NCRB-NCRF-NCIGA

north carolina
RATE BUREAU
REINSURANCE FACILITY
INSURANCE GUARANTY ASSOCIATION

North Carolina Rate Bureau

December 31, 2014

Honorable Wayne Goodwin
Commissioner of Insurance
North Carolina Department of Insurance
1201 Mail Service Center
Raleigh, North Carolina 27699-1201

Re: Revision of Mobile Homeowner's MH(F) Insurance Rates

Dear Sir:

Enclosed herewith for filing on behalf of all member companies of the North Carolina Rate Bureau are revised premium rates for Mobile Homeowner's MH(F) insurance subject to the jurisdiction of the Rate Bureau.

The enclosed memoranda and exhibits set forth and explain the calculations of (1) needed rate level changes that have been capped by territory group to produce overall statewide average rate level changes of 20.5% for MH(F) owners coverages and 21.5% for tenants coverage; (2) revised windstorm and hail exclusion credits; and (3) revised amount of insurance relativity factors. These materials also explain the revised grouping of territories for rating purposes.

The foregoing changes were calculated based on rates currently in force and reflect consideration duly given to data for the experience period set forth herein. Ratios in the filing relating to expense experience were developed from special calls issued by the Rate Bureau. In preparing this filing, due consideration has been given to the factors specified in G.S. 58-36-10(2) and G.S. 58-36-10(7).

Information and statistical data required pursuant to G.S. 58-36-15 and 11 NCAC 10.1105 are shown and referenced in Section E. Additionally, the pre-filed testimony of (a) Robert J. Curry, Assistant Vice President and Actuary - Insurance Services Office, Inc.; (b) Brian Donlan, Allstate Insurance Company, Chairman, Property Rating Subcommittee; (c) Rob Newbold, Senior Vice President – AIR Worldwide Corporation; (d) Dr. James Vander Weide, Financial Strategy Associates; and (e) Dr. David Appel - Director – Milliman, Inc. are submitted herewith.

The foregoing changes are to become effective in accordance with the following Rule of Application:

> These changes are applicable to all new and renewal policies written to become effective on or after August 1, 2015.

Your approval of this filing is respectfully requested.

Very truly yours,

Raymond F. Evans, Jr., CPCU
General Manager

RFE:dms

Enclosure

RECEIVED
DEC 31 2014
N.C. Dept of Insurance
Property & Casualty

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH (F) PROGRAM

SECTION A - SUMMARY OF REVISIONS

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH (F) PROGRAM

STATEWIDE RATE LEVEL CHANGES

FORM	PREMIUM WEIGHT	INDICATED CHANGE	FILED CHANGE
OWNERS	44,750,216	31.5%	20.5%
TENANTS	100,658	29.0%	21.5%
TOTAL	44,850,874	31.5%	20.5%

(A) Year ended 12/31/2011 aggregate premiums at current level.

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH (F) PROGRAM

STATEWIDE AND TERRITORY RATE LEVEL CHANGES

	Indicated		Filed	
Territory Group*	Owners	Tenants	Owners	Tenants
1	182.0%	165.4%	75.0%	75.0%
2	41.6%	33.6%	30.0%	30.0%
3	-6.3%	-3.6%	0.0%	0.0%
Statewide	31.5%	29.0%	20.5%	21.5%

*Territory group 1: Territory 5, 6, 42, 43
*Territory group 2: Territory 32, 34, 41, 44, 45, 46, 47, 53
*Territory group 3: Territory 36, 38, 39, 57, 60

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH (F) PROGRAM

SECTION B - MATERIAL TO BE IMPLEMENTED

NORTH CAROLINA

MOBILE HOMES INSURANCE- MH(F) PROGRAM

MATERIAL TO BE IMPLEMENTED

		TERRITORY GROUP* 1 SURCHARGE		TERRITORY GROUP* 3 DISCOUNT	
1.		CURRENT	FILED	CURRENT	FILED
	OWNERS FORMS	25.0%	60.2%	0.0%	-26.6%
	TENANT FORM	21.4%	63.4%	0.0%	-23.1%

2. OWNERS FORMS; NO DEDUCTIBLE--TERRITORY GROUP* 2

Amount of Insurance				MH(F)-2	MH(F)-2	MH(F)-2	MH(F)-3	MH(F)-3	MH(F)-3
A	B	C	D	CURRENT	FILED	% Change	CURRENT	FILED	% Change
$2,000	$200	$600	$200	$46	$305.14	563.3%	$50	$348.73	597.5%
3,000	300	900	300	58	316.78	446.2%	63	362.04	474.7%
4,000	400	1,200	400	70	329.01	370.0%	77	376.01	388.3%
5,000	500	1,500	500	82	341.24	316.1%	91	389.99	328.6%
6,000	600	1,800	600	94	352.89	275.4%	104	403.30	287.8%
7,000	700	2,100	700	106	365.12	244.5%	118	417.28	253.6%
8,000	800	2,400	800	118	377.35	219.8%	133	431.25	224.2%
9,000	900	2,700	900	130	389.57	199.7%	146	445.23	205.0%
10,000	1,000	3,000	1,000	142	401.22	182.5%	160	458.54	186.6%
11,000	1,100	3,300	1,100	154	413.45	168.5%	174	472.51	171.6%
12,000	1,200	3,600	1,200	166	425.68	156.4%	187	486.49	160.2%
13,000	1,300	3,900	1,300	179	437.33	144.3%	201	499.80	148.7%
14,000	1,400	4,200	1,400	190	449.55	136.6%	215	513.78	139.0%
15,000	1,500	4,500	1,500	202	461.78	128.6%	228	527.75	131.5%
each Add'l. $1,000 - Add				12	12.06	0.5%	14	13.79	-1.5%
Sample Additional Amounts of Insurance									
20,000	2,000	6,000	2,000	262	522.08	99.3%	298	596.70	100.2%
30,000	3,000	9,000	3,000	382	642.68	68.2%	438	734.60	67.7%
40,000	4,000	12,000	4,000	502	763.28	52.0%	578	872.50	51.0%
50,000	5,000	15,000	5,000	622	883.88	42.1%	718	1,010.40	40.7%
60,000	6,000	18,000	6,000	742	1,004.48	35.4%	858	1,148.30	33.8%
70,000	7,000	21,000	7,000	862	1,125.08	30.5%	998	1,286.20	28.9%
80,000	8,000	24,000	8,000	982	1,245.68	26.9%	1,138	1,424.10	25.1%
90,000	9,000	27,000	9,000	1,102	1,366.28	24.0%	1,278	1,562.00	22.2%
100,000	10,000	30,000	10,000	1,222	1,486.88	21.7%	1,418	1,699.90	19.9%

3. TENANT FORM;NO DEDUCTIBLE--TERRITORY GROUP* 2

Amount of Insurance		MH(F)-4	MH(F)-4	MH(F)-4
C	D	CURRENT	FILED	% Change
$2,000	$200	$43	$55.90	30.0%
3,000	300	53	68.90	30.0%
4,000	400	63	81.90	30.0%
5,000	500	73	94.90	30.0%
6,000	600	84	109.20	30.0%
7,000	700	95	123.50	30.0%
8,000	800	104	135.20	30.0%
9,000	900	115	149.50	30.0%
10,000	1,000	125	162.50	30.0%
Each Add'l. $1,000 - Add		10	13.00	30.0%

*Territory group 1: Territory 5, 6, 42, 43
*Territory group 2: Territory 32, 34, 41, 44, 45, 46, 47, 53
*Territory group 3: Territory 36, 38, 39, 57, 60

NORTH CAROLINA

MOBILE HOMES INSURANCE- MH(F) PROGRAM

MATERIAL TO BE IMPLEMENTED

2. OWNERS FORMS; NO DEDUCTIBLE--TERRITORY GROUP* 1

Amount of Insurance				MH(F)-2	MH(F)-2	MH(F)-2	MH(F)-3	MH(F)-3	MH(F)-3
A	B	C	D	CURRENT	FILED	% Change	CURRENT	FILED	% Change
$2,000	$200	$600	$200	$57.50	$488.77	750.0%	$62.50	$558.59	793.7%
3,000	300	900	300	72.50	507.41	599.9%	78.75	579.91	636.4%
4,000	400	1,200	400	87.50	527.00	502.3%	96.25	602.29	525.8%
5,000	500	1,500	500	102.50	546.59	433.3%	113.75	624.68	449.2%
6,000	600	1,800	600	117.50	565.26	381.1%	130.00	646.00	396.9%
7,000	700	2,100	700	132.50	584.85	341.4%	147.50	668.39	353.1%
8,000	800	2,400	800	147.50	604.44	309.8%	166.25	690.77	315.5%
9,000	900	2,700	900	162.50	624.01	284.0%	182.50	713.16	290.8%
10,000	1,000	3,000	1,000	177.50	642.67	262.1%	200.00	734.48	267.2%
11,000	1,100	3,300	1,100	192.50	662.26	244.0%	217.50	756.86	248.0%
12,000	1,200	3,600	1,200	207.50	681.85	228.6%	233.75	779.25	233.4%
13,000	1,300	3,900	1,300	223.75	700.51	213.1%	251.25	800.57	218.6%
14,000	1,400	4,200	1,400	237.50	720.08	203.2%	268.75	822.97	206.2%
15,000	1,500	4,500	1,500	252.50	739.67	192.9%	285.00	845.34	196.6%
Sample Additional Amounts of Insurance									
20,000	2,000	6,000	2,000	327.50	836.26	155.3%	372.50	955.79	156.6%
30,000	3,000	9,000	3,000	477.50	1,029.44	115.6%	547.50	1,176.67	114.9%
40,000	4,000	12,000	4,000	627.50	1,222.61	94.8%	722.50	1,397.56	93.4%
50,000	5,000	15,000	5,000	777.50	1,415.79	82.1%	897.50	1,618.45	80.3%
60,000	6,000	18,000	6,000	927.50	1,608.97	73.5%	1,072.50	1,839.33	71.5%
70,000	7,000	21,000	7,000	1,077.50	1,802.14	67.3%	1,247.50	2,060.22	65.1%
80,000	8,000	24,000	8,000	1,227.50	1,995.32	62.6%	1,422.50	2,281.11	60.4%
90,000	9,000	27,000	9,000	1,377.50	2,188.49	58.9%	1,597.50	2,502.00	56.6%
100,000	10,000	30,000	10,000	1,527.50	2,381.67	55.9%	1,772.50	2,722.88	53.6%

3. TENANT FORM;NO DEDUCTIBLE--TERRITORY GROUP* 1

Amount of Insurance		MH(F)-4	MH(F)-4	MH(F)-4
C	D	CURRENT	FILED	% Change
$2,000	$200	$52.20	$91.35	75.0%
3,000	300	$64.34	$112.60	75.0%
4,000	400	$76.48	$133.84	75.0%
5,000	500	$88.62	$155.09	75.0%
6,000	600	$101.98	$178.46	75.0%
7,000	700	$115.33	$201.83	75.0%
8,000	800	$126.26	$220.95	75.0%
9,000	900	$139.61	$244.32	75.0%
10,000	1,000	$151.75	$265.56	75.0%
Each Add'l. $1,000 - Add		$12.14	$21.25	75.0%

*Territory group 1: Territory 5, 6, 42, 43
*Territory group 2: Territory 32, 34, 41, 44, 45, 46, 47, 53
*Territory group 3: Territory 36, 38, 39, 57, 60

NORTH CAROLINA

MOBILE HOMES INSURANCE- MH(F) PROGRAM

MATERIAL TO BE IMPLEMENTED

2. OWNERS FORMS; NO DEDUCTIBLE--TERRITORY GROUP* 3

Amount of Insurance				MH(F)-2	MH(F)-2	MH(F)-2	MH(F)-3	MH(F)-3	MH(F)-3
A	B	C	D	CURRENT	FILED	% Change	CURRENT	FILED	% Change
$2,000	$200	$600	$200	$46.00	$223.95	386.8%	$50.00	$255.94	411.9%
3,000	300	900	300	58.00	232.49	300.8%	63.00	265.71	321.8%
4,000	400	1,200	400	70.00	241.47	245.0%	77.00	275.96	258.4%
5,000	500	1,500	500	82.00	250.44	205.4%	91.00	286.22	214.5%
6,000	600	1,800	600	94.00	258.99	175.5%	104.00	295.99	184.6%
7,000	700	2,100	700	106.00	267.97	152.8%	118.00	306.25	159.5%
8,000	800	2,400	800	118.00	276.95	134.7%	133.00	316.50	138.0%
9,000	900	2,700	900	130.00	285.91	119.9%	146.00	326.76	123.8%
10,000	1,000	3,000	1,000	142.00	294.46	107.4%	160.00	336.53	110.3%
11,000	1,100	3,300	1,100	154.00	303.44	97.0%	174.00	346.79	99.3%
12,000	1,200	3,600	1,200	166.00	312.42	88.2%	187.00	357.05	90.9%
13,000	1,300	3,900	1,300	179.00	320.97	79.3%	201.00	366.81	82.5%
14,000	1,400	4,200	1,400	190.00	329.93	73.6%	215.00	377.07	75.4%
15,000	1,500	4,500	1,500	202.00	338.91	67.8%	228.00	387.33	69.9%
Sample Additional Amounts of Insurance									
20,000	2,000	6,000	2,000	262.00	383.17	46.2%	298.00	437.93	47.0%
30,000	3,000	9,000	3,000	382.00	471.68	23.5%	438.00	539.14	23.1%
40,000	4,000	12,000	4,000	502.00	560.19	11.6%	578.00	640.35	10.8%
50,000	5,000	15,000	5,000	622.00	648.70	4.3%	718.00	741.56	3.3%
60,000	6,000	18,000	6,000	742.00	737.21	-0.6%	858.00	842.76	-1.8%
70,000	7,000	21,000	7,000	862.00	825.72	-4.2%	998.00	943.97	-5.4%
80,000	8,000	24,000	8,000	982.00	914.23	-6.9%	1,138.00	1,045.18	-8.2%
90,000	9,000	27,000	9,000	1,102.00	1,002.74	-9.0%	1,278.00	1,146.39	-10.3%
100,000	10,000	30,000	10,000	1,222.00	1,091.25	-10.7%	1,418.00	1,247.59	-12.0%

3. TENANT FORM;NO DEDUCTIBLE--TERRITORY GROUP* 3

Amount of Insurance		MH(F)-4	MH(F)-4	MH(F)-4
C	D	CURRENT	FILED	% Change
$2,000	$200	$43.00	$43.00	0.0%
3,000	300	$53.00	$53.00	0.0%
4,000	400	$63.00	$63.00	0.0%
5,000	500	$73.00	$73.00	0.0%
6,000	600	$84.00	$84.00	0.0%
7,000	700	$95.00	$95.00	0.0%
8,000	800	$104.00	$104.00	0.0%
9,000	900	$115.00	$115.00	0.0%
10,000	1,000	$125.00	$125.00	0.0%
Each Add'l. $1,000 - Add		$10.00	$10.00	0.0%

*Territory group 1: Territory 5, 6, 42, 43
*Territory group 2: Territory 32, 34, 41, 44, 45, 46, 47, 53
*Territory group 3: Territory 36, 38, 39, 57, 60

NORTH CAROLINA

MOBILE HOMES INSURANCE- MH(F) PROGRAM

MATERIAL TO BE IMPLEMENTED

4. DEDUCTIBLE CREDITS- MAXIMUM DOLLAR AMOUNTS

	Owners- Section 1 Deductible			
Deductible Amount	$100	$250	$500	$1,000
Percentage Credit	10%	20%	27%	34%
Current Maximum Credit				
--Territory Group* 1	$31.25	$62.50	$125.00	$312.50
--Territory Group* 2 & 3	$25.00	$50.00	$100.00	$250.00
Filed Maximum Credit:				
--Territory Group* 1	$72.42	$144.84	$289.68	$724.19
--Territory Group* 2	$45.21	$90.42	$180.85	$452.11
--Territory Group* 3	$33.18	$66.36	$132.73	$331.82
% Change Maximum Credit:				
--Territory Group* 1	131.7%	131.7%	131.7%	131.7%
--Territory Group* 2	80.8%	80.8%	80.8%	80.8%
--Territory Group* 3	32.7%	32.7%	32.7%	32.7%

	Tenant- Section 1 Deductible			
Deductible Amount	$100	$250	$500	$1,000
Percentage Credit	10%	20%	27%	34%
Current Maximum Credit				
--Territory Group* 1	$30.35	$60.70	$121.40	$303.50
--Territory Group* 2 & 3	$25.00	$50.00	$100.00	$250.00
Filed Maximum Credit:				
--Territory Group* 1	$53.11	$106.23	$212.45	$531.13
--Territory Group* 2	$32.50	$65.00	$130.00	$325.00
--Territory Group* 3	$25.00	$50.00	$100.00	$250.00
% Change Maximum Credit:				
--Territory Group* 1	75.0%	75.0%	75.0%	75.0%
--Territory Group* 2	30.0%	30.0%	30.0%	30.0%
--Territory Group* 3	0.0%	0.0%	0.0%	0.0%

	Owners Theft Deductible		Tenant Theft Deductible	
Deductible Amount	$100	$250	$100	$250
Percentage of Credit	3%	5%	3%	5%
Current Maximum Credit				
--Territory Group* 1	$12.50	$18.75	$12.14	$18.21
--Territory Group* 2 & 3	$10.00	$15.00	$10.00	$15.00
Filed Maximum Credit:				
--Territory Group* 1	$28.97	$43.45	$21.25	$31.87
--Territory Group* 2	$18.08	$27.13	$13.00	$19.50
--Territory Group* 3	$13.27	$19.91	$10.00	$15.00
% Change Maximum Credit:				
--Territory Group* 1	131.7%	131.7%	75.0%	75.0%
--Territory Group* 2	80.8%	80.8%	30.0%	30.0%
--Territory Group* 3	32.7%	32.7%	0.0%	0.0%

5. WINDSTORM OR HAIL EXCLUSION CREDIT -- Territory Group* 1 only

	Owners	Tenant
Current	40.0%	30.0%
Filed	73.9%	61.3%

*Territory group 1: Territory 5, 6, 42, 43
*Territory group 2: Territory 32, 34, 41, 44, 45, 46, 47, 53
*Territory group 3: Territory 36, 38, 39, 57, 60

6. OPTIONAL NAMED STORM PERCENTAGE DEDUCTIBLES -- Territory Group* 1

Section 1 Deductible - Owners

All Other Perils Deductible Amount	$50	$100	$250	$500	$1,000
Percentage Credit:	5%	14%	24%	31%	37%
Current Maximum Credit:	$16.45	$32.89	$65.79	$131.58	$328.95
Filed Maximum Credit:	$38.12	$76.22	$152.46	$304.93	$762.31
% Change Maximum Credit:	131.7%	131.7%	131.7%	131.7%	131.7%

