Chapter 1.	FEMA-102 recommends the regular maintenance of those structural elements that are exposed to flood events. The Uniform Building Code requires that all buildings and structures be maintained in a safe and sanitary condition.

Recommendation: None.

FEMA-102	U.B.C.	Analysis
E.1 and E.2 Waterproof Walls	Chapter 24 Chapter 26 Appendix Chapter 23, Division IV.	FEMA-102 discusses the use of different building materials in the construction of waterproof walls and gives some simple design recommendations. The Uniform Building Code has specific design criteria for the use of these construction materials.

Recommendation: FEMA-102 should recognize that the local building code has authority for the design of such structural elements and it should also provide, as a recommendation only, the latest edition of the referenced documents listed within this section.

FEMA-102	U.B.C.	Analysis
D.3 and D.4 Concrete Slabs	Chapter 26 Chapter 29 Appendix Chapter 23, Division IV.	FEMA-102 discusses, in general terms, two methods of resisting uplift forces in concrete slabs due to a flood event and provides design recommendations as to the relief of such uplift forces. The Uniform Building Code provides specific criteria for the design of such slabs as well as requiring that they resist uplift and buoyancy type forces.

Recommendation: FEMA-102 should recognize the authority of the local building code in the design of such structural elements.

FEMA-102	U.B.C.	Analysis
D.5 Waterproofing	Sec. 1714 Chapter 24 Chapter 26 Appendix Chapter 23, Division IV.	FEMA-102 discusses three methods of waterproofing exterior walls. The Uniform Building Code requires that walls and floors that are impermeable to the passage of water.

Recommendation: None.

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

FEMA-102	U.B.C.	Analysis
D.6 Watertight Cores	None.	FEMA-102 discusses the waterproofing of interior walls when such waterproofing of exterior walls is not feasible. The U.B.C. has no provisions for this.

Recommendation: None.

FEMA-102	U.B.C.	Analysis
D.7 Closures and Flood Shields	Appendix Chapter 23, Division IV.	FEMA-102 discusses the use of closures and flood shields as a means of protecting openings below the base flood elevation and provides several details for different types of openings. The Uniform Building Code requires that openings below the base flood elevation be provided with a watertight closure.

Recommendation: None.

FEMA-102	U.B.C.	Analysis
E.5 Flood Walls	Chapter 24 Chapter 26 Chapter 29 Appendix Chapter 23, Division IV.	FEMA-102 discusses the different types of flood walls that can be used to protect structures from flood events and gives some general design recommendations. The U.B.C. provides design criteria for the design of flood walls, given the applied loads.

Recommendation: FEMA-102 should recommend the use of a soils engineer in the design of such walls and levees.

FEMA-102	U.B.C.	Analysis
E.7 Flood Wall Maintenance	Chapter 1.	FEMA-102 recommends regular inspection and maintenance of flood walls and levees to maintain their structural integrity. The Uniform Building Code requires that all buildings and structures be maintained in a safe and sanitary condition.

Recommendation: None.

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

FEMA-102	U.B.C.	Analysis
C Utilities	Appendix Chapter 23, Division IV. U.P.C.: Sec. 315 (e).	FEMA-102 discusses a number of the techniques for the flood proofing of utilities associated with nonresidential structures. The Uniform Building Code requires that such utilities be either placed above the base flood elevation or protected to prevent water from entering within the system.
Recommendation:	None.	

FEMA-102	U.B.C.	Analysis
Appendix B Glossary	Chapter 4 Appendix Chapter 23, Division IV.	All of the terms found in the glossary of FEMA-102 are related to flood proofing of structures or flood plain management. The Uniform Building Code's definitions are much more general in nature and terms that are not found within are referenced to the definitions found in *Webster's Third New International Dictionary of the English Language Unabridged*, Copyright 1986.
Recommendation:	None.	

FEMA-102	U.B.C.	Analysis
B Design Loads	Chapter 23 Appendix Chapter 23, Division IV.	FEMA-102 provides a general definition of the design loads that may occur on a structure located in a flood plain. The Uniform Building Code provides specific criteria for the determination of these loads with the exception of hydrostatic, hydrodynamic and impact loads generated by flood events. Those are referenced to either well-established engineering principles or approved national standards.
Recommendation:	None.	

FEMA-102	U.B.C.	Analysis
C Performance Criteria	Chapter 23 Appendix Chapter 23, Division IV.	FEMA-102 recommends specific design criteria for the structural analysis of elements that are exposed to waters generated by a design flood event. The Uniform Building Code has specific design criteria for all structures, however, for the loads generated by a design flood event, it references well-established engineering principles in approved national standards for the design of such structures.
Recommendation:	FEMA-102 should recognize the authority of the local building code in this section and include that in the recommended design of these elements.	

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

FEMA-85	U.B.C.	Analysis
Chapter III Elevation and Anchoring Techniques	Chapter 23 Chapter 24 Chapter 25 Chapter 26 Chapter 27 Chapter 29 Appendix Chapter 23, Division IV Appendix Chapters 24 and 25.	FEMA-85 discusses a number of techniques of elevating and anchoring manufactured homes in areas that are subject to flood events. The Uniform Building Code has specific design criteria for the design of most of these methods of elevating or anchoring a manufactured home. However, some of the methods would have to rely on the discretion of the building official.

Recommendation: FEMA-85 should discuss the authority of the local building code in the design and construction of such elevation and anchoring techniques.

FEMA-85	U.B.C.	Analysis
Chapter IV Design of Elevated Foundations	Chapter 23 Chapter 24 Chapter 25 Chapter 26 Chapter 27 Chapter 29 Appendix Chapter 23, Division IV Appendix Chapters 24 and 25.	FEMA-85 provides methods for calculating the hydrostatic and hydrodynamic loads generated by floods as well as certain conditions that may occur that could effect manufactured homes in the event of a flood. FEMA-85 also provides specific design criteria for the sizing of the structural members that elevate manufactured homes, as well as methods of protecting utilities that serve the manufactured homes. The Uniform Building Code provides specific design criteria for the structural design of the supports of manufactured homes, but defers to well-established engineering principles or approved national standards for the calculation of hydrodynamic or hydrostatic loads by licensed engineer or architect.

Recommendation: FEMA-85 should recognize the authority of the local building code in the design and sizing of the structural elements supporting manufactured homes and should recommend that a licensed engineer or architect be utilized in such design.

FEMA-85	U.B.C.	Analysis
Appendix D Calculation Procedure	Chapter 23 Chapter 25 Chapter 26 Appendix Chapter 23, Division IV.	FEMA-85 provides recommended procedures for the design of specific structural elements supporting the manufactured home. The Uniform Building Code provides specific criteria for the design of such members.

Recommendation: FEMA-85 should consider the authority of the local building code in the recommendations of this section.

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

FEMA-85	U.B.C.	Analysis
Appendix E Buoyancy and Drag Forces	Appendix Chapter 23, Division IV.	FEMA-85 provides criteria for the design of ground anchors to counteract any buoyancy or drag forces that may be generated by a flood event. The Uniform Building Code requires that all buildings or structures erected in the flood zone be designed and constructed to resist flotation, collapse or permanent lateral movement due to loads from a flood event.

Recommendation: FEMA-85 should consider that other types of hold-downs may be adequate to resist these generated forces.

Alluvial Fans: **Hazards and Management (FEMA-165)**

FEMA-165	U.B.C.	Analysis
Windows and Doors	Appendix Chapter 23, Division IV.	FEMA-165 recommends that the designer avoid the placement of openings on the uphill side of the structure on alluvial fans to prevent debris and flood water from entering a building. The Uniform Building Code just requires that openings below the base flood elevation be provided with watertight closures adequate to support any generated loads. If such openings are used, then they should be designed to withstand any forces generated by a flood on the alluvial fan.

Recommendation: None.

ICBO UNIFORM BUILDING CODE (U.B.C.) COMPARISON

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

MCRB	U.B.C.	Analysis
III A.1 Unreinforced Block	Sec. 2407 (i) Appendix Chapter 23, Division IV.	The MCRB briefly discusses the use of unreinforced block in non-coastal flood areas. The U.B.C. has specific design criteria for the use of unreinforced block but does not allow residential basements to be located below the BFE.

Recommendation: None, since floodproofing of basements is allowed only in communities that have been granted an exception by FEMA.

MCRB	U.B.C.	Analysis
III A.2 Reinforced and Grouted Block	Chapter 24 Appendix Chapter 23, Division IV	The MCRB briefly discusses the use of reinforced and grouted block in non-coastal flood areas. The U.B.C. has specific criteria for the use of reinforced and grouted block, but does not allow residential basements below the BFE.

Recommendation: See recommendation for MCRB III A.1.

MCRB	U.B.C.	Analysis
III A.3 Unreinforced Concrete	Sec. 2622.	The MCRB briefly discusses the use of unreinforced concrete in residential basement walls in non-coastal flood areas. The U.B.C. has specific provisions for the use of plain (unreinforced) concrete, but does not allow residential basements below the BFE.

Recommendation: See the recommendation for MCRB III A.1.

MCRB	U.B.C.	Analysis
III A.4 Reinforced Concrete	Chapter 26	The MCRB briefly discusses the use of reinforced concrete in residential basement walls in non-coastal flood areas. The U.B.C. has specific provisions for the use of reinforced concrete, but does not allow residential basements below the BFE.

Recommendation: See the recommendation for MCRB III A.1.

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

MCRB	U.B.C.	Analysis
III A.5 Stone, Cribbing and Planking	None.	The MCRB briefly discusses the use of cut stone rubble stone and even cribbing and planking in older residential homes and does not recommend its use as a construction material below the BFE. The U.B.C. does not have such provisions.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
III A.6 Treated Wood Foundations	Sec. 2907.	The MCRB did not have enough information to discuss the use of treated wood foundations. The U.B.C. has specific provisions for the use of treated wood foundations, but does not allow residential basements below the BFE.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
III A.7 Variations of Foundations	Chapter 24 Chapter 26 Chapter 29	The MCRB briefly discusses variations in the design of foundations used in residential basements below the BFE. The U.B.C. has specific provisions for the design of foundations, but does not allow residential basements below the BFE.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
III A.8	Sec. 2903 Appendix Chapter 70	The MCRB discusses specific requirements for excavation, grading and backfilling residential basement walls. The U.B.C. has specific provisions for excavation, grading and backfilling basement walls, but does not allow residential basements below the BFE.
Recommendation:	See the recommendation for MCRB III A.1.	

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

MCRB	U.B.C.	Analysis
III A.9	Sec. 2606	The MCRB discusses the design and construction of formwork for concrete basement walls. The U.B.C. has similar design criteria for formwork for all types of concrete work.

Recommendation: None.

MCRB	U.B.C.	Analysis
III B.1 Basement Slab	Sec. 2623 Sec. 2904	The MCRB discusses the types of slabs used in basement floors below the BFE. The U.B.C. has specific criteria for slabs-on-grade, but does not allow residential basements below the BFE.

Recommendation: See the recommendation for MCRB III A.1.

MCRB	U.B.C.	Analysis
III B.2 Structural Basement Slab	Chapter 26	The MCRB discusses the thickness of slabs used to resist water pressure heads. The U.B.C. has specific provisions for the design of such slabs subject to applied loads, but does not allow residential basements below the BFE.

Recommendation: See the recommendation for MCRB III A.1.

MCRB	U.B.C.	Analysis
III B.3 Footing	Sec. 2907	The MCRB briefly discusses footing construction in residential basement wall foundations below the BFE. The U.B.C. has specific criteria for the design of footing, but does not allow residential basements below the BFE.

Recommendation: See the recommendation for MCRB III A.1.

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

MCRB	U.B.C.	Analysis
III B.4 Underdrain System and Sumps and Pumps	Sec. 2905	The MCRB discusses the use of an underdrain system in sumps and pumps as a method of relieving the build-up of hydrostatic head on the walls and slabs of a basement. The U.B.C. requires that the classification of the soil at each building site shall be determined by the building official who may require that this determination be made by an engineer or architect. The U.B.C., however, does not provide specific provisions for underdrain systems.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
III B.5A Ground Surface Slope	Sec. 2905	The MCRB discusses some techniques of site investigation and some possible findings of the same. The U.B.C. requires that the classification of the soil at each building site shall be determined by the building official who may require that this determination be made by an engineer or architect.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
III B.5B Grading and Surface Drainage	Sec. 2905 and Appendix Chapter 70	The MCRB discusses grading and surface drainage provisions and gives some minimum slopes for proper drainage. The U.B.C. just requires that provisions be made for the control and drainage of surface water around the building.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
III B.6 Seepage Quantities	Sec. 2303	The MCRB discusses a method of determining the size of a drain system using Darcy's law. The U.B.C. relies on approved national standards.
Recommendation:	None.	

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

MCRB	U.B.C.	Analysis
III B.7A Penetrations	Appendix Chapter 23, Division IV.	The MCRB discusses the means of ceiling penetrations through basement walls or slabs. The U.B.C. requires that all floor and wall penetrations be made water tight to prevent flood water seepage.

Recommendation: None.

MCRB	U.B.C.	Analysis
III B.7B Cracks and Joints	Appendix Chapter 23, Division IV.	The MCRB gives a fairly detailed description of techniques to lessen cracking in concrete. The U.B.C. just requires that exterior walls and floors be impermeable to the passage of water with no specific design provision, but does not allow residential basements below the BFE.

Recommendation: See the recommendation for MCRB III A.1.

MCRB	U.B.C	Analysis
III B.7C Waterproofing	Appendix Chapter 29	The MCRB briefly discusses the limitations of waterproofing basements below the BFE. The U.B.C. has design provisions for the waterproofing of foundations and basement walls, but does not allow residential basements below the BFE.

Recommendation: See the recommendation for MCRB III A.1.

MCRB	U.B.C.	Analysis
III B.8 Plumbing Subsystems	None.	The MCRB discusses the materials and considerations in the design of drainage subsystems. The uniform codes have no such provisions.

Recommendation: See the recommendation for MCRB III A.1.

ICBO UNIFORM BUILDING CODE (U.B.C.) COMPARISON

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

MCRB	U.B.C.	Analysis
III B.9 Anchorage	Sec. 2303	The MCRB provides a means of calculating the lateral force due to flood water pressures. The Uniform Building Code has a very general statement that the entire system must be designed to resist all applied loads which would include a hydrostatic load, but does not allow residential basements below the BFE.

Recommendation: See the recommendation for MCRB III A.1.

MCRB	U.B.C.	Analysis
III B.10 Concrete Construction Practices	Chapter 26	The MCRB goes through a number of typical handling and construction techniques for concrete walls and slabs. U.B.C. has specific provisions for the handling, depositing and considerations for concrete construction.

Recommendation: None.

MCRB	U.B.C.	Analysis
III B.11 Block Construction Practices	Chapter 24	The MCRB recommends a number of construction practices for the design and installation of concrete block walls. The U.B.C. has specific provisions for the construction of concrete block walls, but does not allow residential basements below the BFE.

Recommendation: See the recommendation for MCRB III A.

MCRB	U.B.C.	Analysis
III C.1.A-D Soil Loads	Secs. 2904 and 2905	The MCRB has specific provisions for the classification of the soil that may be found at the site. The U.B.C. relies on an engineer or architect licensed by the state to conduct a thorough site investigation for these particular items and to provide a report with the findings.

Recommendation: None.

ICBO UNIFORM BUILDING CODE (U.B.C.) COMPARISON

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

MCRB	U.B.C.	Analysis
III C.1E Soil Erosion	Appendix Chapter 70.	The MCRB provides a brief discussion as to the effects of soil erosion on basement construction. The U.B.C. requires that measures be undertaken by the soil engineer to limit the amount of erosion around the building site.

Recommendation: None.

MCRB	U.B.C.	Analysis
III C.1.F Backfill	Chapter 29 and Appendix Chapter 70	The MCRB provides a discussion as to the means of calculating the lateral pressure due to soil and the backfill behind basement walls. The U.B.C. relies on the judgement of an engineer or architect licensed by the state to practice soil engineering for the determination of the lateral pressure due to the soil and backfill.

Recommendation: None.

MCRB	U.B.C.	Analysis
III C.2 Water Table	Section 2905	The MCRB has a short description of how the water table affects stresses in the soil. The U.B.C. relies on the judgement of the engineer or architect licensed to practice soil engineering for this determination.

Recommendation: None.

MCRB	U.B.C.	Analysis
III C.3 Super Structure Loads and Buoyancy	Chapter 23	The MCRB provides examples of calculating super imposed loads on the basement foundation walls and footings. The U.B.C. does not allow residential basements below the BFE, therefore, there are no such provisions.

Recommendation: See the recommendation for MCRB III A.1.

ICBO UNIFORM BUILDING CODE (U.B.C.) COMPARISON

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

MCRB	U.C.B.	Analysis
III C.4.d Flood Velocity	None.	The MCRB discusses the effect of flood water velocity and it's affect on a structure's structural integrity. The U.B.C. has no such provision.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
III C.4.e Sediment	None.	The MCRB discusses flood water deposited sediment and it's affect on a structure. The U.B.C. has no such provision.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
III C.4.f Rate of Rise	None.	The MCRB discusses the importance of the rate of rise of flood waters as a consideration in the design of a structure's ability to withstand flood water damage. The U.B.C. has no such provision.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
III C.4.g Hydraulic Relations	None.	The MCRB discusses the interdependence of design variables in the analysis of site design. The U.B.C. has no such provisions.
Recommendation:	None.	

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

MCRB	U.B.C.	Analysis
III C.5.h Debris, Wind, Impact, Snow, Ice and Other Live Loads	Chapter 23	The MCRB discusses the importance of debris and impact loading in the design of structures near coastal areas. The U.B.C. generally discusses live loads and defers to approved national standards.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
V A.2.a Building Model Dimensions and Loading	None.	The MCRB provides a cross section of a typical basement wall being loaded by flood water. The U.B.C. has no such sketch or provision.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
V A.2.b Structural Analysis Model	None.	The MCRB provides an analysis model of a loaded beam and it's applicability in flood water design. The U.B.C. has no such provision.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
V A.2.c Structural Plain Concrete	None.	The MCRB provides a model for structural plain concrete and derives some design values. The U.B.C. provides specific equations in design criteria, but does not provide any models by which to follow.
Recommendation:	None.	

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

MCRB	U.B.C.	Analysis
V A.2.d Reinforced Concrete	None.	The MCRB provides a model for reinforced concrete using ultimate strength design. The U.B.C. provides specific equations in design criteria, but does not provide any models by which to follow.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
V A.2.e Plain Masonry Block	None.	The MCRB provides a model for plane masonry block using working stress design. The U.B.C. provides specific equations in design criteria, but does not provide any models by which to follow.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
V A.2.f Reinforced Masonry Block	None.	The MCRB provides a model for reinforced masonry block. The U.B.C. provides specific equations in design criteria, but does not provide any models by which to follow.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
V A.2.g Flood Waters Above Grade	None.	The MCRB provides typical wall analyses for flood waters acting above grade level. The U.B.C. has no such model.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
V A.2.h Slab Thickness	None.	The MCRB calculates the slab thickness in slab span for flood water type loading.
Recommendation:	None.	

ICBO UNIFORM BUILDING CODE (U.B.C.) COMPARISON

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

MCRB	U.B.C.	Analysis
V A.2.i Structural Slab Design	None.	The MCRB provides the design example for the design of structural slabs given flood water conditions. The U.B.C. has no such analysis.

Recommendation: None.

MCRB	U.B.C.	Analysis
V B.1 Weir Load Level		The MCRB gives consideration to weir type effect of windows in the design of structures for flood water conditions. The U.B.C. has no such consideration, but would defer to approved national standards.

Recommendation: None.

MCRB	U.B.C.	Analysis
V B.2 Buoyancy	None.	The MCRB has a brief discussion of the affects of buoyancy in residential basements. The U.B.C. has no such provision, but would defer to approved national standards.

MCRB	U.B.C.	Analysis
V B.3 Slab Venting	None.	The MCRB is a very brief discussion as to the treatment of bending in slabs due to flood water conditions. The U.B.C. has no such provision, but would defer to approved national standards.

Recommendation: None.

MCRB	U.B.C.	Analysis
V B.4 Wall Loads	None.	The MCRB briefly discusses wall design due to flood water conditions. The U.B.C. has no such provisions, but would defer to approved national standards.

Recommendation: None.

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

MCRB	U.B.C.	Analysis
V B.5 Water Infiltration Protection	Appendix Chapter 29	The MCRB discusses the protection of basements from water infiltration and gives some recommendations. The U.B.C. has specific provisions for the protection of foundation walls and would rely upon approved materials for such protection.

Recommendation: None.

MCRB	U.B.C.	Analysis
V B.5.a Drain or Sump System	None.	The MCRB provides a discussion of drain or sump system type protection of basements which assumes some infiltration of water. The U.B.C. has provisions which require the water proofing of foundation walls without allowing any infiltration of water when hydrostatic pressure caused by water table may exist, other than that, damp proofing can be provided.

Recommendation: None.

MCRB	U.B.C.	Analysis
V B.5.b Undrained or Barge System	Appendix Chapter 29	The MCRB discusses undrained or barge system type protection of basement walls and gives some construction details or same. The U.B.C. requires water proofing when hydrostatic pressure may be due to water table they occur on basement walls, other than that, damp proofing may be provided.

Recommendation: None.

MCRB	U.B.C.	Analysis
VIII Appendix A Allowable Bearing Pressures	Chapter 29	The MCRB provides a table of allowable bearing pressures based on consistency of soil as determined by the classification and identification of the soil. The U.B.C. has no such specific provision based on the consistency of soil, but determines the allowable foundation pressure based on the class of the material. Both are acceptable means of determining the allowable bearing pressure.

Recommendation: None.

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

MCRB	U.B.C.	Analysis
VIII Appendix A Allowable Soil Pressures Beneath Footings	Chapter 29	The MCRB provides two charts for determining allowable soil bearing pressure based on the cohesiveness of the soil and the width or depth of the footing. The U.B.C. has no such tables, but would defer to approved national standards.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
VIII A.2.a Soil and Water Loading	Chapter 29	The MCRB provides specific soil and water loading design criteria based on the type of soil in which the structure is located. The U.B.C. does not contain specific soil and water loading design criteria, but would defer to approved national standards.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
VIII A.2.c Water Proofing Systems	Appendix Chapter 29	The MCRB provides two cross sections of basement construction as examples of drained and undrained systems with construction recommendations. The U.B.C. has no specific design criteria for these types of systems, but contains performance criteria which water proofing systems must meet.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
VIII A.2.d Wall Design	Chapter 24 and Appendix Chapter 29.	The MCRB provides an example of designing reinforced masonry basement walls and their water proofing. The U.B.C. has no such example, but has specific design criteria which the system must meet.
Recommendation:	None.	

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

MCRB	U.B.C.	Analysis
VIII A.2.e Slab Design	Chapter 26 and Appendix Chapter 29	The MCRB provides specific example for the design of slabs and their water proofing. The U.B.C. has no such examples, but provides specific design criteria for those systems.

Recommendation: None.

MCRB	U.B.C.	Analysis
VIII B. Acceptable Wall Designs	None.	The MCRB discusses a number of provided structural design curves for basement walls given an equivalent fluid loading condition for different types of construction materials. The U.B.C. has no such design curves, but provides specific design criteria for each construction material.

Recommendation: None.

MCRB	U.B.C.	Analysis
VIII B.1 Structural Plain Concrete Wall	Chapter 26	The MCRB provides specific charts for the design of structural plain concrete walls given an equivalent fluid loading condition. The U.B.C. would rely upon the determination of structural capacity by a licensed engineer or architect and approved national standards.

Recommendation: None.

MCRB	U.B.C.	Analysis
VIII B.2 Reinforced Concrete Wall	Chapter 26	The MCRB provides specific design criteria for reinforced concrete walls given an equivalent fluid loading condition. The U.B.C. has no such provisions, but would rely on the design of a licensed engineer or architect and approved national standard.

Recommendation: None.

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

MCRB	U.B.C.	Analysis
VIII B.3 Unreinforced Masonry Block Wall	Chapter 24	The MCRB provides specific design criteria for unreinforced masonry walls given an equivalent fluid loading condition. The U.B.C. has no such provisions and would rely on the design of a licensed engineer or architect and approved national standards.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
VIII B.4 Reinforced Masonry Block Wall	Chapter 24	The MCRB provides specific design criteria for reinforced masonry block walls given an equivalent fluid loading condition. The U.B.C. has no such provisions and would rely on the design of a licensed engineer or architect and approved national standards.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
VIII B.5 Buoyancy Wall	None.	The MCRB gives specific design criteria for the design of buoyancy walls required in undrained systems. The U.B.C. has no such provisions and does not allow residential basements below the BFE.
Recommendation:	None.	

MCRB	U.B.C.	Analysis
VIII C.6 Reinforced Concrete Slab	Chapter 26	The MCRB provides specific design criteria for the design of basement slabs and undrained systems based on an allowable depth of loading. The U.B.C. has no such provisions.
Recommendation:	None.	

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

MCRB	U.B.C.	Analysis
VIII D.1 Control Joints	Appendix Chapter 29	The MCRB provides specific water proofing provisions for wall and slab control joints. The U.B.C. does not provide specific provisions, but has performance criteria for the water proofing of slabs and walls requiring water proofing.

Recommendation: None.

MCRB	U.B.C.	Analysis
VIII D.2 Sump, Pump and Underdrain	None.	The MCRB provides specific details for the design of sump pumps and associated underdrain system. The U.B.C. has no such provisions.

Recommendation: None.

MCRB	U.B.C.	Analysis
VIII D.3.a Water Proofed Underdrain Slab and Wall System	Appendix Chapter 29	The MCRB provides specific design criteria for water proofing undrained basements. The U.B.C. has no such provisions.

Recommendation: None.

MCRB	U.B.C.	Analysis
VIII D.3.b Water Proofed Drain, Slab and Wall System	Appendix Chapter 29	The MCRB provides specific design criteria for drain basement type systems. The U.B.C. has no such provision.

Recommendation: None.

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

MCRB	U.B.C.	Analysis
VIII D.3.c Slab Wall Footing Juncture	Appendix Chapter 29	The MCRB provides specific details for the protection of the intersection of a slab wall and footing. The U.B.C. has no such details.

Recommendation: None.

MCRB	U.B.C.	Analysis
I B.4 Flood Velocity	None.	The MCRB discusses the effects of high velocities of flood waters and the increased potential for damage to structures in their path. The U.B.C. has no such discussion and would rely on approved national standards.

Recommendation: None.

MCRB	U.B.C.	Analysis
I B.5 Sediment	None.	The MCRB discusses the effects of sediment deposition on structures due to flood events. The U.B.C. has no such discussion.

Recommendation: None.

ICBO UNIFORM BUILDING CODE (U.B.C.) COMPARISON

Technical Standards Bulletin: Wet Flood Proofing, Bulletin No. 85-1

Bulletin No. 85-1	U.B.C.	Analysis
I. Definition	Appendix Chapter 23, Division IV.	FEMA Bulletin No. 85-1 defines wet flood proofing as the intentional internal flooding of a structure in order to alleviate any pressures due to a flood event. The U.B.C. requires that any approved occupiable space, in other than a residential occupancy, that is below the base flood elevation be constructed with exterior walls and floors that are impermeable to the passage of water and designed to meet any hydrostatic and hydrodynamic loads that may be incurred. Other enclosed spaces such as those for building access exits, foyers, storage and parking garages are required to have openings to allow the equalization of pressure due to a flood event.

Recommendation: FEMA Bulletin No. 85-1 should state that this method of floodproofing is only acceptable for the retrofitting of existing buildings.

Bulletin No. 85-1	U.B.C.	Analysis
II. Protection Goals	Appendix Chapter 23, Division IV.	FEMA Bulletin No. 85-1 lists a number of the components in the protection of a building and its contents. The Uniform Building Code does not recognize the viability of wet flood proofing in occupiable spaces.

Recommendation: See the recommendation of Item I in Bulletin No. 85-1.

Bulletin No. 85-1	U.B.C.	Analysis
III. B Structural Considerations	Appendix Chapter 23, Division IV.	FEMA Bulletin No. 85-1 recommends that a structure be designed so that all of its materials, finishes, utilities, etc. be able to withstand any forces generated by flood elements as well as the corrosive nature of water. The U.B.C. does not recognize the viability of wet flood proofing of occupiable spaces, but does recommend that structural members, utilities, etc. that are exposed to such conditions be protected.

Recommendation: See the recommendation of Item I in Bulletin No. 85-1.

Technical Standards Bulletin: Wet Flood Proofing, Bulletin No. 85-1

Bulletin No. 85-1	U.B.C.	Analysis
III. C Building Activity and Use	Appendix Chapter 23, Division IV.	FEMA Bulletin No. 85-1 discusses how the activities and uses within a building can change the likelihood of a building being damaged during a flood event. The Uniform Building Code does not recognize the viability of wet flood proofing in occupiable spaces.

Recommendation: See the recommendation of Item I in Bulletin No. 85-1.

Bulletin No. 85-1	U.B.C.	Analysis
IV. A.1 Foundations	Chapter 29 Appendix Chapter 23, Division IV.	FEMA Bulletin No. 85-1 discusses, in general terms, the loads that a foundation may be subject to during a flood event under a wet flood proofing design. The Uniform Building Code requires a foundation to be designed for all applied loads.

Recommendation: None.

Bulletin No. 85-1	U.B.C.	Analysis
IV. A.2 Cavity Walls	None.	FEMA Bulletin No. 85-1 recommends that if cavity walls are used in the design of a structure, that they must be made so that the cavity space drains at a rate approximately equal to the flood rate and that any material contained within be able to withstand the inundation. The Uniform Building Code has no such provisions.

Recommendation: None.

Bulletin No. 85-1	U.B.C.	Analysis
IV. A.3 Solid Walls	Chapter 24 Chapter 25 Chapter 26 Appendix Chapter 23, Division IV.	FEMA Bulletin No. 85-1 discusses the protection of solid walls due to any moisture permeation, especially any spalling due to freeze/thaw conditions. The Uniform Building Code has provisions for the protection of solid walls due to freeze/thaw conditions and also provides specific design criteria to prevent any spalling due to moisture penetration.

Recommendation: None.

ICBO UNIFORM BUILDING CODE (U.B.C.) COMPARISON

Technical Standards Bulletin: Wet Flood Proofing, Bulletin No. 85-1

Bulletin No. 85-1	U.B.C.	Analysis
IV. A.4 Interior Walls	Chapter 24 Chapter 25 Chapter 26 Appendix Chapter 23, Division IV.	FEMA Bulletin 85-1 discusses the protection of interior walls and recommends that the same provisions for cavity walls and solid walls be used for any such interior walls. The Uniform Building Code does not recognize the wet flood proofing of the interior of an occupiable space as a viable option, therefore, there are no provisions.

Recommendation: See the recommendation of Item I in Bulletin No. 85-1.

Bulletin No. 85-1	U.B.C.	Analysis
IV. A.5 Interior Wall Finishes	Chapter 42 Appendix Chapter 23, Division IV.	FEMA Bulletin No. 85-1 discusses the protection of interior wall finishes due to direct contact with flood waters. The Uniform Building Code does not recognize the viability of wet flood proofing of occupiable spaces, therefore, there are no provisions.

Recommendation: See the recommendation of Item I in Bulletin No. 85-1.

Bulletin No. 85-1	U.B.C.	Analysis
IV. A.6 Floors	Chapter 25 Chapter 42 Appendix Chapter 23, Division IV.	FEMA Bulletin No. 85-1 discusses the protection of floor systems in wet flood proofing situations and recommends that the design of such a floor system be able to withstand a minimum hydrostatic pressure. The Uniform Building Code does not recognize the viability of wet flood proofing occupiable spaces, therefore, there are no provisions.

Recommendation: See the recommendation of Item I in Bulletin No. 85-1.

Bulletin No. 85-1	U.B.C.	Analysis
IV. A.7 Ceilings and Roofs	Chapter 25 Chapter 42 Appendix Chapter 23, Division IV.	FEMA Bulletin No. 85-1 discusses the protection of ceilings and roofs and any other related features from any waters due to a flood event. The Uniform Building Code doe not recognize the viability of wet flood proofing occupiable spaces, therefore, there are no provisions.

Recommendation: See the recommendation of Item I in Bulletin No. 85-1.

Technical Standards Bulletin: Wet Flood Proofing, Bulletin No. 85-1

Bulletin No. 85-1	U.B.C.	Analysis
IV. A.8 Building Envelope Penetrations	Appendix Chapter 23, Division IV.	FEMA Bulletin No. 85-1 discusses the protection of any penetrations or openings in the building's structural envelope and provides some general design criteria. The Uniform Building Code requires that all openings below the base flood elevation shall be provided with watertight closures designed to withstand the applied loads.

Recommendation: See the recommendation of Item I in Bulletin No. 85-1.

Bulletin No. 85-1	U.B.C.	Analysis
IV. A.9 Electrical Systems	Appendix Chapter 23, Division IV.	FEMA Bulletin No. 85-1 discusses the protection of electrical utilities from any waters generated by a design flood and recommends that standby electrical power be available in case of an emergency. The Uniform Building Code requires that new or replacement electrical equipment be either placed above the base flood elevation or protected to prevent water from entering the system.

Recommendation: None.

Bulletin No. 85-1	U.B.C.	Analysis
IV. A.10 H.V.A.C.	Appendix Chapter 23, Division IV.	FEMA Bulletin No. 85-1 discusses the protection of heating, ventilating and air conditioning equipment from waters due to a design flood. The Uniform Building Code requires that such equipment be either placed above the base flood elevation or protected to prevent water from entering the system.

Recommendation: None.

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

Bulletin No. 85-2	U.B.C.	Analysis
Flood Forces	Appendix Chapter 23, Division IV.	FEMA Bulletin No. 85-2 discusses the calculation of the hydrostatic pressures generated by a flood on the exterior walls of a structure and defines hydrodynamic forces. The U.B.C. requires that the structural system of the building be designed in accordance with well-established engineering principles with consideration of the hydrodynamic and hydrostatic loads generated by a flood event.
Recommendation:	None.	

Bulletin No. 85-2	U.B.C.	Analysis
Openings Design Criteria	None.	FEMA Bulletin No. 85-2 discusses the use of openings in exterior walls in equalizing the pressure on either side of such walls. The U.B.C. does not recognize wet flood proofing as a viable method of protecting an occupiable space in a structure, but allows openings for other spaces such as those for building access, exits, foyers, storage and parking garages.
Recommendation:	See the recommendation of Item I in Bulletin No. 85-1.	

ICBO UNIFORM BUILDING CODE (U.B.C.) COMPARISON

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

Bulletin No. 85-3	U.B.C.	Analysis
II. Wind and Water Forces	Appendix Chapter 23, Division IV.	FEMA Bulletin No. 85-3 discusses the wind and water forces that breakaway walls may be subject to. The Uniform Building Code requires that the structural system including breakaway walls be designed in accordance with well-established engineering principles and gives criteria for the design of the connections.

Recommendation: FEMA Bulletin No. 85-3 should recognize the latest edition of the Minimum Design Loads for Buildings and Other Structures, which is ASCE 7-88.

Bulletin No. 85-3	U.B.C.	Analysis
III. Design Approach	Appendix Chapter 23, Division IV.	FEMA Bulletin No. 85-3 gives the loads for the design of the connections of the breakaway wall and reasons for same. The Uniform Building Code requires that breakaway walls be designed for two specific loading requirements in accordance with well-established engineering principles.

Recommendation: None.

Bulletin No. 85-3	U.B.C.	Analysis
Design Considerations	Appendix Chapter 23, Division IV.	FEMA Bulletin No. 85-3 discusses the design of the different elements that make up breakaway walls. The Uniform Building Code requires that this system be designed in accordance with well-established engineering principles and with hydrodynamic and hydrostatic loads considered.

Recommendation: None.

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

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

Bulletin No. 88-1	U.B.C.	Analysis
Pages 1-5	Chapter 23 Appendix Chapter 23, Division IV.	FEMA Bulletin No. 88-1 discusses the potential damage due to high winds on structures in a coastal high-hazard area and provides a general comparison between the three national model codes and the NFIP regulations. The U.B.C. provides specific criteria for the design of structures due to high winds based upon the latest edition of the ANSI document which is now ASCE 7-88.

Recommendation: FEMA Bulletin No. 88-1 should refer to the latest edition of the ANSI document which is now ASCE 7-88.

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

Bulletin No. 88-2	U.B.C.	Analysis
Pages 1-7	Appendix Chapter 23, Division IV.	FEMA Bulletin No. 88-2 discusses different classes of materials which are resistant to damage due to flood events and provides a table of materials and the related flood-resistant classification. The U.B.C. requires that materials exposed to the weather or to water splash be protected with an appropriate material.

Recommendation: None.

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

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

Bulletin No. 88-3	U.B.C.	Analysis
Lower Area Obstructions	Appendix Chapter 23, Division IV.	FEMA Bulletin No. 88-3 discusses the various structural elements that may be found below the lowest floor of a building in a Zone. The U.B.C. discusses the same structural systems and also allows for the storage of portable or mobile items.

Recommendation: None.

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

Bulletin No. 88-3	U.B.C.	Analysis
Perimeter Obstructions	Appendix Chapter 23, Division IV.	FEMA Bulletin No. 88-3 discusses and defines various obstructions that may be found outside the perimeter of a building in a coastal high-hazard area and how they may affect adjacent structures. The Uniform Building Code does not regulate obstructions which may be outside the perimeter of the building, but does require that the structural system be constructed to prevent collapse or permanent lateral movement due to any loads in the flood which may also be caused by obstructions outside the perimeter of the building.
Recommendation:	None.	

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

Bulletin No. 88-3	U.B.C.	Analysis
Attached Perimeter Obstructions	Appendix Chapter 23, Division IV.	FEMA Bulletin No. 88-3 generally discusses any obstruction which may be attached to, but located outside, the perimeter of the building. For example, access stairs, and recommends that it be considered as a part of the building. The U.B.C. would consider anything attached to the building as being a part of the building, even if it were outside the perimeter of the structure and would require that the entire structural system of the building be constructed to resist collapse of permanent lateral movement due to any loads from a flood event.
Recommendation:	None.	

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

Bulletin No. 88-4	U.B.C.	Analysis
Page 3	Appendix Chapter 23, Division IV.	FEMA Bulletin No. 88-4 recommends that any equipment used for the service of elevators be either located above the base flood elevation or, if that is not possible, protected to prevent water from damaging the system. The Uniform Building Code requires that such service facilities be either placed above the base flood elevation or protected to prevent water from entering the system.
Recommendation:	None.	

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

Bulletin No. 90-2	U.B.C.	Analysis
Pages 1-4	Appendix Chapter 23, Division IV.	FEMA Bulletin No. 90-2 discusses the flood proofing of below grade parking garages and recommends specific code language for the design of same, in both A and Zones. The Uniform Building Code has specific requirements for the design of below grade parking garages provided they meet specific enclosure requirements and flood-resistant construction, for both the A and Zones.

Recommendation: None.

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

Bulletin No. 90-3	U.B.C.	Analysis
Pages 1-6	Appendix Chapter 23, Division IV.	FEMA Bulletin No. 90-3 discusses, in general terms, the flood proofing of non-residential structures and requires that a certification of the flood proofing design is provided as well as providing a means of calculating hydrostatic and hydrodynamic type forces. The Uniform Building Code has essentially the same type of requirements, but requires that the structural system be designed in accordance with well-established engineering principles with hydrodynamic and hydrostatic loads under consideration.

Recommendation: None.

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

Bulletin No. 90-4	U.B.C.	Analysis
Pages 3-19	Appendix Chapter 23, Division IV.	FEMA Bulletin No. 90-4 gives specific design recommendations for the installation of manufactured homes in special flood-hazard areas. The U.B.C. requires that all buildings or structures within a flood-hazard zone shall conform to the elevation requirements and flood-resistant construction as found in Appendix Chapter 23, Division IV.

Recommendation: None.

APPENDIX D

COMPARISON BETWEEN THE NFPA STANDARDS AND THE NFIP STANDARDS AND TECHNICAL GUIDELINES

TABLE OF CONTENTS

NATIONAL FIRE PROTECTION ASSOCIATION CODE COMPARISON
NATIONAL FUEL GAS CODE (NFPA 54)

NFIP Flood Resistant Design Standards (44 CFR)

FEMA-44	NFPA 54	Analysis
Chapter 1, 60.6		The scope of the documents differ. 44 CFR is establishing design standards for structures does not define utility requirements found in the Fuel Gas Code.

Coastal Construction Manual (FEMA-55)

FEMA-55	NFPA 54	Analysis
		The scope of the documents differ. In FEMA 55 structural requirements there are no parallel requirements found in the Fuel Gas Code.

Elevated Residential Structures (FEMA 54)

FEMA-54	NFPA 54	Analysis
		The scope of the documents differ. The guidelines for elevated structures, while including mechanical equipment, does not include specifics for Fuel Gas Code use in the installation.

Manufactured Home Installation in Flood Hazard Areas (FEMA 85)

FEMA-85	NFPA 54	Analysis
		The scope of the documents differ with FEMA 85 limited to structural based requirements.

Floodproofing Non-Residential Structures (FEMA 102)

FEMA-102	NFPA 54	Analysis
		Floodproofing design for structures is outside the scope of the Fuel Gas Code.

Retrofitting Flood-Prone Structures (FEMA-114)

FEMA-114	NFPA 54	Analysis
Chapter 9 Protection of Utilities 9.3 Emergency Protective Measures	4.2.1, 4.2.2	Paragraph 9.3 recommends closing the main gas valve when a flood is imminent. NFPA 54 contains requirements when turning the gas back on in paragraphs 4.2.1, 4.2.2 and appendix D.

Recommendation: Add references to NFPA 54.

Alluvial Fans: Hazards and Management (FEMA-165)

FEMA-165	NFPA 54	Analysis
		The Fuel Gas Code does not evaluate environmental factors covered in FEMA 165.

Technical Standards Bulletin: Wet Floodproofing, No 85-1

FEMA-No. 85-1	NFPA 54	Analysis
		Wet floodproofing is not addressed in the Fuel Gas Code.

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

FEMA-No. 85-2	NFPA 54	Analysis
		The Fuel Gas Code contains no requirements for installations addressed in 85-2.

Technical Standards Bulletin: Breakaway Walls No. 85-3

FEMA-No. 85-3	NFPA 54	Analysis
		Breakaway walls are not addressed as a part of the Fuel Gas Code.

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

FEMA-No. 85-3	NFPA 54	Analysis
		No common requirements exist between FEMA 88-3 and NFPA 54.

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

FIA/HUD-No.CR-997	NFPA 54	Analysis
		No common requirements exist between the documents.

NFIP Flood Resistant Design Standards (44 CFR)

FEMA-44	NFPA 58	Analysis
Chapter 1, 60.6		The scope of the documents differ.

Coastal Construction Manual (FEMA-55)

FEMA-55	NFPA 58	Analysis
		The scope of the documents differ.

Elevated Residential Structures (FEMA 54)

FEMA-54	NFPA 58	Analysis
		The scope of the documents differ. The guidelines for Elevated Structures, while including mechanical equipment, does not include specifics for LPG use or handling.

Manufactured Home Installation in Flood Hazard Areas (FEMA 85)

FEMA-85	NFPA 58	Analysis
		The scope of the documents differ.

Floodproofing Non Residential Structures (FEMA 102)

FEMA-102	NFPA 58	Analysis
		Floodproofing is not addressed as a part of LPG storage and handling in NFPA 58.

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

FEMA-85-1	NFPA 58	Analysis
II Protection Goals	4-4, 4-4.3	In part IV, Guidelines for Implementation, Item 10 Heating, Ventilating and Air Conditioning, recommends that "empty tanks, both above and below ground, should be filled with potable water prior to the arrival of floodwater." This is good guidance for tanks that are open to the atmosphere, such as those used for fuel oil, but should not apply to propane tanks. Propane tanks are never empty, but contain residual propane vapor when "empty". The tank should never be opened to the atmosphere as the flammable vapor will probably escape and create a hazard of fire. In addition, the introduction of water and air into the tank will cause corrosion which can result in loss of the odorant that is added to the gas as a warning.

Recommendation: Revise FEMA 85-1 to include a caution on LP-Gas or liquid transfer consistent with NFPA 58 philosophy and requirements.

Retrofitting Flood-prone Residential Structures (FEMA-114)

FEMA-114	NFPA 58	Analysis
9.4 Permanent Protective Measures II Protection Goals	3-2.2.6(g)	NFPA 58 includes requirements for anchoring of propane tanks in flood areas.

Recommendation: Include a reference to NFPA 58 in FEMA 114.

Alluvial Fans: Hazard and Management (FEMA-165)

FEMA-165	NFPA 58	Analysis
	3-2.2.b(g)	NFPA 58 includes requirements for anchoring of propane tanks in flood areas.

Recommendation: Include a reference to NFPA 58 in FEMA-165.

NATIONAL FIRE PROTECTION ASSOCIATION CODE COMPARISON
STANDARD FOR THE STORAGE AND HANDLING OF LIQUEFIED PETROLEUM GASES (NFPA 58)

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

FEMA-85-1	NFPA 58	Analysis
II Protection Goals	4-4, 4-4.3	In part IV, Guidelines for Implementation, Item 10 Heating, Ventilating and Air Conditioning, recommends that "empty tanks, both above and below ground, should be filled with potable water prior to the arrival of floodwater." This is good guidance for tanks that are open to the atmosphere, such as those used for fuel oil, but should not apply to propane tanks. Propane tanks are never empty, but contain residual propane vapor when "empty". The tank should never be opened to the atmosphere as the flammable vapor will probably escape and create a hazard of fire. In addition, the introduction of water and air into the tank will cause corrosion which can result in loss of the odorant that is added to the gas as a warning.

Recommendation: Revise FEMA 85-1 to include a caution on LP-Gas or liquid transfer consistent with NFPA 58 philosophy and requirements.

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

FEMA-165	NFPA 58	Analysis
	3-2.2.b(g)	NFPA 58 includes requirements for anchoring of propane tanks in flood areas.

Technical Standards Bulletin: Foundation Wall Openings No. 85-3

FEMA-85-3	NFPA 58	Analysis
		Breakaway walls are not addressed in NFPA 58.

Technical Standards Bulletin: Free of Obstruction Requirements In Coastal High Hazard Areas No. 88-3.

FEMA-85-3	NFPA 58	Analysis
		No Common requirements exist.

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

FIA/HUD-No.CR-997	NFPA 58	Analysis
		No common requirements exist between the documents.

NATIONAL FIRE PROTECTION ASSOCIATION CODE COMPARISON
NATIONAL ELECTRICAL CODE (NFPA 70)

NFIP Flood Resistant Design Standards (44CFR 59.1 & 60.3)

FEMA-44	NFPA 70	Analysis
59.1 Definitions Recreational vehicle Chapter 1, 60.6	551-1 Definitions	FEMA 44 definition goes into specifics pertaining to design by specifying maximum area built on a single chassis, NFPA 70 goes into more detail as to how the vehicle is used, what it is used for and how it is propelled.

Recommendation: Elliminate the "400 square feet or less when measured at the largest horizontal projection" in Pargraph (c) of FEMA 44.

Elevated Residential Structures (FEMA-54)

FEMA-54	NFPA 70	Analysis
Utility Service P. 92, 93	110-11	FEMA-54 cautions against the results of water damage to utility service. NFPA 70 qualifies electrical service identified for use in the operating environment, no conductors or equipment shall be located in damp or wet locations; where exposed to gases, fumes, vapors, liquids or other agents having a deteriorating effect on the conductors or equipment; nor where exposed to excessive temperatures.

Recommendation: For FEMA-54, electrical supply conduits and cables should be suitable for the environment they are likely to be exposed, especially in locations subject to corrosive environments such as salt water or spray.

FEMA-54	NFPA 70	Analysis
Service Mounting P. 92 P. 93	110-13	Secure mounting of utilities and mechanical equipment are addressed in FEMA-54. NFPA 70 requires electric equipment to be securely fastened to the surface on which it is mounted.

Recommendation: Revise FEMA-54 to clarify that electric equipment shall be securely fastened to the surface on which it is mounted. Wooden plugs driven into holes in masonry, concrete, plaster, or similar materials shall not be used. Underground electric supply conduits or cables should not be fastened to walls, or structures intended to break-away under flood conditions.

Suggested Code revision:
NFPA 70 (110-13(a), 300-5(d)).
Add the following sentence: Buildings designed with breakaway walls shall have electric services secured to the sides of interior piles or within flood proof enclosures attached to interior poles.

FEMA-54	NFPA 70	Analysis
P. 92, 93 Raceways	230-8 230-32 300-5(c), (d)	Electrical service raceways entering from an underground distribution system are recognized in FEMA-54 as vulnerable while NFPA 70 provides more specific guidelines.

Recommendation: For FEMA-54, where electrical conduits supplying the structure are installed underground, the conduit should be sealed. The sealant should be installed at a location in the system so arranged to prevent entrance of water due to flood conditions. Underground electrical conduits or cables should be protected against damage by burying them to a depth which would minimize their shifting under flood conditions.

Elevated Residential Structures (FEMA-54)

FEMA-54	NFPA 70	Analysis
P. 92, 93 Electrical service location	230-53 380-8	FEMA-54, while allowing for the location of electrical service, does not detail design or location similar to NFPA 70.

Recommendation: For FEMA-54, all switches and circuit breakers shall be located so that they can be operated from a readily accessible place. They should be located so that the center of the operating handle is not more than 6 1/2 feet above the floor or platforms. Where necessary, a platform may be installed to provide accessibility where devices are located above the flood plain.

Coastal Construction Manual (FEMA-55)

FEMA-55	NFPA 70	Analysis
4.3.6 Utilities	110-13(a) 300-5(d)	FEMA 55 recommends locating electric utility risers be located on the sides of interior piles or away from the ocean front or located within floodproof enclosures attached to interior piles. Electrical service secured to the structure should be securely fastened in such a way that the building's protective covering will not be damaged where electric wires are pulled away from the structure. NFPA 70 also requires electric equipment to be securely fastened to the surface it is mounted on. NFPA 70 requires enclosures or raceways that may be subject to damage to be rigid metal conduit intermediate metal conduit, Schedule 80 nonmetallic conduit are equivalent.

Recommendation: In the fifth paragraph of Section 4.3.6 of FEMA 55, insert the following as a second sentence: "Since the enclosure or raceway for the electric utilities is subject to physical damage, it should be installed in rigid metal conduit, intermediate metal conduit, or schedule 80 rigid nonmetallic conduit".

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

FEMA-85	NFPA 70	Analysis
Chapter IV p. 69 Utility service	110-11 110-13	Electrical service locations are required to be above flood levels in FEMA-85 while NFPA 70 more specifically outlines performance and material requirements.

Recommendation: For FEMA-85, Electric equipment shall be securely fastened to the surface on which it is mounted. Wooden plugs driven into holes in masonry, concrete, plaster, or similar materials shall not be used. Underground electric supply conduits or cables should not be fastened to walls, or structures intended to break-away under flood conditions. Electrical supply conduits and cables should be suitable for the environment they are likely to be exposed, especially in locations subject to corrosive environments such as salt water or spray.

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

FEMA-85	NFPA 70	Analysis
Chapter IV p. 69 Utility Service	230-8 300-5(c),(d) 230-32 230-53	FEMA-85 generally defines electrical mounting while NFPA 70 is more equipment specific.

Recommendation: For FEMA-85, where electrical conduits supplying the structure are installed underground, the conduit should be sealed. The sealant should be installed at a location in the system so arranged to prevent entrance of water due to flood conditions. Underground electrical conduits or cable should be protected against damage by burying them to a depth which would minimize their shifting under flood conditions. Means should be provided to protect electrical supply conduits emerging from underground to the bottom of the structure from floating debris during flood conditions. All switches and circuit breakers should be located so that they can be operated from a readily accessible place. They should be located so that the center of the operating handle is not more than 6 1/2 feet above the floor or platforms. Where necessary, a platform may be installed to provide accessibility where devices are located above the flood plain.

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

FEMA-85-1	NFPA 70	Analysis
IV A.9 Electrical System	110-11 110-17(b)	FEMA 85-1 recommends that electrical supply lines and equipment be elevated above Design Flood Level or be waterproofed where required to be installed below flood level. NFPA 70 requires electrical supply lines and equipment to be suitable for the environment under normal operating environmental conditions. However, if flooding is often or anticipated due to location, including 100 year flood levels, the electrical installation must be suitable for the expected event.

Recommendation: In the second paragraph, add the following: "Where electrical supply lines cannot be elevated above flood level, they should be installed to arrange for draining away from panelboards, controllers, switches or other electrical equipment."

Floodproofing Non-Residential Structures (FEMA-102)

FEMA 102	NFPA 70	Analysis
Chapter IV D. Wet Floodproofing Techniques	110-11 110-17(b)	FEMA 102 recommends that electrical supply lines and panels be elevated above the Design Flood Level, whereas NFPA 70 requires electrical installations be suitable for the environment under normal operating. However, if the frequency of flooding is often, the electrical code would require the electrical installation to be suitable for that event.

Recommendation: In the fourth paragraph following the second sentence, insert "where electrical supply lines cannot be elevated above the Design Flood Level, they must be installed to arrange for draining away from panelboards, controllers, switches or other electrical equipment".

Retrofitting Flood-prone Residential Structures (FEMA-114)

FEMA-114	NFPA 70	Analysis
8.7 Technical Design Criteria, p. 156 Drainage System	110-3(a)(1) 110-11 410-57(b)	FEMA 114 requires pump and pump motor combination and its associated control devices to be provided with watertight electrical supply. Three-wire heavy duty U.L. listed power receptacles and wire are required to be installed above possible flood water level. NFPA 70 allows equipment that is to be used in a specific environment to be identified as suitable for that use by testing and listing and labeling by a testing laboratory. NFPA 70 does not require the testing laboratory to be U.L. (Underwriters Laboratories, Inc.).

Recommendation: In the third paragraph of FEMA 114, revise the third sentence as follows: "The power receptacle outlet and associated equipment should be of the grounding type and be labeled and listed by a recognized testing laboratory.

Retrofitting Flood-prone Residential Structures (FEMA-114)

FEMA-114	NFPA 70	Analysis
9.3 Emergency Protective Measures	373-2(a)	FEMA 114 recommends shutting off the main power in the distribution panel and removing any fuses from the panelboard when flooding is imminent and all electrical equipment should be cleaned and dried before restoring power. NFPA 70 requires cabinets such as used for panelboards to be of the weatherproof type where installed in wet locations. Cabinets installed in wet locations are required to have at least 1/4 inch space between the cabinet and the structure it is mounted on. NFPA 70 does not address maintenance or refurbishing electrical equipment after being submerged during floods.

Recommendation: Refer to NFPA 70B "Electrical Equipment Maintenance.

FEMA-114	NFPA 70	Analysis
9.4 Permanent Protective Measures pg. 160 Utility Connections	230-53	FEMA 114 recommends relocating electric power lines above the flood level and install electrical conductors in waterproofed conduits. NFPA 70 does not address clearance heights above flood levels, however, it does require conduits exposed to the weather to be arranged to drain should water enter the conduit system.