Section 1 Deductible - Tenants

All Other Perils Deductible Amount	$50	$100	$250	$500	$1,000
Percentage Credit:	5%	14%	24%	31%	37%
Current Maximum Credit:	$15.97	$31.95	$63.89	$127.79	$319.47
Filed Maximum Credit:	$27.95	$55.91	$111.81	$223.63	$559.07
% Change Maximum Credit:	75.0%	75.0%	75.0%	75.0%	75.0%

*Territory group 1: Territory 5, 6, 42, 43

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

SECTION C - SUPPORTING MATERIAL

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

OWNERS FORMS

DETERMINATION OF STATEWIDE RATE LEVEL CHANGE

	(1)	(2)	(3)	(4)	(5)
	INCURRED LOSSES EXCL. HURRICANE (a)	EXCESS LOSSES (b)	[(1)-(2)] x EXCESS FACTOR (c)	LOSSES WITH LAE (3) * LAE (d)	CURRENT COST/AMOUNT FACTOR (e)
2007	14,282,549	511,601	14,528,350	16,707,603	0.931
2008	18,637,634	2,796,206	16,712,707	19,219,613	0.954
2009	19,030,275	2,413,142	17,531,075	20,160,736	0.968
2010	17,217,172	1,889,518	16,170,675	18,596,276	0.948
2011	33,751,759	16,581,164	18,114,978	20,832,225	0.977

	(6)	(7)	(8)	(9)	(10)
	HOUSE-YEARS	TRENDED AVG. LOSS COST (4)*(5)*CPF/(6) (f)	AVERAGE RATING FACTOR (g)	TRENDED BASE-CLASS LOSS COST	YEARLY WEIGHTS
2007	83,154	202.77	1.931	105.01	0.10
2008	77,240	257.33	2.029	126.83	0.15
2009	69,756	303.27	2.127	142.58	0.20
2010	68,749	277.97	2.177	127.68	0.25
2011	69,896	315.65	2.325	135.76	0.30

(11)	WEIGHTED TRENDED NON-HURRICANE BASE-CLASS LOSS COST (h)	130.69
(12)	CREDIBILITY (368,795 HOUSE YEARS)	1.00
(13)	TRENDED MODELED HURRICANE BASE-CLASS LOSS COST (i)	36.93
(14)	FIXED EXPENSE PER POLICY (j)	18.27
(15)	(11) + (13) + (14)	185.89
(16)	1 - (VARIABLE EXPENSE + PROFIT + CONTINGENCIES) (k)	0.7161
(17)	BASE RATE EXCLUDING COMP. FOR ASSESS. RISK, NET REINSURANCE COST, DEVIATIONS (15) / (16)	259.59
(18)	COMPENSATION FOR ASSESSMENT RISK PER POLICY (l)	14.93
(19)	NET REINSURANCE COST PER POLICY (m)	71.34
(20)	(17) + (18) + (19)	345.86
(21)	SELECTED DEVIATION (n)	0.05
(22)	DEVIATION AMOUNT PER POLICY, (20)/{1 - (21)} - (20)	18.20
(23)	REQUIRED BASE RATE, (20) + (22)	364.06
(24)	CURRENT AVERAGE BASE RATE	276.85
(25)	INDICATED RATE-LEVEL CHANGE, (23) / (24)	1.315
(26)	FILED RATE-LEVEL CHANGE	1.205

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

TENANT FORMS

DETERMINATION OF STATEWIDE RATE LEVEL CHANGE

	(1) INCURRED LOSSES EXCL. HURRICANE (A)	(2) LOSSES WITH LAE (1) * LAE (d)	(3) CURRENT COST/AMOUNT FACTOR (E)	(4) HOUSE-YEARS
2007	50,338	58,644	1.047	777
2008	55,257	64,374	1.026	762
2009	28,061	32,691	1.028	760
2010	64,830	75,527	1.037	689
2011	14,660	17,079	1.023	678

	(5) TRENDED AVG. LOSS COST (4)*(5)*CPF/(6) (f)	(6) AVERAGE RATING FACTOR (G)	(7) TRENDED BASE-CLASS LOSS COST	(8) YEARLY WEIGHTS
2007	85.60	1.053	81.29	0.10
2008	93.90	1.032	90.99	0.15
2009	47.91	1.049	45.67	0.20
2010	123.03	1.050	117.18	0.25
2011	27.90	1.047	26.65	0.30

(9)	WEIGHTED TRENDED NON-HURRICANE BASE-CLASS LOSS COST (H)	68.20
(10)	CREDIBILITY (3,666 HOUSE YEARS)	0.10
(11)	EXPECTED NON-MODELED BASE LOSS COST	64.8
(12)	CREDIBILTY-WEIGHTED NON-MODELED BASE LOSS COST	65.14
(13)	TRENDED MODELED HURRICANE BASE-CLASS LOSS COST (I)	9.84
(14)	FIXED EXPENSE PER POLICY (J)	11.23
(15)	(12) + (13) + (14)	86.21
(16)	1 - (VARIABLE EXPENSE + PROFIT + CONTINGENCIES) (K)	0.7161
(17)	BASE RATE EXCLUDING COMP. FOR ASSESS. RISK, NET REINSURANCE COST, DEVIATIONS (15) / (16)	120.39
(18)	COMPENSATION FOR ASSESSMENT RISK PER POLICY (L)	7.66
(19)	NET REINSURANCE COST PER POLICY (M)	46.06
(20)	(17) + (18) + (19)	174.11
(21)	SELECTED DEVIATION (N)	0.05
(22)	DEVIATION AMOUNT PER POLICY, (20)/{1 - (21)} - (20)	9.16
(23)	REQUIRED BASE RATE, (20) + (22)	183.27
(24)	CURRENT AVERAGE BASE RATE	142.10
(25)	INDICATED RATE-LEVEL CHANGE, (23) / (24)	1.290
(26)	FILED RATE-LEVEL CHANGE	1.215

(a) Incurred losses excluding hurricane have been adjusted by the following loss development factors:

Year Ended	Loss Development Factor
12/31/2007	1.000
12/31/2008	1.000
12/31/2009	1.000
12/31/2010	1.000
12/31/2011	1.000

(b,c) Excess Losses and Excess Factor are calculated on page D-36.

(d) The trended loss adjustment expenses have been calculated to be 15.0% of the incurred losses for Owners Forms and 16.5% of the incurred losses for Tenants. These factors are developed on page D-35.

(e) Current Cost/Amount Factors are displayed on page D-28.

(f) "CPF" refers to the Composite Projection Factor. The calculation of the Composite Projection Factor is displayed on page D-28.

(g) The Average Rating Factor is the ratio of average rate at current manual level and average current base rate.

(h) The Weighted Trended Non-Modeled Base Loss Cost is the sum of the products, by year, of the Trended Base Loss Costs and the accident year weights.

(i) Modeled hurricane losses are calculated by multiplying the modeled hurricane loss cost per $1000 of coverage developed by AIR Worldwide by total limits insurance years (in thousands of dollars). To obtain a loss cost value, the modeled loss amounts are divided by 2011 house-years. To convert the average modeled loss cost to a trended base level, it is divided by the trended average rating factor. The trended average rating factor is calculated as (2011 average rating factor) x (2011 current Amount Factor) x Premium Projection Factor. The AIR loss costs and total limit insurance-years referenced above are displayed on page D-38. The trend factors referenced above are derived on page D-28. The derivation of the modeled hurricane base loss cost is shown on page D-40.

(j) The development of Fixed Expense per policy is shown on page D-35.

(k) The development of the Expected Loss and Fixed Expense Ratio is shown on page D-33.

(l) The Compensation for Assessment Risk loading is 4.4% of premium and is based on an analysis done by D. Appel. The provision is calculated as (.044 x Current Base Rate) / (1 - Provisions for Commission & Taxes). The commission and tax provisions are those shown on page D-33.

(m) Derivation of the net reinsurance cost loadings is provided on page D-42. These loadings are based on analysis done by D. Appel.

(n) The anticipated deviation of 5% was selected by the North Carolina Rate Bureau.

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) OWNERS FORMS

INDICATED BASE LOSS COSTS BY TERRITORY

TERRITORY GROUP*	(1) NON-HURRICANE BASE CLASS LOSS COST	(2) FIVE-YEAR HOUSE-YEARS*	(3) CREDI-BILITY	(4) CREDI-BILITY WEIGHTED BASE LOSS COST	(5) MODELED HURRICANE BASE LOSS COST	(6) TOTAL LOSS COST	(7) INDICATED RELATIVITY TERR(7)/SW(7)	(8) INDICATED STATEWIDE BASE LOSS COST	(9) INDICATED BASE LOSS COST TERR(8)/ SW(8)*(9)
1	98.63	26,281	0.600	100.88	171.80	272.68	1.996	167.62	334.54
2	104.08	171,431	1.000	104.08	35.76	139.84	1.024	167.62	171.63
3	104.54	171,083	1.000	104.54	8.54	113.08	0.828	167.62	138.78
Statewide	104.25	368,795				136.59	1.0001		

*Territory Group 1: Terr 5, 6, 42, 43
*Territory Group 2: Terr 32, 34, 41, 44, 45, 46, 47, 53
*Territory Group 3: Terr 36, 38, 39, 57, 60

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) OWNERS FORMS

INDICATED BASE CLASS RATE AND RATE LEVEL CHANGE BY TERRITORY AND COVERAGE

TERRITORY GROUP*	(1) INDICATED BASE LOSS COST	(2) TRENDED FIXED EXPENSES	(3) VARIABLE EXPENSE, PROFIT, CONTINGENCY	(4) CURRENT BASE CLASS RATE	(5) INDICATED NET BASE RATE ((1)+(2)*(4)) / (1.0-(3))	(6) COMPENSATION FOR ASSESSMENT RISK	(7) NET REINS. COST	(8) (5) + (6) + (7)	(9) SELECTED DEVIATION	(10) DOLLAR DEVIATION PER EXPOSURE ((8) / (1.0- (9))) -(8)	(11) INDICATED REQUIRED BASE RATE (8) + (10)	(12) INDICATED RATE LEVEL CHANGE (ALL COVERAGES) (11) / (4)	(13) 5-YR EARNED PREMIUM	(14) BALANCED INDICATED CHANGE
1	334.54	0.0644	0.3119	340.00	518.00	18.33	386.35	922.68	0.05	48.56	971	2.856	16,664,591	2.820
2	171.63	0.0614	0.2924	272.00	266.14	14.66	90.10	370.90	0.05	19.52	390	1.434	112,888,929	1.416
3	138.78	0.0717	0.2485	272.00	210.62	14.66	19.44	244.72	0.05	12.88	258	0.949	96,512,153	0.937
SW			0.2839									1.332	226,065,673	1.315

Territory Group	(18) Filed Base-Class Rate
1	1.750
2	1.300
3	1.000
Diff. for Terr. Grp.1 (I)	1.602
Diff. for Terr. Grp.3 (I)	0.734

*Territory Group 1: Terr 5, 6, 42, 43
*Territory Group 2: Terr 32, 34, 41, 44, 45, 46, 47, 53
*Territory Group 3: Terr 36, 38, 39, 57, 60

(I): Differential for Territory Group by coverage = (column(13) / Off Balance for Territory Group) / (column(13) for Territory Group 2 / Off Balance for Territory Group 2)
In order to introduce the new Amount of Insurance on a revenue-neutral basis, an "off -balance" factor was used in the calculation of the revised base-class rate.
For Amount of Insurance analysis, please refer to Section F of this filing.

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) TENANTS FORMS

INDICATED BASE LOSS COSTS BY TERRITORY

TERRITORY GROUP*	(1) NON-HURRICANE BASE CLASS LOSS COST	(2) FIVE-YEAR HOUSE-YEARS*	(3) CREDI-BILITY	(4) CREDI-BILITY WEIGHTED BASE LOSS COST	(5) MODELED HURRICANE BASE LOSS COST	(6) TOTAL LOSS COST	(7) INDICATED RELATIVITY TERR(7)/SW(7)	(8) INDICATED STATEWIDE BASE LOSS COST	(9) INDICATED BASE LOSS COST TERR(8)/ SW(8)*(9)
1	2.82	257	0.000	56.17	50.39	106.56	1.656	74.98	124.07
2	32.76	1,990	0.100	53.83	7.33	61.16	0.950	74.98	71.17
3	95.00	1,420	0.100	60.05	1.49	61.54	0.956	74.98	71.62
Statewide	56.17	3,666				64.35	1.0008		

*Territory Group 1: Terr 5, 6, 42, 43
*Territory Group 2: Terr 32, 34, 41, 44, 45, 46, 47, 53
*Territory Group 3: Terr 36, 38, 39, 57, 60

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MOBILE HOMES INSURANCE - MH(F) TENANT FORMS

INDICATED BASE CLASS RATE AND RATE LEVEL CHANGE BY TERRITORY AND COVERAGE

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
TERRITORY GROUP*	INDICATED BASE LOSS COST	TRENDED FIXED EXPENSES	VARIABLE EXPENSE, PROFIT, CONTINGENCY	CURRENT BASE CLASS RATE	INDICATED NET BASE RATE ((1)+(2)*(4)) / (1.0-(3))	COMPENSATION FOR ASSESSMENT RISK	NET REINS. COST	(5) + (6) + (7)	SELECTED DEVIATION	DOLLAR DEVIATION PER EXPOSURE ((8) / (1.0- (9))) -(8)	INDICATED REQUIRED BASE RATE (8) + (10)	INDICATED RATE LEVEL CHANGE (ALL COVERAGES) (11) / (4)	BALANCED INDICATED CHANGE
1	124.07	0.0702	0.3119	169.96	197.65	9.16	222.02	428.83	0.05	22.57	451	2.654	2.654
2	71.17	0.0825	0.2924	140.00	116.90	7.55	53.29	177.74	0.05	9.35	187	1.336	1.336
3	71.62	0.0762	0.2485	140.00	109.50	7.55	11.50	128.55	0.05	6.77	135	0.964	0.964
SW			0.2839									1.290	1.290

Territory Group	(14) Filed Base-Class Rate
1	1.750
2	1.300
3	1.000
Diff. for Terr. Grp.1 (I)	1.634
Diff. for Terr. Grp.3 (I)	0.769

*Territory Group 1: Terr 5, 6, 42, 43
*Territory Group 2: Terr 32, 34, 41, 44, 45, 46, 47, 53
*Territory Group 3: Terr 36, 38, 39, 57, 60

(I): Differential for Territory Group by coverage = (column(13) / Off Balance for Territory Group) / (column(13) for Territory Group 2 / Off Balance for Territory Group 2)
In order to introduce the new Amount of Insurance on a revenue-neutral basis, an "off -balance" factor was used in the calculation of the revised base-class rate.
For Amount of Insurance analysis, please refer to Section F of this filing.

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MOBILEHOME INSURANCE - MH(F) PROGRAM

DERIVATION OF WIND EXCLUSION CREDITS

The filed wind exclusion credits, Page B-3, are based on the following formula:

C = $[\,[I - [\,(Ld+F)\,/\,(1.0-V) + kB\,]\,/\,(1.0-D)]\,]\,pr$, where

C = filed credit

I = filed rate

L = pure-premium underlying indicated rate-level change

d = portion of L that is attributable to non-wind losses

F = fixed expense provision underlying indicated rate-level change

V = variable expense provision

B = provision in indicated rate for the Compensation for Assessment Risk loading

k = adjusment factor, applied to B, to reflect exclusion of wind coverage
= (Indicated non-wind rate without B) / (Indicated rate, without B)
= $[(Ld+F)\,/\,(1.0-V)]\;/\;[(L+F)\,/\,(1.0-V)] = (Ld+F)\;/\;(L+F)$

D = selected deviation percentage

p = average protection class, construction class relativity

r = average policy form relativity

The derivation of the filed credits, using the formula defined above, is displayed on page C-9.

The d values used in this calculation are obtained by the following formula:

$$d = \frac{N}{N + W}, \text{ where}$$

N = 5-year average annual non-wind losses
W = X + Y, where
X = 2011 modeled hurricane losses; and
Y = 5-year average annual non-hurricane wind losses

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MOBILEHOME INSURANCE - MH(F) PROGRAM

DERIVATION OF WIND EXCLUSION CREDIT - TERRITORY GROUP^ 1

Forms	*L*	*d'*	F *	*(1-V)* **	*k*	*B* ***	*D*	*I*	*C*
Owners	334.54	0.322	21.90	0.6881	0.364	18.33	0.05	788.13	73.9%
Tenant	124.07	0.483	11.93	0.6881	0.528	9.16	0.05	297.39	61.3%

* equals product of columns (2) and (4) on pages C-7

** equals (1.0 - statewide provisions for profit, contingencies, commission,taxes) x statewide column(12) / statewide column (14)

*** equals 4.4% of current class rate x (1 - Provisions for Commission & Taxes)

^ Territory group 1 - Territories 05, 06, 42, 43

' Because of low credibility the d value for tenants was selected to be 1.5 times the d value for owners.
This 1.5 factor is consistent with the relationship between owners and tenants d values in the last homeowners filing.

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MOBILE HOMES INSURANCE - MH(F) PROGRAM

SECTION D - EXPLANATORY MATERIAL

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

EXPLANATORY MEMORANDUM

This memorandum supplements the filing letter and supporting exhibits setting forth a revision of Mobile Homes MH(F) insurance rates in the State of North Carolina. It is the purpose of this memorandum to describe the source data used and to set forth in detail the insurance ratemaking procedures reflected in the filing. Certain pages in the filing and accompanying material contain a notation "all carriers" or other similar wording. This indicates that the data are combined for all statistical agents and companies except as noted in Section E.

Premium and Loss Experience

This revision is based upon the combined premium and loss experience of all licensed companies writing Mobile Home MH(F) insurance in this State, except as noted in Section E. In order to have this experience available in all detail necessary for rate review and ratemaking in accordance with accepted standards, all such companies are required to file each year their total Mobile Home MH(F) insurance experience with the official statistical agents. Experience is recorded pursuant to the officially approved statistical plans and reported by the companies in accordance with instructions issued by the statistical agents under the Official Calls for Experience.

The Commissioner appointed the following statistical agents for the collection of Mobile Home insurance experience in North Carolina: Insurance Services Office (ISO), Independent Statistical Services, Inc. (ISS), American Association of Insurance Services (AAIS), and National Independent Statistical Service (NISS).

Experience utilized in the filing was collected under the Personal Lines Statistical Plan (Other Than Automobile), and the 2011 Official Statistical Programs of ISO, the Statistical Plan for Mobile Home Policies, 2011 Statistical Programs of ISS, the Mobile Homes Statistical Plan developed by AAIS and the 2011 Statistical Programs of the AAIS[1], the Dwelling Statistical Plan developed by the NISS and the 2011 Statistical Programs of the NISS. In substance, the statistical plans of all statistical agents are similar in North Carolina, and provide for the recording and reporting of the experience in the detail required for ratemaking and in such form that the experience of all companies can be combined.