Recommendation: Add the following as a fifth sentence in Section 9.4 Utility Connections: "Where electric service conductors are located within flood level range, most type services can be installed to raise the electrical service above flood level range.

Alluvial Fans: Hazards and Management (FEMA-165)

FEMA-165	NFPA 70	Analysis
		FEMA-165 addresses no electrical code concerns.

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

FEMA-85-2	NFPA 70	Analysis
		The National Electrical Code contains no requirements for installations addressed in No. 85-2.

Technical Standards Bulletin: Breakaway Walls No. 85-3

FEMA-85-3	NFPA 70	Analysis
	110-13(a) 300-5(d)	Breakaway walls do not meet NFPA 70 requirements for secure fastening of electrical equipment.

Recommendation: See FEMA 55 utility requirements.

Technical Standards Bulletin: Free Of Obstruction Requirements in Coastal High Hazard Areas. No. 88-3

FEMA-88-3	NFPA 70	Analysis
		No common requirements exist between FEMA 88-3 and NFPA 70.

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

FIA/HUD-No.CR-997	NFPA 70	Analysis
		No common requirements exist between the documents.

NFIP Flood Resistant Design Standards (44 CFR)

FEMA-44	NFPA 101	Analysis
Chapter 1, 60.6		The scope of the documents differ.

Coastal Construction Manual (FEMA-55)

FEMA-55	NFPA 101	Analysis
Breakaway walls 4.3.5.1	5-1.3.1	FEMA-55 while defining breakaway walls does not relieve the designer from meeting fire barriers construction requirements.

Recommendation: For FEMA-55, as a part of a required enclosure or separation must maintain hourly rating requirements. This may be accomplished using masonry walls or wood stud walls discussed in 4.3.5.1 of FEMA-55.

Elevated Residential Structures (FEMA 54)

FEMA-54	NFPA 101	Analysis
		The scope of the documents differ.

Manufactured Home Installation In Flood Hazard Areas (FEMA 85)

FEMA-85	NFPA 101	Analysis
		The scope of the documents differ with FEMA 85 lilmited to structerally based requirements.

Floodproofing Non-Residential Structures (FEMA-102)

FEMA 102	NFPA 101	Analysis
p. 11, 67, 68 Watertight Doors		FEMA 102 in addressing watertight doors promotes their use for daily activities. NFPA 101 in Chapter 5 on egress and in educational and assembly occupancies has door hardware requirements that must be met for latching, and force to open. Key among these are requirements for fire exit hardware.

Recommendation: In FEMA 102, p. 11 should add a paragraph to 2. Watertight Doors. "The force to open doors as a part of means of egress requirements should be maintained for exit doors. Latching requirements for exterior doors may include the use of fire exit hardware in educational or assembly occupancies".

Floodproofing Non-Residential Structures (FEMA-102)

FEMA 102	NFPA 101	Analysis
p. 161		FEMA 102 in Building Code qualifies a Building Code as a collection of regulators while not recognizing companion standards such as the National Electrical Code, the Fuel Gas Code, or the Life Safety Code.

Recommendation: Reword the definition of Building Code to include provisions for standards other than a Model Building Code.

Retrofitting Flood Prone Residential Structures (FEMA 114)

FEMA 114	NFPA 101	Analysis
		There are no common requirements.

Alluvial Fans: Hazards and Management (FEMA-165)

FEMA 165	NFPA 101	Analysis
		The Life Safety Code does not evaluate environmental factors covered in FEMA 165.

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

FEMA-85-1	NFPA 101	Analysis
Protection of Interior Finishes	6-5.1.2, 6-5.1.2.1, 9-3.3, 9-3.3.1, 9-3.3.2,9-3.3.3, 10-3.1, 11-3.3.1, 12-3.3.1, 13-3.3.1, 13-3.3.2, 14-3.3.1, 15-3.3.1, 16-3.3.1, 17-3.3.1, 18-3.3.1, 19-3.3.1, 21-3.2.1, 22-3.3.3, 23-3.3.3, 24-3.3.1, 25-3.3.1, 26-3.3.1, 27-3.3.1, 28-3.3.1, 29-3.3.1, 30-3.3.1	FEMA 85-1 while encouraging water resistant interior finishes, may inadvertently negate the finish requirements outlined in NFPA 101.

Recommendation: Technical bulletin 85-1 should qualify the use of water resistant finishes to as to include the maintenance of interior finish requirements to a particular occupancy as defined by other codes.

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

FEMA No. 85-2	NFPA 101	Analysis
		There are no common requirements.

Technical Standards Bulletin, Breakaway Walls No. 85-3

FEMA No. 85-2	NFPA 101	Analysis
		There are no common requirements.

Technical Standards Bulletin: Free Of Obstruction Requirements In Coastal High Hazard Areas, No. 88-3

FEMA No. 88-3	NFPA 101	Analysis
		There are no common requirements.

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

FIA/HUD-No.CR-997	NFPA 101	Analysis
		No common requirements exist between the documents.

APPENDIX E

COMPARISON BETWEEN THE MANUFACTURED HOUSING CODES AND STANDARDS THE NFIP STANDARDS AND TECHNICAL GUIDELINES

TABLE OF CONTENTS

Manufactured Home Construction and Safety Standards [MHCSS]

National Flood Insurance Program (Regulations for Floodplain Management and Flood Hazard Identification) [NFIP]

The following is a comparison between Sections 59.1 and 60.3 of the NFIP, the MHCSS, and selected requirements from FEMA 85. The definitions in Section 59.1 have been compared with the MHCSS and found to be compatible.

NFIP	MHCSS	Analysis
§59.1 §60.3 (in its entirety)	§3280.2 (a)(16)	NFIP provides a definition of a "manufactured home" consistent with the MHCSS. Additionally, §60.3 of the NFIP sets forth requirements for both recreational vehicles and manufactured homes. However, the NFIP does not address other types of factory-built or industrialized housing (i.e., modular). Current language in the NFIP such as "manufactured home," "proposed construction," and "new construction" may not be readily understood to include modular homes.

Recommendation: Revise the NFIP to include a consistent definition for modular housing. Clarify existing regulations by including modular in the applicable code sections.

NFIP	MHCSS	Analysis
§60.3 (a)(3) §60.3 (b)(8)		NFIP differentiates between old parks and new parks. The MHCSS provides no installation requirements, but rather requires that the manufacturer of the home provide instructions for the site installation.

Recommendation: None.

NFIP	MHCSS	Analysis
§60.3 (b)(8)		NFIP §60.3 (b)(8) states in part ". . . Methods of anchoring may include, but are not limited to, use of over-the-top or (emphasis added) frame tie to ground anchors." It is presumed from this section that an acceptable method of anchoring would be the application of over-the-top ties alone. Generally, over-the-top ties alone are insufficient to resist lateral flood forces. Again, the MHCSS provides no installation or anchorage provisions.

Recommendation: It is recommended that the NFIP section be clarified to use similar language to that provided in §60.3 (c)(6)(iv).

NFIP	MHCSS	Analysis
§60.3 (a)(3)(iii)(iv) §60.3 (b)(8) §60.3 (c)(6) §60.3 (c)(12)		The requirements of NFIP §60.3 (a)(3)(iii)(iv) appear to provide the community latitude in reviewing the appropriateness of a proposed permit application when that latitude may not be provided by other more prescriptive sections of the NFIP. For example, under §60.3 (a)(3)(iii)(iv) a community may reject a permit for an elevated double-wide manufactured home because the HVAC air duct crossover connecting the two units is typically suspended below the floor level. The community could conclude that the crossover may become dislodged during flood conditions and permit entry of flood waters into the floor and duct system. However, §60.3 (c)(6)(iv) suggests that only the lowest floor (and not the duct) need be elevated to or above the base flood elevation. Additionally, it appears that §60.3 (a)(3)(iii)(iv) is referenced in sections of the NFIP that contain more prescriptive and in some instances less restrictive requirements. (See for example, §60.3 (b)(2).)

Recommendation: Option 1: Revise §60.3 (a)(3)(iii)(iv) to reflect the elevation of the "lowest floor above the base flood elevation." Option 2: Revise the "lowest floor above the base flood elevation" to more clearly reflect the performance requirements outlined in §60.3 (a)(3)(iii)(iv) and allow for certain unusual construction techniques in manufactured housing. Option 3: Redefine the "lowest floor" to clearly include the depth of the chassis I-beam. This may help elevate many of the "undersiung" utilities above "harm's way."

Other Areas for Clarification or Enhancement:

NFIP	MHCSS	Analysis
§60.3 (c)(10) and others		The NFIP currently provides for construction in Zones A1-30 and AE on the communities' FIRM provided that the cumulative effect will not increase the water surface elevation of the base flood by more than one foot. FEMA reference documents such as FEMA 85 "Manufactured Home Installation in Flood Hazard Areas" provide several design tables that when subjected to an additional flood load of 12" become inapplicable.

Recommendation: None.

National Flood Insurance Program (Regulations for Floodplain Management and Flood Hazard Identification) [NFIP]

The HUD Permanent Foundations Guide provides design methods and data for site installation of factory-built single family dwelling units that are transportable in one or more sections. These are considered manufactured homes built in accordance with the HUD MHCSS.

NFIP	HUD 4930.3	Analysis
§59.1		The HUD Handbook contains only definitions applicable to the construction of foundation walls and piers. Since HUD 4930.3 is used as a guide for homes built per HUD MHCSS, the definitions therein are relevant. The NFIP definitions are generally compatible with the MHCSS. However, the NFIP does not address other types of factory-built or industrialized housing (i.e., modular). Current language in the NFIP such as "manufactured home," "proposed construction" and "new construction" may not be readily understood to include modular homes.

Recommendation: Revise the NFIP to include a consistent definition for modular housing. Clarify existing regulations by including modular in the applicable code sections.

NFIP	HUD 4930.3	Analysis
§60.3 (in its entirety)	102-2.C 201-2.B	HUD 4930.3 references FEMA 85 for manufactured homes on elevated foundations, and provides that homes on elevated foundations must comply with the requirements of NFIP. Therefore, there is no incompatibility.

Recommendation: None.

NFIP	HUD 4930.3	Analysis
§60.3(b)(8)	402-3.C	NFIP requires methods of anchoring in Zone A that are in addition to applicable state and local requirements for wind loading. HUD 4930.3 states that in hurricane zones or where severe wind pressures occur, special treatment may be required, such as foundations that resist greater uplift, more deeply buried foundations, or strengthened home-to-foundation connection.

Recommendation: None.

1989 CABO Appendix C [CABO App. C]

National Flood Insurance Program (Regulations for Floodplain Management and Flood Hazard Identification) [NFIP]

Appendix C of the 1989 CABO One and Two Family Dwelling Code applies to the construction, alteration, and repair of foundation systems and building equipment for manufactured homes installed on privately owned (nonrental) lots.

NFIP	CABO App. C	Analysis
§59.1	C-201	The definitions in NFIP and CABO App. C are compatible.

Recommendation: None.

NFIP	CABO App. C	Analysis
§60.3		CABO App. C does not contain any special provisions for the installation of manufactured homes in flood hazard areas.

Recommendation: CABO Appendix C should be revised to include a reference to the NFIP for manufactured home installation in flood hazard areas.

Suggested Code Change [or addition]: Add to Appendix C Section C-101 - Scope, last §, last sentence: Refer to National Flood Insurance Program for installations in flood hazard areas.

National Flood Insurance Program (Regulations for Floodplain Management and Flood Hazard Identification) [NFIP]

The MHI Model Manufactured Home Installation Manual is intended as a guide to manufacturers in the preparation of the specific installation instructions that are required under Federal law to accompany the shipment of the homes. The preface to the manual further states that the manual provides a suggested outline and format for manufacturers' installation manuals rather than specific requirements.

NFIP	MHI-MIM	Analysis
§59.1	Chapter 2	The definitions in NFIP and MHI-MIM are not incompatible.

Recommendation: None

NFIP	MHI-MIM	Analysis
§60.3 (in its entirety)	4.4.1, 4.5.4, 5.4.3.3	The MHI-MIM recommends against siting a manufactured home in riverine or coastal flood-prone areas. It further states that special local regulations or flood insurance provisions may apply, and that special elevation and anchoring are required in flood-prone areas. A registered professional or structural engineer is to be consulted to ensure conformance to applicable federal, state, and local regulations. FEMA 85, "Manufactured Home Installation in Flood Hazard Areas," is also referenced in MHI-MIM. By referencing FEMA 85, MHI-MIM is compatible with NFIP.

Recommendation: None

NFIP	MHI-MIM	Analysis
§60.3(b)(8)	5.4.3.3	NFIP requires that homes placed within Zone A be anchored to resist flotation, collapse, or lateral movement, in addition to state and local requirements for wind loading. The MHI-MIM states that unconventional anchorage and tiedowns may be required in flood-prone areas.

Recommendation: None.

NFPA 501A-1987, Manufactured Home Installations [NFPA 501A]

National Flood Insurance Program (Regulations for Floodplain Management and Flood Hazard Identification) [NFIP]

NFPA 501A-1987 covers the firesafety requirements for the installation of manufactured home and home sites. In essence, this standard includes specific requirements for fuel supply piping. The definitions in NFIP Section 59.1 have been compared with those in NFPA 501A and found to be compatible.

NFIP	NFPA 501A	Analysis
§60.3 (in its entirety)	4-2.3	Section 4-2.3 of NFPA 501A requires that manufactured home installations, including the support system and utility and structural connections, be compliant with the manufacturer's instructions or the authority having jurisdiction. Support system design is to consider the climatic and geological conditions present at the home site. There is no incompatibility with NFIP.

Recommendation: None.

National Flood Insurance Program (Regulations for Floodplain Management and Flood Hazard Identification) [NFIP]

The ANSI A225.1 Manufactured Home Installations Standard is intended to be adopted by jurisdictions having responsibility for the safety and health of manufactured home users and for establishing regulations applicable to manufactured home communities. These standards are applicable to single family dwelling units that are built in accordance with the HUD Manufactured Home Construction and Safety Standards (MHCSS), which require that the manufacturer of the home provide instructions for site installation using at least one system of support and anchorage that can resist the design dead, live, and wind loads.

NFIP	A225.1	Analysis
§59.1	1-3	The definitions in the NFIP and A225.1 are generally in agreement and therefore compatible.

Recommendation: None.

NFIP	A225.1	Analysis
§60.3(in its entirety)	App. G	Appendix G of A225.1 refers to the National Flood Insurance Program. However, it is stated that Appendix G is not part of the requirements of A225.1 but rather is included only as information.

Recommendation: None.

NFIP	A225.1	Analysis
§60.3(b)(8)	1-2.2	NFIP requires methods of anchoring in Zone A that are in addition to state and local requirements for wind loading. A225.1 states that it does not relieve the installer of a manufactured home of responsibility for compliance with manufacturer's instructions and any state and local ordinances, codes, or regulations. There is no incompatibility.

Recommendation: None.

NFIP	A225.1	Analysis
§60.3(c)(12)(ii)	2-6.1.3	NFIP requires that homes placed in an existing park or subdivision in Zones A1-30, AH, or AE have the lowest floor at or above BFE or supported by piers or other foundation elements at least 36 in. above grade. A225.1 requires that a foundation system that places the bottom of the main frame members more than 3 ft. above ground be designed by registered engineer or architect and be approved by local authority having jurisdiction. No incompatibility exists.

Recommendation: None.

Retrofitting Flood Prone Residential Structures [FEMA 114]

The HUD Manufactured Home Construction and Safety Standards (MHCSS) are performance requirements for the construction of factory-built single family dwelling units that are transportable in one or more sections. This standard requires that the manufacturer of the home provide instructions for the site installation using at least one system of support and anchorage that can resist the design dead, live, and wind loads. The MHCSS does not include provisions for flood loads.

The requirement that the manufacturer provide one installation instruction system is the only installation implication of this standard; it does not cover installation details. Therefore, many of the site retrofit issues of FEMA 114 are topically out of range of the HUD MHCSS, and thus a direct comparison of those provisions is not applicable. After review, the FEMA 114 sections for which comparisons were not made are as follows:

3.3	Foundation Walls	8.2	Sealants considerations
3.14	Open foundations technical design	8.3	Sealing techniques
3.5	Extended foundation walls	8.4	Sealing closures
6.2	Floodwalls considerations	8.5	Sealing design details
6.3	Floodwalls construction techniques	8.7	Sealing technical design
6.5	Floodwalls technical design criteria	9.4	Utilities permanent protection
7.2	Closures considerations	9.8	Utilities tank anchorage
7.3	Closures low profile permanent	C.1	Hydrostatic loads
7.4	Closures materials and construction	C.2	Hydrodynamic loads
7.6	Closures technical design criteria	C.3	Impact Loads

Comparisons and analysis for applicable sections of FEMA 114 are as follows:

FEMA 114		MHCSS	Analysis
3.12	Technical design criteria – Extended wall foundations	§3280.305(c)	Section 3.12 of FEMA 114 refers to Appendix C for design loads, which in turn refers to the three model building codes for determination of wind loading characteristics. The wind design data presented in Appendix C is not necessarily in agreement with the wind design criteria in §3280.305(c) of the MHCSS. While §3280.305(c)(2)(ii) states that HUD may establish more stringent requirements in areas with 125 mph and greater recorded wind velocity, HUD has not been known to establish more stringent requirements than those specified in §3280.305(c) [25 psf lateral, 15 psf uplift].

Recommendation: Further research/study is recommended to determine: a) if the wind design criteria in MHCSS is adequate for areas of high wind velocity; and/or b) if stronger recommendations against siting such homes in flood prone areas are in order. This study should be undertaken by HUD and the manufactured housing industry.

FEMA 114		MHCSS	Analysis
3.13	Technical design criteria – Anchorage of superstructure to foundation	§3280.305(c)	Section 3.13 of FEMA 114 covers the importance of the floor diaphragm in maintaining the stability of the foundation walls and cautions against using connections that pull out if the underside of the floor is subjected to upward hydrostatic forces. Hydrostatic forces are not covered in the HUD MHCSS. However, Zone II (hurricane) homes when designed in accordance with §3280.305(c) are connected to the steel frame - chassis so as to sustain 15 psf uplift. (Caution, this is not sufficient for hydrostatic pressures in excess of 3" water column.)

Recommendation: FEMA research on the effects of hydrostatic pressure on manufactured homes has resulted in the requirement to elevate above BFE. If HUD and the manufactured housing industry were to embark on a program to set construction standards for homes sited in flood prone areas, a method of certification similar to the wind zone map and label used in the present MHCSS needs to be devised to provide notice on the homes that identifies the flood intensity for which the home is constructed.

FEMA 114		MHCSS	Analysis
9.5	Utility relocations to existing space		Not applicable. Water heaters and furnaces are installed on the main floor. Relocation of utilities in a manufactured home is generally not recommended. If undertaken at all, it is at great risk of violating the standards for fuel pipe sizing and testing, air duct sizing, etc., and is generally not economical.

Recommendation: None.

FEMA 114		MHCSS	Analysis
10.4	Floating structures	§3280.306(a)	Section 10.4 of FEMA 114 describes a system of floats and collars that control the buoyant movement of the structure that can be used in areas of low wind and/or water velocity. The HUD MHCSS requires that each home have provisions for support and anchoring to resist overturning and lateral movement as imposed by the respective design loads.

Recommendation: None, since FEMA 114, Section 10.4, does not apply to manufactured homes.

FEMA 114		MHCSS	Analysis
C.4	Wind loads	§3280.305(c)(1) and (2)	MHCSS specifies that the wind design forces for homes designated for Zone I, non-hurricane, shall be 15 psf lateral and 9 psf uplift, and the wind design forces for Zone II, hurricane, shall be 25 psf lateral and 15 psf uplift. In FEMA 114, wind zones are delineated in wind velocities (mph) according to the ANSI A58.1 map for 50-year recurrence. When applying the formulas from ANSI A58.1, the resulting wind pressures in high wind zones may exceed the MHCSS minimum pressures. §3280.305(c)(2)(ii) states that HUD may establish more stringent requirements than those specified in §3280.305(c) for areas with 125 mph and greater wind velocities.

Recommendation: Further research/study is recommended to determine: a) if the wind design criteria in MHCSS is adequate for areas of high wind velocity; and/or b) if stronger recommendations against siting such homes in flood prone areas are in order. This study should be undertaken by HUD and the manufactured housing industry.

Retrofitting Flood-Prone Residential Structures [FEMA 114]

The HUD Permanent Foundations Guide provides design methods and data for site installation of factory-built single family dwelling units that are transportable in one or more sections. These are considered manufactured homes built in accordance with the HUD MHCSS.

Inasmuch as the HUD MHCSS does not provide at all for site retrofit of manufactured homes, and because the emphasis of the handbook, HUD 4930.3, is directed toward windstorm resistance, many of the issues of FEMA 114 are topically out of range of the handbook and thus a direct comparison of the provisions made for those issues is not applicable. After review, the FEMA 114 sections for which comparisons with HUD 4930.3 were not made are as follows:

3.3	Foundation Walls	8.3	Sealing techniques
6.3	Floodwalls construction techniques	8.4	Sealing closures
6.5	Floodwalls technical design criteria	8.5	Sealing design details
7.2	Closures considerations	8.7	Sealing technical design
7.3	Closures low profile permanent	9.8	Utilities tank anchorage
7.4	Closures materials and construction	C.1	Hydrostatic loads
7.6	Closures technical design criteria	C.2	Hydrodynamic loads
8.2	Sealants considerations	C.3	Impact Loads

Comparisons and analysis for applicable sections of FEMA 114 are as follows:

FEMA 114		HUD 4930.3	Analysis
3.5	Extended foundation walls	102-2.C Standards	HUD 4930.3 references FEMA 85 for manufactured homes on elevated foundations.
		201-2.B	HUD 4930.3 provides that homes built on elevated foundations must comply with requirements of the NFIP and to refer to FEMA 85 for Manufactured Home Installation in Flood-Hazard Areas.
		402	Chapter 4 in HUD 4930.3 makes no provision for the application of hydrostatic, hydrodynamic, or impact loads.

Recommendation: Since provision is made for coastal wind forces in Section 402.3 of HUD 4930.3, it is advisable to include in HUD 4930.3 either complete design provisions for flooding, or a notice that additional lateral, hydrostatic, hydrodynamic, and impact loads need to be included for foundation walls subjected to flooding.

Suggested Change [or addition]: (a) Change §201-2.B.2 to read: "Homes built on elevated foundations in communities that are part of the National Flood Insurance Program (NFIP) must comply with the NFIP."

(b) Change §402-3.B to add item #3: If the site is in a floodplain, hydrostatic, hydrodynamic, and impact loads must be considered. Refer to FEMA 85 for guidance.

FEMA 114		HUD 4930.3	Analysis
3.12	Technical design criteria – Extended wall foundations	App. H12	The Wind Speed Map, H-12, in HUD 4930.3 corresponds with the 50-year mean recurrence map in Figure C-5b of FEMA 114.
		App. H1	The Flood Map, H-1, in HUD 4930.3 does not provide any provisions for hydrostatic, hydrodynamic, static loads.

Recommendation: On the flood map in HUD 4930.3, it is necessary to include a notice to design for lateral, hydrostatic, hydrodynamic, and impact loads for foundation walls subjected to flooding. Reference to FEMA 85 will suffice.

Suggested Change [or addition]: Revise the Flood Map on Page H-1 to include the following:

Note: 1. Consult with local Building or Planning Office to determine whether home is in the floodplain.
2. See FEMA 85 for recommended hydrostatic, hydrodynamic, and impact loads to be applied to foundation walls subject to flood.

FEMA 114		HUD 4930.3	Analysis
3.13	Technical design criteria – Anchorage of superstructure to foundation	App. B	The designs in HUD 4930.3 are apparently to resist wind and gravity loads only. No provision has been made for buoyancy. The loads given for vertical uplift in Table B-2 of HUD 4930.3 would be ample for approximately 1.7' water depth above the top of the foundation.

Recommendation: Include a notice in Appendix B, Table B1 of HUD 4930.3 that additional anchorage may be required in areas subject to flooding in order to resist hydrostatic, hydrodynamic, and impact loads.

Suggested Change [or addition]: Provide a note at the end of the first paragraph in Appendix B:

Note: Additional anchorage may be required to resist hydrostatic, hydrodynamic, and impact loads in areas subject to flooding. Refer to FEMA 85.

FEMA 114		HUD 4930.3	Analysis
3.14	Technical design criteria – Open foundations	203	HUD 4930.2 identifies "unstable clays" as a possible cause for foundation instability, while the FEMA 114 favors clay soils for their resistance to scouring. These provisions are incompatible.

Recommendation: Further research/study is recommended to reconcile the limits for foundations in clay soil. This study should be undertaken in a collaborative effort by HUD, FEMA, and the manufactured housing industry.

FEMA 114		HUD 4930.3	Analysis
6.2	Considerations	301-1	The provision in HUD 4930.3, "provide the best available routing of run-off water to assure that buildings or other important facilities will not be endangered by the path of a major emergency flood run-off which would occur if the site storm drainage is exceeded," does not provide notice that this might require the use of flood walls. FEMA 114 discusses the fact that flood wall design is dependent upon the type of flooding expected.

Recommendation: In HUD 4930.3, Section 301-1, include a statement that adequate flood walls provide one way to accomplish the rerouting of run-off water.

Suggested Change [or addition]: Add a sentence to the end of §301-1:

One way to accomplish rerouting of run-off water in retrofitting is to use flood walls. Refer to FEMA 114 for examples.

Note: Flood walls are not acceptable for new installations.

FEMA 114		HUD 4930.3	Analysis
9.4	Permanent protective measures	Chapter 7	There is no provision in HUD 4930.3 for flood protection of utilities. The overall emphasis of this publication is on structural aspects. The scope of Chapter 7 (Final Check) is limited to foundation design.

Recommendation: In HUD 4930.3, refer to FEMA 85 for home installations in flood-prone areas in order to provide protection of utilities.

Suggested Change [or addition]: Add a Section 7004:

700-4 Flood Protection of Utilities

For homes subject to flooding, verify that provisions have been made in the design to protect utilities. Refer to FEMA 85 for methods.

FEMA 114	HUD 4930.3	Analysis
9.5 Utility relocations to existing space		Not applicable. Water heaters and furnaces are installed on the main floor. Relocation of utilities in a manufactured home is generally not recommended. If undertaken at all, it is at great risk of violating the standards for fuel pipe sizing and testing, air duct sizing, etc., and is generally not economical.

Recommendation: None.

FEMA 114	HUD 4930.3	Analysis
10.4 Floating structures		HUD 4930.3 contains no provisions for floating structures.

Recommendation: None, since FEMA 114, Section 10.4, does not apply to manufactured homes.

FEMA 114	HUD 4930.3	Analysis
C.4 Wind loads	402-3, App. H-12	Provision is made in the design charts of HUD 4930.3 for coastal and inland wind loads. The wind velocity map presented in Appendix H-12 conforms with the 50-year recurrence map published in FEMA 114.

Recommendation: None.

Retrofitting Flood-Prone Residential Structures [FEMA 114]

Appendix C of the 1989 CABO One and Two Family Dwelling Code applies to the construction, alteration and repair of foundation systems and building service equipment for manufactured homes installed on privately-owned (nonrental) lots. It does not apply to the design or construction of manufactured homes themselves. Homes built subsequent to June 14, 1976, are required to conform with Federal Manufactured Home Construction and Safety Standards (MHCSS). Others are required to be labeled certifying compliance with NFPA 501/ANSI 119.1. Modifications to the homes themselves are applicable only if they are otherwise not prohibited.

In its application to existing homes and service equipment, CABO Appendix C provides different directions depending upon whether the retrofit is an addition, or an alteration, or a repair. Retrofits classified as additions are required to conform with one of the following:

- Certification under the National Manufactured Housing Construction and Safety Standards Act of 1974.
- Design and construction per the applicable provisions of the National Manufactured Housing Construction and Safety Standards Act of 1974.
- Design and construction per the codes adopted by the local jurisdiction.

Alterations or repairs may be made to any manufactured home or to its building service equipment without requiring the existing manufactured home or its building service equipment to comply with other provisions in CABO provided the alteration or repair conforms to that required for new construction, and provided that no hazard to life, health, or safety will be created by the additions alterations or repairs. Nonstructural alterations or repairs that do not adversely affect any structural member can be made using material equivalent to the materials used in the manufacture of the home subject to approval of the authority having jurisdiction.

The requirement that the manufacturer provide one installation instruction system is the only installation implication of the HUD MHCSS. This standard does not cover installation details. Therefore, many of the site retrofit issues of FEMA 114 are topically not applicable to HUD MHCSS, and consequently, to the extent that CABO relies directly on the HUD Standard, not applicable to CABO. Thus a direct comparison of those provisions is not applicable. After review, the FEMA 114 sections for which comparisons were not made are as follows:

6.2 Floodwalls considerations	8.3 Sealing techniques
6.3 Floodwalls construction techniques	8.4 Sealing closures
6.5 Floodwalls technical design criteria	8.5 Sealing design details
7.2 Closures considerations	8.7 Sealing technical design
7.3 Closures low profile permanent	9.4 Utilities permanent protection
7.4 Closures materials and construction	C.1 Hydrostatic loads
7.6 Closures technical design criteria	C.2 Hydrodynamic loads
8.2 Sealants considerations	C.3 Impact Loads

Comparisons and analysis for applicable sections of FEMA 114 are as follows:

FEMA 114	CABO App. C	Analysis
3.5 Extended foundation walls	C-503.2	Appendix C itself does not cover foundation walls; however Section C-503.2 refers to other provisions in CABO by stating that retaining walls used as permanent perimeter enclosure must conform to the code provisions for foundation walls. Section R-304, Foundation Walls, prescribes specific designs for masonry, concrete and stone foundation walls. [Reference Tables R-304.3a, 3b.] None of the prescribed designs in the CABO Tables are usable to resist hydrostatic, hydrodynamic, or impact loads specified in FEMA 114. Hydraulic venting of the foundations, as provided in FEMA 114, is not specified in CABO. R-304.5 in CABO prescribes all wood foundation wall designs. The comparisons noted above are applicable.

Recommendation: Clarification is needed for the CABO tables to state that designs subject to flood loads require special consideration for such loads that have not been accommodated in the tabulated designs.

Suggested Code Change [or addition]: Add a sentence to the end of §R-304.4:

R-304.4 Design required: . . . accepted engineering practices. Note that designs subject to flood loads require special consideration. Flood loads have not been accommodated in the designs in Tables R-304.3a and R-304.3b.

FEMA 114	CABO App. C	Analysis
3.12 Technical design criteria – Extended wall foundations		While CABO Appendix C is generally not applicable to foundation design, the wind design data presented in Appendix A of CABO is in general agreement with the wind design criteria in Appendix C of FEMA 114, to which Section 3.12 refers.

Recommendation: None.

FEMA 114	CABO App. C	Analysis
3.13 Technical design criteria – Anchorage of superstructure to foundation	C-605	CABO C-605 requires that "wood floor support systems shall be fixed to perimeter foundations in accordance with this code." CABO Figure R-303 specifies the anchorage of sill plates to concrete foundations using ½"ϕ bolts, 6' o.c. maximum. CABO Table R-402.3a specifies joists secured to sills using 3-8d nails, toe nailed. No provision is made to resist hydrostatic lift-off of the floor.

Recommendation: Clarification is needed in CABO C-605 that additional anchorage may be needed to resist hydrostatic lift in flood-prone areas. Reference to FEMA 85 may suffice.

Suggested Code Change [or addition]: In §C-605, add a sentence that follows the second sentence in the second paragraph:

. . . resist the wind load stated in this code. Note that additional anchorage is needed to resist buoyancy due to flooding in those areas where applicable.

FEMA 114	CABO App. C	Analysis
3.14 Technical design criteria – Open foundations	C-602, C-603, C604, C-605	CABO C-602 (Pier Construction) specifically excludes lateral wind and earthquake loads from consideration in the application of the piers specified in this code. Note that the typical manufactured housing foundation system uses diagonal ties that are secured to ground anchors for lateral load resistance. CABO C-603 (Height of Piers) specifies construction details for three height ranges of pier application. Each of these designs is to be used with the anchors and ties specified in Sections C-604 and C-605 respectively. The reliability of ground anchors in flooded soils has not been demonstrated. It would be prudent at this time to specifically disallow their use in the flood plains.

Recommendation: Clarification is needed in CABO to caution that the ground anchor system specified is generally not rated for flooding or for high open foundations.

Suggested Code Change [or addition]: At the end of §C-604.1, add: The use of ground anchors is permitted in the flood plain when substantiating data are provided that satisfy the authority having jurisdiction.

FEMA 114	CABO App. C	Analysis
9.5 Utility relocations to existing space		Not applicable. Water heaters and furnaces are installed on the main floor of manufactured housing. Relocation of utilities in a manufactured home is generally not recommended. If undertaken at all, it is at risk of violating the Standards for fuel pipe sizing and testing, air duct sizing, etc., and is generally not economical.

Recommendation: None.

FEMA 114	CABO App. C	Analysis
9.8 Storage tank anchorage	M-1914	CABO M-1914 requires that "oil tanks be designed to resist all loads and stresses to which they may be subjected."

Recommendation: None.

FEMA 114	CABO App. C	Analysis
10.4 Floating structures	C-604.1 C-604.2	CABO C-604 requires that the home be anchored to the ground. Utilization of a floating confined, tethered system described in FEMA 114 is a violation of this standard and the HUD MHCSS.

Recommendation: None, since FEMA 114, Section 10.4, does not apply to manufactured homes.

FEMA 114	CABO App. C	Analysis
C.4 Wind loads	C-501.1 Appendix A	CABO C-501 requires that foundations be designed and constructed to sustain loads specified in the CABO code. CABO Appendix A, Wind Probability Map, specifies wind pressures in four zones. No wind velocities and no coefficients are shown. The wind pressures specified in the coastal zone of Florida (Zone IV) is 45 psf lateral load and 32 psf uplift applied normal to the roof surface. Zone III pressures are 34 psf lateral and 32 psf uplift. FEMA 114 refers to the building code requirements that apply within a given jurisdiction. It is assumed that the wind load provisions of these two standards are compatible since FEMA 114 references the three model building codes and the CABO Code is a compilation of data from the three model codes.

Recommendation: None.

Retrofitting Flood-Prone Residential Structures [FEMA 114]

The MHI Model Manufactured Home Installation Manual is intended as a guide to manufacturers in the preparation of the specific installation instructions that are required under Federal law to accompany the shipment of the homes. The Preface to the manual further states that the manual provides a suggested outline and format for manufacturers' installation manuals rather than specific requirements.

Direct comparisons of MHI-MIM with FEMA 114 are not applicable with regard to many of the retrofit provisions because general site work and retrofitting of any kind is outside the scope of MHI-MIM. After review, the FEMA 114 sections for which comparisons were not made are as follows:

3.3 Elevation on Foundation Walls
6.2 Floodwalls considerations
6.3 Floodwalls construction techniques
6.5 Floodwalls technical design criteria
7.2 Closures considerations
7.3 Closures low profile permanent
7.4 Closures materials and construction
7.6 Closures technical design criteria
8.2 Sealants considerations
8.3 Sealing techniques
8.4 Sealing closures
8.5 Sealing design details
8.7 Sealing technical design
9.4 Utilities permanent protection
9.8 Utilities tank anchorage
C.1 Hydrostatic loads
C.2 Hydrodynamic loads
C.3 Impact Loads

Several of the site retrofit provisions of FEMA 114 are technically outside the scope of MHI-MIM due to the exclusionary language of Paragraph 4.4.1 in MHI-MIM which states "XYZ Corporation does not recommend siting your home in river or coastal flood-prone areas. Special local regulations or flood insurance provisions may apply. Special elevation and anchoring techniques are required when locating in a flood-prone area. Consult a registered professional engineer to make sure that home design and construction conform to applicable federal, state and local regulations." Reference is made to FEMA 85, Manufactured Home Installation In Flood Hazard Areas. In the case that some manufacturers may wish to offer manufactured homes that are factory ready for flood hazard retrofit, the applicable comparisons of FEMA and MHI-MIM are as follows:

FEMA 114	MHI-MIM	Analysis
3.5 Extended foundation walls	4.4.1	MHI-MIM recommends that homes not be sited in flood-prone areas, and further cites the possibility that special local regulations or flood insurance provisions might apply, and that special elevation and anchoring techniques are required. MIM also references FEMA 85, Manufactured Home Installation in Flood Hazard Areas, and recommends that the homeowner consult with a professional engineer to assure that a home installed in a flood hazard area conforms with applicable federal, state, and local codes and regulations.

Recommendation: None.

FEMA 114	MHI-MIM	Analysis
3.12 Technical design criteria – Extended wall foundations	4.4.2, Figure 5.3	The wind design data in FEMA 114 is not fully in agreement with the wind design criteria in §3280.305(c) of the HUD MHCSS, to which homes installed per MHI-MIM must comply. The MHCSS forms the basis for the wind resistance tiedowns specified in the MIM. While MHCSS §3280.305(c)(2)(ii) states that HUD may establish more stringent requirements in areas with 125 mph and greater recorded wind velocity, HUD has not been known to establish more stringent requirements than those specified in §3280.305(c) [25 psf lateral, 15 psf vertical uplift]. MIM refers to HUD Handbook 4930.3 (1989). This has the effect of imposing a more severe design load on the foundations and the foundation to home connections than is required for the homes themselves. (110 mph vs. 88 mph wind velocity)

Recommendation: Further research/study is recommended to determine: a) if the wind design criteria in MHCSS is adequate for areas of high wind velocity; and/or b) if stronger recommendations against siting such homes in flood prone areas are in order. This study should be undertaken by HUD and the manufactured housing industry.

FEMA 114	MHI-MIM	Analysis
3.13 Technical design criteria – Anchorage of superstructure to foundation	4.4.1	Generally not applicable. MHI-MIM recommends that homes not be sited in flood-prone areas, and further cites the possibility that special local regulations or flood insurance provisions might apply, and that special elevation and anchoring techniques are required. MIM also references FEMA 85, Manufactured Home Installation in Flood Hazard Areas, and recommends that the homeowner consult with a professional engineer to assure that a home installed in a flood hazard area conforms with applicable federal, state, and local codes and regulations. However, Zone II homes (hurricane) when designed in accordance with MHCSS §3280.305(c) are connected to the steel frame - chassis so as to sustain 15 psf uplift. (Caution, this is not sufficient for hydrostatic pressures in excess of 3" water column.)

Recommendation: Further research/study is recommended to determine: a) if the wind design criteria in MHCSS is adequate for areas of high wind velocity; and/or b) if stronger recommendations against siting such homes in flood prone areas are in order. This study should be undertaken by HUD and the manufactured housing industry.

FEMA 114	MHI-MIM	Analysis
3.14 Technical design criteria – Open foundations	4.4.1	See analysis for "FEMA 14, 3.13" above. Consequently no provisions are made in MHI-MIM for special open foundations.

Recommendation: Further research/study is recommended to determine: a) if the wind design criteria in MHCSS is adequate for areas of high wind velocity; and/or b) if stronger recommendations against siting such homes in flood prone areas are in order. This study should be undertaken by HUD and the manufactured housing industry.

FEMA 114	MHI-MIM	Analysis
9.5 Utility relocations to existing space		Not applicable. Water heaters and furnaces are installed on the main floor. Relocation of utilities in a manufactured home is generally not recommended. If undertaken at all, it is at great risk of violating the standards for fuel pipe sizing and testing, air duct sizing, etc., and is generally not economical.

Recommendation: None.

FEMA 114	MHI-MIM	Analysis
10.4 Floating structures		The MHI-MIM contains no provisions for floating structures.

Recommendation: None, since FEMA 114, Section 10.4, does not apply to manufactured homes.

FEMA 114	MHI-MIM	Analysis
C.4 Wind loads	4.4.2; and ref HUD 4930.3, App. H-13	MIM cautions against installing homes in wind zones more severe than the wind zone indicated on the data plate. It also references HUD Handbook 4930.3, the Wind Speed Map, Appendix H-12, which identifies many Special Wind Regions as well as many coastal areas for which the standard and hurricane wind specifications exceed those found on the Manufactured Home Data plate referred to in the MHI-MIM. §3280.305(c)(2)(ii) of the HUD MHCSS states that HUD may establish more stringent requirements than those specified in §3280.305(c) for areas with 125 mph and greater wind velocities. Presently, HUD has not been known to do so.

Recommendation: Further research is recommended to determine if the Zone II (Hurricane) requirements in MHCSS are adequate or if the ASCE-7 maps should be incorporated. This research should be undertaken by HUD and the manufactured housing industry.

Retrofitting Flood-Prone Residential Structures [FEMA 114]

NFPA 501A-1987 covers the firesafety requirements for the installation of manufactured homes and manufactured home sites. This standard includes only the firesafety portions of the scope previously covered by ANSI A225.1/NFPA 501A. The non-firesafety aspects are published separately as ANSI A225.1. Because NFPA 501A is essentially provisions for fuel supply piping and connections, a direct comparison with the retrofit provisions of FEMA 114 are for the most part not applicable. After review, the FEMA 114 sections for which comparisons were not made are as follows:

3.3 Elevation on Foundation Walls
3.12 Design criteria–wall foundations
3.13 Design criteria–anchorage
3.14 Design criteria–open foundations
6.2 Floodwalls considerations
6.3 Floodwalls construction techniques
6.5 Floodwalls technical design criteria
7.2 Closures considerations
7.3 Closures low profile permanent
7.4 Closures materials and construction
7.6 Closures technical design criteria
8.2 Sealants considerations
8.3 Sealing techniques
8.4 Sealing closures
8.5 Sealing design details
8.7 Sealing technical design
9.4 Utilities permanent protection
9.5 Utility relocations
9.8 Utilities tank anchorage
10.4 Floating structures

Comparisons and analysis of applicable sections of FEMA 114 are as follows:

FEMA 114		NFPA 501A	Analysis
3.5	Extended foundation walls	4-2.3	Section 4-2.3 of NFPA 501A requires that manufactured home installations, including the support system and utility and structural connections, be compliant with the manufacturer's instructions or the authority having jurisdiction. Support system design is to consider the climatic and geological conditions present at the home site. There is no incompatibility with FEMA 114.
C.1	Hydrostatic loads		
C.2	Hydrodynamic loads		
C.3	Impact loads		
C.4	Wind loads		

Recommendation: None.

Retrofitting Flood-Prone Residential Structures [FEMA 114]

The ANSI A225.1 Manufactured Home Installations Standard is intended to be adopted by jurisdictions having responsibility for the safety and health of manufactured home users and for establishing regulations applicable to manufactured home communities. These standards are applicable to single family dwelling units that are built in accordance with the HUD Manufactured Home Construction and Safety Standards (MHCSS), which require that the manufacturer of the home provide instructions for the site installation using at least one system of support and anchorage that can resist the design dead, live, and wind loads.

Some of the site retrofit issues of FEMA 114 are topically out of range of ANSI A225.1. Thus a direct comparison of those provisions is not applicable. After review, the FEMA 114 sections for which comparisons were not made are as follows:

3.3 Foundation Walls
6.2 Floodwalls considerations
6.3 Floodwalls construction techniques
6.5 Floodwalls technical design criteria
7.2 Closures considerations
7.3 Closures low profile permanent
7.4 Closures materials and construction
7.6 Closures technical design criteria
8.2 Sealants considerations
8.3 Sealing techniques
8.4 Sealing closures
8.5 Sealing design details
8.7 Sealing technical design
9.4 Utilities permanent protection
9.5 Utility relocations
9.8 Utilities tank anchorage
C.1 Hydrostatic loads
C.2 Hydrodynamic loads
C.3 Impact Loads

Comparisons and analysis for applicable sections of FEMA 114 are as follows:

FEMA 114	A225.1	Analysis
3.5 Extended foundation walls	2-3.1.2 Appendix G	Criteria are presented for the design and construction of built-up foundation walls in FEMA 114. The foundation walls and floors are required to withstand the added hydrostatic pressures and provision needs to be made for hydrostatic relief by means of vents, 1 si per sf of floor area. Connections from the building to the foundation need to be designed to carry the additional loads. ANSI A225.1, Section 2-3.1.2 (Evaluation), states that "Each site shall be evaluated by the authority having jurisdiction to determine: . . . (c) if such hazards as flood erosion, . . . exist which might impair the use or utility of the property." ANSI A225.1 Appendix G provides information on NFIP. The reader is referred to FEMA for additional information. No reference is made to specific FEMA documents.

Recommendation: None.

FEMA 114	A225.1	Analysis
3.12 Technical design criteria – Extended wall foundations	Appendix B B-4.1	Section 3.12 of FEMA 114 refers to Appendix C therein for design loads. The wind design data presented in Appendix C is not fully in agreement with the wind design criteria in Appendix B of A225.1 since A225.1 applies to homes constructed per the HUD MHCSS. Standard A225.1 provides that the authority having jurisdiction should be consulted to determine whether recurrent wind velocities exceed 90 mph, and that the manufactured homes should be designed for the recurrent wind. Specific data is not provided either for wind or for flooding.

Recommendation: Further research is recommended to determine if the Zone II (Hurricane) requirements in MHCSS are adequate or if the ASCE-7 maps should be incorporated. This research should be undertaken by HUD and the manufactured housing industry.

FEMA 114		A225.1	Analysis
3.13	Technical design criteria – Anchorage of superstructure to foundation		Section 3.13 of FEMA 114 covers the importance of the floor diaphragm in maintaining the stability of the foundation walls and cautions against using connections that pull out if the underside of the floor is subjected to upward hydrostatic forces. This topic is not within the scope of A225.1 since A225.1 does not cover home design and construction. However, Zone II (hurricane) homes when designed in accordance with HUD MHCSS are connected to the steel frame - chassis so as to sustain 15 psf uplift. (Caution, this is not sufficient for hydrostatic pressures in excess of 3" water column.)

Recommendation: Further research/study is recommended to determine: a) if the wind design criteria in MHCSS is adequate for areas of high wind velocity; and/or b) if stronger recommendations against siting such homes in flood prone areas are in order. This study should be undertaken by HUD and the manufactured housing industry.

FEMA 114		A225.1	Analysis
3.14	Technical design criteria - Open foundations	2-5	Section 3.14 of FEMA 114 describes systems of piers, columns, posts, and piles, each of which is required to resist "all facets of loading, including water loads, wind loads, structural dead loads, and design live loads." FEMA's Coastal Construction Manual is referenced for details of pile design. A225.1 does not provide any special foundation designs for flood-prone installations.

Recommendation: ANSI A225.1 needs to be enhanced to reference the NFIP and FEMA 85 within the body of the standard in order to provide guidance for home installations in flood hazard areas.

FEMA 114		A225.1	Analysis
10.4	Floating structures		Section 10.4 of FEMA 114 describes a system of floats and collars that control the buoyant movement of the structure that can be used in areas of low wind and/or water velocity. This method of flood damage abatement is clearly not found in Standard A225.1.

Recommendation: None, since FEMA 114, Section 10.4, does not apply to manufactured homes.

FEMA 114		A225.1	Analysis
C.4	Wind loads	App. B	Appendix C.4 of FEMA 114 presents a general overview of wind design criteria as found in the model building codes published by BOCA, ICBO, and SBCCI. The wind velocity maps for 50 year recurrence and 100 year recurrence are included. Coefficients and methods, however, are not included. Hence, the designer will refer to the building code required by the authority having jurisdiction. The Wind Zone Map in Appendix B of A225.1 is that used in the HUD MHCSS.

Recommendation: Further research is recommended to determine if the Zone II (Hurricane) requirements in MHCSS are adequate or if the ASCE-7 maps should be incorporated. This research should be undertaken by HUD and the manufactured housing industry.

Manufactured Home Installation in Flood Hazard Areas [FEMA 85]

The HUD Manufactured Home Construction and Safety Standards (MHCSS) are performance requirements for the construction of factory-built single family dwelling units that are transportable in one or more sections. This standard requires that the manufacturer of the home provide instructions for the site installation using at least one system of support and anchorage that can resist the design dead, live, and wind loads. The MHCSS does not include provisions for flood loads.

The requirement that the manufacturer provide one installation instruction system is the only installation implication of HUD MHCSS. This standard does not cover installation details, economics, and several other areas addressed in FEMA 85, and thus a direct comparison of those provisions is not applicable. After review, the FEMA 85 provisions for which the comparison was not made are as follows:

pg. 31	Evacuation
Chapter V	Economics
pg. 68	Jacking
Appendix B	Federal and State Contacts
Appendix C	Sources of flood Information

Comparisons and analysis for applicable sections of FEMA 85 are as follows:

FEMA 85		MHCSS	Analysis
pg. 3	Manufactured home characteristics	§3280.2 (a)(16)	FEMA 85 states that manufactured homes can be designed for removal of the steel chassis. Subsequent to the publication of FEMA 85, the Department of Housing and Urban Development has advised manufactured home manufacturers and design approval agencies that the chassis shall not be removed.

Recommendation: Design methodology and construction details in FEMA 85 consider that the chassis remains attached to the home. Therefore, only a revision to clarify that the chassis shall not be removed is appropriate.

FEMA 85		MHCSS	Analysis
pg. 5	Conventional manufactured home installation techniques	§3280.306	FEMA 85 describes typical installation techniques and is consistent with the requirements of the MHCSS.

Recommendation: None.

FEMA 85		MHCSS	Analysis
pg. 8	Effects of flooding	§3280.306	FEMA 85 describes the effects of riverine and coastal flooding on manufactured homes. Flood forces are not currently considered in the MHCSS.

Recommendation: None. Since the MHCSS require that manufacturers supply installation instructions with each home, the issues of elevation and anchoring are outside the scope of the MHCSS.

FEMA 85		MHCSS	Analysis
pg. 11	Regulatory requirements	§3282.11	FEMA 85 describes the NFIP insurance structure and state and local regulations regarding siting manufactured homes in flood hazard areas. The MHCSS do not preempt the authority of states to enact regulations regarding installation of manufactured homes.

Recommendation: None.

FEMA 85		MHCSS	Analysis
pg. 15	Hazards from floods	§3280.2 §3280.306	FEMA 85 defines "hydrostatic," "hydrodynamic," and "debris impact" forces. The section further defines "depth," "velocity," "rate-of-rise," "duration of flooding," "duration of flooding," "frequency of flooding" and "debris load." The MHCSS does not require that the manufactured home or manufactured home foundation resist flood forces. Consequently, MHCSS does not offer any similar definitions.

Recommendation: None. The requirements of the NFIP (and FEMA 85) are not appreciably strengthened by the possible introduction of the aforementioned "flood" definitions into the MHCSS. The current approach of designing the foundation for flood forces and removing the manufactured home structure from "harm's way" appear appropriate. However, the foundation design and structure provided by the manufacturer may perform adequately under no or very low velocity and limited rate-of-rise conditions. Therefore, FEMA 85 could give consideration to clearly defining appropriate parameters and definitions.

FEMA 85		MHCSS	Analysis
pg. 17	Wind hazards	§3280.306 §3280.305 (c)	FEMA 85 and the MHCSS are incompatible. The issue of increased wind pressure at higher elevations is addressed on pg. 46 of FEMA 85.

Recommendation: None.

FEMA 85		MHCSS	Analysis
pg. 19	Elevation on fill	§3280.306	FEMA 85 describes the application of fill, including suggested slopes, minimum distances, etc. to elevate the manufactured home above flood level. The MHCSS does not include any requirements for the foundation design. However, requirements of FEMA 85 are generally consistent with typical specifications provided by the manufacturer in the manufactured home installation manual.

Recommendation: None.

FEMA 85		MHCSS	Analysis
pg. 21	Elevated foundations (piers, posts, horizontal beams)	§3280.306	FEMA 85 provides general and in some instances prescriptive guidelines for the construction of built-up and cast-in-place piers, piles, and bracing. Although not necessarily incompatible with the MHCSS, the MHCSS provides performance criteria for foundations generally without the prescription of construction materials and techniques. Therefore, it is possible for a manufacturer to provide a foundation design that satisfies the MHCSS but may not satisfy FEMA 85.

Recommendation: Prescriptive guidelines in FEMA 85 are generally not incompatible because the typical foundation design provided by the manufacturer does not address flood forces. However, designs provided by the manufacturer may be acceptable for no or very low velocity flood forces but may not satisfy FEMA 85 requirements. Therefore, FEMA 85 should be clarified to describe under what flood conditions the manufacturer's design is acceptable and under what conditions the prescriptive requirements of FEMA 85 should prevail.

FEMA 85		MHCSS	Analysis
pg. 28	Anchoring	§3280.306	FEMA 85 and the MHCSS are not incompatible. The MHCSS sets forth minimum performance requirements for anchor resistance and prescriptive requirements for the strapping material. FEMA 85 describes the typical application of these requirements. However, neither document currently provides a standard to determine the capacity of the anchoring devices. Commonly, the capacity of the anchor is determined in unsaturated soil. It is anticipated that the withdrawal capacity of the anchor will be reduced under flood conditions.

Recommendation: Further research/study is recommended to determine the capacity of anchors and to consider the withdrawal capacity of the anchor under saturated soil conditions. This study should be undertaken in a collaborative effort by HUD, FEMA, and the manufactured housing industry.

FEMA 85		MHCSS	Analysis
pg. 33	Design of elevated foundations	§3280.305 §3280.306	FEMA 85 reiterates the design parameters of the MHCSS. The sections are currently compatible.

Recommendation: None.

FEMA 85		MHCSS	Analysis
pg. 34	Hydrostatic forces	§3280.305 §3280.306	FEMA 85 describes the application of hydrostatic, hydrodynamic, and impact forces on a manufactured home. The MHCSS does not address the application of hydrostatic forces on the floor diaphragm. However, in Zone I and Zone II homes when designed in accordance with §3280.305 (c), floors are connected to the chassis to resist a net uplift force applied to the roof of 9 psf and 15 psf respectively. This design approach does not generally consider the attachment of the floor sheathing to floor joists to resist hydrostatic loads applied to the underside of the home. However, this connection has some limited resistance to these forces as well. The documents are not incompatible in that FEMA 85 states that the only practical design approach is to elevate the unit above flood waters.

Recommendation: None.

FEMA 85		MHCSS	Analysis
pg. 34	Lateral forces	§3280.305 §3280.306	See above comments for hydrostatic forces.

Recommendation: None.

FEMA 85		MHCSS	Analysis
pg. 35	Buoyancy	§3280.305 §3280.306	See above comments for hydrostatic forces.

Recommendation: None.

FEMA 85		MHCSS	Analysis
pg. 36	Hydrodynamic forces	§3280.305 §3280.306	See above comments for hydrostatic forces.

Recommendation: None.

FEMA 85		MHCSS	Analysis
pg. 39	Impact forces	§3280.305 §3280.306	See above comments for hydrostatic forces.

Recommendation: None.

FEMA 85		MHCSS	Analysis
pg. 39	Scour	§3280.305 §3280.306	The MHCSS and FEMA 85 are not incompatible. However, FEMA 85 sets requirements for consideration to scour in the foundation design. The MHCSS do not contain requirements for flood forces.