The licensing of an organization and its appointment as a statistical agent in the various states is predicated upon demonstration by the organization of its ability to perform this function. Moreover, the performance of the statistical agents is reviewed periodically through examination by personnel of state insurance departments under the convention examinations of the National Association of Insurance Commissioners. From time to time such organizations are called upon by Insurance Department examiners to verify, and do verify the data consolidated by them as statistical agents.

The insurance companies likewise are subject to a variety of checks and controls. Effective controls are maintained within the company over the activities of company employees connected with the company's statistics. Companies are required by statute to submit directly to the insurance department statistical and accounting information to be found in the Annual Statement and the Insurance Expense Exhibit. These documents are scrutinized by experienced insurance department personnel throughout the country. The insurance companies are also subject to examination by the insurance department, which examinations extend into the statistical records of the companies.

1. AAIS did not report any data for the experience period included in this filing.

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

EXPLANATORY MEMORANDUM

Tabulations of experience reported to Independent Statistical Services, Inc., and National Independent Statistical Services are provided to the Insurance Services Office. The Insurance Services Office combines the experience of all statistical agents and develops the analysis included in this filing. This work is performed at the direction of the North Carolina Rate Bureau.

Statewide Rate Level Exhibits

1. Experience

The Mobile Home insurance experience for the MH(F) program was compiled on a calendar accident year basis for the years ended December 31, 2011, 2010, 2009, 2008, and 2007. For any twelve-month period, the accident year experience brings together the losses resulting from accidents occurring during that period with the premiums and number of mobile homes "earned" during the same period. Since this filing utilizes a computer model to measure losses attributable to hurricanes, an estimate of actual hurricane losses have been removed from the ratemaking experience.

2. Average Rating Factors

The earned premiums at present manual rates for the mobile home insurance forms are calculated by multiplying the number of insured houses earned during the experience period by the rates in effect at the time of review. Earned premiums at present rates are used to determine average rating factors. The average rating factor is the ratio of the average rate (earned premium at manual level divided by corresponding house-years) and the "base class" rate. The average rating factor is used to convert the pure-premiums incurred during the experience period to the base-class level.

The "base class" for MH(F) Owners Forms is defined to be: $25,000 Coverage A limit, Form 2, no tie-down, $250 all-perils deductible. The "base class" for the MH(F) Tenant Form is defined to be: $15,000 Coverage C limit, no tie-down, $250 all-perils deductible, and no theft deductible.

3. Losses

Losses compiled for any accident year include paid losses as well as loss reserves. Each year the experience is compiled for the latest five years, all valued as of three months after the close of the latest accident year period. The amounts that will ultimately be required as payments of claims on open cases are carefully determined by the claim departments of the companies, and experience has shown that these determinations are highly accurate in the aggregate. A selected loss development factor of 1.000 has been applied to the losses for each accident year.

4. "Excess Wind" Losses and Modeled Hurricane Losses

In order to insure stability in rate levels while maintaining adequacy in the event of wide swings in hurricane and other losses, an excess procedure and a hurricane loss model have been utilized. Hence, extreme shifts in rate level (both upward and downward), which might result from reflecting large hurricane and other losses only in the year in which they occur will be avoided.

For the MH(F) Owners Forms, the incurred non-modeled excess losses are those losses which result from unusually severe loss activity (other than hurricane). They are removed from the experience used in developing rates. In order to reflect the impact of excess losses (that are not related to hurricanes and not accounted for in the hurricane model) on a long-term basis, the non-modeled losses are multiplied by an excess factor of 1.055. The derivation of the excess non-modeled losses is shown on page D-36. Since the number of years available for mobile homes experience is limited, the excess calculation uses Homeowners insurance experience for years prior to 2001, year 2005, and year 2006. The derivation of the excess wind factor is described below.

Statewide excess wind losses by year are calculated by determining a "normal" wind-to-total-minus-wind ratio which represents the long-term expected wind-to-total-minus-wind ratio. All losses above the "normal" ratio are defined as "excess" wind losses.

The "normal" wind-to-total-minus-wind ratio is determined by first capping the historical ratios for unusually large wind loss years at 5 times the median statewide value. (The capped wind-to-total-minus wind ratios are shown in column (5) of the excess wind factor exhibit, page D-36). An excess wind-to-total-minus-wind ratio for a given year is composed of two parts:

(1) a capped excess wind-to-total-minus-wind ratio and

(2) an "excess wind-to-total-minus-wind ratio above the cap".

The excess wind factor is calculated as:

Excess Factor = 1.0 + [(average capped excess ratio + average excess ratio above the cap) ÷ (1.0 + normal ratio - average capped excess ratio)]

The modeled hurricane losses used in this filing are based on analysis performed by AIR-Worldwide on behalf of the North Carolina Rate Bureau and are displayed on page D-38.

The excess procedure is not involved in the development of the rate-level indication for the MH(F) Tenant Form.

5. Loss Adjustment Expense

The Mobile Homes Insurance loss adjustment expenses, prior to trend considerations, are determined as an average percentage of the North Carolina incurred losses for calendar accident years 2007-2011 for Mobile Home Insurance MH(F), based on a North Carolina expense call. The average is calculated using the five year period, removing the high and low values, and averaging the remaining three years. See pages D-34 and D-35.

6. Credibility Factor Determination

Credibility considerations enter into the Mobile Homes ratemaking formula in the calculation of statewide rate level indications which depend, in part, on the determination of the weighted statewide trended pure-premium.

The statewide credibility procedure is the same as the procedure currently used in North Carolina Homeowners filings. This procedure is based on the ‘frequency with severity modification’ model discussed in "Credibility of the Loss cost" by Mayerson, Bowers and Jones. The full credibility standard is based on a normal distribution with a 90% probability of meeting the test and a 5% maximum departure from the expected value, translated to house year standards. Partial credibility (Zp) is calculated as follows:

$Z_p = \sqrt{\text{five year house years / full credibility standard}}$ (truncated to the nearest tenth)

The full credibility standard is 240,000 house years for the Owners Forms, and 285,000 house years for the Tenant Form.

7. Loss Trend

Loss Trend is based on external trend information. For the owners' forms, loss trend relies on the Boeckh Residential Index and the Modified Consumer Price Index, which are averaged (weighted 55% and 45%, respectively) and comprise the Current Cost Index. For the tenant form, the Modified Consumer Price Index is used.

The loss trending procedure is accomplished in two steps. In the first step Current Cost Factors are applied to each year's losses. The Current Cost Factors are derived from the external indices and, when applied to a given year's losses, translate these losses to a cost level which represents May 15, 2014. In order to trend losses from May 15, 2014 to two years beyond the assumed effective date of June 1, 2015, a Loss Projection Factor is applied. This projection factor is based on the annual change inherent in the latest twelve quarterly points of the Current Cost Index.

Since the external indices necessarily ignore the effect of policy deductibles, a First Dollar procedure to trend from the first dollar of loss is incorporated into the calculation of the Loss Projection Factor. The calculation of the first-dollar effect is the average effect for the $250, $500 and $1,000 deductibles for owners forms and average effect for the $250 and $500 for tenant form.

The procedures described above are displayed on Pages D-10-16 and D-28.

While the index trend constitutes part of the loss methodology, the information provided by historical experience is not ignored. To incorporate the historical information, pure-premiums and severities are calculated by year in cause-of-loss (i.e., fire-related, water-related, etc.) detail, and fitted least-squares annual rates of change are computed. Based on a comparison of external index rates of change, and the fitted changes for the historical pure-premiums and severities, "Loss Trend Adjustment" factors of 2.5% and 2.0% were selected for MH(F) Owners and MH(F) Tenants, respectively, and incorporated into the projection calculations.

8. Premium Trend

Since the rate-of-change in MH(F) manual rates by policy limit varies somewhat with the choice of deductible, the average (implicit) policy amount relativities used in the premium trend calculations are based on the data for the $250, $500, and $1,000 deductibles for owners and $250 and $500 deductibles for tenant which are the typically-selected options for each form. The historical policy amount average relativities are used to calculate an average annual change. This rate of change is used to estimate the average relativity at the point in time corresponding to the midpoint of the latest quarter of the Current Cost Index (May 15, 2014). The Current Amount Factor for a given year is calculated as the ratio of the May 15, 2014 average relativity and the given year's average relativity. In order to calculate the Premium Projection Factor, the annual rate of change is compounded over the time period between May 15, 2014 and December 1, 2016 (18 months beyond the assumed effective date). The calculation is shown on pages D-17 - D-28.

9. Composite Loss/Premium Trend

Since the base-class pure-premium is the basic quantity underlying the overall rate-making procedure, and since it is in the form: (average pure premium) / (average rating factor), the loss and premium trend factors are applied in a "composite" form of "Current Cost/Amount" factors and "Composite Projection Factor" (CPF). The Current Cost/Amount Factor, for a given year, is the ratio of the Current Cost Factor and the Current Amount Factor for the given year. The Composite Projection Factor is the ratio of the Loss Projection and Premium Projection factors. These calculations are shown on pages D-18, D-20, D-22, D-24, and D-26.

10. Expense Trend

The selected annual change to be applied to general expense, other acquisition expense and loss adjustment expense costs is based on the observed growth in the All Items Consumer Price Index and the Compensation Cost Index. The selected annual change is 2.0% based on analysis and review of the index data, which are displayed on Pages D-29 - D-32. Item 12 below describes how the selected annual change is used in the derivation of the loadings for general, other acquisition and loss adjustment expenses.

11. Trend Periods

The effective date assumed in this filing for trend purposes is June 1, 2015. Given this effective date and the assumption that the rates will be in effect for three years, the trend periods for premiums, losses and expenses are as follows:

- premiums, and the corresponding average rating factors, are trended from January 1 of the given year to December 1, 2016.
- losses are trended from July 1 of the given year to June 1, 2017.
- general expense and other acquisition expense percentages, since they are based on 2009-2011 data, are trended from July 1, 2010 to December 1, 2016.
- loss adjustment expense percentages, since they are based on 2007-2011 data, are trended from July 1, 2009 to June 1, 2017.

12. Expense Loadings (other than L.A.E.)

General and Other Acquisition Expenses (Fixed Expenses) - The loadings for these "fixed" expenses are based on the information collected in special "calls" for North Carolina expense experience and reflect the 2009, 2010, and 2011 call results as reported by all companies licensed in North Carolina during those years. Based on information in these calls, the provisions for these expenses are expressed as percentages of all MH(F) forms premium. The percentage provision for these expenses (which, in effect, represents the ratio of a "numerator" of expense dollars and a "denominator" of premium dollars) is trended. The numerator is trended based on the indices shown on pages D-29 - D-32, from which a selection of 2.0% annual growth was made, and the denominator is trended using appropriate premium trend factors that are relevant in the overall ratemaking methodology. Once the percentage provision for general and other acquisition expenses is trended, it is converted to a corresponding dollar value which can be incorporated into the pure-premium ratemaking methodology utilized in this filing. The dollar value is obtained by multiplying the trended percentage by the trended average rate at current manual level. Distinct dollar values are generated for the Owners and Tenant forms.

The calculation described above, and the conversion to the base-class level that is required by the ratemaking methodology utilized in this filing, is shown in detail on page D-35. The underlying experience is shown on page D-33.

Commissions and Taxes (Variable Expenses) - The loadings for these expenses are based on the same special call information, and the same years, as described above for general and other acquisition expenses. Since these expenses are "variable," there is no need for trending or conversion to a dollar value. The underlying experience for these expenses is shown on page D-33.

Loss Adjustment Expense - The percentage loading for this expense is based on the same special call information as described above for general and other acquisition expenses. Since loss adjustment expense is measured relative to losses, a longer time period, 2007-2011, is used. The percentage loading for loss adjustment expense is trended in a manner that is analogous to trending of the percentage loading for general and other acquisition expenses: the numerator, i.e., dollars of expense, is trended using the indices shown on pages D-29 - D-32, and the denominator, i.e., dollars of loss, is trended using appropriate loss trend factors that are relevant in the overall ratemaking methodology. This calculation and the underlying data are displayed in detail on pages D-34 - D-35.

Net Cost of Reinsurance - The provisions for the net cost of reinsurance are based on an analysis provided by D. Appel. This analysis generates the total dollars required by territory group based on 2011 house-years for MH(F) Owners and Tenant forms. The allocation of these dollars to individual forms and territory groups is based on the distribution of earned premium at manual level. This calculation and the conversion to the required base-class level are shown on page D-42.

Compensation for Assessment Risk -The provisions for compensation for assessment risk are calculated as (.044 x Current Average Base Rate) / (1.0 - (Provision for Commissions + Provision for Taxes)). The .044 value is based on analysis performed by D. Appel. The commission and tax provisions are those shown on page D-33. (See also pre-filed testimony of D. Appel.)

Determination of Base-Class Loss Costs by Territory Group

1. Non-Modeled Base-Class Loss Cost

   A five-year non-modeled base-class loss cost by territory group is derived by dividing five-year territory-group losses excluding hurricane by the product of the five-year average rating factor and five-year house-years. The territory-group losses excluding hurricane include a territory-group wind provision for Mobile Home MH(F) Owners.

   The territory-group wind provision is calculated in a two-step process. In the first step, the statewide excess loss amounts and the excess factor are used to determine a statewide "wind provision". The wind provision is the dollar value of the "implicit" wind losses that remain in the rate-making loss experience, after excess wind losses are removed and the excess factor is applied. The statewide wind provision is defined as $(T - E)F - (T - L)$, where:

   T = statewide incurred non-modeled losses
   E = statewide non-modeled excess wind losses
   F = statewide excess wind factor
   L = non-hurricane wind losses

   In the second step, the long-term history of wind losses by territory group is used to distribute the statewide wind provision to each territory group. This calculation is illustrated on page D-37.

2. Credibility

   The five-year base-class loss cost excluding hurricane is assigned a credibility value based upon the number of house-years underlying this loss cost. The standard for full credibility is 60,000 house years for the Owners Forms and 75,000 house years for Tenants, with partial credibility equal to:

   $Z_p = \sqrt{\text{five year house years / full credibility standard}}$ (truncated to the nearest tenth)

   The complement of credibility is assigned to the statewide five-year base-class loss cost excluding hurricane.

   The territory credibility procedure is based on the "frequency with severity modification" model discussed in "Credibility of the Pure-Premium" by Mayerson, Bowers, and Jones. The full credibility standard is based on a normal distribution with 90% probability of meeting the test and a 10% maximum departure from the expected value, translated to house year standards.

3. Modeled Hurricane Base-Class Loss Cost

   The modeled hurricane base-class loss cost is derived by dividing modeled hurricane territory-group losses by the product of the average rating factor and house-years.

4. Total Base-Class Loss Cost

   The base-class loss cost for total losses is the sum of the credibility weighted base-class loss cost excluding hurricane and the modeled hurricane base-class loss cost.

5. Indicated Relativity for Base-Class Loss Costs

   The total loss costs by territory group are made to be relative to the state by taking the ratio of the by territory-group loss costs and the statewide average loss cost.

6. Indicated Base-Class Loss Costs By Territory Group

   The territory-group relativities are applied to the statewide base-class loss cost (computed on the statewide indications pages) in order to obtain the indicated base-class loss costs by territory group.

Determination of Base Rates by Territory Group & Indicated Rate Level Changes by Territory Group

1. Fixed Expenses (i.e., General and Other Acquisition Expenses) By Territory Group

   The statewide provisions for general and other acquisition expenses are adjusted in order to reflect the varying size of the current rates by territory group. This is accomplished by multiplying the statewide provisions (in percentage form) by the ratio of the current statewide average rate and the current average rate for the given territory group.

2. Variable Expenses, Profit and Contingency Loading By Territory Group

   The variable expense loadings include provisions for commissions, taxes, profit, and contingencies. The profit and contingencies provisions vary by territory group. These provisions are shown on page D-33. (See also pre-filed testimony of D. Appel.).

3. Compensation for Assessment Risk

   The Compensation for Assessment Risk provision is calculated as (.044 × Current Base Rate) / (1.0 - (Provision for Commissions + Provision for Taxes)). The .044 value is based on analysis performed by D. Appel. The commission and tax provisions are those shown on page D-33. (See also pre-filed testimony of D. Appel.)

4. Net Cost of Reinsurance

   The provisions for the net cost of reinsurance are based on analysis provided by D. Appel. This analysis generates the all-forms total dollars required by territory group based on 2011 house-years. The allocation of these dollars to individual forms and territory groups is based on the distribution of earned premium at manual level. This calculation and the conversion to the base-class level that is required by the ratemaking methodology utilized in this filing are shown on pages D-42. (See also pre-filed testimony of D. Appel.).

EXPLANATORY MEMORANDUM

5. Selected Deviation

A 5% deviation provision was selected by the NCRB.

6. Calculation of Indicated Base-Class Rates By Territory Group

The calculation of the revised rates is based on the following formula:

Revised Rate = [(Base-Class Loss Cost) + (Fixed Expense Provision * Current Rate)] / (1- Variable Expense Provision)

The calculation includes the reflection of the necessary provisions for profit, deviations, and contingencies. In order to reflect the varying risk of hurricane losses, the profit and contingencies provisions vary by territory group. (See testimony of D. Appel.)

NORTH CAROLINA

MOBILEHOMES - MH-F OWNERS

DEVELOPMENT OF CURRENT COST FACTORS (CCF) AND LOSS PROJECTION FACTOR

QUARTER ENDING JUNE 30, 2014

PART A: ESTABLISHMENT OF MONTHLY CURRENT COST INDEX (CCI) WITH:
45% WEIGHT TO MODIFIED COMSUMER PRICE INDEX (MCPI)
55% WEIGHT TO BOECKH RESIDENTIAL INDEX (BRI) FOR N.C.
(MCPI BASE: 1967 = 100 BRI BASE: 1967 = 100)

	HO Owners				HO Owners				HO Owners			
MO	BRI	MCPI	CCI	QCCI	BRI	MCPI	CCI	QCCI	BRI	MCPI	CCI	QCCI
		2011-2012				2012-2013				2013-2014		
07	951.4	432.4	717.9		978.9	442.9	737.7		991.0	446.3	745.9	
08	961.6	433.3	723.9		982.9	442.8	739.9		998.1	447.6	750.4	
09	960.9	434.3	723.9	721.9	982.0	444.5	740.1	739.2	997.8	448.7	750.7	749.0
10	962.0	436.2	725.4		982.6	445.2	740.8		995.9	448.8	749.7	
11	967.2	436.5	728.4		985.1	444.7	741.9		998.3	447.5	750.4	
12	966.4	435.6	727.5	727.1	984.0	442.8	740.5	741.1	996.1	445.4	748.3	749.5

	HO Owners				HO Owners				HO Owners			
MO	BRI	MCPI	CCI	QCCI	BRI	MCPI	CCI	QCCI	BRI	MCPI	CCI	QCCI
		2012				2013				2014		
01	969.0	437.2	729.7		987.9	444.5	743.4		999.9	447	751.1	
02	970.9	439.8	731.9		988.5	446.9	744.8		1,001.3	449.8	753.1	
03	973.2	441.5	733.9	731.8	987.2	447.9	744.5	744.2	1,000.7	451.1	753.4	752.5
04	975.9	442.3	735.8		990.0	447.9	746.1		1,003.5	451.5	755.1	
05	976.7	442.8	736.4		992.7	447.0	747.1		1,003.7	451.5	755.2	
06	978.2	442.9	737.3	736.5	991.3	447.1	746.4	746.5	1,003.5	451.1	754.9	755.1

PART B: CALCULATION OF CURRENT COST FACTORS (CCF)

CALENDAR YEAR AVERAGE CCI		HO Owners		CURRENT COST FACTORS BASED ON AVERAGE CCI VALUE FOR QUARTER ENDING 6/30/2014 755.1
YEAR	BRI	MCPI	CCI	
2007	900.7	410.5	680.1	1.110
2008	918.8	416.6	692.8	1.090
2009	930.5	423.0	702.1	1.075
2010	937.3	426.4	707.4	1.067
2011	951.8	433.0	718.3	1.051

NORTH CAROLINA

MOBILEHOMES- MH-F OWNERS

DEVELOPMENT OF CURRENT COST FACTORS (CCF) AND LOSS PROJECTION FACTOR
QUARTER ENDING JUNE 30, 2014

PART C: COMPUTATION OF LOSS PROJECTION FACTOR

CAL. YEAR	QUARTER ENDING	TIME (2X)	4X^2	AVG. CCI (Y)	Z=LN(Y)	2XZ	FITTED CCI
2011	SEP. 30	-11	121	721.9	6.582	-72.402	724.9
2011	DEC. 31	-9	81	727.1	6.589	-59.301	727.8
2012	MAR. 31	-7	49	731.8	6.596	-46.172	730.7
2012	JUN. 30	-5	25	736.5	6.602	-33.010	733.6
2012	SEP. 30	-3	9	739.2	6.606	-19.818	736.6
2012	DEC. 31	-1	1	741.1	6.608	-6.608	739.5
2013	MAR. 31	1	1	744.2	6.612	6.612	742.5
2013	JUN. 30	3	9	746.5	6.615	19.845	745.5
2013	SEP. 30	5	25	749.0	6.619	33.095	748.4
2013	DEC. 31	7	49	749.5	6.619	46.333	751.4
2014	MAR. 31	9	81	752.5	6.623	59.607	754.5
2014	JUN. 30	11	121	755.1	6.627	72.897	757.5
			572		79.298	1.078	

EQUATIONS:

$$Y = E^{A+BX}$$
$$Z = A+BX$$
$$SZ = NA + BSX$$
$$SXZ = ASX + BSX^2$$

WHERE A = MEAN OF FITTED LINE
B = AVERAGE QUARTERLY INCREMENT
S = SUMMATION
N = NUMBER OF OBSERVATIONS

2SXZ = 1.078 OR SXZ = 0.539 S4X^2 = 572 OR SX^2 = 143

A (MEAN OF FITTED LINE) = 79.298 / 12 = 6.608
B (AVG. QUARTERLY INCREMENT) = 0.539 / 143 = 0.004

QUARTERLY RATE OF CHANGE = $E^{0.0040} - 1$ = 0.0040

ANNUAL RATE OF CHANGE = $(E^{0.0040})^{4}$ = 1.016 OR 1.6%

LOSS PROJECTION FACTOR* = $(E^{0.0040})^{36.5/3}$ = 1.050

* TO PROJECT LOSSES FROM 5/15/14 TO 6/1/17

NORTH CAROLINA

MOBILEHOMES - MH-F TENANTS

DEVELOPMENT OF CURRENT COST FACTORS (CCF) AND LOSS PROJECTION FACTOR

QUARTER ENDING JUNE 30, 2014

PART A: ESTABLISHMENT OF MONTHLY CURRENT COST INDEX (CCI) WITH:
MODIFIED CONSUMER PRICE INDEX ONLY (BASE: 1967 = 100)

MO.	HO Tenants MCPI 2011-2012	QCCI	HO Tenants MCPI 2012-2013	QCCI	HO Tenants MCPI 2013-2014	QCCI
07	308.8		313.3		313.5	
08	309.5		313.1		314.0	
09	310.4	309.6	314.5	313.6	314.9	314.1
10	311.7		315.2		314.9	
11	311.4		314.5		313.6	
12	310.1	311.1	312.4	314.0	311.5	313.3

MO	HO Tenants MCPI 2012	QCCI	HO Tenants MCPI 2013	QCCI	HO Tenants MCPI 2014	QCCI
01	310.8		313.3		312.2	
02	312.6		314.9		313.9	
03	314.0	312.5	315.7	314.6	315.2	313.8
04	314.6		315.8		315.4	
05	314.5		315.2		315.0	
06	313.9	314.3	314.6	315.2	314.3	314.9

PART B: CALCULATION CURRENT COST FACTORS (CCF)

AVERAGE ANNUAL CCI YEAR	CCI	CURRENT COST FACTORS BASED ON AVERAGE CCI VALUE FOR QUARTER ENDING 6/30/2014 = 314.9
2007	306.1	1.029
2008	307.1	1.025
2009	309.1	1.019
2010	307.3	1.025
2011	309.5	1.017

NORTH CAROLINA
MOBILEHOMES- MH-F TENANTS

DEVELOPMENT OF CURRENT COST FACTORS (CCF) AND LOSS PROJECTION FACTOR
QUARTER ENDING JUNE 30, 2014

PART C: COMPUTATION OF LOSS PROJECTION FACTOR

CAL. YEAR	QUARTER ENDING	TIME (2X)	$4X^2$	AVG. CCI (Y)	Z=LN(Y)	2XZ	FITTED CCI
2011	SEP. 30	-11	121	309.6	5.735	-63.085	311.5
2011	DEC. 31	-9	81	311.1	5.740	-51.660	311.8
2012	MAR. 31	-7	49	312.5	5.745	-40.215	312.2
2012	JUN. 30	-5	25	314.3	5.750	-28.750	312.5
2012	SEP. 30	-3	9	313.6	5.748	-17.244	312.8
2012	DEC. 31	-1	1	314.0	5.749	-5.749	313.1
2013	MAR. 31	1	1	314.6	5.751	5.751	313.4
2013	JUN. 30	3	9	315.2	5.753	17.259	313.7
2013	SEP. 30	5	25	314.1	5.750	28.750	314.0
2013	DEC. 31	7	49	313.3	5.747	40.229	314.3
2014	MAR. 31	9	81	313.8	5.749	51.741	314.7
2014	JUN. 30	11	121	314.9	5.752	63.272	315.0
			572		68.969	0.299	

EQUATIONS:

$$Y = E^{A+BX}$$
$$Z = A+BX$$
$$SZ = NA + BSX$$
$$SXZ = ASX + BSX^2$$

WHERE A = MEAN OF FITTED LINE
B = AVERAGE QUARTERLY INCREMENT
S = SUMMATION
N = NUMBER OF OBSERVATIONS

2SXZ = 0.299 OR SXZ = 0.15 S4X^2 = 572 OR SX^2 = 143

A (MEAN OF FITTED LINE) = 68.969 / 12 = 5.747
B (AVG. QUARTERLY INCREMENT) = 0.15 / 143 = 0.001

QUARTERLY RATE OF CHANGE = $E^{0.0010} - 1$ = 0.0010

ANNUAL RATE OF CHANGE = $(E^{0.0010})^{4}$ = 1.004 OR 0.4%

LOSS PROJECTION FACTOR* = $(E^{0.0010})^{36.5/3}$ = 1.012

* TO PROJECT LOSSES FROM 5/15/14 TO 6/1/17

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

NOTES TO THE DETERMINATION OF LOSS TREND

Modified Consumer Price Index - source: Bureau of Labor Statistics. Weights are applied to individual Consumer Price Index components as follows:

Owners Forms:	Tenant Forms:
48% House Furnishings	54% House Furnishings
20% Medical Care	10% Medical Care
16% Apparel Commodities	18% Apparel Commodities
16% Entertainment Commodities	18% Entertainment Commodities

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM - OWNERS

DEVELOPMENT OF FIRST DOLLAR OF LOSS ADJUSTMENT FACTORS

				Weight		
(1)	Current cost factor	2007	1.110	0.10		
		2008	1.090	0.15		
		2009	1.075	0.20		
		2010	1.067	0.25		
		2011	1.051	0.30		
(2)	Weighted Current Cost Factor		1.072			
(3)	Loss Projection Factor		1.050			
(4)	Loss Trend = (2) x (3)		1.126			
			$250 Deductible	$500 Deductible	$1,000 Deductible	Combined
(5)	5-yr Incurred Losses		52,105,061	30,400,552	15,266,980	97,772,593
(6)	5-yr Incurred Claims Subject to Deductible		14,142	8,357	3,104	25,603
(7)	Losses Eliminated by Deductible		3,535,537	4,178,403	3,103,695	10,817,635
(8)	Adjustment to Trend from First Dollar of Loss					
		Non-Hurricane	1.008	1.015	1.023	1.012
		Modeled Hurricane	1.006	1.012	1.018	1.010

=((5z) + (7z))x (4)) / ((5z) x (4)), where z = a, b, or c

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM - TENANT

DEVELOPMENT OF FIRST DOLLAR OF LOSS ADJUSTMENT FACTORS

				Weight	
(1)	Current cost factor	2007	1.029	0.10	
		2008	1.025	0.15	
		2009	1.019	0.20	
		2010	1.025	0.25	
		2011	1.017	0.30	
(2)	Weighted Current Cost Factor		1.022		
(3)	Loss Projection Factor		1.012		
(4)	Loss Trend = (2) x (3)		1.034		
			$250 Deductible	$500 Deductible	Combined
(5)	5-yr Incurred Losses		128,397	61,456	189,853
(6)	5-yr Incurred Claims Subject to Deductible		36	26	62
(7)	Losses Eliminated by Deductible		8,997	13,012	22,009
(8)	Adjustment to Trend from First Dollar of Loss				
		Non-Hurricane	1.002	1.007	1.004
		Modeled Hurricane	1.002	1.006	1.003

=((5z) + (7z))x (4)) / ((5z) x (4)), where z = a, b, or c

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

TREND IN AVERAGE RELATIVITY

MH-F OWNERS
$250 Deductible Option

CAL. YEAR	X	Y*	Z=ln Y	X*Z
2007	-2.000	2.371	0.863	-1.726
2008	-1.000	2.476	0.907	-0.907
2009	0.000	2.536	0.931	0.000
2010	1.000	2.467	0.903	0.903
2011	2.000	2.633	0.968	1.936
			4.572	0.206

A (mean of fitted line) = (Sum Z)/5 = 4.572 /5 = 0.914

B (average annual increment) = (Sum X*Z)/10 = 0.206 /10 = 0.021

Average Annual Rate of Change = $e^{0.021} - 1$ = 0.021

Latest Year Relativity trended from 01/01/11 to 05/15/14

$2.633 * 1.021^{40.5/12}$ = 2.824

* Average Policy Amount Relativity

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

DEVELOPMENT OF CURRENT COST / AMOUNT AND PROJECTION FACTORS

MH-F OWNERS
$250 Deductible Option

CAL. YEAR	(1) Average Rel.	(2) (2) = 2.824 (A) / (1)	(3) Current Amount Factor [(2)-1]*1+1	(4) Current Cost Factor	(5) Current Cost/ Amount Factor
2007	2.371	1.191	1.191	1.110	0.932
2008	2.476	1.141	1.141	1.090	0.955
2009	2.536	1.114	1.114	1.075	0.965
2010	2.467	1.145	1.145	1.067	0.932
2011	2.633	1.073	1.073	1.051	0.979

			Non-Hurricane	Modeled Hurricane
(6) Premium Projection Factor	1.021 (30.5 /12)	=	1.054	1.054
(7) Loss Projection Factor		=	1.050	1.050
(8) Adjustment to Trend from First Dollar of Loss		=	1.008	1.006
(9) Annual Loss Trend Adjustment % (LTA)		=	1.025	1.025
(10) Total Period LTA		=	1.078	1.078
(11) Composite Projection Factor for Loss Ratio = (7) * (8) * (10) / (6)		=	1.0825	1.0804

(A) 2.002 is the projected average relativity at 05/15/14

Premium projection factor reflects trend from 05/15/14 to 12/01/16

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

TREND IN AVERAGE RELATIVITY

MH-F OWNERS
$500 Deductible Option

CAL. YEAR	X	Y*	Z=ln Y	X*Z
2007	-2.000	1.760	0.565	-1.130
2008	-1.000	1.816	0.597	-0.597
2009	0.000	1.851	0.616	0.000
2010	1.000	1.865	0.623	0.623
2011	2.000	1.879	0.631	1.262
			3.032	0.158

A (mean of fitted line) = (Sum Z)/5 = 3.032 /5 = 0.606

B (average annual increment) = (Sum X*Z)/10 = 0.158 /10 = 0.016

Average Annual Rate of Change = $e^{0.016} - 1$ = 0.016

Latest Year Relativity trended from 01/01/11 to 05/15/14

$1.879 * 1.016^{40.5/12}$ = 1.982

* Average Policy Amount Relativity

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

DEVELOPMENT OF CURRENT COST / AMOUNT AND PROJECTION FACTORS

MH-F OWNERS
$500 Deductible Option

CAL. YEAR	(1) Average Rel.	(2) (2) = 1.982 (A) / (1)	(3) Current Amount Factor [(2)-1]*1+1	(4) Current Cost Factor	(5) Current Cost/ Amount Factor
2007	1.760	1.126	1.126	1.110	0.986
2008	1.816	1.091	1.091	1.090	0.999
2009	1.851	1.071	1.071	1.075	1.004
2010	1.865	1.063	1.063	1.067	1.004
2011	1.879	1.055	1.055	1.051	0.996

				Non-Hurricane	Modeled Hurricane
(6) Premium Projection Factor	1.016	(30.5 /12)	=	1.041	1.041
(7) Loss Projection Factor			=	1.050	1.050
(8) Adjustment to Trend from First Dollar of Loss			=	1.015	1.012
(9) Annual Loss Trend Adjustment % (LTA)			=	1.025	1.025
(10) Total Period LTA			=	1.078	1.078
(11) Composite Projection Factor for Loss Ratio = (7) * (8) * (10) / (6)			=	1.1036	1.1004

(A) 1.982 is the projected average relativity at 05/15/14

Premium projection factor reflects trend from 05/15/14 to 12/01/16

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

TREND IN AVERAGE RELATIVITY

MH-F OWNERS
$1,000 Deductible Option

CAL. YEAR	X	Y*	Z=ln Y	X*Z
2007	-2.000	1.828	0.603	-1.206
2008	-1.000	1.914	0.649	-0.649
2009	0.000	2.021	0.704	0.000
2010	1.000	2.071	0.728	0.728
2011	2.000	2.107	0.745	1.490
			3.429	0.363

A (mean of fitted line) = (Sum Z)/5 = 3.429 /5 = 0.686

B (average annual increment) = (Sum X*Z)/10 = 0.363 /10 = 0.036

Average Annual Rate of Change = $e^{0.036} - 1$ = 0.037

Latest Year Relativity trended from 01/01/11 to 05/15/14

$2.107 * 1.037^{40.5/12} = 2.382$

* Average Policy Amount Relativity

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

DEVELOPMENT OF CURRENT COST / AMOUNT AND PROJECTION FACTORS

MH-F OWNERS
$1,000 Deductible Option

CAL. YEAR	(1) Average Rel.	(2) (2) = 2.382 (A) / (1)	(3) Current Amount Factor [(2)-1]*1+1	(4) Current Cost Factor	(5) Current Cost/ Amount Factor
2007	1.828	1.303	1.303	1.110	0.852
2008	1.914	1.245	1.245	1.090	0.876
2009	2.021	1.179	1.179	1.075	0.912
2010	2.071	1.150	1.150	1.067	0.928
2011	2.107	1.131	1.131	1.051	0.929

			Non-Hurricane	Modeled Hurricane
(6) Premium Projection Factor	1.037 (30.5 /12)	=	1.097	1.097
(7) Loss Projection Factor		=	1.050	1.050
(8) Adjustment to Trend from First Dollar of Loss		=	1.023	1.018
(9) Annual Loss Trend Adjustment % (LTA)		=	1.025	1.025
(10) Total Period LTA		=	1.078	1.078
(11) Composite Projection Factor for Loss Ratio = (7) * (8) * (10) / (6)		=	1.0555	1.0504

(A) 2.382 is the projected average relativity at 05/15/14

Premium projection factor reflects trend from 05/15/14 to 12/01/16

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

TREND IN AVERAGE RELATIVITY

MH-F TENANT
$250 Deductible Option

CAL. YEAR	X	Y*	Z=ln Y	X*Z
2007	-2.000	1.177	0.163	-0.326
2008	-1.000	1.175	0.161	-0.161
2009	0.000	1.153	0.142	0.000
2010	1.000	1.135	0.127	0.127
2011	2.000	1.134	0.126	0.252
			0.719	-0.108

A (mean of fitted line) = (Sum Z)/5 = 0.719 /5 = 0.144

B (average annual increment) = (Sum X*Z)/10 = -0.108 /10 = -0.011

Average Annual Rate of Change = $e^{-0.011} - 1$ = -0.011

Latest Year Relativity trended from 01/01/11 to 05/15/14

1.134 * $0.989^{40.5/12}$ = 1.092

* Average Policy Amount Relativity

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

DEVELOPMENT OF CURRENT COST / AMOUNT AND PROJECTION FACTORS

MH-F TENANT
$250 Deductible Option

CAL. YEAR	(1) Average Rel.	(2) (2) = 1.092 (A) / (1)	(3) Current Amount Factor [(2)-1]*+1	(4) Current Cost Factor	(5) Current Cost/ Amount Factor
2007	1.177	0.928	0.928	1.029	1.109
2008	1.175	0.929	0.929	1.025	1.103
2009	1.153	0.947	0.947	1.019	1.076
2010	1.135	0.962	0.962	1.025	1.065
2011	1.134	0.963	0.963	1.017	1.056

			Non-Hurricane	Modeled Hurricane
(6) Premium Projection Factor	0.989 (30.5 /12)	=	0.972	0.972
(7) Loss Projection Factor		=	1.012	1.012
(8) Adjustment to Trend from First Dollar of Loss		=	1.002	1.002
(9) Annual Loss Trend Adjustment % (LTA)		=	1.020	1.020
(10) Total Period LTA		=	1.062	1.062
(11) Composite Projection Factor for Loss Ratio = (7) * (8) * (10) / (6)		=	1.1079	1.1079