Recommendation: See above recommendation for elevated foundations (FEMA 85. pg. 21).

FEMA 85		MHCSS	Analysis
pg. 41	Design loads	§3280.305 §3280.306	FEMA 85 wind, roof, and floor live and dead loads are consistent with the requirements of the MHCSS. However, FEMA 85 also restates design considerations for flood forces. (See also analysis for hydrostatic forces.)

Recommendation: None.

FEMA 85		MHCSS	Analysis
pg. 45	Evaluation of elevated foundations	§3280.305 §3280.306	FEMA 85 describes maximum water velocity as a function of the angle of the support strap and height of flood water above the floor and concludes that elevation is the "optimum strategy." Such analysis is based on typical construction techniques used in manufactured housing. The MHCSS does not require the manufacturer to design the home or foundation for flood forces. (See also analysis for anchoring, FEMA 85, pg. 28.)

Recommendation: See above recommendation for anchoring (FEMA 85, pg. 28).

FEMA 85		MHCSS	Analysis
pg. 45	Design forces and loads	§3280.305 §3280.306	FEMA 85 restates the design loads of the MHCSS for determination of the vertical member loads. The sections are currently compatible.

Recommendation: None.

FEMA 85		MHCSS	Analysis
pg. 48	Vertical support members (piers)	§3280.305 §3280.306	(a) FEMA 85 provides general and in some instances prescriptive guidelines for the construction of foundation components. Although FEMA 85 is not necessarily incompatible with the MHCSS, the MHCSS provide performance criteria for the design of foundations generally without the prescription of construction materials and techniques. Therefore, it is possible for a manufacturer to provide a foundation design that satisfies the MHCSS but may not satisfy FEMA 85. (b) Additionally, Figure 4.32 in FEMA 85, "Typical Ground Anchor Detail," shows incorrect orientation of the ground anchor. (c) FEMA 85 states, ". . . all pier designs must have the bottom of the footing at least 30 inches below grade or to the frostline, (emphasis added) whichever is greater." The MHCSS does not require placement of the footing below grade. However, it is the manufacturer's general practice to require that footings be placed below the frostline.

Recommendation: (a) Prescriptive guidelines in FEMA 85 are generally not incompatible because the typical foundation design provided by the manufacturer does not address flood forces. However, designs provided by the manufacturer may be acceptable for no or very low velocity flood forces but may not satisfy FEMA 85 requirements. Therefore, FEMA 85 should be clarified to describe under what flood conditions (if any) the manufacturer's design is acceptable and under what conditions the prescriptive requirements of FEMA 85 should prevail.

(b) Provide a revised Figure 4.32 in FEMA 85 with correct orientation of the ground anchor. (See also above recommendation for anchoring, FEMA 85, pg. 28.)

(c) None.

FEMA 85		MHCSS	Analysis
pg. 53	Vertical support members (posts and piles)	§3280.305 §3280.306	FEMA 85 restates the design loads of the MHCSS for determination of the vertical member loads. The sections are currently compatible. (See analysis for vertical support members, FEMA 85, pg. 48.)

Recommendation: See above recommendation for vertical support members (FEMA 85, pg. 48).

FEMA 85		MHCSS	Analysis
pg. 58	Horizontal Support beams	§3280.305 §3280.306	FEMA 85 restates the design loads of the MHCSS for determination of the vertical member loads. The sections are currently compatible. (See analysis for vertical support members, FEMA 85, pg. 48.)

Recommendation: See above recommendation for vertical support members (FEMA 85, pg. 48).

FEMA 85		MHCSS	Analysis
pg. 60	Cross bracing	§3280.305 §3280.306	FEMA 85 restates the design loads of the MHCSS for determination of the vertical member loads. The sections are currently compatible. (See analysis for vertical support members, FEMA 85, pg. 48.)

Recommendation: See above recommendation for vertical support members (FEMA 85, pg. 48).

FEMA 85		MHCSS	Analysis
pg. 62	End bracing	§3280.305 §3280.306	FEMA 85 restates the design loads of the MHCSS for determination of the vertical member loads. The sections are currently compatible. (See analysis for vertical support members, FEMA 85, pg. 48.)

Recommendation: See above recommendation for vertical support members (FEMA 85, pg. 48).

FEMA 85		MHCSS	Analysis
pg. 63	Horizontal beam connections	§3280.305 §3280.306	FEMA 85 restates the design loads of the MHCSS for determination of the vertical member loads. The sections are currently compatible. (See analysis for vertical support members, FEMA 85, pg. 48.)

Recommendation: See above recommendation for vertical support members (FEMA 85, pg. 48).

FEMA 85		MHCSS	Analysis
pg. 64	Chassis I-beam connections	§3280.305 §3280.306	FEMA 85 restates the design loads of the MHCSS for determination of the vertical member loads. The sections are currently compatible. (See analysis for vertical support members, FEMA 85, pg. 48.)

Recommendation: See above recommendation for vertical support members (FEMA 85, pg. 48).

FEMA 85		MHCSS	Analysis
pg. 66	Cross bracing connections	§3280.305 §3280.306	FEMA 85 restates the design loads of the MHCSS for determination of the vertical member loads. The sections are currently compatible. (See analysis for vertical support members, FEMA 85, pg. 48.)

Recommendation: See above recommendation for vertical support members (FEMA 85, pg. 48).

FEMA 85		MHCSS	Analysis
pg. 67	End bracing connections	§3280.305 §3280.306	FEMA 85 restates the design loads of the MHCSS for determination of the vertical member loads. The sections are currently compatible. (See analysis for vertical support members, FEMA 85, pg. 48.)

Recommendation: See above recommendation for vertical support members (FEMA 85, pg. 48).

FEMA 85		MHCSS	Analysis
pg. 67	Longitudinal support beams connections	§3280.305 §3280.306	FEMA 85 restates the design loads of the MHCSS for determination of the vertical member loads. The sections are currently compatible. (See analysis for vertical support members, FEMA 85, pg. 48.)

Recommendation: See above recommendation for vertical support members (FEMA 85, pg. 48).

FEMA 85	MHCSS	Analysis
pg. 69 Utility service	§3282.11 §3282.1 Subpart H Subpart I	FEMA 85 requires that utilities be placed in waterproofed risers adjacent to down stream foundation members. The MHCSS do not contain requirements for protection of utilities where they connect to the structure.

Recommendation: None. The MHCSS do not preempt utility service protective measures.

FEMA 85	MHCSS	Analysis
pg. 69 Mechanical systems	§3282.11 §3282.1	FEMA 85 requires that external equipment be elevated above anticipated flooding. The MHCSS do not contain requirements for elevating exterior mechanical systems above the base flood elevation.

Recommendation: None. The MHCSS do not preempt external mechanical equipment elevation.

FEMA 85	MHCSS	Analysis
pg. 70 Access and egress	§3280.105 §3280.106	The MHCSS requires that each home be provided with two exterior exit doors located remote from each other and each sleeping room be provided with an egress window. FEMA 85 requires that "a clear access and egress path to the manufactured home be provided . . . ." FEMA 85 and the MHCSS are not incompatible. However, elevation of a structure by its very nature will reduce the ease with which egress may be provided from the structure.

Recommendation: None.

FEMA 85	MHCSS	Analysis
Appendix D Calculation procedures for elevated foundation design	§3280.306	MHCSS requires that the design wind loads be increased by a safety factory of 1.5 when used in calculating resistance to overturning and lateral movement. Additionally, the MHCSS does not permit the allowable stresses of materials required to resist such loads to be increased. Otherwise, MHCSS permits any calculation methods to be used in structural analysis, provided it is in accordance with accepted engineering practice. Therefore, except as described above, the design methodologies presented in FEMA 85 Appendix D to determine various loads are compatible with MHCSS requirements.

Recommendation: Although installations of manufactured homes are not preempted by MHCSS, FEMA 85 should be revised to include the 1.5 safety factor in its design methodologies. It should also prohibit any increases to the basic allowable stresses of materials required to resist overturning and lateral movement due to wind loads. Certain tables in FEMA 85 Chapter IV that are based on these design methodologies may also need to be revised.

FEMA 85	MHCSS	Analysis
Appendix E Buoyancy and drag forces	§3280.306	FEMA 85 and MHCSS are not incompatible since the ties designed to resist buoyancy and drag forces are in addition to any ties required for wind anchorage. As previously stated, MHCSS does not address "flood forces." However, MHCSS does require that wind anchoring equipment be capable of resisting a minimum allowable working load of 3150 pounds. FEMA 85 tables and calculations are based on a working load of 2200 pounds.

Recommendation: Tables in FEMA 85 for spacing of ground anchors should be based on ground anchors with a minimum allowable working load of 3150 pounds rather than 2200 pounds.

FEMA 85	MHCSS	Analysis
Appendix F Design worksheet	§3280.306	MHCSS requires that the design wind loads be increased by a safety factor of 1.5 when used in calculating resistance to overturning and lateral movement. Additionally, MHCSS does not permit the allowable stresses of materials required to resist such loads to be increased.

Recommendation: Although installation of manufactured homes are not preempted by MHCSS, FEMA 85 should be revised to include the 1.5 safety factor in its design methodologies. It should also prohibit any increases to the basic allowable stresses of materials required to resist overturning and lateral movement due to wind loads. Certain tables in FEMA 85 Chapter IV that are based on these design methodologies may also have to be revised.

Manufactured Home Installation in Flood Hazard Areas [FEMA 85]

The HUD Permanent Foundations Guide provides design methods and data for site installation of factory-built single family dwelling units that are transportable in one or more sections. These are considered manufactured homes built in accordance with the HUD MCHSS.

FEMA 85		HUD 4930.3	Analysis
pg. 3	Manufactured home characteristics	100-1. and 100-2	FEMA 85 and HUD 4930.3 describe the same general features.

Recommendation: None.

FEMA 85		HUD 4930.3	Analysis
pg. 5	Conventional manufactured home installation techniques	Figure 1.13	FEMA 85 explains that the installation instructions supplied with the home normally do not provide for resistance to loading caused by flooding. HUD Handbook 4930.3 is for permanent foundations, and flooding loads are not provided for. Figure 1.13, Type 2 Tie Down in FEMA 85 depicts an unstable wind resistance system.

Recommendation: This section of FEMA 85 should be clarified to point to specific flood load remedies elsewhere in the document. Figure 1.13 should carry a notice that the method depicted is not stable and is not recommended for any loading – flood or not.

FEMA 85		HUD 4930.3	Analysis
pg. 8	Effects of flooding	201-2	HUD 4930.1 does not provide design loads or procedures for homes in flood-prone sites. References are made to FEMA 85, NFIP, and HUD Handbooks 4135.2 and 4145.1.

Recommendation: None.

FEMA 85		HUD 4930.3	Analysis
pg. 11	Regulatory requirements		FEMA 85 explains how the NFIP works together with state and local jurisdictions. HUD 4930.3 apparently is intended to be used to assist HUD field offices in making determinations of whether or not homes have been installed on permanent foundations, and therefore contains no regulatory requirements.

Recommendation: None.

FEMA 85		HUD 4930.3	Analysis
pp. 15-18	Flood and wind hazards	201-2	HUD 4930.3 does not provide loads or design methods to abate damages from floods; rather, it refers to FEMA 85 for that purpose.

Recommendation: None.

FEMA 85		HUD 4930.3	Analysis
pg. 17	Wind hazards	402-3.C	HUD 4930.3 does not provide for the resistance of severe hurricane wind loads. It refers to the Institute for Disaster Research publication, Mobile Homes in Windstorms. FEMA 85 refers to the MHCSS wind force requirements. The statement on Page 18 of FEMA 85, "wind and flood forces can be additive, thereby taxing the structure, its foundation system, and any anchoring mechanisms," does not appear to be a true statement. It seems that it would be reasonable to design each component individually for wind and for flood, using whichever load produces the more critical design for the component.

Recommendation: Revise the statement on page 18 of FEMA 85 in accordance with the analysis above.

FEMA 85		HUD 4930.3	Analysis
pg. 19	Elevation on fill	303-2	FEMA 85 limits the flood velocity in accordance with the fill materials and fill cover selected. HUD 4930.3 requires that fill be engineered to 90% in accordance with ASTM D1557, Modified Proctor Test. There is no incompatibility.

Recommendation: None.

FEMA 85		HUD 4930.3	Analysis
pg. 21	Elevated foundations	402	While the design methods and design loads provided in HUD 4930.3 would be applicable to elevated foundations, the handbook does not provide the hydrostatic, hydrodynamic and impact loads. HUD 4930.3 references FEMA 85.

Recommendation: None.

FEMA 85		HUD 4930.3	Analysis
pg. 28	Anchoring	A-6 Note N°1	FEMA 85 does not discourage the use of auger type ground anchors. HUD 4930.3 requires anchorage into concrete.

Recommendation: FEMA 85 should disallow ground anchors in flood-prone installations.

FEMA 85		HUD 4930.3	Analysis
pg. 31	Evacuation techniques	602	FEMA 85 proposes that evacuation using quick disconnect from foundations is a practicable strategy. HUD 4930.3 requires permanent foundations and attachment thereto. The two approaches are not reconcilable into one standard.

Recommendation: FEMA 85 should be changed to prohibit such quick disconnects, unless further study suggests that manufactured housing be factory-prepared for floating.

FEMA 85		HUD 4930.3	Analysis
pg. 33	Design of elevated foundations	402-2, 402-3	FEMA 85 relies on the HUD MHCSS for roof live loads and wind loads. HUD 4930.3 recommends snow and wind loads from ANSI A58.1-1982.

Recommendation: While the manufactured homes built to the HUD MHCSS have generally less conservative design values for wind and snow loads than recommended in ANSI A58.1, FEMA 85 should consider requiring that the foundation designs be made using the snow and wind loads of ANSI A58.1 as in the HUD 4930.3, even though this introduces an inconsistency with foundations designed for one set of loads and the foundation designed for another.

FEMA 85		HUD 4930.3	Analysis
pp. 34-40	Flood forces and their application	201-2	HUD 4930.3 does not provide design data or methods for homes in flood sites. It refers to FEMA Flood Maps, HUD Handbooks 4135.1, 4145.1 and the requirements of the NFIP.

Recommendation: None.

FEMA 85		HUD 4930.3	Analysis
pp. 41-42	Design loads	402.2, 402.3	FEMA 85 provides design charts for dead load, live load, snow load, and wind load calculations. The charts use snow and wind loads from the HUD MHCSS. [Homes manufactured since 1976 under the HUD Standards are themselves certified to those loads.] HUD 4930.3 uses ANSI A58.1-1982 for snow and wind loads.

Recommendation: Revise FEMA 85 and HUD MHCSS to incorporate ANSI A58.1 snow and wind loads.

FEMA 85		HUD 4930.3	Analysis
pg. 45	Design forces and loads - Evaluation of elevated foundations		FEMA 85 provides a chart to define limits of effectiveness for ground anchors as a function of water velocity and depth of flood. The accompanying narrative also refers to Appendix E for a discussion of buoyancy, drag and effectiveness of ground anchors in floods. The discussion of buoyancy appears to have overlooked the limits of the connection of the home to the frame. The homes are designed either for 9 psf uplift or 15 psf uplift. This is not sufficient for hydrostatic pressures of more than 7" and 12" ultimate respectively.

Recommendation: The table on pg. 45 of FEMA 85 should either be dropped, or tests should be undertaken to substantiate that ground anchors can perform effectively in saturated soils. Appendix E of FEMA 85 needs to be revised to make provision for the limits of floor-to-frame connections that have been designed according to the wind uplift provisions of the HUD MHCSS. Also it appears that some performance criteria is needed to enable the ground anchor designers, vendors and users to know how to determine whether or not ground anchors can be relied upon.

FEMA 85		HUD 4930.3	Analysis
pp. 47-48	Vertical support members	402.2, 402.3	FEMA 85 provides design charts for dead load, live load, snow load, and wind load calculations. The charts use snow and wind loads from the HUD MHCSS. [Homes manufactured since 1976 under the HUD Standards are themselves certified to those loads.] HUD 4930.3 uses ANSI A58.1-1982 for snow and wind loads.

Recommendation: Revise FEMA 85 and HUD MHCSS to incorporate ANSI A58.1 snow and wind loads.

FEMA 85		HUD 4930.3	Analysis
pg. 48	Piers	App. A	FEMA 85 prescribes designs for piers, and cautions that, due to the likelihood of scouring, pier systems should not be used in areas where flooding velocity is anticipated. Appendix A of HUD 4930.3 recommends Foundation Type C2 [reinforced masonry or concrete piers] for high wind and indicates that engineering design is not required. While the Flood-Prone Sites exclusions provided in Section 201-2 might be sufficient for some designers, it seems prudent that it be repeated in the Appendices.

Recommendation: The design appendices in HUD 4930.3 should repeat the references to the FEMA documents and caution that the designs presented have not taken flood conditions into account.

Suggested Change [or addition]: Add a sentence to Paragraph B, Page A-1: Note that none of the charted designs takes flood loads into account. Refer to FEMA 85 for design loads and procedures.

FEMA 85	HUD 4930.3	Analysis
pp. 53-58 **Posts and Piles**	App. A	FEMA 85 includes provisions for pile foundations with sample load and application charts. HUD 4930.3 lists twelve foundation designs in the Foundation Selection Chart in Appendix A. Piles are not included. HUD Handbook 4930.3 is not for flood resistant installations.

Recommendation: None.

FEMA 85	HUD 4930.3	Analysis
Appendix E Buoyancy and drag forces		Appendix E in FEMA 85 discusses buoyancy, drag and effectiveness of ground anchors in floods. The discussion of buoyancy appears to have overlooked the limits of the connection of the home to the frame. The homes are designed either for 9 psf uplift or 15 psf uplift. This is not sufficient for hydrostatic pressures of more than 7" and 12" ultimate respectively. The issue of whether or not ground anchors are effective needs to be addressed convincingly.

Recommendation: Appendix E of FEMA 85 needs to be revised to make provision for the limits of floor-to-frame connections that have been designed according to the wind uplift provisions of the HUD MHCSS. Resolve whether or not ground anchors are permitted.

Manufactured Home Installation in Flood Hazard Areas [FEMA 85]

Appendix C of the 1989 CABO One and Two Family Dwelling Code addresses those aspects of manufactured homes not preempted by the HUD Manufactured Home Construction and Safety Standards (MHCSS). This includes the construction of foundation and anchorage systems for the installation of the dwelling unit on a privately-owned (nonrental) lot.

The CABO Code generally covers time-tested construction methods. It does not cover seldom-used systems or performance type systems. The construction methods in CABO also do not take into consideration any special loads such as those imposed by floods. It is suggested that CABO Appendix C reference FEMA 85 in order to cover such special loads as flooding. A direct comparison of certain sections was not made because they were beyond the scope of Appendix C of the CABO One and Two Family Dwelling Code. After review, FEMA 85 sections for which comparisons were not made are as follows:

Chapter I	Overview
Chapter II	Hazards from Floods
Chapter III	Elevation on Fill
Chapter III	Elevated Foundations exc. "Piers"
Chapter III	Evacuation
Chapter IV	A. Flood Forces and Applications exc. "Design Loads"
Chapter IV	C. Bracing Support and Connections
Chapter IV	D. Additional Design Considerations
Chapter V	Economics

Comparisons and analysis for applicable sections of FEMA 85 are as follows:

FEMA 85		CABO App. C	Analysis
Pg. 22	Piers	C-602	FEMA 85 limits the spacing of supporting members to ten feet on center whereas CABO Appendix C permits the spacing to be as specified in the manufacturer's installation instructions.

Recommendation: None.

FEMA 85		CABO App. C	Analysis
Pg. 22	Piers	C-603	FEMA 85 generally limits the height of built-up piers to ten feet or to ten times their least dimension. CABO Appendix C does not set a limit on the height of piers. However, piers constructed in accordance with CABO C-602 are not considered to resist any lateral loads. Note: CABO R-404.4 does set a height limit of ten times the least dimension for unsupported masonry piers.

Recommendation: None.

FEMA 85		CABO App. C	Analysis
Pg. 22	Piers	C-502.3	FEMA 85 specifies that built-up piers should be at least 12 in. by 12 in. and be reinforced with four No. 5 steel bars. In CABO, the cross section of a built-up pier may vary from 128 sq. in. to 16 in. by 16 in., depending on the height. Piers designed in accordance with CABO are required to be reinforced with four No. 5 steel bars only if they are over 80 inches in height.

Recommendation: Rather than providing only one option, FEMA 85 should have the section on piers expanded to include a variety of pier constructions as in CABO. Depending on the height requirements needed to elevate the home above the flood level, the installer would then be provided with different pier options.

FEMA 85		CABO App. C	Analysis
Pg. 22	Piers	C-602	a) FEMA 85 requires the bottom of the pier footing to extend a minimum of 30 in. below grade. CABO only requires the footings to extend a minimum of 12 in. below finished grade. Both require the footing to extend below the frost line. b) FEMA 85 requires built-up piers to be laid with type M or S mortar. In addition to types M or S, CABO permits Type N mortar. No incompatibilities.

Recommendations: Since the 30 inch requirement would be excessive for piers located in areas where scouring is not a problem, two separate requirements in FEMA 85 and CABO for minimum pier depths should be made depending on the flow conditions likely to be encountered.

Suggested Code Change [or addition]: In §C-602, add to the last sentence . . . wind, flood pressure, scouring, or earthquake forces.

FEMA 85		CABO App. C	Analysis
Pg. 28	Anchoring	C-604	Unlike FEMA 85, CABO does not prescribe an installation method for ground anchors other than to require that they be installed in accordance with the terms of their listing and the anchor manufacturer's instructions. Listing and labeling of ground anchors presently is a problem because there is no standard for their evaluation. It is desirable that local building officials have available some readily recognizable method to determine compliance.

Recommendation: None.

FEMA 85		CABO App. C	Analysis
Pg. 41 Pg. 45	Design Loads Design Forces and Loads	R-201.2	Design loads specified in FEMA 85 are the same as those in HUD MHCSS whereas the design criteria for CABO is established by the jurisdiction. As a guideline, the tables in FEMA 85 appear to be adequate. Where records or experience indicate significant differences, HUD may establish more stringent requirements.

Recommendation: None.

FEMA 85		CABO App. C	Analysis
Pg. 48	Vertical Support Members - "Piers"	C-603	FEMA 85 pier designs A, B, and C do not meet the minimum cross sectional area – 128 square inches – specified by CABO. Design A is for reinforced concrete and B is for 8" x 12" concrete block. Neither of these piers is included in CABO. These differences can be accommodated.

Recommendation: None.

FEMA 85		CABO App. C	Analysis
Pg. 53	Posts and Piles		CABO generally covers time-tested construction methods. It does not cover seldom-used systems such as posts or pile construction methods. The requirements are compatible as long as it is understood that CABO Appendix C is not applicable to flood loads.

Recommendation: Change CABO Appendix C to clarify that it does not consider flood loads.

Suggested Code Change [or addition]: In §C-602, add to the last sentence . . . wind, flood pressure, scouring, or earthquake forces.

Manufactured Home Installation in Flood Hazard Areas [FEMA 85]

The MHI Manufactured Home Installation Manual is intended to assist manufacturers who are required to design at least one acceptable foundation and anchorage method in accordance with the requirements of the Manufactured Housing Construction and Safety Program (MHCSS). The MHCSS does not include provisions for flood loads.

Section 4.4.1 of the Manufactured Home Installation Manual requires that a homeowner with a home intended to be sited in a flood hazard area consult with a registered professional or a structural engineer to make sure that the foundation design and construction conform to applicable federal, state, and local codes and regulations. FEMA 85 is referenced as a source for construction recommendations. If it is assumed that every home located in a flood hazard area is to follow the recommendations made in FEMA 85, the documents are compatible by the reference alone and no further comparison is warranted.

However, a comparison is provided below in consideration that FEMA 85 may be solely intended to supplement the requirements of the MHI design manual or the consulting engineer's design. The following sections in FEMA 85 were found to be not applicable to the Manufactured Home Installation Manual:

pg. 31	Evacuation
Chapter V	Economics
pg. 53	Vertical support members (posts and piles)
pg. 58	Horizontal Support beams
pg. 60	Cross bracing
pg. 62	End bracing
pg. 62	Connections
pg. 63	Horizontal beam
pg. 66	Cross bracing
pg. 67	End bracing
pg. 68	Jacking
pg. 70	Access and egress
Appendix B	Federal and State Contacts
Appendix C	Sources of flood Information
Appendix D	Calculation procedures for elevated foundation design
Appendix E	Buoyancy and drag forces
Appendix F	Design worksheet

Comparisons and analysis for applicable sections of FEMA 85 are as follows:

FEMA 85		MHI-MIM	Analysis
pg. 3	Manufactured home characteristics	4.3 4.5	FEMA 85 states that manufactured homes can be designed for removal of the steel chassis. Subsequent to the publication of FEMA 85, the Department of Housing and Urban Development has ruled that the chassis shall not be removed. MHI draft manual appears to make no provisions for removal of the chassis.

Recommendation: Design methodology and construction details in FEMA 85 should consider that the chassis remains attached to the home. Therefore, only a revision to clarify that the chassis shall not be removed is appropriate.

FEMA 85		MHI-MIM	Analysis
pg. 5	Conventional manufactured home installation techniques	5.4	FEMA 85 describes typical installation techniques and is consistent with the requirements of the MHI-MIM. It should be noted however, that FEMA 85 pg. 6, Figure 1.13, Type 2 will not provide resistance to overturning loads by the strapping method shown.

Recommendation: Clarify pg. 6, Figure 1.13, Type 2 in FEMA 85 to state that additional fastening to prevent overturning loads is required.

FEMA 85		MHI-MIM	Analysis
pg. 8	Effects of flooding	4.5.4 4.4.1	FEMA 85 describes the effects of riverine and coastal flooding on manufactured homes. Flood forces are not currently considered in MHI-MIM because siting in flood prone areas is not recommended.

Recommendation: None.

FEMA 85		MHI-MIM	Analysis
pg. 11	Regulatory requirements	1.2	FEMA 85 describes the NFIP insurance structure and state and local regulations regarding siting manufactured homes in flood hazard areas. MHI-MIM requires coordination with the authority having jurisdiction.

Recommendation: None.

FEMA 85		MHI-MIM	Analysis
pg. 15	Hazards from floods	4.4.1	FEMA 85 defines "hydrostatic," "hydrodynamic," and "debris impact" forces. The section further defines "depth," "velocity," "rate-of-rise," "duration of flooding," "duration of flooding," "frequency of flooding" and "debris load." MHI-MIM does not require that the manufactured home or manufactured home foundation resist flood forces. Consequently, MHI-MIM does not offer any similar definitions. MIM does not recommend siting in flood prone areas.

Recommendation: The requirements of the NFIP (and FEMA 85) are not appreciably strengthened by the possible introduction of the aforementioned "flood" definitions into MHI-MIM.

FEMA 85		MHI-MIM	Analysis
pg. 17	Wind hazards	4.4.2 5.4 5.4.1 5.4.2	FEMA 85 and MHI-MIM are not incompatible; FEMA 85 reiterates the same lateral and uplift design wind pressures as the MHCSS. The requirements of MHI-MIM are based on the design wind loads in the MHCSS. Please note, however, that Section 5.4 in MHI-MIM states that, ". . . the installer should secure the home against the wind unless the local jurisdiction permits otherwise." (emphasis added) It appears that FEMA 85 requires the anchoring of homes against wind loads under all circumstances.

Recommendation: It is not intended that a participant in the NFIP (i.e., local jurisdiction) would not require that a home not be anchored against wind loads. However, the compatibility of the documents would be enhanced by a revision to MHI Section 5.4 to state that anchorage of the unit against wind forces is always required.