(A) 1.092 is the projected average relativity at 05/15/14

Premium projection factor reflects trend from 05/15/14 to 12/01/16

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

TREND IN AVERAGE RELATIVITY

MH-F TENANT
$500 Deductible Option

CAL. YEAR	X	Y*	Z=ln Y	X*Z
2007	-2.000	1.329	0.284	-0.568
2008	-1.000	1.292	0.256	-0.256
2009	0.000	1.321	0.278	0.000
2010	1.000	1.342	0.294	0.294
2011	2.000	1.329	0.284	0.568
			1.396	0.038

A (mean of fitted line) = (Sum Z)/5 = 1.396 /5 = 0.279
B (average annual increment) = (Sum X*Z)/10 = 0.038 /10 = 0.004

Average Annual Rate of Change = $e^{0.004} - 1$ = 0.004

Latest Year Relativity trended from 01/01/11 to 05/15/14

$1.329 * 1.004^{40.5 /12}$ = 1.347

* Average Policy Amount Relativity

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

DEVELOPMENT OF CURRENT COST / AMOUNT AND PROJECTION FACTORS

MH-F TENANT
$500 Deductible Option

CAL. YEAR	(1) Average Rel.	(2) (2) = 1.347 (A) / (1)	(3) Current Amount Factor [(2)-1]*+1	(4) Current Cost Factor	(5) Current Cost/ Amount Factor
2007	1.329	1.014	1.014	1.029	1.015
2008	1.292	1.043	1.043	1.025	0.983
2009	1.321	1.020	1.020	1.019	0.999
2010	1.342	1.004	1.004	1.025	1.021
2011	1.329	1.014	1.014	1.017	1.003

			Non-Hurricane	Modeled Hurricane
(6) Premium Projection Factor	1.004 (30.5 /12)	=	1.010	1.010
(7) Loss Projection Factor		=	1.012	1.012
(8) Adjustment to Trend from First Dollar of Loss		=	1.007	1.006
(9) Annual Loss Trend Adjustment % (LTA)		=	1.020	1.020
(10) Total Period LTA		=	1.062	1.062
(11) Composite Projection Factor for Loss Ratio = (7) * (8) * (10) / (6)		=	1.0716	1.0705

(A) 1.347 is the projected average relativity at 05/15/14

Premium projection factor reflects trend from 05/15/14 to 12/01/16

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

DEVELOPMENT OF CURRENT AMOUNT FACTORS (CAF) AND PREMIUM TREND PROJECTION FACTORS

Owners

	$250 Deductible		$500 Deductible		$1,000 Deductible		Combined
	Current Amount Factor	Earned Premium At manual Level	Current Amount Factor	Earned Premium At manual Level	Current Amount Factor	Earned Premium At manual Level	Current Amount Factor
2007	1.191	23,323,947	1.126	9,950,228	1.303	5,994,627	1.192
2008	1.141	22,905,747	1.091	9,927,059	1.245	5,569,987	1.143
2009	1.114	21,731,762	1.071	9,775,973	1.179	4,981,398	1.111
2010	1.145	23,243,673	1.063	9,299,136	1.150	4,735,647	1.125
2011	1.073	27,020,934	1.055	9,046,184	1.131	4,669,796	1.076
Premium Trend Projection Factors							
	1.054		1.041		1.097		1.057

Tenant

	$250 Deductible		$500 Deductible		Combined
	Current Amount Factor	Earned Premium At manual Level	Current Amount Factor	Earned Premium At manual Level	Current Amount Factor
2007	0.928	35,692	1.014	64,415	0.983
2008	0.929	36,581	1.043	59,069	0.999
2009	0.947	38,089	1.020	59,086	0.991
2010	0.962	33,860	1.004	54,646	0.988
2011	0.963	33,730	1.014	54,358	0.994
Premium Trend Projection Factors					
	0.972		1.01		0.996

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

Summary of Trend Factors for Statewide Rate-Level Indication

		Owners		Tenant	
(1) Current Cost Factors (a):	2007	1.110		1.029	
	2008	1.090		1.025	
	2009	1.075		1.019	
	2010	1.067		1.025	
	2011	1.051		1.017	
(2) Current Amount Factors* (b):	2007	1.192		0.983	
	2008	1.143		0.999	
	2009	1.111		0.991	
	2010	1.125		0.988	
	2011	1.076		0.994	
(3) Current Cost/Amount Factors = (1) / (2):	2007	0.931		1.047	
	2008	0.954		1.026	
	2009	0.968		1.028	
	2010	0.948		1.037	
	2011	0.977		1.023	
		Non-Hurricane	Modeled Hurricane	Non-Hurricane	Modeled Hurricane
(4) Premium Projection Factor* (c):		1.057	1.057	0.996	0.996
(5) Loss Projection Factor (d):		1.050	1.050	1.012	1.012
(6) Adjustment to Trend from First Dollar of Loss*:		1.012	1.010	1.004	1.003
(7) Total Period Loss Trend Adjustment		1.078	1.078	1.062	1.062
(8) Composite Projection Factor for Loss Ratio =(5) x (6) x (7) / (4)		1.084	1.082	1.083	1.082

(a) average of by-coverage Current Cost Factors. Non-modelled incurred losses, by coverage, used as weights
(b) average of by-coverage Current Amount Factors. Earned premium at manual level, by coverage, used as weights
(c) average of by-coverage Premium Projection Factors. Earned premium at manual level, by coverage, used as weights
(d) average of by-coverage Loss Projection Factors. Non-modelled incurred losses, by coverage, used as weights
* All deductibles combined.

NORTH CAROLINA
MOBILE HOMES INSURANCE - MH(F) PROGRAM
DETERMINATION OF TREND FOR EXPENSES

	ALL ITEMS (LESS ENERGY) CPI INDEX	COMPENSATION COST INDEX
Jul-10	220.3	
Aug-10	220.6	112.2
Sep-10	221.0	
Oct-10	221.2	
Nov-10	221.2	112.2
Dec-10	221.0	
Jan-11	221.7	
Feb-11	222.5	113.7
Mar-11	223.3	
Apr-11	223.8	
May-11	224.3	114.8
Jun-11	224.6	
Jul-11	225.0	
Aug-11	225.8	114.9
Sep-11	226.3	
Oct-11	226.8	
Nov-11	226.8	115.2
Dec-11	226.8	
Jan-12	227.4	
Feb-12	227.9	115.3
Mar-12	228.7	
Apr-12	229.3	
May-12	229.5	116.3
Jun-12	229.8	
Jul-12	229.8	
Aug-12	230.1	117.3
Sep-12	230.7	
Oct-12	231.2	
Nov-12	231.2	116.5
Dec-12	231.0	
Jan-13	231.7	
Feb-13	232.4	117.3
Mar-13	232.9	
Apr-13	233.1	
May-13	233.3	119.2
Jun-13	233.5	
Jul-13	233.6	
Aug-13	234.1	120.5
Sep-13	234.5	
Oct-13	234.9	
Nov-13	234.9	120.9
Dec-13	234.8	
Jan-14	235.2	
Feb-14	235.9	121.5
Mar-14	236.8	
Apr-14	237.4	
May-14	238.0	122.6
Jun-14	238.1	

NORTH CAROLINA
MOBILE HOMES INSURANCE - MH(F) PROGRAM
DETERMINATION OF TREND FOR EXPENSES

	All Items (A)	CCI (B)	Combined (C)
(1) Annual Change in indices based on exponential curve of best fit for the latest 48 points (or 16 quarters)	1.99%	2.30%	2.14%
(2) Annual Change in indices based on exponential curve of best fit for the latest 36 points (or 12 quarters)	1.81%	2.49%	2.15%
(3) Annual Change in indices based on exponential curve of best fit for the latest 24 points (or 8 quarters)	1.77%	3.00%	2.39%
(4) Annual Change in indices based on exponential curve of best fit for the latest 12 points (or 4 quarters)	2.12%	2.30%	2.21%

(5) Average Annual Index (D)

	All Items (A)	CCI (B)
Year Ended 12/31/2011	224.81	114.65
Year Ended 6/31/2012	227.51	115.43
Year Ended 12/31/2012	229.72	116.35
Year Ended 6/31/2013	231.73	117.58
Year Ended 12/31/2013	233.63	119.48
Year Ended 6/31/2014	235.69	121.38

(6) Current Cost Factor (Index Value Divided by Average Annual Index)

	All Items (A)	CCI (B)	Combined (C)
Year Ended 12/31/2011	1.059	1.069	1.064
Year Ended 6/31/2012	1.047	1.062	1.054
Year Ended 12/31/2012	1.037	1.054	1.045
Year Ended 6/31/2013	1.028	1.043	1.035
Year Ended 12/31/2013	1.019	1.026	1.023
Year Ended 6/31/2014	1.010	1.010	1.010

Selected Annual Change = 2.0% (based on Comp. Cost Index and CPI with and without energy)

Notes: (A) All items CPI index (urban, less energy). Source: Bureau of Labor Statistics.

(B) Total Compensation Cost Index - Insurance Carriers, Agent Brokers, and Service. Source: Bureau of Labor Statistics.

(C) Weighted Average determined as .50 (All items) + .50 (CCI).

(D) Average year ended index for period shown.

NORTH CAROLINA
MOBILE HOMES INSURANCE - MH(F) PROGRAM
DETERMINATION OF TREND FOR EXPENSES

	ALL ITEMS CPI INDEX	COMPENSATION COST INDEX
Jul-10	218.0	
Aug-10	218.3	112.2
Sep-10	218.4	
Oct-10	218.7	
Nov-10	218.8	112.2
Dec-10	219.2	
Jan-11	220.2	
Feb-11	221.3	113.7
Mar-11	223.5	
Apr-11	224.9	
May-11	226.0	114.8
Jun-11	225.7	
Jul-11	225.9	
Aug-11	226.5	114.9
Sep-11	226.9	
Oct-11	226.4	
Nov-11	226.2	115.2
Dec-11	225.7	
Jan-12	226.7	
Feb-12	227.7	115.3
Mar-12	229.4	
Apr-12	230.1	
May-12	229.8	116.3
Jun-12	229.5	
Jul-12	229.1	
Aug-12	230.4	117.3
Sep-12	231.4	
Oct-12	231.3	
Nov-12	230.2	116.5
Dec-12	229.6	
Jan-13	230.3	
Feb-13	232.2	117.3
Mar-13	232.8	
Apr-13	232.5	
May-13	232.9	119.2
Jun-13	233.5	
Jul-13	233.6	
Aug-13	233.9	120.5
Sep-13	234.1	
Oct-13	233.5	
Nov-13	233.1	120.9
Dec-13	233.0	
Jan-14	233.9	
Feb-14	234.8	121.5
Mar-14	236.3	
Apr-14	237.1	
May-14	237.9	122.6
Jun-14	238.3	

NORTH CAROLINA
MOBILE HOMES INSURANCE - MH(F) PROGRAM
DETERMINATION OF TREND FOR EXPENSES

	All Items (A)	CCI (B)	Combined (C)
(1) Annual Change in indices based on exponential curve of best fit for the latest 48 points (or 16 quarters)	2.05%	2.30%	2.18%
(2) Annual Change in indices based on exponential curve of best fit for the latest 36 points (or 12 quarters)	1.66%	2.49%	2.07%
(3) Annual Change in indices based on exponential curve of best fit for the latest 24 points (or 8 quarters)	1.67%	3.00%	2.34%
(4) Annual Change in indices based on exponential curve of best fit for the latest 12 points (or 4 quarters)	2.32%	2.30%	2.31%

(5) Average Annual Index (D)

Year Ended	12/31/2011	224.93	114.65
Year Ended	6/31/2012	227.56	115.43
Year Ended	12/31/2012	229.59	116.35
Year Ended	6/31/2013	231.35	117.58
Year Ended	12/31/2013	232.96	119.48
Year Ended	6/31/2014	234.97	121.38

(6) Current Cost Factor (Index Value Divided by Average Annual Index)

Year Ended	12/31/2011	1.060	1.069	1.064
Year Ended	6/31/2012	1.047	1.062	1.055
Year Ended	12/31/2012	1.038	1.054	1.046
Year Ended	6/31/2013	1.030	1.043	1.036
Year Ended	12/31/2013	1.023	1.026	1.025
Year Ended	6/31/2014	1.014	1.010	1.012

Selected Annual Change = 2.0% (based on Comp. Cost Index and CPI with and without energy)

Notes: (A) All items CPI index (urban). Source: Bureau of Labor Statistics.

(B) Total Compensation Cost Index - Insurance Carriers, Agent Brokers, and Service. Source: Bureau of Labor Statistics.

(C) Weighted Average determined as .50 (All items) + .50 (CCI).

(D) Average year ended index for period shown.

NORTH CAROLINA
MOBILE HOMES INSURANCE - MH(F) PROGRAM

EXPENSE DATA

All carriers:	2009	2010	2011	Average
Commission & Brokerage	6,585,699	6,134,399	6,873,570	
Written Premium including deviations	42,838,334	39,893,775	42,412,726	
Ratio:	0.1537	0.1538	0.1621	0.1565
Total Other Acquisitions	2,338,619	2,159,211	2,131,237	
Earned Premium excluding deviations	57,208,201	55,508,942	55,036,678	
Earned Premium at current manual level	57,706,872	55,508,942	55,036,678	
Ratio:	0.0405	0.0389	0.0387	0.0394
General Expense	1,884,357	1,520,933	1,574,420	
Earned Premium excluding deviations	57,208,201	55,508,942	55,036,678	
Earned Premium at current manual level	57,706,872	55,508,942	55,036,678	
Ratio:	0.0327	0.0274	0.0286	0.0296
Taxes, Licenses & Fees	1,051,833	1,233,517	1,126,629	
Written Premium including deviations	42,838,334	39,893,775	42,412,726	
Ratio:	0.0246	0.0309	0.0266	0.0274

	TERRITORY 1^	TERRITORY 2^	TERRITORY 3^	STATEWIDE
Profit and Contingencies	12.8%	10.8%	6.5%	10.0%
1.0 - (commision,tax,profit,conting.)	0.6881	0.7076	0.7515	0.7161
Compensation for Assessment Risk *	4.4%	4.4%	4.4%	4.4%

* in ratemaking exhibits, expressed as 4.4% of current base rate and loaded for commission and taxes
Territory 1^: Terr 5, 6, 42, 43
Territory 2^: Terr 32, 34, 41, 44, 45, 46, 47, 53
Territory 3^: Terr 36, 38, 39, 57, 60

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

EXPENSE EXHIBIT

All carriers:

	2007	2008	2009	2010	2011	Average
Allocated LAE	33,277	194,813	132,195	101,698	94,492	
Unallocated LAE	2,278,332	2,893,773	3,011,960	2,633,664	6,883,867	
Total LAE	2,311,609	3,088,586	3,144,155	2,735,362	6,978,359	
Incurred Losses	15,569,925	20,440,884	21,921,897	18,684,630	65,290,287	
Ratio: LAE/I.L.	0.148	0.151	0.143	0.146	0.107	0.139 (A)

(A) A selection of .146 was made by excluding the high and low years (2008 and 2011).

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

CALCULATION OF TRENDED EXPENSE RATIOS

(1) Factor for trending losses:

Owners:	1.075	*	1.050	*	1.012	=	1.142
Tenant:	1.019	*	1.012	*	1.004	=	1.035

(2) Factor for trending LAE based on Current Expense Index:

All Forms: $1.020^{(95.0\ /\ 12)} = 1.170$

(3) Factor for trending premiums

Owners:	1.125	*	1.057	=	1.189
Tenant:	0.988	*	0.996	=	0.984

(4) Factor for trending GE, OA expenses based on Current Expense Index:

All Forms: $1.020^{(77.0\ /\ 12)} = 1.135$

Owners:

Trended LAE Factor =	1 + (	0.1460	*	1.170	/	1.142	)	=	1.150
Trended GE Ratio =		0.0296	*	1.135	/	1.189		=	0.028
Trended OA Ratio =		0.0394	*	1.135	/	1.189		=	0.038
Average Current Base Rate								=	276.85
Fixed Expense Per Policy		276.85	* (	0.028	+	0.038	)	=	18.27

Tenant:

Trended LAE Factor =	1 + (	0.1460	*	1.170	/	1.035	)	=	1.165
Trended GE Ratio =		0.0296	*	1.135	/	0.984		=	0.034
Trended OA Ratio =		0.0394	*	1.135	/	0.984		=	0.045
Average Current Base Rate								=	142.10
Fixed Expense Per Policy		142.1	* (	0.034	+	0.045	)	=	11.23

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM
DERIVATION OF EXCESS FACTOR AFTER THE REMOVAL OF HURRICANE LOSSES

Year	(1)* Combined Reported Wind Losses	(2A)** Combined Reported Total Losses	(3)*** Total minus Wind (2B) - (1)	(4) Wind / Total minus Wind	(5) Capped Wind Ratio < (5 X med)	(6) Capped Excess Wind Ratio (5)-Ave(5)	(7) Capped Excess Wind Losses (3) x (6)	(8) Non-Modelled Excess Wind Ratio Above The Cap	(9) Excess Wind Losses Above The Cap (8) X (3)	(10) Total Non-Modelled Excess Wind Losses (7) + (9)
1950	1,388,467	312,200	312,200	0.088	0.088	0.000	0	0.000	0	0
1951	1,422,207	290,780	290,780	0.080	0.080	0.000	0	0.000	0	0
1952	1,440,159	792,365	792,365	0.216	0.216	0.032	25,356	0.000	0	25,356
1956	2,297,877	1,928,925	1,928,925	0.329	0.329	0.145	279,694	0.000	0	279,694
1957	2,117,102	839,255	839,255	0.156	0.156	0.000	0	0.000	0	0
1961	301,538	2,663,173	2,361,635	0.128	0.128	0.000	0	0.000	0	0
1962	272,921	3,126,852	2,853,931	0.096	0.096	0.000	0	0.000	0	0
1963	694,065	5,638,155	4,944,090	0.140	0.140	0.000	0	0.000	0	0
1964	607,512	6,064,576	5,457,064	0.111	0.111	0.000	0	0.000	0	0
1965	671,048	6,901,947	6,230,899	0.108	0.108	0.000	0	0.000	0	0
1966	719,568	8,005,594	7,286,026	0.099	0.099	0.000	0	0.000	0	0
1967	915,862	8,050,817	7,134,955	0.128	0.128	0.000	0	0.000	0	0
1968	498,227	10,627,905	10,129,678	0.049	0.049	0.000	0	0.000	0	0
1969	563,307	13,143,012	12,579,705	0.045	0.045	0.000	0	0.000	0	0
1970	2,479,513	17,038,702	14,559,189	0.170	0.170	0.000	0	0.000	0	0
1971	2,627,662	21,885,664	19,258,002	0.136	0.136	0.000	0	0.000	0	0
1972	1,260,381	21,914,689	20,654,308	0.061	0.061	0.000	0	0.000	0	0
1973	2,266,976	30,436,168	28,169,192	0.080	0.080	0.000	0	0.000	0	0
1974	9,401,408	43,362,415	33,961,007	0.277	0.277	0.093	3,158,374	0.000	0	3,158,374
1975	5,485,456	53,538,527	48,053,071	0.114	0.114	0.000	0	0.000	0	0
1976	2,972,442	52,540,898	49,568,456	0.060	0.060	0.000	0	0.000	0	0
1977	3,476,744	60,315,936	56,839,192	0.061	0.061	0.000	0	0.000	0	0
1978	10,628,669	70,467,546	59,838,877	0.178	0.178	0.000	0	0.000	0	0
1979	3,105,986	71,072,268	67,966,282	0.046	0.046	0.000	0	0.000	0	0
1980	6,474,397	106,691,350	100,216,953	0.065	0.065	0.000	0	0.000	0	0
1981	4,950,144	109,000,823	104,050,679	0.048	0.048	0.000	0	0.000	0	0
1982	9,654,141	118,487,782	108,833,641	0.089	0.089	0.000	0	0.000	0	0
1983	9,722,115	123,552,849	113,830,734	0.085	0.085	0.000	0	0.000	0	0
1984	21,436,988	140,713,231	119,276,243	0.180	0.180	0.000	0	0.000	0	0
1985	30,960,043	179,473,338	148,513,295	0.208	0.208	0.024	3,564,319	0.000	0	3,564,319
1986	16,262,975	157,609,675	141,346,700	0.115	0.115	0.000	0	0.000	0	0
1987	23,190,753	185,616,181	162,425,428	0.143	0.143	0.000	0	0.000	0	0
1988	66,411,702	243,501,978	177,090,276	0.375	0.375	0.191	33,824,243	0.000	0	33,824,243
1989	83,498,398	278,467,229	194,968,831	0.428	0.428	0.244	47,572,395	0.000	0	47,572,395
1990	37,671,988	220,252,894	182,580,906	0.206	0.206	0.022	4,016,780	0.000	0	4,016,780
1991	18,151,400	219,353,728	201,202,328	0.090	0.090	0.000	0	0.000	0	0
1992	26,654,935	222,532,035	195,877,100	0.136	0.136	0.000	0	0.000	0	0
1993	97,830,965	321,921,890	224,090,925	0.437	0.437	0.253	56,695,004	0.000	0	56,695,004
1994	28,862,821	278,066,775	249,203,954	0.116	0.116	0.000	0	0.000	0	0
1995	52,370,482	291,974,195	239,603,713	0.219	0.219	0.035	8,386,130	0.000	0	8,386,130
1996	40,901,941	332,747,529	291,845,588	0.140	0.140	0.000	0	0.000	0	0
1997	37,382,138	303,669,980	266,287,842	0.140	0.140	0.000	0	0.000	0	0
1998	120,075,356	394,840,091	274,764,735	0.437	0.437	0.253	69,515,478	0.000	0	69,515,478
1999	58,232,430	350,186,938	291,954,508	0.199	0.199	0.015	4,379,318	0.000	0	4,379,318
2000	2,638,389	16,567,551	13,929,162	0.189	0.189	0.005	69,646	0.000	0	69,646
2001	1,212,549	18,079,627	16,867,078	0.072	0.072	0.000	0	0.000	0	0
2002	2,186,891	19,163,073	16,976,182	0.129	0.129	0.000	0	0.000	0	0
2003	8,723,033	23,896,208	15,173,175	0.575	0.575	0.391	5,932,711	0.000	0	5,932,711
2004	2,423,276	17,677,162	15,253,886	0.159	0.159	0.000	0	0.000	0	0
2005	48,759,994	427,428,940	378,668,946	0.129	0.129	0.000	0	0.000	0	0
2006	94,077,678	496,085,897	402,008,219	0.234	0.234	0.050	20,100,411	0.000	0	20,100,411
2007	2,655,248	14,282,549	11,627,301	0.228	0.228	0.044	511,601	0.000	0	511,601
2008	5,258,658	18,637,634	13,378,976	0.393	0.393	0.209	2,796,206	0.000	0	2,796,206
2009	5,000,380	19,030,275	14,029,895	0.356	0.356	0.172	2,413,142	0.000	0	2,413,142
2010	4,275,270	17,217,172	12,941,902	0.330	0.330	0.146	1,889,518	0.000	0	1,889,518
2011	19,245,054	33,751,759	14,506,705	1.327	0.690	0.506	7,340,393	0.637	9,240,771	16,581,164
Total	1,044,767,628	6,211,436,706	5,175,334,890	10.933	10.296	2.830	272,470,717	0.637	9,240,771	281,711,488
Average				0.195	0.184	0.051		0.011		

Average of Column (5) =	0.184
Median value of Column (4)	0.138
Median * 5 =	0.690
Excess Factor = 1.0 + [(Avg(6) + Avg(8)) / (1.0 + Avg (5) - Avg(6))] =	1.055

* Dwelling E.C. Premiums for 1950-59.

** Dwelling E.C. Losses for 1950-59.

*** All Dwelling E.C. Losses for 1950-59 are assumed to be Wind Losses.
All Losses from 1960 to 1999, 2005, & 2006 reflect NC Homeowners experience.

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

METHODOLOGY FOR CALCULATING WIND PROVISIONS BY TERRITORY - OWNER FORMS

In order to develop Wind Provisions by territory*, the statewide provision is distributed using each territory's "expected" wind losses. This procedure is illustrated in the following example. (All hurricane losses accounted for by the model have been removed. Modeled hurricane losses are not included in this procedure):

Territory	(1) Long-Term** Ratio of Wind to Non-Wind Losses	(2) Non-Wind Losses for Latest Five Years	(3) "Expected" Wind Losses for Latest Five Years (1) x (2)	(4) "Expected" Wind Distribution (3) ÷ Total (3)
A	.250	$16,000,000	$4,000,000	.400
B	.200	6,000,000	1,200,000	.120
C	.600	8,000,000	4,800,000	.480
			Total 10,000,000	1.000

	(5)	(6)	(7)	(8)	(9)	(10)	(11)
		"Expected" Wind Distribution			Territory Wind Provision		
Year	Statewide Wind Provision***	Territory A	Territory B	Territory C	Territory A (5) x (6)	Territory B (5) x (7)	Territory C (5) x (8)
x	$4,000,000	.400	.120	.480	$1,600,000	$480,000	$1,920,000
x+1	1,000,000	.400	.120	.480	400,000	120,000	480,000
x+2	2,000,000	.400	.120	.480	800,000	240,000	960,000
x+3	3,000,000	.400	.120	.480	1,200,000	360,000	1,440,000
x+4	2,000,000	.400	.120	.480	800,000	240,000	960,000

* In calculating the five-year non-hurricane loss costs by territory shown in Column (1) of page C-4, actual non-modeled wind losses by territory are replaced with the losses arrived at using this procedure.

** Average of yearly ratios of non-modeled wind to non-wind losses based on territory experience for all available years.

*** Statewide Wind Provision = (Non Hurricane Incurred Losses - Excess Losses) x Excess Factor
- (Non Hurricane Losses - Non Hurricane Wind Losses)

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

MODELED HURRICANE LOSSES

Forms	Territory Group^	AIR Loss Cost Per $1,000	Estimated 2011 Total Limit Insurance Years (000)	Modeled Hurricane Losses*
Owners	1	5.3948	242,732	1,309,495
	2	1.1218	2,931,883	3,288,987
	3	0.2662	2,321,602	617,900
	Statewide			5,216,382
Tenant	1	2.6800	822	2,202
	2	0.4000	8,018	3,207
	3	0.0820	5,149	422
	Statewide			5,832

^Territory 1: Terr 5, 6, 42, 43

^Territory 2: Terr 32, 34, 41, 44, 45, 46, 47, 53

^Territory 3: Terr 36, 38, 39, 57, 60

* Modeled Hurricane Losses in this exhibit are at a $250 deductible basis.

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

DERIVATION OF MODELED BASE-CLASS LOSS COST

OWNERS

Territory Group*	Modeled Losses^	Latest-Yr House Years	Latest-Yr Avg. Rating Factor	Modeled BCLC
1	1,128,609	3,452	1.903	171.80
2	3,108,802	34,510	2.519	35.76
3	592,268	31,934	2.172	8.54

TENANT

Territory Group*	Modeled Losses^	Latest-Yr House Years	Latest-Yr Avg. Rating Factor	Modeled BCLC
1	1,992	40	0.984	50.39
2	2,922	389	1.025	7.33
3	405	249	1.092	1.49

*Territory 1: Territory 5, 6, 42, 43

*Territory 2: Territory 32, 34, 41, 44, 45, 46, 47, 53

*Territory 3: Territory 36, 38, 39, 57, 60

^ Modeled Hurricane Losses in this exhibit are adjusted to a reported deductible basis to be consistent with non-modeled experience. For unadjusted Modeled Hurricane Losses, please refer to page D-38.

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

DERIVATION OF STATEWIDE MODELED HURRICANE BASE-CLASS LOSS COST

	Owners	Tenant
a. Modeled Hurricane Losses*	4,936,137	5,418
b. Latest-Year Current Cost Factor	1.051	1.017
c. Loss Projection Factor	1.143	1.078
d. Loss Adjustment Expense Factor	1.150	1.165
e. Latest-Year House-Years	69,896	678
f. Latest-Year Average Rating Factor	2.325	1.047
g. Latest-Year Current Amount Factor	1.076	0.994
h. Premium Projection Factor	1.057	0.996
Modeled Base-Class Loss Cost = PRODUCT(a:d) / PRODUCT(e:h) =	36.93	9.84

* Modeled Hurricane Losses in this exhibit are adjusted to a reported deductible basis to be consistent with non-modeled experience.
For unadjusted Modeled Hurricane Losses, please refer to page D-38.

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

ACTUAL HURRICANE LOSSES (Excluded from Experience)^

TERRITORY GROUP*	YEAR	Owners	Tenants
1	2009	2,534	0
	2010	39,143	0
	2011	4,719,005	0
2	2009	46,070	0
	2010	105,943	0
	2011	18,441,183	5,667
3	2009	27,904	7
	2010	83,245	0
	2011	215,414	0
Statewide	2009	76,508	7
	2010	228,331	0
	2011	23,375,602	5,667

*Territory 1: Territory 5, 6, 42, 43

*Territory 2: Territory 32, 34, 41, 44, 45, 46, 47, 53

*Territory 3: Territory 36, 38, 39, 57, 60

^There are no actual hurricane losses for years 2007 & 2008.

DERIVATION OF NET REINSURANCE COST AT BASE-CLASS LEVEL

MH(F) Forms

Territory Group^	(1)* Reinsurance Cost	(2) Latest-Year Earned Premium	(3) Teritory Earned Premium	(4) Est'd Reins. Dollars =(1)×(2)/(3)	(5) Latest-Yr House Years	(6) Latest-Yr Avg. Rating Factor	(7) Latest-Yr CAF	(8) Prem. Proj. Factor	(9)** Variable Expense	(10) Reinsurance Cost, Base Class =[(4)/(5)]/[(6)×(7)×(8)]/[1-(9)]
				OWNERS						
1	1,992,229	2,232,960	2,239,681	1,986,251	3,452	1.903	1.076	1.057	0.312	386.35
2	6,318,481	23,647,494	23,703,340	6,303,595	34,510	2.519	1.076	1.057	0.292	90.10
3	1,154,748	18,869,762	18,907,853	1,152,421	31,934	2.172	1.076	1.057	0.248	19.44
Statewide	9,465,458	44,750,216	44,850,874	9,442,267	69,896	2.325	1.076	1.057	0.2839	71.34
				TENANT						
1	1,992,229	6,721	2,239,681	5,978	40	0.984	0.994	0.996	0.312	222.02
2	6,318,481	55,846	23,703,340	14,887	389	1.025	0.994	0.996	0.292	53.29
3	1,154,748	38,091	18,907,853	2,326	249	1.092	0.994	0.996	0.248	11.50
Statewide	9,465,458	100,658	44,850,874	23,191	678	1.047	0.994	0.996	0.2839	46.06

* From D. Appel's analysis

** Column (9), Variable Expense, represents the combined loading for Taxes, Commissions, Profit and Contingencies

^Territory 1: Terr 5, 6, 42, 43

^Territory 2: Terr 32, 34, 41, 44, 45, 46, 47, 53

^Territory 3: Terr 36, 38, 39, 57, 60

Note: There are some rounding differences in the calculations.

SECTION E
SUPPLEMENTAL MATERIAL

NORTH CAROLINA
MOBILEHOMES INSURANCE- MH-F

SUPPLEMENTAL MATERIAL

North Carolina G.S. 58-36-15(h) specifies that the following information must be included in all policy form, rule and rate filings filed under Article 12B. 11 NCAC 10.1105 specifies that additional detail be provided under each of these items. These materials are contained on the pages indicated.

STATISTICAL DATA TO COMPLY WITH NORTH CAROLINA
REQUIREMENTS FOR A MOBILEHOMES INSURANCE- MH-F-RATE FILING
AS PER 11 NCAC 10.1105

1. NORTH CAROLINA EARNED PREMIUMS AT THE ACTUAL AND CURRENT RATE LEVEL, LOSSES AND LOSS ADJUSTMENT EXPENSES, EACH ON PAID AND INCURRED BASES WITHOUT TRENDING OR OTHER MODIFICATION FOR THE EXPERIENCE PERIOD, INCLUDING THE LOSS RATIO ANTICIPATED AT THE TIME THE RATES WERE PROMULGATED FOR THE EXPERIENCE PERIOD

Exhibit (1)

NORTH CAROLINA
MOBILEHOMES INSURANCE- MH-F INSURANCE

EARNED PREMIUMS AT ACTUAL AND CURRENT RATE LEVEL

I. EARNED PREMIUM AT COLLECTED LEVEL

Year	Owners	Tenant
2007	$ 38,860,666	$ 134,597
2008	37,110,169	128,932
2009	35,435,544	130,217
2010	37,136,910	119,159
2011	40,261,710	117,983

II. EARNED PREMIUM AT CURRENT LEVEL

Year	Owners	Tenant
2007	$44,806,658	$ 116,415
2008	43,498,806	111,911
2009	40,956,205	113,187
2010	41,267,867	102,740
2011	44,750,216	100,658

NORTH CAROLINA
MOBILEHOMES INSURANCE- MH-F- INSURANCE

PAID/INCURRED LOSSES AND ALLOCATED LOSS ADJUSTMENT EXPENSE

I. PAID LOSSES

The Rate Bureau is advised by ISO that paid loss and loss adjustment expenses are not available for the experience period of this filing.

II. INCURRED LOSSES (a)

Year	Owners	Tenant
2007	$ 14,282,549	$ 50,338
2008	18,637,634	55,257
2009	19,106,783	28,068
2010	17,445,503	64,830
2011	57,127,361	20,327

(a) Incurred losses include actual hurricane losses and do not include loss adjustment expense. These expenses are reflected via a factor. For Owners this factor is 15.0%. For Tenant this factor is 16.5%.

NORTH CAROLINA
MOBILEHOMES INSURANCE- MH-F- INSURANCE

ANTICIPATED LOSS AND LOSS ADJUSTMENT EXPENSE RATIOS

The anticipated loss and LAE ratio included in the 2008 filing was 0.487.

NORTH CAROLINA
MOBILEHOMES INSURANCE- MH-F- INSURANCE

EXCLUDED COMPANIES

Data for the following companies are not available or not available in sufficient detail:

Windsor Mount Joy Insurance Company

Based on 2011 written premium, this company writes 4.6% of the total market.

-- Premium trend calculations are based on policies for which $250, $500, or $1,000 deductibles applied for owners and based on policies for which $250 or $500 deductibles applied for tenant. Based on 2007-2011 exposures, these deductible options accounted for 92% of all exposures.

-- Data included for these MH-F Insurance analyses excludes any data that uses inaccurate coding (deductible, wind exclusion, old territories, etc.). Data excluded for this reason make up about 3.4% and 0.4% of all owners and tenant exposures respectively.

House-years by year are as follows:

	Owners	Tenant
2007	83,154	777
2008	77,240	762
2009	69,756	760
2010	68,749	689
2011	69,896	678

Exhibit (1)(b)

Not applicable to Mobilehomes insurance.

Exhibit (1)(c)

NORTH CAROLINA
MOBILEHOMES INSURANCE- MH-F- INSURANCE

ADJUSTMENTS TO PREMIUMS, LOSSES, LOSS ADJUSTMENT EXPENSES,
EXPENSES AND EXPOSURES

Due to the volatile nature and the catastrophic potential of hurricane losses, they have been removed from the actual data and replaced with expected hurricane losses produced by a model designed by AIR Worldwide Corporation (AIR). Also see prefiled testimony of R. Curry, B. Donlan, and R. Newbold.

NORTH CAROLINA
MOBILEHOMES INSURANCE- MH-F- INSURANCE

EARNED PREMIUM AT PRESENT RATES CALCULATION

Earned premium at present rates is calculated by the following formula for each individual insured:

(R -T - D) x C where,

R = base deductible manual rate for given policy limit and coverage option
T = applicable tie-down credit
D= applicable deductible credit
C = Optional Coverage Factor

The results are then summed over all territories to generate aggregate earned premium at present rates.

A sample calculation for the owners form for a single insured is shown below. This sample policy is for a coverage limit of $25,000, no tie-down, $250 higher optional deductible.

(1)	Base Deductible rate for $25,000	$ 322
(2)	Tie-down credit	$ 0
(3)	Credit for $250 Deductible*	$ 50
(4)	Optional Coverage Factor	1.0783
(5)	Premium at Manual Level = [(1) - (2) - (3)] x (4)	$ 293.30
	* 20% of (1) subject to $50 maximum	

EXHIBIT (1) (e)

Company Name	2011 (a) Written Premium	2011 Written Premium Market Share		2011 (a) Earned Premium	2011 Earned Premium Market Share
American Family Home Insurance Company	13,285,841	31.33%		13,105,736	30.74%
State Farm Fire & Casualty Company	9,441,697	22.26%		9,304,964	21.83%
North Carolina Farm Bureau Mutual Insurance Company	7,304,530	17.22%		7,401,358	17.36%
Allstate Insurance Company	6,178,445	14.57%		7,110,449	16.68%
American Bankers Insurance Company of Florida	2,739,557	6.46%		2,456,015	5.76%
Windsor Mount Joy Mutual Insurance Company	1,944,590	4.58%		1,877,117	4.40%
Erie Insurance Exchange	1,517,994	3.58%		1,374,108	3.22%
Nationwide Mutual Fire Insurance Company	72	0.00%		535	0.00%
Aegis Security Insurance Company	-	0.00%		-	0.00%
Total	$ 42,412,726	100.00%	$	42,630,282	100.00%
Grand Total	42,412,726			42,630,282	

(a) Per the 2011 MH(F) Expense Experience
Note: Only companies that report MH(F) in NC are included.