Suggested Change [or addition]: **Change Paragraph 5.4 Anchoring Instructions.** After blocking and leveling, the installer should secure the home to resist the wind forces required in this manual or higher wind forces if required by the authority having jurisdiction.

FEMA 85		MHI-MIM	Analysis
pg. 19	Elevation on fill	3.2 3.3 3.4	FEMA 85 describes the application of fill including suggested slopes, minimum distances, etc. to elevate the manufactured home above flood level. MHI-MIM does not include similar requirements for the foundation design to be provided by the manufacturer. However, requirements of FEMA 85 are generally consistent with typical specifications provided by the manufacturer in the manufactured home installation manual.

Recommendation: None.

FEMA 85		MHI-MIM	Analysis
pg. 21	Elevated foundations (piers, posts, horizontal beams)	4.1 4.2	FEMA 85 provides general and in some instances prescriptive guidelines for the construction of built-up and cast-in-place piers, piles, and bracing. MHI-MIM provides several pier construction methods that are primarily designed to withstand vertical loads. MHI-MIM only requires concrete and reinforcement to be used when the pier height exceeds 80 inches. Additionally, FEMA 85 requires the footing to be a minimum of 30 inches below the frost line. MHI-MIM permits the footing to be located directly on the soil if acceptable to the authority having jurisdiction.

Recommendation: None.

FEMA 85		MHI-MIM	Analysis
pg. 28	Anchoring	5.4	FEMA 85 and MHI-MIM are compatible. FEMA 85 describes the typical application of ground anchor requirements. However, neither document currently provides a standard to determine the capacity of the anchoring devices. Commonly, the capacity of the anchor is determined in unsaturated soil. It is anticipated that the withdrawal capacity of the anchor will be reduced under flood conditions.

Recommendation: Further research/study is recommended to determine the capacity of anchors and to consider the withdrawal capacity of the anchor under saturated soil conditions. This study should be undertaken in a collaborative effort by HUD, FEMA, and the manufactured housing industry.

FEMA 85		MHI-MIM	Analysis
pg. 33	Design of elevated foundations	4.1.3	FEMA 85 reiterates the design parameters of the HUD MHCSS. The tables provided in MHI-MIM are based on roof and wind loads specified in the MHCSS. The sections are currently compatible.

Recommendation: None.

FEMA 85		MHI-MIM	Analysis
pg. 34	Hydrostatic forces	4.4.1 5.4.3	FEMA 85 describes the application of hydrostatic, hydrodynamic, and impact forces on a manufactured home. MHI-MIM recommends that homes to be located in flood-prone areas be designed in accordance with FEMA 85. Manufactured homes designed for Wind Zones I or II are connected to the chassis to resist a net uplift force applied to the roof of 9 psf and 15 psf respectively. This design approach does not generally consider the attachment of the floor sheathing to floor joists to resist hydrostatic loads applied to the underside of the home. However, this connection has some limited resistance to these forces as well. The documents are not incompatible in that FEMA 85 states that the only practical design approach is to elevate the unit above flood waters.

Recommendation: None. The current approach to elevate units above flood waters appears to be appropriate.

FEMA 85		MHI-MIM	Analysis
pg. 34	Lateral forces	5.4.3	See above analysis for "hydrostatic forces."

Recommendation: None.

FEMA 85		MHI-MIM	Analysis
pg. 35	Buoyancy	5.4.3	See above analysis for "hydrostatic forces."

Recommendation: None.

FEMA 85		MHI	Analysis
pg. 36	Hydrodynamic forces	4.4.1 5.4.3	See above analysis for "hydrostatic forces."

Recommendation: None.

FEMA 85		MHI	Analysis
pg. 39	Impact forces	4.4.1 5.4.3	See above analysis for "hydrostatic forces."

Recommendation: None.

FEMA 85		MHI	Analysis
pg. 39	Scour	4.4.1 5.4.3	MHI-MIM and FEMA 85 are not incompatible. However, FEMA 85 sets requirements for consideration to scour in the foundation design. MHI-MIM does not contain requirements for flood forces.

Recommendation: See recommendation for "elevated foundations."

FEMA 85		MHI-MIM	Analysis
pg. 41	Design loads	4.1.3	FEMA 85 and MHI-MIM wind and roof loads are consistent with the requirements of the HUD MHCSS. However, FEMA 85 also restates design considerations for flood forces. (See also analysis for "hydrostatic forces.")

Recommendation: None.

FEMA 85		MHI-MIM	Analysis
pg. 45	Evaluation of elevated foundations	4.4.1 5.4.3.3	FEMA 85 describes maximum water velocity as a function of the angle of the support strap and height of flood water above the floor and concludes that elevation is the "optimum strategy." Such analysis is based on typical construction techniques used in manufactured housing. MHI-MIM recommends that when the home is to be located in flood-prone areas the anchoring systems be designed by an engineer. (See also analysis for "anchoring.")

Recommendation: See recommendation for "anchoring."

FEMA 85		MHI-MIM	Analysis
pg. 45	Design forces and loads	3.1.1	Both the MHI-MIM and FEMA 85 restate the design parameters of the MHCSS for determination of the vertical member loads. The sections are therefore compatible.

Recommendation: None.

FEMA 85		MHI-MIM	Analysis
pg. 48	Vertical support members (piers)	4.1 4.2.2	(a) FEMA 85 provides general and in some instances prescriptive guidelines for the construction of built-up and cast-in-place piers, piles, and bracing. MHI-MIM provides several pier construction methods that are primarily designed to withstand vertical loads. MHI-MIM only requires that concrete and reinforcement be used when the pier height exceeds 80 inches. Additionally, FEMA 85 requires the footing to be a minimum of 30 inches below the frost line. MHI-MIM permits the footing to be located directly on the soil if acceptable to the authority having jurisdiction. (b) Additionally, Figure 4.32 in FEMA 85, "Typical Ground Anchor Detail," shows incorrect orientation of the ground anchor.

Recommendation: (a) Prescriptive guidelines in FEMA 85 are generally not incompatible because the typical foundation design provided by the manufacturer does not address flood forces. However, designs provided by the manufacturer may be acceptable for no or very low velocity flood forces but may not satisfy FEMA 85 requirements. Therefore, FEMA 85 should be clarified to describe under what flood conditions the manufacturer's design is acceptable and under what conditions the prescriptive requirements of FEMA 85 should prevail.

(b) Provide a revised detail with correct orientation of the ground anchor in FEMA 85, Figure 4.32. (See also related concerns pg. 28, "Anchoring.")

FEMA 85		MHI-MIM	Analysis
pg. 64	Chassis I-beam	5.4	MHI-MIM provides for anchors to be used to secure the home against wind and does not address special flood forces such as "buoyancy." Since FEMA 85 recommends that the home be elevated above the flood level, these provisions are compatible.

Recommendation: None

FEMA 85		MHI-MIM	Analysis
pg. 68	Longitudinal support beams	4.1.5	MHI-MIM does not recommend any perimeter installation methods which could be considered incompatible with FEMA 85.

Recommendation: None

FEMA 85		MHI-MIM	Analysis
pg. 69	Utility service	Chapter 8	FEMA 85 requires that utilities be placed in waterproofed risers adjacent to down stream foundation members. MHI-MIM does not contain requirements for protection of utilities where they connect to the structure but references FEMA 85.

Recommendation: None.

FEMA 85		MHI-MIM	Analysis
pg. 69	Mechanical systems	8.5.1	FEMA 85 requires that external equipment be elevated above anticipated flooding. MHI-MIM states that an oil tank should be located where it is accessible and also safe from hazards.

Recommendation: None.

Manufactured Home Installations in Flood Hazard Areas [FEMA 85]

NFPA 501A-1987, covers the firesafety requirements for the installation of manufactured homes and manufactured home sites. This standard includes only the firesafety portions of the scope previously covered by ANSI A225.1/NFPA 501A. The non-firesafety aspects are published separately as ANSI A225.1. Because NFPA 501A is essentially provisions for fuel supply piping and connections, a direct comparison with the provisions of FEMA 85 are for the most part not applicable. After review, the FEMA 85 sections for which comparisons were not made are as follows:

p 3	Manufactured home characteristics	p 45	Design forces, loads, evaluation of elevated foundations
p 5	Conventional mh installation	pp 47-48	Vertical support members
p 8	Effects of flooding	p 48	Piers
p 11	Regulatory requirements	pp 53-58	Posts and piles
pp 15-18	Flood and wind hazards	pp 58-68	Bracing and connections for elevated foundations
p 17	Wind hazards	pp 71-75	Economics
p 19	Elevation and anchoring techniques	Appendix A	Bibliography
p 19	Elevation and fill	Appendix B	Federal and state contacts
p 21	Elevated foundations	Appendix C	Sources of information
p 28	Anchoring	Appendix D	Calculational procedures
p 31	Evacuation techniques	Appendix E	Buoyancy
p 33	Design of elevated foundations	Appendix F	Design worksheets
pp 34-40	Flood forces and their application		
pp 41-42	Design loads		

Comparisons and analysis of applicable sections of FEMA 85 are as follows:

FEMA 85		NFPA 501A	Analysis
p. 69	Additional design considerations Utility service	§2-4.3	FEMA 85 recommends that the utility services, water, sewer and gas entering a structure that has been elevated to avoid flooding be protected using waterproof risers. Propane and fuel oil tanks are to be located on the downstream side of the home to afford protection from debris impact. NFPA 501A §2-4.3 requires that gas outlet risers, regulators, meters, valves, or other exposed equipment be protected against accidental damage.

Recommendation: None.

Manufactured Home Installation in Flood Hazard Areas [FEMA 85]

The ANSI A225.1 Manufactured Home Installations Standard is intended to be adopted by jurisdictions having responsibility for the safety and health of manufactured home users and for establishing regulations applicable to manufactured home communities. They are applicable to single family dwelling units that are built in accordance with the HUD Manufactured Home Construction and Safety Standards (MHCSS), which require that the manufacturer of the home provide instructions for the site installation using at least one system of support and anchorage that can resist the design dead, live, and wind loads.

Some of the site installation issues of FEMA 85 are topically out of range of ANSI A225.1. Thus a direct comparison of those provisions is not applicable. After review, the FEMA 85 sections for which comparisons were not made are as follows:

p 19	Elevation and anchoring	Appendix A	Bibliography
pp 58-68	Bracing support and connections	Appendix B	Federal and state contacts
pp 68-70	Additional design considerations	Appendix C	Sources of information
pp 71-75	Economics	Appendix D	Calculational procedures
		Appendix F	Design worksheet

Comparisons and analysis for applicable sections of FEMA 85 are as follows:

FEMA 85		A225.1	Analysis
Pg. 3	Manufactured home characteristics	1-3	FEMA 85 and A225.1 describe the same general features.

Recommendation: None.

FEMA 85		A225.1	Analysis
pg. 5	Conventional manufactured home installation techniques	2-1.2, 2-1.3	FEMA 85 states that the installation instructions supplied with the home and A225.1 are not adequate to resist flood forces. Figure 1.13, Type 2 Tie Down in FEMA 85 depicts an unstable wind resistance system. Section 2-1.2 of A225.1 calls a manufactured home foundation system one that is constructed in accordance with the instructions supplied with the home. Provision is made in 2-1.3 for the homeowner to design for unusual installations.

Recommendation: This section of FEMA 85 should be clarified to point to specific flood load remedies elsewhere in the document. Figure 1.13 therein should carry a notice that the method depicted is not stable and is not recommended for any loading – flood or not.

FEMA 85		A225.1	Analysis
pg. 8	Effects of flooding	Appendix B Appendix C Appendix I	A225.1 does not provide design loads or procedures for homes in flood-prone sites, nor does A225.1 provide notice that the specifications are not applicable to installations in flood-prone sites. Appendices G and I in A225.1 make reference to the NFIP. No specific FEMA documents, however, are specified.

Recommendation: None.

FEMA 85		A225.1	Analysis
pg. 11	Regulatory requirements	Appendix G	FEMA 85 explains how the NFIP works together with state and local building code jurisdictions. Appendix G of A225.1, included in A225.1 for informational purposes only, simply provides notice of the existence of the NFIP and that manufactured housing is included in the NFIP definition of the word "building."

Recommendation: None.

FEMA 85		A225.1	Analysis
pg. 19	Elevation on fill	2-5.1	FEMA 85 limits the flood velocity in accordance with the fill materials and fill cover selected. Section 2-5.1.3(b) in A225.1 requires that fill be free of grass and organic material and have a minimum bearing capacity of 1000 psf.

Recommendation: None.

FEMA 85		A225.1	Analysis
pg. 21	Elevated foundations	Chapter 2	The design methods and design loads provided in A225.1 are not applicable to elevated foundations, and no provisions are made for hydrostatic, hydrodynamic and impact loads.

Recommendation: None.

FEMA 85		A225.1	Analysis
pg. 28	Anchoring	2-4.4	FEMA 85 does not discourage the use of auger type ground anchors. A225.1 requires that ground anchor application instructions include load capacities for various types of soil and the standard provides a calibration chart to determine soil quality using a torque measuring instrument. Information is not provided in FEMA 85 or in A225.1 to caution about the possible reduction in anchor resistance in saturated soils.

Recommendation: Further study is needed to determine load capacities in saturated soils or ground anchors in flood-prone installations.

FEMA 85		A225.1	Analysis
pg. 31	Evacuation techniques	Not applicable	FEMA 85 proposes that evacuation using quick disconnect from foundations is a practicable strategy. No such provision is found in A225.1. Evacuation might be a viable strategy for small park model homes. It is not a viable strategy for multi-wides or for large single-wide homes.

Recommendation: FEMA 85 should remove the recommendation for evacuation.

FEMA 85		A225.1	Analysis
pg. 33	Design of elevated foundations	Appendix B B-4.1	FEMA 85 and A225.1 use the roof live loads and wind loads from the HUD MHCSS. A225.1 states that areas where recurrent winds up to 90 miles per hour (25 psf) are experienced should use similarly designed manufactured homes.

Recommendation: ANSI A225.1 should define the specific areas where wind loads of higher magnitude than the 25 psf limit are needed.

Suggested Standard Change [or addition]: Change Paragraph **B-4.1 The Wind Zone Map**, last sentence as follows: Consult the authority having jurisdiction. Note that an enlarged supplementary map of the Gulf and Atlantic Coastal areas has been supplied in order to more reliably determin the high wind zones. Provide such a map.

FEMA 85		A225.1	Analysis
pp 34-40	Flood forces and their application		A225.1 does not provide design data or methods for homes in flood sites, nor does it refer to FEMA Flood Maps or specific requirements of the NFIP.

Recommendation: None.

FEMA 85		A225.1	Analysis
pp 41-42	Design loads	Table 2-4.2.1	FEMA 85 provides design charts for dead load, live load, snow load, and wind load calculations. A225.1 provides Table 2-4.2.1 for design loads. The loads are nearly identical (5 psf difference in dead loads.)

Recommendation: None.

FEMA 85		A225.1	Analysis
pg. 45	Design forces and loads - Evaluation of elevated foundations		FEMA 85 provides a chart to define limits of effectiveness for ground anchors as a function of water velocity and depth of flood. The accompanying narrative also refers to Appendix E for a discussion of buoyancy, drag and effectiveness of ground anchors in floods. The discussion of buoyancy appears to have overlooked the limits of the connection of the home to the frame. The homes are designed either for 9 psf uplift or 15 psf uplift. This is not sufficient for hydrostatic pressures of more than 7" and 12" ultimate respectively.

Recommendation: The table on p.45 of FEMA 85 should either be dropped, or tests should be undertaken to substantiate that ground anchors can perform effectively in saturated soils. Appendix E of FEMA 85 needs to be revised to make provision for the limits of floor-to-frame connections that have been designed according to the wind uplift provisions of the HUD MHCSS. Also it appears that some performance criteria is needed to enable the ground anchor designers, vendors and users to know how to determine whether or not ground anchors can be relied upon. Notices are needed in A225.1 to either caution that flooding is not included in the charted loads or provide flood loads for homes to be sited in flood-prone areas, or require the application of the flood loads.

FEMA 85		A225.1	Analysis
pp 47-48	Vertical support members	Appendix B	FEMA 85 provides design charts for dead load, live load, snow load, and wind load calculations. The charts use snow and wind loads from the HUD MHCSS. [Homes manufactured since 1976 under the HUD Standards are themselves certified to those loads] A225.1 uses the same live, snow, and wind loads as FEMA 85.

Recommendation: Revise ANSI A225.1, Appendix B, to incorporate ASCE-7 snow and wind loads.

Suggested Standard Change [or addition]: **Add a Paragraph:**

B-4.3 Flood Loads:

Refer to FEMA 85 for flood loading. The loads in these Tables do not include loads attributable to flooding.

FEMA 85		A225.1	Analysis
pg. 48	Piers	Appendix C	FEMA 85 prescribes designs for piers, and cautions that, due to the likelihood of scouring, pier systems should not be used in areas where flooding velocity is anticipated. Appendix C of A225.1 provides designs for pier foundations and issues no cautions concerning scouring. (Note that overall A225.1 is not for homes sited in flood- prone areas.)

Recommendation: Appendix C of A225.1 should reference the FEMA documents and caution that the designs presented have not taken flood conditions into account.

Suggested Standard Change [or addition]: Add a paragraph after the introductory paragraph to Appendix C, second column:

Flood Designs:

Refer to FEMA 85 for flood designs and design methods. These designs do not include loads attributable to flooding.

FEMA 85		A225.1	Analysis
pp 53-58	Posts and Piles	Appendix A	FEMA 85 includes provisions for pile foundations with sample load and application charts. Piles are not included in A225.1. [A225.1 is not for flood resistant installations.]

Recommendation: None.

FEMA 85		A225.1	Analysis
App. E	Buoyancy and drag forces		Appendix E of FEMA 85 discusses buoyancy, drag and effectiveness of ground anchors in floods. The discussion of buoyancy appears to have overlooked the limits of the connection of the home to the frame. The homes are designed either for 9 psf uplift or 15 psf uplift. This is not sufficient for hydrostatic pressures of more than 7" and 12" ultimate respectively. The issue of whether or not ground anchors are effective needs to be addressed convincingly.

Recommendation: Appendix E of FEMA 85 should be revised to make provision for the limits of floor-to-frame connections that have been designed according to the wind uplift provisions of the HUD MHCSS. Resolve whether or not ground anchors are permitted.

APPENDIX F

COMPARISON BETWEEN THE CABO ONE AND TWO FAMILY DWELLING CODE AND THE NFIP STANDARDS AND TECHNICAL GUIDELINES

TABLE OF CONTENTS

CABO ONE AND TWO FAMILY DWELLING CODE (OTFDC) COMPARISON

The prescriptive requirements of the CABO One and Two Family Dwelling Code are for conventional construction with wind pressures less than 30 psf and seismic zones 0, 1, and 2.

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

59.1 - Definitions

NFIP	OTFDC	Analysis
Base Flood Breakaway Wall Critical Feature Development Elevated Building Flood Floodplain or Flood-Prone Area Lowest Floor 100-year Flood Storm Cellar Substantial Improvement	R-115	NFIP contains definitions which only apply to floodplain management. OTFDC does not contain these definitions.

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

NFIP	OTFDC	Analysis
Appurtenant Structure Basement Building Existing Construction Existing Structures Manufactured Home Structure	R-115	The definitions of "appurtenant structure/accessory structure" and "basement" are compatible. NFIP definition of "building (structure)" applies to any walled and roofed building while OTFDC addresses only one-and two-family dwellings. NFIP definition of "existing construction" applies to construction begun before the date of FIRM while OTFDC definition applies to buildings erected before the adoption of the Code. NFIP definition of "manufactured home" applies only to structures transportable in one or more sections, built on a permanent chassis, and designed for use with or without a permanent foundation while OTFDC also contains dimensional parameters.

Recommendation: NFIP should expand definition of manufactured home to include dimensional parameters.

60.3 Floodplain Management Criteria for Flood-Prone Areas

NFIP	OTFDC	Analysis
60.3(b)(8) Manufactured Home Installation	Appendix C	Appendix C contains provisions which apply to the construction, alteration and repair of any foundation system which is necessary to provide for the installation of a manufactured home unit; construction, installation, addition, alteration, repair or maintenance of the building service equipment which is necessary for connecting manufactured homes to water, fuel, or power supplies and sewage systems. See NCSBCS comparison to Appendix C.

Recommendation: None.

NFIP	OTFDC	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. OTFDC does not address floodplain management or elevation of structure.

Recommendation: None.

NFIP	OTFDC	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. OTFDC does not address non-residential structures.

Recommendation: None.

NFIP	OTFDC	Analysis
60.3(c)(5) Flood Openings	R-311	NFIP requires fully enclosed areas below the lowest floor, other than basements, to be provided with flood openings to equalize hydrostatic flood forces. OTFDC does not address floodplain management; however, it does require openings for crawl space ventilation.

Recommendation: OTFDC should address openings for floodwater and equalize hydrostatic forces.

NFIP	OTFDC	Analysis
60.3(e)(4) Pilings	R-301.2	NFIP requires structures 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. OTFDC requires the foundation and its structural system to be capable of accommodating all superimposed live, dead, snow, wind, seismic and any other loads in accordance with accepted engineering practice.

Recommendation: NFIP should address snow and seismic loads.

NFIP	OTFDC	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. OTFDC does not address floodplain management or breakaway walls.

Recommendation: None.

NFIP	OTFDC	Analysis
60.3(e)(6) Fill	N/A	NFIP prohibits only in V zones the use of fill material to support buildings in flood-prone areas. OTFDC does not address floodplain management and does not prohibit the use of fill material to support buildings.

Recommendation: None.

60.6 Variances and Exceptions

NFIP	OTFDC	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. OTFDC does not address floodplain management.

Recommendation: None.

CABO ONE AND TWO FAMILY DWELLING CODE (OTFDC) COMPARISON

The prescriptive requirements of the CABO One and Two Family Dwelling Code are for conventional construction with wind pressures less than 30 psf and seismic zones 0, 1, and 2.

Elevated Residential Structures (FEMA 54)

FEMA 54	OTFDC	Analysis
Posts Post Embedment Post Anchorage (Pages 68-71)	R-303	FEMA 54 addresses the use of wood, concrete, or steel posts as the foundation to elevate residential structures; hole depth, end bearing, hole size, and backfilling of posts; and anchorage of post foundations. OTFDC does not specifically address post foundations but does permit foundations of any type provided it is designed to safely support the loads imposed.

Recommendation: None.

FEMA 54	OTFDC	Analysis
Piers (Page 75)	R-404.4	FEMA 54 describes the suitability of pier foundations and types of pier foundations and types of pier foundations which are suitable for the flood areas with low velocity and minimal erosion. OTFDC does not address the suitability of any type of foundations in any area. OTFDC requires the foundations to be of sufficient design to support safely the loads imposed.

Recommendation: None.

FEMA 54	OTFDC	Analysis
Brick and Concrete Masonry Piers (Pages 75, 76)	R-404.4 R-602.2.1	FEMA 54 provides minimum reinforcing, minimum dimensional requirements, maximum height, spacing, and recommended shape. FEMA 54 requires the piers to be filled with concrete. OTFDC bases the height on the least dimension whether the pier is filled with concrete or not. OTFDC does not require reinforcing. FEMA 55 permits the maximum spacing to be 8 ft or 12 ft. OTFDC permits the spacing to be based on girder span and girder spacing.

Recommendation: FEMA 54 and OTFDC are in general agreement.

FEMA 54	OTFDC	Analysis
Concrete Piers (Page 77)	R-303 R-404.4	FEMA 54 provides a general description and discussion of poured-in-place concrete piers. OTFDC does not specifically address concrete piers. OTFDC requires foundations to be of sufficient design to support safely the loads imposed.

Recommendation: None since both FEMA 54 and OTFDC basically require the foundation to be based on a structural analysis.

FEMA 54	OTFDC	Analysis
Pier Footings (Page 77)	R-303	Both FEMA 54 and OTFDC require the footing sizes to be based on the properties of the soil.

Recommendation: None.

FEMA 54	OTFDC	Analysis
Shear Walls and Floor Diaphragm (Page 79)	R-303	FEMA 54 addresses the use of plywood shear walls and floor diaphragms to brace piles or post foundations. OTFDC requires the foundation to be of sufficient design to support safely the loads imposed.

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	OTFDC	Analysis
Pier Foundation Connection (Pages 84, 85)	R-401.2 R-601.2	FEMA 54 addresses anchorage of platform framing construction to pier foundations. OTFDC requires the wall and floor construction to be capable of accommodating all loads imposed and transmitting the resulting loads to its supporting structural elements. OTFDC does not address pier anchorage but does address continuous masonry wall foundations.

Recommendation: OTFDC should provide requirements for pier foundation anchorage.

FEMA 54	OTFDC	Analysis
Floor Beams (Page 86, Paragraph 2)	R-602.2.1 Table R-402.3a	FEMA 54 provides a general discussion of built-up floor beams, (nailing, location of splices, and size). OTFDC provides nailing requirements and sizes based on girder span and spacing.

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

FEMA 54	OTFDC	Analysis
Cantilevers (Page 86, 87)	R-601.2	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. OTFDC requires the wood members to be capable of accommodating all loads imposed.

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

FEMA 54	OTFDC	Analysis
Floor Beam to Floor Joist Connection (Page 88)	R-601.2	FEMA 54 requires positive connection between the floor joists and floor beams with a general discussion of the connection and connectors. OTFDC requires the floor system to be capable of accommodating all loads imposed and transmitting the resulting loads to its supporting structural elements.

Recommendation: None.

FEMA 54	OTFDC	Analysis
Figure 4.48, Protective Utility Shaft (Page 92)	M-1901	FEMA 54 requires mechanical and plumbing piping serving an elevated structure to be attached to the leeward side of posts/columns or enclosed in a protective shaft. The OTFDC requires (1) water service and DWV to be protected from freezing and (2) fuel piping to conform to good practice. The OTFDC does not address flooding.

Recommendation: None.

FEMA 54	OTFDC	Analysis
Mechanical Equipment Page 93, Paragraph 2)	M-1106 M-1306 M-1307 M-1308	FEMA 54 requires all mechanical equipment to be elevated above expected floodwaters, with indoor components, preferably installed in attics. The OTFDC allows attic installation, but does not specify minimum elevations for equipment. The OTFDC does not address flooding.
	M-1602	FEMA 54 requires ductwork to have minimum slopes to opening at lowest levels to allow drainage. The OTFDC does not require such slope on air ducts, and does not address flooding.

Recommendation: None.

FEMA 54	OTFDC	Analysis
Septic Tanks (Page 93, Paragraph 3	P-2503 P-2506.2	FEMA 54 requires that septic tanks be floodproofed to stop floating and potential discharge of effluent. The OTFDC requires that septic tanks be designed to withstand all anticipated loads.

Recommendation: None since both approach the problem from different directions. FEMA - prescriptive OTFDC - performance.

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

Recommendation: None.

FEMA 54	OTFDC	Analysis
Wood (Page 94)	R-309	FEMA requires wood exposed to the elements to be preservative treated. OTFDC requires wood subject to decay damage to be pressure preservatively treated or decay-resistant wood.

Recommendation: FEMA 54 should include "decay resistant wood."

FEMA 54	OTFDC	Analysis
Steel (Pages 94, 95)	N/A	FEMA 54 addresses the need for galvanization of steel exposed to the elements to prevent corrosion. OTFDC does not address corrosion protection of steel members.

Recommendation: None.

FEMA 54	OTFDC	Analysis
Concrete and Masonry (Page 95)	R-404.14.1	FEMA 54 addresses the need to increase the durability of reinforced concrete and masonry by the use of chemical additives and coatings. OTFDC requires minimum corrosion protection of joint reinforcement, anchor ties and wire fabric for use in masonry wall construction.

Recommendation: None.

FEMA 54	OTFDC	Analysis
Insulation (Pages 95, 96)	M-1706	FEMA 54 requires underfloor exposed pipes to be insulated with impermeable or inexpensively replaced insulation. The OTFDC does not address flooding. It does address refrigerant piping insulation and where it is required.

Recommendation: None.

FEMA 54	OTFDC	Analysis
Glossary (Pages 113-115)	N/A	FEMA 54 contains definitions of terms which are relevant to floodplain management. OTFDC does not address floodplain management.

Recommendation: None.

FEMA 54	OTFDC	Analysis
Performance Criteria (Pages 125-135)	R-201.2 R-303 R-401.2 R-601.2 R-701.2 Appendix A (Seismic Risk Map, Wind Probability Map, and Snow Load Map	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. OTFDC requires the construction to be capable of accommodating all loads imposed and transmitting the resulting loads to its supporting structural elements.

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

CABO ONE AND TWO FAMILY DWELLING CODE (OTFDC) COMPARISON

The prescriptive requirements of the CABO One and Two Family Dwelling Code are for conventional construction with wind pressures less than 30 psf and seismic zones 0, 1, and 2.

Coastal Construction Manual (FEMA 55)

FEMA 55	OTFDC	Analysis
4.1 Flood Frequency (Page 4-1, Paragraph 4)	N/A	FEMA 55 addresses the wave crest elevation that would be present during the base (100 year) flood. OTFDC does not address floodplain management.

Recommendation: None.

FEMA 55	OTFDC	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)	Appendix A (Wind Probability Map)	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. OTFDC contains a wind probability map with wind design loads based on ANSI A58.1-1982.

Recommendation: FEMA 55 should confirm that the wind load provisions are consistent with ASCE 7-88. The 1992 OTFDC does reference ASCE 7-88.

FEMA 55	OTFDC	Analysis
4.1.2 Salt Air Moisture and Wind-Driven Rain (Pages 4-7, 4-8)	R-309 R-404.14.1	FEMA provides general discussion of the hazards of salt air, moisture, and wind-driven rain on wood, nails, and connectors. OTFDC requires wood subject to decay damage to be naturally durable or pressure treated but does not address nails or connectors. OTFDC does address corrosion protection of joint reinforcement, anchor ties, and wire fabric for use in masonry wall construction.

Recommendation: OTFDC should address corrosion protection.

FEMA 55	OTFDC	Analysis
4.1.3 Water, Waves, and Debris (Page 4-8, Paragraph 4)	R-303	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 of 0.5 ft. OTFDC requires the foundation and its structural elements to be capable of accommodating all superimposed live, dead, snow, wind, seismic, and all lateral loads in accordance with accepted engineering practice.

Recommendation: None.

FEMA 55	OTFDC	Analysis
4.1.4 Effects of Forces on Higher and Larger Structures (Pages 4-9)	Appendix A (Wind Probability Map)	FEMA 55 discusses the higher wind forces, uplift and overturning with respect to the height of the building. OTFDC contains a factor to increase the wind design loads when the mean roof height is greater than 30 ft but less than 50 ft.

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

FEMA 55	OTFDC	Analysis
4.2 Construction Materials (Pages 4-9)	Ch. 3, 4, 5, 6 & 7	FEMA 55 provides a general discussion of the types of construction materials (wood, steel, concrete) and their use in the coastal environment. OTFDC provides requirements for the use of these materials in any environment.

Recommendation: None.

FEMA 55	OTFDC	Analysis
4.2.1.1 Pilings (Wood) (Pages 4-9, 4-10)	R-301.2	FEMA 55 provides general comments on the use of wood pilings (species and decay resistance). OTFDC does not specifically address pile foundations but does require the foundation and its structural elements to be capable of accommodating all superimposed live, dead, snow, wind, seismic, and all lateral loads in accordance with accepted engineering practice.

Recommendation: FEMA 55 should address snow and seismic loads.

FEMA 55	OTFDC	Analysis
4.2.1.2 Main Supporting Members (Beams, Wood) (Page 4-10)	T. R-402.3a R-602.2.1 T. R-602.2.1a T. R-602.2.1b	Both FEMA 55 and OTFDC address the use of built-up beams and girders. FEMA 55 provides general nailing requirements and splice location. OTFDC provides allowable spans and nailing requirements for built-up beams.

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

FEMA 55	OTFDC	Analysis
4.2.1.3 Other Wood Construction Members (Page 4-10)	R-309	FEMA 55 does not require preservative treatment of miscellaneous wood members but highly recommends it. OTFDC requires wood subject to decay to be a naturally durable species or pressure treated.

Recommendation: None.

FEMA 55	OTFDC	Analysis
4.2.1.4 Wood Preservative (Page 4-10)	R-309	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 discussion of wood preservatives. OTFDC requires wood subject to decay to be a naturally durable species or pressure treated and provides a list of AWPA standards.

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

FEMA 55	OTFDC	Analysis
4.2.2 Masonry Materials and Concrete (Page 4-11)	R-302.2 R-304.1 R-404	FEMA 55 addresses the use of masonry and concrete in the coastal environment. OTFDC provides a chart to determine the minimum compressive strength of concrete based on weathering potential but does not address exposure of masonry.

Recommendation: FEMA should add reference to ACI 318.

FEMA 55	OTFDC	Analysis
4.2.3.1 Aluminum (Page 4-11)	R-403 R-605 R-705.2	FEMA 55 addresses the problem of corrosion of aluminum in the coastal environment. OTFDC only addresses the use of aluminum structurally in buildings and references aluminum standards.

Recommendation: None.

FEMA 55	OTFDC	Analysis
4.2.3.2 Steel (Page 4-11)	R-403 R-605 R-705	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. OTFDC requires the steel to comply with the appropriate standards. OTFDC does not address corrosion in coastal environment.

Recommendation: OTFDC should address corrosion protection.

FEMA 55	OTFDC	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). OTFDC does not address dissimilar metals.

Recommendation: None.

FEMA 55	OTFDC	Analysis
4.3.1 Foundations (Design Details) (Pages 4-11, 4-12)	R-303	FEMA 55 recommends foundation types which are suitable for supporting elevated structures in coastal high hazard areas. OTFDC requires the foundation system to be of sufficient design to support the loads imposed as determined from the character of the soil. OTFDC does provide minimum foundation sizes. OTFDC does not address coastal high hazard areas.

Recommendation: None.

FEMA 55	OTFDC	Analysis
4.3.1.1 Soil Conditions (Pages 4-12, 4-13)	R-301.4	Both FEMA 55 and OTFDC address the need to determine the quality of the soil foundation purposes. FEMA 55 provides commentary type information also.

Recommendation: None.

FEMA 55	OTFDC	Analysis
4.3.1.2 Piles (Pages 4-13 to 4-18)	R-303	FEMA 55 provides general information on types of piles, the need for sufficient pile embedment, methods of pile installation. OTFDC does not specifically address pile foundations but does require the foundation system to be of sufficient design to support the loads imposed.

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

FEMA 55	OTFDC	Analysis
4.3.1.3 Posts (Wood) (Page 4-18)	R-303	FEMA 55 explains that wood posts are recommended in areas subject to wave forces and/or scour and erosion. OTFDC does not specifically address post foundations but does require the foundation system to be of sufficient design to support the loads imposed.

Recommendation: None.

FEMA 55	OTFDC	Analysis
4.3.1.4 Piers (Pages 4-18 to 4-20)	R-303 R-404.4	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. OTFDC requires the foundation system to be of sufficient design to support the loads imposed. OTFDC provides minimum guidelines to 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	OTFDC	Analysis
4.3.2.1 Framing Methods (Pages 4-20, 4-21)	R-601.2	Both FEMA 55 and OTFDC addresses platform framing. FEMA 55 addresses pole construction and provides commentary on the types of construction.

Recommendation: None.

FEMA 55	OTFDC	Analysis
4.3.2.2 Beams (Pages 4-21, 4-22)	T. R-402.3a R-602.2.1 T. R-602.2.1a T. R-602.2.1b	FEMA 55 addresses the preferable direction of floor beams to reduce the impact of the storm water. FEMA 55 and OTFDC addresses built-up beams and solid members. FEMA 55 mentions "glulam" beams. OTFDC provides nailing requirements for built-up members.

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

FEMA 55	OTFDC	Analysis
4.3.2.3 Joists and Rafters (Page 4-22)	R-602.2.1 R-602.4	The title of the section in FEMA 55 is joist 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. FEMA 55 and OTFDC describe typical cross bridging methods. FEMA 55 requires cross bridging at a maximum of 8 ft while OTFDC requires cross bridging for joists having a depth-to-thickness ratio exceeding six at a maximum of 10 ft.

Recommendation: FEMA 55 should delete the reference to rafters.

FEMA 55	OTFDC	Analysis
4.3.2.4 Subflooring (Pages 4-22, 4-23)	R-602.2.2 R-606.1 R-607.1.2	Both FEMA 55 and OTFDC permit the use of lumber and plywood subflooring. OTFDC 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-grove joints to avoid the need for blocking and to produce a stronger diaphragm. OTFDC permits the use of smooth common or deformed shank nails with no mention of gluing. OTFDC provides minimum thickness, span of subfloor, and nail spacing.

Recommendation: The provisions are compatible. FEMA 55 should provide some recommended nail spacing and spans. FEMA 55 should permit the use of particleboard subfloors.

FEMA 55	OTFDC	Analysis
4.3.2.5 Studs (Page 4-23)	R-402.3	FEMA 55 recognizes that 2x4 wood studs at 16 inches on centers are commonly used and permits 2x6 wood studs and metal studs. OTFDC addresses the use of wood studs based on lateral unsupported stud height, spacing of studs, and number of stories.

Recommendation: FEMA 55 should address the length of the stud in addition to the number of stories which the stud supports.

FEMA 55	OTFDC	Analysis
4.3.2.6 Wall Sheathing (Page 4-23)	R-402.3	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. OTFDC list permits plywood and particleboard wall sheathing.

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

FEMA 55	OTFDC	Analysis
4.3.2.7 Wall Bracing (Page 4-24)	R-404.10 T. R-402.3b T. R-402.3c	Both FEMA 55 and OTFDC permit the use of let-in diagonal wood bracing and plywood. FEMA permits diagonal boards. OTFDC permits particleboard or approved metal strap devices.

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	OTFDC	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. OTFDC does not provide details or discuss performance of specific designs.

Recommendation: None.

FEMA 55	OTFDC	Analysis
4.3.3 Foundation Bracing (Pages 4-27 to 4-29)	R-303	FEMA 55 addresses the need for bracing wood foundation piles. OTFDC requires the foundation to be of sufficient design to support safely the loads imposed.

Recommendation: None.

FEMA 55	OTFDC	Analysis
4.3.3.1 Knee Bracing (Page 4-29)	R-303	FEMA 55 recommends the use of knee braces for wood piles even though bracing may not be needed. OTFDC requires the foundation to be of sufficient design to withstand the loads imposed.

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	OTFDC	Analysis
4.3.3.2 Grade Beams (Pages 4-29, 4-30)	R-303	FEMA 55 recommends the need for lateral support of the piles at the ground line. OTFDC requires the foundation to be of sufficient design to withstand the loads imposed.

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

FEMA 55	OTFDC	Analysis
4.3.3.3 Truss Bracing (Pages 4-30, 4-31)	R-303	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. OTFDC requires the foundation system to be of sufficient design to safely support the loads imposed.

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

FEMA 55	OTFDC	Analysis
4.3.3.4 Shear Walls (Page 4-31)	R-303	FEMA 55 addresses only reinforced concrete or reinforced masonry sheer walls. OTFDC does not specifically address shear walls but does require foundation systems to be of sufficient design to safely support the loads imposed.

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

FEMA 55	OTFDC	Analysis
4.3.4 Connections 4.3.4.1 Roof to Wall 4.3.4.2 Wall to Floor Joist 4.3.4.3 Floor Joist to Floor Beam (Pages 4-31 to 4-35)	R-303 R-401.2 R-601.2 R-701.2	FEMA provides commentary type language that the roof to wall, wall to floor joist, and floor joist to floor beam connections to be sufficient to withstand the anticipated forces. OTFDC requires that the interconnection of the roof to wall to floor to foundation be capable of transmitting the resulting loads to its supporting structure elements.

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

FEMA 55	OTFDC	Analysis
4.3.4.4 Floor Beam to Pile, Post, or Pier (Pages 4-35 to 4-40)	R-303 R-601.2	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. OTFDC requires that the interconnection be capable of transmitting the resulting loads to its supporting structural elements.

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

FEMA 55	OTFDC	Analysis
4.3.5 Breakaway Walls 4.3.5.1 Breakaway Wall Design 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. OTFDC does not address breakaway walls.

Recommendation: None.

FEMA 55	OTFDC	Analysis
4.3.6 Utilities (Pages 4-50 to 4-52)	M-1102 M-1106 M-1306 M-1307 M-1308 M-1901 P-2003	FEMA 55 requires all mechanical equipment to be elevated above BFE and fuel, water service, and DWV to be on the leeward side of posts/columns or enclosed in shafts. The OTFDC does not address flooding. The OTFDC does allow attic or elevated installations with minimum clearances to combustibles and accessibility. The OTFDC requires water service and DWV to be protected from freezing and fuel piping to conform to good practice.

Recommendation: None.

FEMA 55	OTFDC	Analysis
4.3.7 Wind and Storm Protection of Interior (Page 4-52)	R-411	FEMA 55 provides commentary on the need to protect the buildings from glass breakage in order to prevent water damage. OTFDC does not address glass breakage. OTFDC requires the windows to be tested and certified to indicate compliance with AAMA (ANSI) 101, ANSI/NWWDA I.S.2, or ASTM D 4099.

Recommendation: FEMA 55 should reference the window standards and require the windows to be designed for the wind pressures.

FEMA 55	OTFDC	Analysis
4.3.7.1 Window Selection (Pages 4-52, 4-53)	R-208.5 R-411	FEMA 55 addresses the importance of window selection to reduce water infiltration. OTFDC requires the windows to be tested and certified to indicate compliance with AAMA (ANSI) 101, ANSI/NWWDA I.S.2, or ASTM D 4099 and be capable of safely withstanding the wind loads.

Recommendation: FEMA 55 should reference the window standards and require the windows to be designed for the wind pressures.

FEMA 55	OTFDC	Analysis
4.3.7.2 Operable Shutters (Pages 4-53, 4-54)	R-208.5 R-411	FEMA 55 addresses the need for shutters to protect against wave and wind action. OTFDC requires the windows to be tested and certified to indicate compliance with AAMA (ANSI) 101, ANSI/NWWDA I.S.2, or ASTM D 4099 and be capable of safely withstanding the wind loads.

Recommendation: FEMA 55 should require the shutter to be designed for the wind loads.

FEMA 55	OTFDC	Analysis
4.3.7.3 Gable and Eave Vents (Page 4-54)	R-701.1 R-701.2 R-707	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 or to assure that they will withstand the wind loads. OTFDC requires ventilation of the attic space based on a ratio of free ventilating area. OTFDC requires the roof-ceiling construction to be capable of accommodating all loads imposed.

Recommendation: OTFDC should clarify that the ventilators that are to withstand the wind loads. This is implied in R-701.1.

FEMA 55	OTFDC	Analysis
4.3.7.4 Roof Materials (Page 4-54)	R-801.2	FEMA 55 emphasizes the need to use self-sealing, heavyweight shingles to avoid the possible loss of roofing material in high winds. OTFDC requires the roof covering to be capable of accommodating the imposed loads and provide a barrier against the weather.

Recommendation: FEMA 55 should emphasize the need to have the roof covering to withstand the uplift from the wind.

FEMA 55	OTFDC	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. OTFDC does not address maintenance but does require repairs or rehabilitation to comply with the requirements of the OTFDC for new construction.

Recommendation: None.

FEMA 55	OTFDC	Analysis
Chapter 5 - Larger Structures 5.1 General Design Considerations 5.2 Foundations 5.3 Slabs at Grade 5.4 Superstructure 5.5 Elevated Floors 5.6 Exterior Walls 5.7 Recommendations (Pages 5-1 to 5-9)	N/A	Chapter 5 of FEMA 55 addresses the design and construction of mid- to high-rise structures located in coastal high hazard areas. OTFDC only addresses one- or two-family dwellings and one-family townhouses not more than three stories in height.

Recommendation: None.

FEMA 55	OTFDC	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)	Ch. 2, 3, 4, 6, 7 & 8	FEMA 55 provides design tables. OTFDC is more performance oriented than specification oriented.

Recommendation: None.

FEMA 55	OTFDC	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)	R-303	FEMA provides various recommendations and details for bracing methods. OTFDC is more performance oriented than specification oriented.

Recommendation: None.

FEMA 55	OTFDC	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. OTFDC is more performance oriented than specification oriented.

Recommendation: None.

FEMA 55	OTFDC	Analysis
G-2. Purpose (Page G-1)	R-102	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. The purpose of the OTFDC is to provide minimum standards for the protection of life, limb, health, property, environment and for the safety and welfare of the consumer, general public and the owners and occupants of residential buildings regulated by the Code.

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

FEMA 55	OTFDC	Analysis
G-3 Scope (Page G-2)	R-103	Both FEMA 55 and OTFDC apply to new construction and improvements on 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 OTFDC requires all improvements to comply with the Code.

Recommendation: Since market value is a variable based on location, economy, etc., FEMA 55 should require compliance for all improvements since noncompliance of any part of the structure makes the entire structure out of compliance.

FEMA 55	OTFDC	Analysis
G-4 Definitions (Pages G-2, G-3)	R-115	FEMA 55 contains only definitions which are related to coastal construction. OTFDC contains definitions which are applicable to one- and two-family dwellings in any location. Dead load, live load, and grade have similar definitions.

Recommendation: None.

FEMA 55	OTFDC	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. OTFDC does not prohibit construction in any location.

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

FEMA 55	OTFDC	Analysis
G-6 Determination of Loading Forces G-6.1 Water Loads G-6.2 Wind Loads (Page G-3)	R-303 R-401.2 R-402.3 R-601.2 R-701.2 App. A (Wind Probability Map)	Both FEMA 55 and OTFDC require the structure to be of sufficient strength to support the loads and forces encountered. The loads in the OTFDC are dead, live, snow, wind, and seismic. FEMA 55 references ANSI A58.1-1982 for the wind load provisions. OTFDC contains a wind zone map with wind design loads based on ANSI A58.1-1982. OTFDC does not specifically address water loads.

Recommendation: FEMA 55 should update its reference to ASCE 7-88. FEMA 55 should also address snow and seismic loads. The 1992 OTFDC does reference ASCE 7-88.

FEMA 55	OTFDC	Analysis
G-7. Foundation Standards (Page G-4)	R-303	Both FEMA 55 and OTFDC require the foundations to be designed to support the loads and forces encountered.

Recommendation: None.

FEMA 55	OTFDC	Analysis
G-7.1 Pile Foundation Design (Pages G-4, G-5)	R-303	FEMA 55 requires the pile spacing to pile diameter ratio to not be less than 8:1 with a maximum spacing of 12 ft. FEMA 55 provides minimum embedment of foundation piles based on mean sea level and BFE. FEMA 55 requires the piles to be analyzed as a column for the unsupported length. FEMA 55 provides dimensional criteria for round and square wood piles. FEMA 55 provides commentary type language for methods of bracing piles to resist the horizontal forces. OTFDC does not specifically address pile foundations but requires the foundation to be of sufficient design to support safely the loads imposed.

Recommendation: None.

FEMA 55	OTFDC	Analysis
G-7.2 Column Foundation Design (Page G-5)	R-303 R-404.4	FEMA 55 requires reinforcing of masonry piers or poured-in-place concrete piers. OTFDC requires piers to be of sufficient design to support safely the loads imposed.

Recommendation: None.

FEMA 55	OTFDC	Analysis
G-8 Anchoring Standards G-8.1 Connection 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 to G-6)	R-303 R-401.2 R-601.2 R-701.2	FEMA 55 requires anchorage to prevent flotation, collapse, or permanent lateral movement during the base flood concurrent with the 100 year design wind velocity. Both FEMA 55 and OTFDC require the connectors to support the loads and forces encountered but FEMA 55 prohibits the use of toe nailing. FEMA 55 provides prescriptive requirements for the beam to pile connection, floor joists to floor beam/girders, exterior wall connections and ceiling joist/rafter connections. OTFDC provides some prescriptive requirements but also requires the construction to be capable of accommodating all loads and transmitting the resulting loads to its supporting structural elements.

Recommendation: FEMA 55 should not prohibit toe nailing if the connection is adequate for the calculated loads. FEMA should address snow and seismic loads.

FEMA 55	OTFDC	Analysis
G-9 Roof Sheathing (Pages G-6, G-7)	R-703 R-704	FEMA 55 requires roof sheathing to be a minimum of 15/32 inch thick plywood. OTFDC 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 and/or roof overhang. FEMA 55 also provides commentary language addressing the roof slopes and construction at points of discontinuity of the roofing surface.

Recommendation: FEMA 55 should permit particleboard roof sheathing provided it is of the appropriate strength and does not deteriorate in the moist coastal environment.

FEMA 55	OTFDC	Analysis
G-10. Protection of Openings (Page G-7)	R-208.5 R-411 R-412	FEMA 55 requires exterior openings to be designed to withstand the appropriate windloads. OTFDC requires glass areas in exterior walls subject to wind loading to be capable of safely withstanding the wind loads and be tested and certified that they comply with AAMA (ANSI) 101, ANSI/NWWDA I.S.2, ANSI/NWWDA I.S.3 and ASTM D 4099.

Recommendation: None.

FEMA 55	OTFDC	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)	N/A	FEMA 55 prohibits the use of the space below the elevated floor to be used for any other purpose than parking or building access and be either free of obstructions or constructed of breakaway walls. OTFDC does not prohibit the use of the space below the elevated floor and does not address breakaway walls.

Recommendation: None.

FEMA 55	OTFDC	Analysis
G-12 Utilities (Page G-8)	M-1106 M-1306 M-1307 M-1308 M-1102	FEMA 55 requires all mechanical equipment to be elevated above expected flood waters. The OTFDC does not address flooding. However, it does allow elevated installations with minimum access and clearance to combustibles.
	P-2016 P-2111	FEMA 55 requires sanitary sewer and storm drainage systems, which have openings below the BFE, to have backflow valves where these lines penetrate the building envelope. The OTFDC does not address flooding, but does allow backwater valves.

Recommendation: None.

FEMA 55	OTFDC	Analysis
G-13 Certification Requirements (Page G-8)	R-108	FEMA 55 requires new and substantial improvements to be designed by a professional engineer or architect. OTFDC does not require design by a professional engineer or architect. OTFDC permits alternate materials and methods provided that the method of design or construction is equivalent to that of this Code.

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

FEMA 55	OTFDC	Analysis
G-14 Reference Documents (Page G-8)	Chapter 26	FEMA 55 references ANSI A58.1-1982, Shore Protection Manual by the Department of the Army, and the Coastal Construction Manual by FEMA. OTFDC does not reference any of these documents.

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

CABO ONE AND TWO FAMILY DWELLING CODE (OTFDC) COMPARISON

The prescriptive requirements of the CABO One and Two Family Dwelling Code are for conventional construction with wind pressures less than 30 psf and seismic zones 0, 1, and 2.

Manufactured Home Installation in Flood Hazard Areas (FEMA 85)

FEMA 85	OTFDC	Analysis
Chapter III Elevation and Anchoring Techniques Chapter IV Design of Elevated Foundations Appendix D Calculational Procedure for Elevated Foundation Design Appendix E Buoyancy and Drag Forces (Pages 19-101)	Appendix C	Appendix C contains provisions which applies to the construction, alteration and repair of any foundation system which is necessary to provide for the installation of a manufactured home unit; construction, installation, addition, alteration, repair or maintenance of the building service equipment which is necessary for connecting manufactured homes to water, fuel, or power supplies and sewage systems. See NCSBCS comparison to Appendix C.

Recommendation: None.

CABO ONE AND TWO FAMILY DWELLING CODE (OTFDC) COMPARISON

The prescriptive requirements of the CABO One and Two Family Dwelling Code are for conventional construction with wind pressures less than 30 psf and seismic zones 0, 1, and 2.

Floodproofing Non-Residential Structures (FEMA 102)

FEMA 102	OTFDC	Analysis
Chapter I - VI Appendices A-E (Pages 8-193)	N/A	The OTFDC is applicable only to detached one- or two-family dwellings and one-family townhouses not more than three stories in height (residential occupancies only) therefore, FEMA 102 does not apply.

Recommendation: None.

CABO ONE AND TWO FAMILY DWELLING CODE (OTFDC) COMPARISON

The prescriptive requirements of the CABO One and Two Family Dwelling Code are for conventional construction with wind pressures less than 30 psf and seismic zones 0, 1, and 2.

Retrofitting Flood-Prone Residential Structures (FEMA 114)

FEMA 114	OTFDC	Analysis
3.5 Elevation Onto Extended Foundation Walls (Pages 46-49)	R-103 R-303	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. OTFDC requires alterations and repair to comply with the Code. OTFDC requires the foundation systems to be of sufficient design to support safely the loads imposed.

Recommendation: None.

FEMA 114	OTFDC	Analysis
3.12 Technical Design Criteria Extended Wall Foundations (Pages 61-63)	R-303	Both FEMA 114 and OTFDC require the foundation system with the increased foundation wall height to be of sufficient design to support safely the loads imposed.

Recommendation: None.

FEMA 114	OTFDC	Analysis
3.13 Technical Design Criteria Anchorage of Superstructure to Foundation (Pages 63-67)	R-303 R-401.2 R-601.2	FEMA 114 provides design details for the anchorage of the superstructure to the foundation system. OTFDC requires the construction to be capable of accommodating all loads and transmitting the resulting loads to its supporting structural elements.

Recommendation: None.

FEMA 114	OTFDC	Analysis
3.14 Technical Design Criteria Open Foundations (Pages 67-68)	R-303	FEMA 114 describes three types of open foundation systems, (piers, columns, or piles) and requires them to be designed for the loads encountered. OTFDC does not address piles. OTFDC addresses columns or piers and requires them to be of sufficient design to support safely the loads imposed.

Recommendation: None.

FEMA 114	OTFDC	Analysis
6.2 Considerations (Floodwalls) 6.3 Construction Techniques and Materials (Floodwalls) 6.5 Technical Design Criteria (Floodwalls) (Pages 111-129)	N/A	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. FEMA 114 addresses techniques and types of materials for the construction of floodwalls. FEMA 114 contains design criteria for floodwall design which addresses materials, soils, loads, overturning resistance, sliding resistance, and actual foundation requirements. OTFDC does not address floodplain management; therefore, it does not address the use of floodwalls.

Recommendation: None.

FEMA 114	OTFDC	Analysis
7.2 Considerations (Closures) 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. OTFDC does not address floodplain management nor does it address the use of closures to keep water from entering the building.

Recommendation: None.

FEMA 114	OTFDC	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. OTFDC does not address floodplain management; therefore, it does not address sealing, making watertight, or dry floodproofing of the structure.

Recommendation: None.

FEMA 114	OTFDC	Analysis
9.4 Permanent Protective Measures (Utilities) (Pages 160-165)	M-1102 Ch. 13 M-1301 M-1303 M-1305 M-1306 M-1307 M-1308	FEMA 114 requires (1) utility connections to be above flood level, (2) shielding for basement appliances, (3) elevated installation for exterior appliances, (4) suspension of underfloor/crawlspace equipment, and (5) anchoring of fuel storage tanks. The OTFDC does not address flooding. The OTFDC does not prohibit such equipment installations but does require minimum access and clearances to combustible materials.