Not applicable to Mobilehomes insurance.

NORTH CAROLINA
MOBILEHOMES -MH-F- INSURANCE
LOSSES AND LOSS ADJUSTMENT EXPENSE

The data requested by 11 NCAC 10.1105(1)(i)(i,ii) were not being collected or reported in the experience period. The response to 11 NCAC 10.1105(1), page E-4, provides incurred loss and loss adjustment expense information. The response to 11 NCAC 10.1105(1)(1) provides incurred data by cause of loss. Additional information concerning loss development is provided in the response to 11 NCAC 10.1105(3). Additional information concerning loss adjustment expenses is provided in the response to 11 NCAC 10.1105(7). Additional information concerning loss trend is provided in Section D and in the prefiled testimony of R. Curry and B. Donlan.

(iii)

Year	Owners Applied Loss Development Factor	Tenant Applied Loss Development Factor
2007	1.000	1.000
2008	1.000	1.000
2009	1.000	1.000
2010	1.000	1.000
2011	1.000	1.000

(iv)

Year	Owners Loss Adjustment Expense Percentage	Tenant Loss Adjustment Expense Percentage
2007	14.8%	14.8%
2008	15.1%	15.1%
2009	14.3%	14.3%
2010	14.6%	14.6%
2011	10.7%	10.7%

(v)

Year	Owners Applied Loss Trend Factor	Tenant Applied Loss Trend Factor
2007	1.271	1.110
2008	1.249	1.106
2009	1.231	1.100
2010	1.222	1.106
2011	1.204	1.097

(vi)

	Owners Trended Incurred Losses and LAE	Tenant Trended Incurred Losses and LAE
2007	$ 28,524,480	$ 73,293
2008	30,958,576	78,992
2009	31,272,227	43,751
2010	29,155,785	90,642
2011	31,903,066	25,652

(vii) This information is given in the response to 11 NCAC 10.1105(1), page E-5**.**

Not applicable to Mobilehomes insurance.

See prefiled testimony of R. Curry, B. Donlan, and R. Newbold.

NORTH CAROLINA
MOBILEHOMES-MH-F- INSURANCE

CAUSE OF LOSS DATA

Loss experience by cause of loss is provided on the attached Exhibit (1)(1).

North Carolina Mobilehomes
Statewide Cause of Loss

MH-F Program

Coverage	COL	Year	Incurred Losses	Incurred Claims	Pure Premium	Frequency	Severity
OWNERS							
	1-FIRE						
		2007	6,213,856	781	74.73	0.94%	7956.28
		2008	6,799,659	874	88.03	1.13%	7779.93
		2009	6,685,412	731	95.84	1.05%	9145.57
		2010	5,297,760	860	77.06	1.25%	6160.19
		2011	7,317,651	851	104.69	1.22%	8598.88
	2-WIND						
		2007	2,655,248	1,361	31.93	1.64%	1950.95
		2008	5,258,658	2,180	68.08	2.82%	2412.23
		2009	5,030,422	1,764	72.11	2.53%	2851.71
		2010	4,337,858	1,591	63.10	2.31%	2726.50
		2011	41,563,289	9,028	594.64	12.92%	4603.82
	3-THEFT						
		2007	1,162,387	671	13.98	0.81%	1732.32
		2008	1,412,743	723	18.29	0.94%	1954.00
		2009	1,536,563	767	22.03	1.10%	2003.34
		2010	1,442,629	677	20.98	0.98%	2130.91
		2011	1,539,153	762	22.02	1.09%	2019.89
	4-WATER						
		2007	2,927,361	1,150	35.20	1.38%	2545.53
		2008	3,618,467	1,159	46.85	1.50%	3122.06
		2009	4,062,590	1,241	58.24	1.78%	3273.64
		2010	4,203,449	1,155	61.14	1.68%	3639.35
		2011	3,575,350	904	51.15	1.29%	3955.03
	5-OPD						
		2007	719,547	432	8.65	0.52%	1665.62
		2008	1,208,344	496	15.64	0.64%	2436.18
		2009	1,375,118	661	19.71	0.95%	2080.36
		2010	1,867,726	807	27.17	1.17%	2314.41
		2011	2,789,581	883	39.91	1.26%	3159.21
	6-LIABILITY						
		2007	604,150	169	7.27	0.20%	3574.85
		2008	334,572	133	4.33	0.17%	2515.58
		2009	416,457	130	5.97	0.19%	3203.52
		2010	296,081	117	4.31	0.17%	2530.61
		2011	342,337	122	4.90	0.17%	2806.04
	7-CREDIT CARD						
		2008	5,191	1	0.13	0.00%	5191.00
		2009	221	1	0.01	0.00%	221.00

North Carolina Mobilehomes
Statewide Cause of Loss

MH-F Program

Coverage	COL	Year	Incurred Losses	Incurred Claims	Pure Premium	Frequency	Severity
TENANTS							
	1-FIRE						
		2007	24,723	3	66.46	0.81%	8241.00
		2008	31,678	3	88.73	0.84%	10559.33
		2009	2,158	2	7.32	0.68%	1079.00
		2010	52,307	6	81.22	0.93%	8717.83
		2011	405	1	1.63	0.40%	405.00
	2-WIND						
		2007	1,093	1	2.70	0.25%	1093.00
		2010	645	1	1.70	0.26%	645.00
		2011	6,933	2	17.82	0.51%	3466.50
	3-THEFT						
		2007	8,898	6	12.39	0.84%	1483.00
		2008	22,085	9	31.42	1.28%	2453.89
		2009	11,736	9	16.62	1.27%	1304.00
		2010	11,878	8	18.44	1.24%	1484.75
		2011	7,303	7	11.45	1.10%	1043.29
	4-WATER						
		2008	300	1	0.74	0.25%	300.00
		2009	1,010	1	3.42	0.34%	1010.00
		2011	5,686	2	8.91	0.31%	2843.00
	5-OPD						
		2007	4,001	1	12.78	0.32%	4001.00
		2009	3,314	2	4.69	0.28%	1657.00
	6-LIABILITY						
		2007	11,623	1	37.13	0.32%	11623.00
		2008	1,194	1	2.95	0.25%	1194.00
		2009	9,850	5	13.95	0.71%	1970.00

North Carolina Mobilehomes
Cause of Loss by Territory Group

MH-F Program

Coverage	Territory Group	COL	Year	Incurred Losses	Incurred Claims	Pure Premium	Frequency	Severity
OWNERS								
	1							
		1-FIRE						
			2007	445,178	44	51.63	0.51%	10117.68
			2008	464,151	25	73.99	0.40%	18566.04
			2009	454,087	26	110.83	0.63%	17464.88
			2010	131,502	21	34.28	0.55%	6262.00
			2011	662,836	40	192.02	1.16%	16570.90
		2-WIND						
			2007	141,266	50	16.38	0.58%	2825.32
			2008	239,990	74	38.26	1.18%	3243.11
			2009	123,539	45	30.15	1.10%	2745.31
			2010	426,782	112	111.26	2.92%	3810.55
			2011	4,870,090	783	1410.80	22.68%	6219.78
		3-THEFT						
			2007	55,604	33	6.45	0.38%	1684.97
			2008	30,451	17	4.85	0.27%	1791.24
			2009	32,320	15	7.89	0.37%	2154.67
			2010	45,332	12	11.82	0.31%	3777.67
			2011	34,813	13	10.08	0.38%	2677.92
		4-WATER						
			2007	251,833	85	29.20	0.99%	2962.74
			2008	228,355	70	36.40	1.12%	3262.21
			2009	170,222	44	41.55	1.07%	3868.68
			2010	212,964	55	55.52	1.43%	3872.07
			2011	246,196	40	71.32	1.16%	6154.90
		5-OPD						
			2007	25,994	11	3.01	0.13%	2363.09
			2008	27,289	3	4.35	0.05%	9096.33
			2009	38,574	11	9.42	0.27%	3506.73
			2010	137,424	41	35.82	1.07%	3351.80
			2011	739,192	91	214.13	2.64%	8122.99
		6-LIABILITY						
			2007	65,923	7	7.65	0.08%	9417.57
			2008	18,431	9	2.94	0.14%	2047.89
			2009	3,000	3	0.73	0.07%	1000.00
			2010	5,047	6	1.32	0.16%	841.17
			2011	3,107	4	0.90	0.12%	776.75
		7-CREDIT CARD						
			2008	300	1	0.05	0.02%	300.00
	2							
		1-FIRE						
			2007	3,765,435	389	102.31	1.06%	9679.78
			2008	3,381,439	456	96.75	1.30%	7415.44
			2009	3,367,234	347	104.64	1.08%	9703.84
			2010	3,210,919	444	97.34	1.35%	7231.80
			2011	4,012,178	417	116.26	1.21%	9621.53
		2-WIND						
			2007	888,182	474	24.13	1.29%	1873.80
			2008	2,653,392	1,199	75.92	3.43%	2213.00
			2009	2,356,130	949	73.22	2.95%	2482.75
			2010	2,330,332	892	70.64	2.70%	2612.48
			2011	26,934,589	5,835	780.49	16.91%	4616.04

North Carolina Mobilehomes
Cause of Loss by Territory Group

MH-F Program

Coverage	Territory Group	COL	Year	Incurred Losses	Incurred Claims	Pure Premium	Frequency	Severity
		3-THEFT						
			2007	673,015	371	18.29	1.01%	1814.06
			2008	873,915	437	25.00	1.25%	1999.81
			2009	954,534	472	29.66	1.47%	2022.32
			2010	905,804	402	27.46	1.22%	2253.24
			2011	1,043,613	508	30.24	1.47%	2054.36
		4-WATER						
			2007	1,115,447	486	30.31	1.32%	2295.16
			2008	1,460,727	514	41.79	1.47%	2841.88
			2009	1,598,399	525	49.67	1.63%	3044.57
			2010	2,189,385	602	66.37	1.82%	3636.85
			2011	1,790,977	461	51.90	1.34%	3884.98
		5-OPD						
			2007	345,185	209	9.38	0.57%	1651.60
			2008	618,799	265	17.71	0.76%	2335.09
			2009	571,580	289	17.76	0.90%	1977.79
			2010	909,075	414	27.56	1.26%	2195.83
			2011	1,109,387	493	32.15	1.43%	2250.28
		6-LIABILITY						
			2007	311,176	78	8.45	0.21%	3989.44
			2008	78,624	55	2.25	0.16%	1429.53
			2009	271,223	73	8.43	0.23%	3715.38
			2010	82,640	47	2.51	0.14%	1758.30
			2011	213,930	65	6.20	0.19%	3291.23
		7-CREDIT CARD						
			2008	4,891	0	0.14	0.00%	#DIV/0!
			2009	221	1	0.01	0.00%	221.00
	3							
		1-FIRE						
			2007	2,003,243	348	53.10	0.92%	5756.45
			2008	2,954,069	393	82.02	1.09%	7516.72
			2009	2,864,091	358	85.55	1.07%	8000.25
			2010	1,955,339	395	61.25	1.24%	4950.23
			2011	2,642,637	394	82.75	1.23%	6707.20
		2-WIND						
			2007	1,625,800	837	43.09	2.22%	1942.41
			2008	2,365,276	907	65.67	2.52%	2607.80
			2009	2,550,753	770	76.19	2.30%	3312.67
			2010	1,580,744	587	49.51	1.84%	2692.92
			2011	9,758,610	2,410	305.59	7.55%	4049.22
		3-THEFT						
			2007	433,768	267	11.50	0.71%	1624.60
			2008	508,377	269	14.11	0.75%	1889.88
			2009	549,709	280	16.42	0.84%	1963.25
			2010	491,493	263	15.39	0.82%	1868.79
			2011	460,727	241	14.43	0.75%	1911.73
		4-WATER						
			2007	1,560,081	579	41.35	1.53%	2694.44
			2008	1,929,385	575	53.57	1.60%	3355.45
			2009	2,293,969	672	68.52	2.01%	3413.64
			2010	1,801,100	498	56.41	1.56%	3616.67
			2011	1,538,177	403	48.17	1.26%	3816.82

North Carolina Mobilehomes
Cause of Loss by Territory Group

MH-F Program

Coverage	Territory Group	COL	Year	Incurred Losses	Incurred Claims	Pure Premium	Frequency	Severity
		5-OPD						
			2007	348,368	212	9.23	0.56%	1643.25
			2008	562,256	228	15.61	0.63%	2466.04
			2009	764,964	361	22.85	1.08%	2119.01
			2010	821,227	352	25.72	1.10%	2333.03
			2011	941,002	299	29.47	0.94%	3147.16
		6-LIABILITY						
			2007	227,051	84	6.02	0.22%	2702.99
			2008	237,517	69	6.59	0.19%	3442.28
			2009	142,234	54	4.25	0.16%	2633.96
			2010	208,394	64	6.53	0.20%	3256.16
			2011	125,300	53	3.92	0.17%	2364.15
TENANTS								
	1							
		1-FIRE						
			2007	323	1	5.47	1.69%	323.00
			2008	379	1	6.42	1.69%	379.00
	2							
		1-FIRE						
			2010	10,889	2	28.66	0.53%	5444.50
		2-WIND						
			2007	1,093	1	2.70	0.25%	1093.00
			2010	645	1	1.70	0.26%	645.00
			2011	6,933	2	17.82	0.51%	3466.50
		3-THEFT						
			2007	6,010	3	14.84	0.74%	2003.33
			2008	11,634	7	28.73	1.73%	1662.00
			2009	8,741	6	21.27	1.46%	1456.83
			2010	10,956	7	28.83	1.84%	1565.14
			2011	4,446	5	11.43	1.29%	889.20
		4-WATER						
			2008	300	1	0.74	0.25%	300.00
			2011	4,000	1	10.28	0.26%	4000.00
		5-OPD						
			2009	2,513	1	6.11	0.24%	2513.00
		6-LIABILITY						
			2008	1,194	1	2.95	0.25%	1194.00
			2009	2,000	2	4.87	0.49%	1000.00
	3							
		1-FIRE						
			2007	24,400	2	77.96	0.64%	12200.00
			2008	31,299	2	105.03	0.67%	15649.50
			2009	2,158	2	7.32	0.68%	1079.00
			2010	41,418	4	156.89	1.52%	10354.50
			2011	405	1	1.63	0.40%	405.00
		3-THEFT						
			2007	2,888	3	9.23	0.96%	962.67
			2008	10,451	2	35.07	0.67%	5225.50
			2009	2,995	3	10.15	1.02%	998.33
			2010	922	1	3.49	0.38%	922.00
			2011	2,857	2	11.47	0.80%	1428.50
		4-WATER						
			2009	1,010	1	3.42	0.34%	1010.00
			2011	1,686	1	6.77	0.40%	1686.00

North Carolina Mobilehomes
Cause of Loss by Territory Group

MH-F Program

Coverage	Territory Group	COL	Year	Incurred Losses	Incurred Claims	Pure Premium	Frequency	Severity
		5-OPD						
			2007	4,001	1	12.78	0.32%	4001.00
			2009	801	1	2.72	0.34%	801.00
		6-LIABILITY						
			2007	11,623	1	37.13	0.32%	11623.00
			2009	7,850	3	26.61	1.02%	2616.67

STATISTICAL DATA TO COMPLY WITH NORTH CAROLINA
REQUIREMENTS FOR A MOBILEHOMES-MH-F- RATE FILING
AS PER 11 NCAC 10.1105

2. CREDIBILITY FACTOR DEVELOPMENT AND APPLICATION

The credibility procedures used in MH-F ratemaking are the same as have been used in recent Homeowners insurance rate filings. These procedures are described below.

The statewide credibility procedure is based on the 'frequency with severity modification' model discussed in "Credibility of the Pure Premium" by Mayerson, Bowers and Jones. The full credibility standard is based on a normal distribution with a 90% probability of meeting the test and a 5% maximum departure from the expected value, translated to house year standards. Partial credibility (Zp) is calculated as follows:

$$Z_p = \sqrt{\text{five year house years / full credibility standard}} \text{ (truncated to the nearest tenth)}$$

The full credibility standard is 240,000 house years for the Homeowners Owners Forms and 285,000 house-years for the Tenant form. These standards have been used for the development the statewide and by-territory indications for MH-F.

To distribute the statewide change by territory, a credibility procedure was used on the non-hurricane loss costs. The credibility standard used was based on the same model as statewide credibility. The full credibility standard is based on a normal distribution with a 90% probability of meeting the test and a 10% maximum departure from the expected value, translated to house years. The full credibility standards are 60,000 for Homeowners Owners' Forms and 75,000 for the Tenant Form. These standards have been used for the development the indications by territory for MH-F. Partial credibility (Zp) is calculated using the square root rule:

$$Z_p = \sqrt{\text{five year house years / full credibility standard}} \text{ (truncated to the nearest tenth)}$$

The Rate Bureau has not considered alternative credibility procedures in the last three years.

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See Section D and prefiled testimony of R. Curry and B. Donlan.

3. LOSS DEVELOPMENT FACTOR DERIVATION AND APPLICATION ON BOTH PAID AND INCURRED BASES AND IN BOTH NUMBERS AND DOLLARS OF CLAIMS

(a)-(g) Not applicable to Mobilehomes insurance.

STATISTICAL DATA TO COMPLY WITH NORTH CAROLINA
REQUIREMENTS FOR A MOBILEHOMES-MH-F- RATE FILING
AS PER 11 NCAC 10.1105

4. TRENDING FACTOR DEVELOPMENT AND APPLICATION

(a) See Section D and prefiled testimony of R. Curry and B. Donlan. The Rate Bureau has not considered alternative loss trend methodologies in the last three years.

(b) See prefiled testimony of R. Curry and B. Donlan.

(c) Not applicable for Mobilehomes insurance.

STATISTICAL DATA TO COMPLY WITH NORTH CAROLINA
REQUIREMENTS FOR A MOBILEHOMES-MH-F- RATE FILING
AS PER 11 NCAC 10.1105

5. CHANGES IN PREMIUM BASE RESULTING FROM RATING EXPOSURE TRENDS

(a) See Section D and prefiled testimony of R. Curry and B. Donlan. The Rate Bureau has not considered alternative exposure trend methodologies in the last three years.

(b) Not applicable to Mobilehomes insurance.

6. LIMITING FACTOR DEVELOPMENT AND APPLICATION

Limitations were applied to the territorial rate changes. The filed overall rate level change for territory group 1 (Territory 5, 6, 42, and 43), group 2 (Territory 32, 34, 41, 44, 45, 46, 47, and 53), group 3 (Territory 36, 38, 39, 57, and 60) were selected at +75%, +30%, and 0% respectively.