Recommendation: None.

FEMA 114	OTFDC	Analysis
9.5 Utility Relocations to Existing Space (Pages 163-164)	M-1102 Ch. 13	FEMA 114 addresses relocation of mechanical equipment from a basement to the upper levels or attic. The OTFDC does not address flooding, but does allow elevated installations with access and minimum clearance to combustibles.

Recommendation: None.

FEMA 114	OTFDC	Analysis
9.6 Utility Relocations to New Spaces (Pages 164-165)	M-1102 Ch. 13	FEMA 114 addresses relocation of mechanical equipment below BFE to newly constructed spaces above BFE. The OTFDC does not address flooding; however, it does allow mechanical rooms which must have adequate access for equipment and afford clearance to combustibles.

Recommendation: None.

FEMA 114	OTFDC	Analysis
9.8 Storage Tank Anchorage (Page 166)	M-1914	FEMA 114 requires anchorage of fuel storage tanks. The OTFDC does not address flooding. The OTFDC does require oil tanks to resist all loads and stresses to which they are subjected.

Recommendation: None.

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

Recommendation: None.

FEMA 114	OTFDC	Analysis
Appendix C - Forces (Pages 197-207)	R-201.2 R-303 R-401.2 R-601.2 R-701.2	FEMA 114 addresses hydrostatic loads, hydrodynamic loads, impact loads, and wind loads. FEMA 114 also provides definitions, application and methodology for design. OTFDC requires the structure to be capable of accommodating all loads imposed and transmitting the resulting loads to its supporting structural elements.

Recommendation: FEMA 114 should update the wind speed maps to the latest editions and address snow and seismic loads.

CABO ONE AND TWO FAMILY DWELLING CODE (OTFDC) COMPARISON

The prescriptive requirements of the CABO One and Two Family Dwelling Code are for conventional construction with wind pressures less than 30 psf and seismic zones 0, 1, and 2.

Alluvial Fans: Hazards and Management (FEMA 165)

FEMA 165	OTFDC	Analysis
Windows and Doors (Page 10)	R-208.5 R-411 R-412	FEMA 165 prohibits openings on the uphill side of the structure to prevent debris and floodwater from entering the building. OTFDC does not address floodplain management; therefore, it does prohibit openings on the uphill side of the structure. OTFDC requires the glass areas subject to wind loading to be capable of withstanding the wind loads. OTFDC requires windows and sliding glass doors to be tested and certified in accordance with AAMA (ANSI) 101, ANSI/NWWDA I.S.2, ANSI/NWWDA I.S.3, or ASTM D 4099.

Recommendation: None.

CABO ONE AND TWO FAMILY DWELLING CODE (OTFDC) COMPARISON

The prescriptive requirements of the CABO One and Two Family Dwelling Code are for conventional construction with wind pressures less than 30 psf and seismic zones 0, 1, and 2.

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

Chapter III Basement Construction

A. Construction Types – Walls

MCRB	OTFDC	Analysis
III.A.1 Unreinforced Block (Page 13)	R-304.1 R-304.3 R-404.3.1 R-405	MCRB provides commentary type language for minimum thickness, lack of reinforcing, and lack of resistance to lateral pressures. OTFDC provides minimum thickness of foundation walls based on type of wall construction, depth of unbalanced fill, soil condition, and seismic zone. OTFDC permits unreinforced masonry to be designed and constructed in accordance with BIA "Building Code Requirements for Engineered Brick Masonry" and ACI/ASCE 530.

Recommendation: MCRB should reference BIA and ACI/ASCE 530.

MCRB	OTFDC	Analysis
III.A.2 Reinforced and Grouted Block (Pages 13, 14)	R-304.1 R-404.3.2 R-408 R-409 R-410	MCRB provides commentary and prescriptive type language for minimum thickness, vertical and horizontal reinforcing, bond beam, and the capacity to resist lateral loads. OTFDC requires reinforced masonry to be designed and constructed in accordance with BIA "Building Code Requirements for Engineered Brick Masonry" and ACI/ASCE 530.

Recommendation: MCRB should reference BIA and ACI/ASCE 530.

MCRB	OTFDC	Analysis
III.A.3 Structural Plain Concrete (Page 14)	R-304.3	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	OTFDC	Analysis
III.A.4 Reinforced Concrete (Pages 14, 15)	R-304.1 R-304.3	MCRB provides commentary and prescriptive type of language for minimum thickness, reinforcing, and ability to resist lateral loads. OTFDC provides minimum thickness and reinforcing based on depth of unbalanced fill. OTFDC also permits foundation walls to be constructed in accordance with ACI 318.

Recommendation: MCRB should reference ACI 318.

MCRB	OTFDC	Analysis
III.A.5 Cut Stone, Rubble Stone, and Cribbing and Planking (Page 15)	R-304.3	MCRB provides commentary type language and will not consider them any further because they are not commonplace. OTFDC provides minimum thickness and limit on height of rubble stone foundations.

Recommendation: None.

MCRB	OTFDC	Analysis
III.A.6 Treated Wood Foundations (Page 15)	R-302.1 R-304.5	MCRB explains that sufficient research is not available on treated wood foundations under flooded conditions, therefore they are not included in the MCRB. OTFDC contains details for wood foundation basement walls and requires them to be constructed in accordance with NFoPA Technical Report No. 7, however the OTFDC does not address floodplain management.

Recommendation: None.

MCRB	OTFDC	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. OTFDC does not provide commentary language.

Recommendation: None.

MCRB	OTFDC	Analysis
III.A.8 Excavation and Backfill (Pages 16-18)	R-303 R-304.2 R-311.3	MCRB requires 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. OTFDC contains basically the same provisions.

Recommendation: None.

MCRB	OTFDC	Analysis
III.A.9 Formwork (Pages 18, 19)	N/A	MCRB requires the forms to be substantial and sufficiently tight to prevent leakage of cement paste, properly braced to maintain position, and removed in such a manner as not to damage the concrete. OTFDC does not address formwork but requires concrete to be constructed in accordance with ACI 318.

Recommendation: None.

B. Other Construction Features

MCRB	OTFDC	Analysis
III.B.1 Basement Slab (Page 19)	R-603	MCRB states that basement slabs are typically between 3 and 4 inches thick, with and without steel wire reinforcement. OTFDC provides minimum compressive strength, distance between control joints with and without wire reinforcement based on thickness of slab, site preparation requirements and vapor barrier requirements.

Recommendation: MCRB should provide site preparation requirements, minimum compressive strength, and vapor barrier requirements.

MCRB	OTFDC	Analysis
III.B.2 Structural Basement Slab (Pages 19, 20)	N/A	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." OTFDC does not address structural basement slabs.

Recommendation: None.

MCRB	OTFDC	Analysis
III.B.3 Footing (Foundation) (Page 20)	R-303	Both MCRB and OTFDC require the bottom of the footing to below the depth of frost penetration and provide "typical" footing sizes.

Recommendation: None.

MCRB	OTFDC	Analysis
III.B.4 Underdrain Systems-Sumps and Pumps (Pages 20-23)	R-305 R-306	MCRB requires waterproofing (subsurface drain and/or sump pump) where hydrostatic pressure conditions exist. OTFDC requires foundation drainage and dampproofing of foundation walls enclosing basements regardless of whether hydrostatic pressure conditions exist or not.

Recommendation: None.

MCRB	OTFDC	Analysis
III.B.5.a Ground Surface Slope - Site Investigation (Pages 23, 24)	R-305 R-306	MCRB provides commentary type language addressing site investigation of the soil to determine the drainage method needed to maintain a dry basement. OTFDC requires foundation drainage and dampproofing of foundation walls enclosing basements without a site investigation.

Recommendation: None.

MCRB	OTFDC	Analysis
III.B.5.b Ground Surface Slope - Grading and Surface Drainage (Pages 24, 25)	R-301.3	Both MCRB and OTFDC require the finish grade to slope away from the foundation for drainage. MCRB requires provisions to be made to prevent soil erosion.

Recommendation: None.

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

Recommendation: None.

MCRB	OTFDC	Analysis
III.B.7.a Penetrations, Cracks, Joints, and "Waterproofing" - Utility Openings (Page 31)	R-306 P-2003.8 P-2012	MCRB requires penetrations through walls to be watertight. OTFDC requires waterproofing (dampproofing) of basement walls. OTFDC requires plumbing penetrations to be watertight.

Recommendation: None.

MCRB	OTFDC	Analysis
III.B.7.b Penetrations, Cracks, Joints, and "Waterproofing" - Techniques That Lessen Cracking in Concrete (Pages 31-34)	R-603.1	MCRB provides commentary type language addressing crack control of concrete. OTFDC requires control joints spaced according to slab thickness and type of wire-reinforcing.

Recommendation: None.

MCRB	OTFDC	Analysis
III.B.7.c Penetrations, Cracks, Joints, and "Waterproofing" - "Waterproofing" Basements (Pages 34, 35)	R-305 R-306	MCRB addresses the use of drains and sump pumps. OTFDC addresses the use of foundation drainage but does not address sumps.

Recommendation: None.

MCRB	OTFDC	Analysis
III.B.8 Subsystems (Plumbing) (Pages 35, 36)	N/A	MCRB recommends the use of a 1/3 to 1/2 HP sump pump. OTFDC does not require sump pumps. MCRB requires sanitary sewer outlets below the flood level to be provided with gate valves. MCRB requires water supply systems located in a Flood Hazard Area to be designed and installed to prevent contamination from flood waters. OTFDC does not address floodplain management.

Recommendation: None.

MCRB	OTFDC	Analysis
III.B.9 Anchorage (Pages 36, 37)	R-303	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. OTFDC requires a minimum of 1/2 inch anchor bolts spaced a maximum of 6 ft anchored 15 inches into masonry or 7 inches into concrete and not more than 12 inches from corners.

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

MCRB	OTFDC	Analysis
III.B.10 Some Concrete Construction Practices (Pages 37-46)	R-304.1	MCRB contains provisions for handling and depositing concrete, consolidating concrete, cold weather considerations, additives, placing reinforcement, etc. OTFDC does not contain the specific provisions but does reference ACI 318 which contains similar provisions.

Recommendation: None.

MCRB	OTFDC	Analysis
III.B.11 Some Block Construction Practices (Pages 47-50)	R-404 R-405	MCRB contains commentary type language addressing ways to improve the waterproofing quality of concrete masonry walls. OTFDC contains minimum requirements for all types of masonry construction.

Recommendation: None.

MCRB	OTFDC	Analysis
III.C. Loads 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)	R-301.4 R-301.5 R-303	MCRB contains commentary type language on soil types, expansive soils, permeability, and saturation. MCRB contains sample calculations. OTFDC requires the "character of the soil" to be determined and slabs on expansive soils to be designed and installed in accordance with PTI or WRI.

Recommendation: None.

MCRB	OTFDC	Analysis
III.C. Loads III.C.1 Soil III.C.1.e Erosion (Page 58)	R-301.3	MCRB addresses methods of inhibiting erosion by soil treatment, seeding, and mulching. OTFDC does not address erosion. OTFDC requires the lots to be provided with adequate drainage and shall be graded so as to drain surface water away from foundation walls.

Recommendation: None.

MCRB	OTFDC	Analysis
III.C. Loads III.C.1 Soil III.C.1.f Backfill Material Related to Lateral Pressure (Pages 58-63)	R-304.2	MCRB provides commentary type language addressing lateral pressures exerted from backfill material. OTFDC prohibits the backfill from being placed until the wall has sufficient strength or has been sufficiently braced to prevent damage by the backfill.

Recommendation: None.

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

Recommendation: None.

MCRB	OTFDC	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. OTFDC does not provide sample calculations.

Recommendation: None.

MCRB	OTFDC	Analysis
III.C.4 Flood Waters III.C.4.d Velocity III.C.4.e Sediment III.C.4.f Rate of Rise III.C.4.g Hydraulic/Hydrologic Relations (Pages 72-75)	N/A	MCRB provides commentary type language addressing increased structural damage which may result from the high velocity of flood waters. MCRB provides commentary type language addressing flood water deposited sediment. 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. 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). OTFDC does not address floodplain management.

Recommendation: None.

MCRB	OTFDC	Analysis
III.C.5 Debris, Wind, Impact, Snow, Ice, and Other Live Loads (Page 75)	R-201.1 R-201.2 R-301.1 R-301.2 R-401.2 R-601.2 R-701.2	MCRB states that other than debris and impact loads; wind, snow, and ice are not considered to alter the designs in the MCRB. OTFDC requires every building to be designed and constructed to support safely all loads and forces encountered.

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

Chapter V Basements in Floods

MCRB	OTFDC	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. OTFDC does not provide sample calculations.

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

MCRB	OTFDC	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.5a Drained or Sump System V.B.5b 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. OTFDC does not provide commentary type language or address design philosophy.

Recommendation: None.

VIII. Appendices

MCRB	OTFDC	Analysis
Appendix A-Soils Data Allowable Bearing Pressures (Page 164) Allowable Soil Pressures Beneath Footings (Page 166)	R-303	MCRB contains allowable bearing pressures for various soil types. OTFDC assumes that the soil has a minimum of 2000 pounds per square foot.

Recommendation: None.

VIII. Building's Guide

MCRB	OTFDC	Analysis
VIII.A. Introduction VIII.A.2.a Soil and Water Loading on Wall Cross-Section (Page 198) VIII.A.2.c "Waterproofing" System (Page 206) VIII.A.2.d Wall Design (Page 209) VIII.A.2.e Slab Design (Page 211) VIII.B. Acceptable Wall Designs VIII.B.1 Structural Plain Concrete (Unreinforced) VIII.B.2 Reinforced Concrete VIII.B.3 Unreinforced Masonry Block VIII.B.4 Reinforced Masonry Block VIII.B.5 Buoyancy Wall (Pages 212-239) VIII.C. Acceptable Slab Designs (Pages 240-246) VIII.D. Acceptable Control Joint Designs, Underdrain, and "Waterproofing" and Seals VIII.D.1 Overview and Control Joints VIII.D.2 Sump, Pump, and Underdrain (for Drained System) VIII.D.3 "Waterproofing" and Seals VIII.D.3.a Underdrained Slab and Wall System VIII.D.3.b Drained Slab and Wall System VIII.D.3.c Slab/Wall/Footing Juncture (Pages 247-262)	Part III-Construction	MCRB contains details and design charts for wall design, slab design, control joints, sumps, and/or waterproofing. OTFDC does contain details and design charts but not details and design charts for basement design in flood prone areas.

Recommendation: None.

MCRB	OTFDC	Analysis
Hydraulic/Hydrologic Manual I. Introduction I.B. Flood Waters I.B.4 Velocity I.B.5 Sediment (Pages 7-9)	N/A	MCRB contains commentary type language addressing increased structural damage which may result from the high velocity of flood waters and flood water deposited sediment. OTFDC does not address floodplain management.

Recommendation: None.

CABO ONE AND TWO FAMILY DWELLING CODE (OTFDC) COMPARISON

The prescriptive requirements of the CABO One and Two Family Dwelling Code are for conventional construction with wind pressures less than 30 psf and seismic zones 0, 1, and 2.

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

No. 85-1	OTFDC	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. OTFDC does not address floodplain management; therefore, it does not address wet floodproofing or floodproofing of any type.

Recommendation: None.

No. 85-1	OTFDC	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. OTFDC does not address floodplain management; therefore, it does not wet floodproofing or floodproofing of any type.

Recommendation: None.

No. 85-1	OTFDC	Analysis
III.B. Structural Features (Pages 4-5)	R-303 R-305 R-306	No. 85-1 addresses the superstructure materials as far as their durability, resistance to flood forces, resistance to the deterioration caused by flood waters, and water resistance. OTFDC does not address floodplain management; therefore, it does not address durability, deterioration, or water-resistance of the foundation. OTFDC does require the foundation system to be of sufficient design to support safely the loads imposed, foundation drainage, and foundation dampproofing.

Recommendation: None.

No. 85-1	OTFDC	Analysis
III.C. Building Activity and Use (Pages 5-6)	R-103	No. 85-1 addresses the need to determine the feasibility of wet floodproofing based on building activity and use. OTFDC only addresses one type of building use which is residential.

Recommendation: None since it would not be appropriate to intentionally flood a residence.

No. 85-1	OTFDC	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 when wet floodproofing is used. OTFDC does not address floodplain management; therefore, it does not address wet floodproofing or floodproofing of any type. OTFDC does require the foundation system to be of sufficient design to support safely the loads imposed.

Recommendation: None.

No. 85-1	OTFDC	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. OTFDC does not address floodplain management; therefore, it does not address wet floodproofing or floodproofing of any type.

Recommendation: None.

No. 85-1	OTFDC	Analysis
IV.A.3 Solid Wall Construction (Pages 7-8)	R-305 R-306	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. OTFDC does not address floodplain management; therefore, it does not address wet floodproofing or floodproofing of any type. OTFDC does require foundation drainage and foundation dampproofing.

Recommendation: None.

No. 85-1	OTFDC	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. OTFDC does not address floodplain management; therefore, it does not address wet floodproofing or floodproofing of any type.

Recommendation: None.

No. 85-1	OTFDC	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. OTFDC does not address floodplain management; therefore, it does not address wet floodproofing or floodproofing of any type.

Recommendation: None.

No. 85-1	OTFDC	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. OTFDC does not address floodplain management; therefore, it does not address wet floodproofing or floodproofing of any type.

Recommendation: None.

No. 85-1	OTFDC	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. OTFDC does not address floodplain management; therefore, it does not address wet floodproofing or floodproofing of any type.

Recommendation: None.

No. 85-1	OTFDC	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. OTFDC does not address floodplain management; therefore, it does not address wet floodproofing or floodproofing of any type.

Recommendation: None.

No. 85-1	OTFDC	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. OTFDC does not address floodplain management. See NFIPA comparison to NFIPA 70.

Recommendation: None.

No. 85-1	OTFDC	Analysis
IV.A.10 HVAC (Pages 11-12)	Ch. 13 M-1102	No. 85-1 requires mechanical equipment to be elevated above BFE or enclosed for protection. The OTFDC does not address flooding. The OTFDC would allow such installations with minimum access and clearance to combustibles.

Recommendation: None.

CABO ONE AND TWO FAMILY DWELLING CODE (OTFDC) COMPARISON

The prescriptive requirements of the CABO One and Two Family Dwelling Code are for conventional construction with wind pressures less than 30 psf and seismic zones 0, 1, and 2.

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

No. 85-2	OTFDC	Analysis
Flood Forces (Pages 1-3)	R-303	No. 85-2 provides commentary type language on flood forces (hydrostatic and hydrodynamic pressure) and formulas to determine these pressures. OTFDC requires the foundation system to be of sufficient design to support safely the loads imposed, (wind, water, seismic, and snow).

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

No. 85-2	OTFDC	Analysis
Openings Design Criteria (Pages 4-6)	R-311 Ch. 13	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. OTFDC only addresses crawl space openings needed for ventilation and equipment access.

Recommendation: None.

CABO ONE AND TWO FAMILY DWELLING CODE (OTFDC) COMPARISON

The prescriptive requirements of the CABO One and Two Family Dwelling Code are for conventional construction with wind pressures less than 30 psf and seismic zones 0, 1, and 2.

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

No. 85-3	OTFDC	Analysis
II. Wind and Water Forces (Pages 2-3)	R-201.2 R-303 R-401.2 R-601.2 R-701.2	No. 85-3 addresses wind and flood water loads. OTFDC requires the construction to be capable of accommodating all loads imposed. OTFDC does not specifically address floodwater forces but does address wind, snow, and seismic loads. No. 85-3 references the building codes on ANSI A58.1-1982 for information on wind loads.

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

No. 85-3	OTFDC	Analysis
III. Design Approach (Page 4)	R-401.2	No. 85-3 requires the breakaway wall to be designed to withstand at least 10 psf but no more than 20 psf. OTFDC does not address breakaway walls. OTFDC requires the construction to be capable of accommodating the loads imposed.

Recommendation: None.

No. 85-3	OTFDC	Analysis
IV. Design Considerations (Pages 4-10)	R-401.2	No. 85-3 provides commentary type language and details for various types of breakaway walls. OTFDC does not address breakaway walls. OTFDC requires the construction to be capable of accommodating the loads imposed.

Recommendation: None.

CABO ONE AND TWO FAMILY DWELLING CODE (OTFDC) COMPARISON

The prescriptive requirements of the CABO One and Two Family Dwelling Code are for conventional construction with wind pressures less than 30 psf and seismic zones 0, 1, and 2.

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

No. 88-1	OTFDC	Analysis
Pages 1-5	R-201.2 R-303 R-401.2 R-601.2 R-701.2 App. A (Wind Probability Map)	No. 88-1 addresses wind loads and references ANSI A58.1-1982. OTFDC contains a wind probability map with wind design loads. OTFDC requires the construction to be capable of accommodating the loads imposed.

Recommendation: No. 88-1 should update reference to ASCE 7-88. The 1992 OTFDC does reference ASCE 7-88.

CABO ONE AND TWO FAMILY DWELLING CODE (OTFDC) COMPARISON

The prescriptive requirements of the CABO One and Two Family Dwelling Code are for conventional construction with wind pressures less than 30 psf and seismic zones 0, 1, and 2.

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

No. 88-2	OTFDC	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. OTFDC does not address flood resistant materials.

Recommendation: None.

CABO ONE AND TWO FAMILY DWELLING CODE (OTFDC) COMPARISON

The prescriptive requirements of the CABO One and Two Family Dwelling Code are for conventional construction with wind pressures less than 30 psf and seismic zones 0, 1, and 2.

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

No. 88-3	OTFDC	Analysis
Lower Area Obstructions (Pages 2-4)	R-201.2 R-303 R-401.2 R-601.2 R-701.2	No. 88-3 prohibits the construction of anything except breakaway walls, open wood latticework, or insect screening, beneath the lowest horizontal structural member. OTFDC does not prohibit construction provided it is capable of accommodating all loads imposed.

Recommendation: None.

No. 88-3	OTFDC	Analysis
Obstructions Outside the Perimeter of the Coastal Building (Pages 4-6)	R-201.2 R-303 R-401.2 R-601.2 R-701.2	No. 88-3 requires structures outside the perimeter of the coastal building to be anchored to resist flotation, collapse, and lateral movement due to combined effects of wind and water loads. OTFDC requires the construction to be capable of accommodating the loads imposed and transmitting the resulting loads to its supporting structural elements. OTFDC does not address flotation.

Recommendation: None.

No. 88-3	OTFDC	Analysis
Obstruction Attached to But Outside the Building Perimeter (Page 6)	R-201.2 R-303 R-401.2 R-601.2 R-701.2	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. OTFDC requires the building or structure to comply with the Code.

Recommendation: None.

CABO ONE AND TWO FAMILY DWELLING CODE (OTFDC) COMPARISON

The prescriptive requirements of the CABO One and Two Family Dwelling Code are for conventional construction with wind pressures less than 30 psf and seismic zones 0, 1, and 2.

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

No. 88-4	OTFDC	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. OTFDC does not address floodplain management or elevators.

Recommendation: None.

CABO ONE AND TWO FAMILY DWELLING CODE (OTFDC) COMPARISON

The prescriptive requirements of the CABO One and Two Family Dwelling Code are for conventional construction with wind pressures less than 30 psf and seismic zones 0, 1, and 2.

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

No. 90-2	OTFDC	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. OTFDC does not address floodplain management or below grade parking.

Recommendation: None.

CABO ONE AND TWO FAMILY DWELLING CODE (OTFDC) COMPARISON

The prescriptive requirements of the CABO One and Two Family Dwelling Code are for conventional construction with wind pressures less than 30 psf and seismic zones 0, 1, and 2.

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

No. 90-3	OTFDC	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. The OTFDC is applicable only to detached one- or two-family dwelling and one-family townhouses not more than three stories in height (residential occupancies only) therefore, No. 90-3 does not apply.

Recommendation: None.

CABO ONE AND TWO FAMILY DWELLING CODE (OTFDC) COMPARISON

The prescriptive requirements of the CABO One and Two Family Dwelling Code are for conventional construction with wind pressures less than 30 psf and seismic zones 0, 1, and 2.

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

No. 90-4	OTFDC	Analysis
Pages 3-19	Appendix C	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. Manufactured home installation is addressed in Appendix C. See NCSBCS comparison to Appendix C.

Recommendation: None.

CONSULTATIVE COUNCIL

Chairman: Hugh C. MacDonald, MacDonald Masonry Consultants, Falls Church, VA
Vice Chairman: Joseph O'Neil, American Council of Independent Laboratories, Washington, DC
Secretary: Noel J. Raufaste, Jr., National Institute of Standards and Technology, Gaithersburg, MD

Erv Bales, Ph.D., Building Engineering Architecture Research Center, New Jersey Institute of Technology, Newark,NJ
James Beyreis, P.E., Underwriters Laboratories, Inc., Northbrook, IL
Francis W. Biehl, P.E., Biehl Engineering, Inc., Menomonee Falls, WI
James DiLuigi, AIA, Universal Designers and Consultants, Silver Spring, MD
G. Day Ding, School of Architecture & Environmental Design, California Polytechnic Institute, San Luis Obispo, CA
Earl L. Flanagan, Alexandria, VA
John C. Gerard, National Fire Protection Association, Alexandria, VA
Whayne H. Haffler, AIA, Washington, DC
Steve M. Hays, P.E., CIH, Gobbell Hays Partners, Inc., Nashville, TN
Arlie Heald, International Brotherhood of Electrical Workers, Washington, DC
Ward C. Hitchings, National Forest Products Association, Washington, DC
William Hoffman, Quest Co., Inc., Bethesda, MD
Donald M. Holmes, P.E., Clapp & Holmes Consulting Engineers, Harrisburg, PA
William R. Lawson, AIA, HTB, Inc., Washington, DC
Ted S. Lundy, Tennessee Technical University, Center for Manufacturing, Cooksville, TN
Henry J. Mader, H.J. Mader & Associates, Pittsburgh, PA
Kenneth D. Mentzer, Mineral Insulation Manufacturing Association, Alexandria, VA
Lester A. Obst, John S. McQuade Company, Philadelphia, PA
Thomas R. Rutherford, P.E., Directorate of Engineering and Construction, Office of Secretary of Defense, Falls Church, VA
Kenneth M. Sedor, Real Estate Support Services, Inc., Minneapolis, MN
Lloyd H. Siegel, FAIA, Office of Architecture & Engineering, Department of Veterans Affairs, Washington, DC
John H. Slayter, Newberry Building Systems Corp., Newberry, MI
Robert W. Spangler, Council of American Building Officials, Falls Church, VA
William Tangye, Southern Building Code Congress International, Inc., Birmingham, AL
James A. Thomas, ASTM, Philadelphia, PA
William A. Tippin, IV, EnviroControl, Inc., Alexandria, VA
Jon S. Traw, P.E., Intl. Conference of Building Officials, Whittier, CA
Frank Walter, Manufactured Housing Institute, Arlington, VA
Leroy E. Worley, Intl. Association of Bridge, Structural & Ornamental Ironworkers, Washington, DC
H. Glenn Ziegenfuss, Ph.D., American Welding Society, Miami, FL
Joel P. Zingeser, AIA, Building Technology, Inc., Silver Spring, MD

BOARD OF DIRECTORS

NIBS PROFESSIONAL STAFF

National Institute of
BUILDING SCIENCES
1201 L Street, N.W., Suite 400
Washington, D.C. 20005

☆U.S. GOVERNMENT PRINTING OFFICE: 1997 - 519-659/90057