STATISTICAL DATA TO COMPLY WITH NORTH CAROLINA
REQUIREMENTS FOR A MOBILEHOMES-MH-F- RATE FILING
AS PER 11 NCAC 10.1105

7. OVERHEAD EXPENSE DEVELOPMENT AND APPLICATION OF COMMISSION AND BROKERAGE, OTHER ACQUISITION EXPENSES, GENERAL EXPENSES, TAXES, LICENSES, AND FEES

(a) Exhibit (7)(a) provides all information relating to expense provisions contained in the filing. The Rate Bureau has not considered alternative expense trend methodologies in the last three years.

(b) Not applicable to Mobilehomes insurance.

(c) Not applicable to Mobilehomes insurance.

Exhibit 7 (a)

The following provides a description of the derivation of Mobilehomes MH-F expense provisions. The underlying expense data are provided by the North Carolina Rate Bureau and are displayed on pages D-33-34.

The filed expense provision methodology makes a distinction between those provisions which require trending and those that do not. For example, since commission and brokerage, and taxes, licenses and fees vary directly with premium, no additional trend is required. In contrast, general expense, other acquisition expense, and loss adjustment expense do not vary directly with premium and are subject to trend.

The filed provision for commission and brokerage expenses and the filed provision for taxes, licenses, and fees are based on the data shown on page D-33 for the latest three years.

Since the general expense and other acquisition expense percentages are relative to earned premiums and the loss adjustment expense percentage is relative to losses, separate trend factors are required for premiums, losses, and expenses. The following describes the calculation of the trended expense provisions used for the MH-F Owners form.

General Expense and Other Acquisition Expense - Based on the 2009-2011 experience on page D-33, general expense averages 2.96% of earned premium and other acquisition expense averages 3.94% of earned premium. The average date of payment of the 2009-2011 expenses is 7/1/2010. Similarly, the average date represented in the 2009-2011 premiums is 7/1/2010. Since the average date of payment of the expenses on these policies is 18 months after the assumed effective date of 6/1/2015, or 12/1/2016, the historical general and other acquisition expense ratios need to be trended to the 12/1/2016 level.

The trend factor for the expenses represented in the numerator is based on the indices displayed on pages D-29 - D-32. This index is constructed by weighting the Compensation Cost Index with Consumer Price Index. These two sources receive equal weights. Based on these data, an average annual change of 2.0% is selected. This average annual change is projected 77 months (from 7/1/2010 to 12/1/2016). The premiums in the denominator are projected 71 months (from 1/1/2011 to 12/1/2016).

To trend the premiums in the denominator, two multiplicative factors are applied. The first is the 2011 Current Amount Factor shown on page D-28. The second is the Premium Projection Factor shown on page D-28.

Once the percentage provision for general and other acquisition expenses is trended, it is converted to a corresponding dollar value which can be incorporated into the pure-premium ratemaking methodology utilized in this filing. The dollar value is obtained by multiplying the trended percentage by the trended average rate at current-manual level. Distinct dollar values are generated for the Owners and Tenant forms.

Loss Adjustment Expense - Based on the 2007-2011 experience shown on page D-35, loss adjustment expenses (both allocated and unallocated) average 15.0% and 16.5% of incurred losses for owners and tenant respectively, after excluding the high- and low-valued years. The average date of loss in these data is 7/1/2009.
Both the numerator and denominator are trended 95.0 months, from 7/1/2009 to 6/1/2017 (24 months beyond the anticipated effective date of 6/1/2015).

The trend factor used for expenses in the numerator is determined in a similar way as for general and other acquisition expenses. The 2.0% selected average annual change is projected 95.0 months (from 7/1/2009 to 6/1/2017).

To trend the losses in the denominator, quantities that are calculated in the loss trend procedure are used. Several factors are applied. To adjust losses from the 7/1/2009 (average) level to 5/15/2014, the Current Cost Factor for 2011 shown on page D-28 is applied. To project losses from 5/15/2014 to 6/1/2017 (24 months beyond the assumed effective date) the Loss Projection Factor shown on page D-28 and the First Dollar factor shown on page D-28 are applied.

For the MH-F tenant coverage, the procedure for deriving the trended expense provisions is completely analogous to the procedure described above.

No alternate expense trend methodology has been considered within the last three years

STATISTICAL DATA TO COMPLY WITH NORTH CAROLINA
REQUIREMENTS FOR A MOBILEHOMES-MH-F- RATE FILING
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8. PERCENT RATE CHANGE

The overall statewide rate change by coverage is shown on page A-1. The statewide rate changes are applied uniformly by coverage amount and deductible.

The proposed rate changes have been calculated based on an assumed effective date of 6/1/2015 and an assumption that the rates will be in effect for three years. The effective date requested in the filing is 8/1/2015. If the actual implementation date of the new rates is later than the requested effective date, that change will affect the proposed rate changes because such a change will affect all of the trending periods used in the filing and a change in the trending periods will affect all of the losses, fixed expenses, and premiums used in the calculation of the rate level indications.

If the effective date were to be changed, advance notice of 120 days is required for an orderly implementation of the change in rates.

9. FINAL PROPOSED RATES

The proposed rates are shown in Section B.

STATISTICAL DATA TO COMPLY WITH NORTH CAROLINA
REQUIREMENTS FOR A MOBILEHOMES-MH-F- RATE FILING
AS PER 11 NCAC 10.1105

10. INVESTMENT EARNINGS, CONSISTING OF INVESTMENT INCOME AND REALIZED PLUS UNREALIZED CAPITAL GAINS, FROM LOSS, LOSS EXPENSE AND UNEARNED PREMIUM RESERVES

(a) See attached Exhibit (10)(a) and the prefiled testimony of R. Curry and D. Appel. This information is available for five calendar years.

(b) Not applicable to Mobilehomes insurance.

(c) Not applicable to Mobilehomes insurance.

NORTH CAROLINA
MOBILE HOMES INSURANCE - MH-F PROGRAM

ESTIMATED INVESTMENT EARNINGS ON UNEARNED PREMIUM RESERVES AND ON LOSS RESERVES

A.	Unearned Premium Reserve			
	1.	Direct Earned Premium for Accident Year Ended 12/31/12		834,423,626
	2.	Mean Unearned Premium Reserve (1) x	0.5334	445,081,562
	3.	Deduction for Prepaid Expenses		
		Commission and Brokerage		15.77%
		Taxes, Licenses and Fees		2.55%
		1/2 General Expenses		2.02%
		1/2 Other Acquisition		2.71%
		Total		23.05%
	4.	(2) x (3)		102,591,300
	5.	Net Subject to Investment (2) - (4)		342,490,262
B.	Delayed Remission of Premium (Agents' Balances)			
	1.	Direct Earned Premium (A-1)		834,423,626
	2.	Average Agents' Balances		0.155
	3.	Delayed Remission (1) x (2)		129,335,662
C.	Loss Reserve			
	1.	Direct Earned Premium (A-1)		834,423,626
	2.	Expected Incurred Losses and Loss Adjustment Expense (1) x	0.6323	527,606,059
	3.	Expected Mean Loss Reserves (2) x	0.416	219,484,121
D.	Net Subject to Investment (A-5)-(B-3)+(C-3)			432,638,721
E.	Average Rate of Return			3.49%
F.	Investment Earnings on Net Subject to Investment (D) x (E)			15,099,091
G.	Average Rate of Return as a Percent of Direct Earned Premium (F) / (A-1)			1.81%
H.	Average Rate of Return as a Percent of Direct Earned Premium after Federal Income Taxes (G) x		0.760	1.38%

NORTH CAROLINA
MOBILE HOMES INSURANCE - MH-F PROGRAM

ESTIMATED INVESTMENT EARNINGS ON UNEARNED
PREMIUM RESERVES AND ON LOSS RESERVES

EXPLANATORY NOTES

Line A-1
Direct earned premiums are the Homeowners earned premiums for companies writing Mobilehomes insurance in North Carolina; from page 15 of the Annual Statement.

Line A-2
The mean unearned premium reserve is determined by multiplying the direct earned premiums in line (1) by the ratio of the mean unearned premium reserve to the collected earned premium for calendar year ended 12/31/12. These data are from Page 15 of the Annual Statement and represent North Carolina Homeowners data for companies writing mobilehomes insurance.

1. Collected Earned Premium for Calendar Year ended 12/31/12	$834,423,626
2. Unearned Premium Reserve as of 12/31/11	441,138,851
3. Unearned Premium Reserve as of 12/31/12	449,025,291
4. Mean Unearned Premium Reserve 1/2 [(2) + (3)]	445,082,071
5. Ratio (4) ÷ (1)	0.5334

Line A-3
Deduction for prepaid expenses:
Production costs and a large part of the other company expenses in connection with the writing and handling of Mobile Homes policies, exclusive of claim adjustment expenses, are incurred when the policy is written and before the premium is paid. The deduction for these expenses is determined from Mobilehomes data provided by the NCRB for the year ended 12/31/12.

Line B-2
Delayed remission of premium:
This deduction is necessary because of delay in remission and collection of premium to the companies, which amounts to approximately 50-75 days after the effective dates of the policies. Therefore, funds for the unearned premium reserve required during the initial days of all policies must be taken from the company's surplus.

1. Agents' balances for premiums due less than 90 days as a ratio to net written premium (based on data for all companies writing Mobile Homes insurance in North Carolina)	15.14%
2. Factor to include effect of agents' balances or uncollected premiums overdue for more than 90 days (based on data provided by A. M. Best)	1.022
3. Factor for agents' balances (1) x (2)	0.155

Line C-2

The expected loss and loss adjustment expense ratio reflects the Mobilehomes expense provisions for the year ended 12/31/12.

Line C-3

The mean loss reserve is determined by multiplying the incurred losses in line (2) by the North Carolina ratio of the mean loss reserves to the incurred losses in 2012. This ratio is based on North Carolina companies' Homeowners Page 15 annual statement data (for companies writing Mobilehomes) and has been adjusted to include loss adjustment expense reserves.

1. Incurred Losses for Calendar Year 2012	451,667,160
2. Loss Reserves as of 12/31/11	196,884,849
3. Loss Reserves as of 12/31/12	154,426,509
4. Mean Loss Reserve 2012: 1/2 [(2) + (3)]	175,655,679
5. Ratio (4) ÷ (1)	0.389
6. Ratio of LAE Reserves to Loss Reserves (a)	0.238
7. Ratio of Incurred LAE to Incurred Losses (a)	0.158
8. Loss and LAE Reserve [(5)x(1.0+(6))/(1.0+(7))]	0.416

(a) Based on 2012 All-Industry Insurance Expense Exhibit (source: A.M. Best)

Line E

The rate of return is the ratio of net investment income earned to mean cash and invested assets. Net investment income is computed for all companies writing Mobile Homes insurance in North Carolina as follows:

Year	Net Investment Income Earned	Mean Cash and Invested Assets	Rate of Return
2012	2,508,045,683	71,959,082,978	3.49%

Line H

The average rate of Federal income tax was determined by applying the average tax rate for net investment income and the current tax rate applicable to realized capital gains (or losses) to the rates of return as calculated above.

	Rate of Return	Federal Income Tax Rate
Net Investment Income Earned	3.49%	0.229

The average rate of Federal income tax was determined by applying current tax rates to the distribution of investment income earned for all companies. These data are for 2012 from Best's Aggregates and Averages, Underwriting and Investment Exhibit, Part 1, Column 8.

Bonds	Taxable	24,976,829	0.350
	Non-Taxable	12,612,176	-
	Sub-Total	37,589,005	0.233
Stocks	Taxable (a)	5,584,133	0.105
	Non-Taxable	562,545	-
	Sub-Total	6,146,678	0.095
Mortgage Loans		307,795	
Real Estate		1,780,449	
Collateral Loans		1,080	
Cash/short term investments		175,985	
		(18,711)	
All Other		8,213,612	
Sub-Total		10,460,210	0.350
Total		54,195,893	0.240
Investment Deductions		4,958,989	0.350
Net Investment Income Earned		49,236,904	0.229

(a) Only 30% of dividend income on stock is subject to the full corporate income tax rate of 35%. The applicable tax rate is thus 10.5% (.35 x .3 = 10.5%)

NORTH CAROLINA
MOBILE HOMES INSURANCE - MH-F PROGRAM

ESTIMATED INVESTMENT EARNINGS ON UNEARNED
PREMIUM RESERVES AND ON LOSS RESERVES

A.	Unearned Premium Reserve		
1.	Direct Earned Premium for Accident Year Ended 12/31/11		859,268,034
2.	Mean Unearned Premium Reserve (1) x	0.5717	491,243,535
3.	Deduction for Prepaid Expenses		
	Commission and Brokerage		16.21%
	Taxes, Licenses and Fees		2.21%
	1/2 General Expenses		1.85%
	1/2 Other Acquisition		2.50%
	Total		22.77%
4.	(2) x (3)		111,856,153
5.	Net Subject to Investment (2) - (4)		379,387,382
B.	Delayed Remission of Premium (Agents' Balances)		
1.	Direct Earned Premium (A-1)		859,268,034
2.	Average Agents' Balances		0.150
3.	Delayed Remission (1) x (2)		128,890,205
C.	Loss Reserve		
1.	Direct Earned Premium (A-1)		859,268,034
2.	Expected Incurred Losses and Loss Adjustment Expense (1) x	0.6389	548,986,347
3.	Expected Mean Loss Reserves (2) x	0.196	107,601,324
D.	Net Subject to Investment (A-5)-(B-3)+(C-3)		358,098,501
E.	Average Rate of Return		3.59%
F.	Investment Earnings on Net Subject to Investment (D) x (E)		12,855,736
G.	Average Rate of Return as a Percent of Direct Earned Premium (F) / (A-1)		1.50%
H.	Average Rate of Return as a Percent of Direct Earned Premium after Federal Income Taxes (G) x	0.768	1.15%

NORTH CAROLINA
MOBILE HOMES INSURANCE - MH-F PROGRAM

ESTIMATED INVESTMENT EARNINGS ON UNEARNED
PREMIUM RESERVES AND ON LOSS RESERVES

EXPLANATORY NOTES

Line A-1
Direct earned premiums are the Homeowners earned premiums for companies writing Mobilehomes insurance in North Carolina; from page 15 of the Annual Statement.

Line A-2
The mean unearned premium reserve is determined by multiplying the direct earned premiums in line (1) by the ratio of the mean unearned premium reserve to the collected earned premium for calendar year ended 12/31/11. These data are from Page 15 of the Annual Statement and represent North Carolina Homeowners data for companies writing mobilehomes insurance.

1. Collected Earned Premium for Calendar Year ended 12/31/11	$859,268,034
2. Unearned Premium Reserve as of 12/31/10	541,402,046
3. Unearned Premium Reserve as of 12/31/11	441,138,851
4. Mean Unearned Premium Reserve 1/2 [(2) + (3)]	491,270,449
5. Ratio (4) ÷ (1)	0.5717

Line A-3
Deduction for prepaid expenses:
Production costs and a large part of the other company expenses in connection with the writing and handling of Mobile Homes policies, exclusive of claim adjustment expenses, are incurred when the policy is written and before the premium is paid. The deduction for these expenses is determined from Mobilehomes data provided by the NCRB for the year ended 12/31/11.

Line B-2
Delayed remission of premium:
This deduction is necessary because of delay in remission and collection of premium to the companies, which amounts to approximately 50-75 days after the effective dates of the policies. Therefore, funds for the unearned premium reserve required during the initial days of all policies must be taken from the company's surplus.

1. Agents' balances for premiums due less than 90 days as a ratio to net written premium (based on data for all companies writing Mobile Homes insurance in North Carolina)	14.63%
2. Factor to include effect of agents' balances or uncollected premiums overdue for more than 90 days (based on data provided by A. M. Best)	1.024
3. Factor for agents' balances (1) x (2)	0.150

Line C-2

The expected loss and loss adjustment expense ratio reflects the Mobilehomes expense provisions for the year ended 12/31/11.

Line C-3

The mean loss reserve is determined by multiplying the incurred losses in line (2) by the North Carolina ratio of the mean loss reserves to the incurred losses in 2011. This ratio is based on North Carolina companies' Homeowners Page 15 annual statement data (for companies writing Mobilehomes) and has been adjusted to include loss adjustment expense reserves.

1. Incurred Losses for Calendar Year 2011	1,062,750,018
2. Loss Reserves as of 12/31/10	184,982,224
3. Loss Reserves as of 12/31/11	196,884,849
4. Mean Loss Reserve 2011: 1/2 [(2) + (3)]	190,933,537
5. Ratio (4) ÷ (1)	0.180
6. Ratio of LAE Reserves to Loss Reserves (a)	0.235
7. Ratio of Incurred LAE to Incurred Losses (a)	0.134
8. Loss and LAE Reserve [(5)x(1.0+(6))/(1.0+(7))]	0.196

(a) Based on 2011 All-Industry Insurance Expense Exhibit (source: A.M. Best)

Line E

The rate of return is the ratio of net investment income earned to mean cash and invested assets. Net investment income is computed for all companies writing Mobile Homes insurance in North Carolina as follows:

Year	Net Investment Income Earned	Mean Cash and Invested Assets	Rate of Return
2011	2,586,652,733	71,977,443,270	3.59%

Line H

The average rate of Federal income tax was determined by applying the average tax rate for net investment income and the current tax rate applicable to realized capital gains (or losses) to the rates of return as calculated above.

	Rate of Return	Federal Income Tax Rate
Net Investment Income Earned	3.59%	0.221

The average rate of Federal income tax was determined by applying current tax rates to the distribution of investment income earned for all companies. These data are for 2011 from Best's Aggregates and Averages, Underwriting and Investment Exhibit, Part 1, Column 8.

Bonds	Taxable	25,986,958	0.350
	Non-Taxable	13,575,785	-
	Sub-Total	39,562,743	0.230
Stocks	Taxable (a)	4,850,078	0.105
	Non-Taxable	1,971,532	-
	Sub-Total	6,821,610	0.075
Mortgage Loans		279,685	
Real Estate		1,802,464	
Collateral Loans		458	
Cash/short term investments		182,216	
		(23,419)	
All Other		7,590,952	
Sub-Total		9,832,356	0.350
Total		56,216,709	0.232
Investment Deductions		4,861,352	0.350
Net Investment Income Earned		51,355,357	0.221

(a) Only 30% of dividend income on stock is subject to the full corporate income tax rate of 35%. The applicable tax rate is thus 10.5% (.35 x .3 = 10.5%)

NORTH CAROLINA
MOBILE HOMES INSURANCE - MH-F PROGRAM

ESTIMATED INVESTMENT EARNINGS ON UNEARNED
PREMIUM RESERVES AND ON LOSS RESERVES

A.	Unearned Premium Reserve			
	1.	Direct Earned Premium for Accident Year Ended 12/31/10		1,030,602,162
	2.	Mean Unearned Premium Reserve (1) x	0.4979	513,136,816
	3.	Deduction for Prepaid Expenses		
		Commission and Brokerage		15.38%
		Taxes, Licenses and Fees		2.58%
		1/2 General Expenses		1.85%
		1/2 Other Acquisition		2.63%
		Total		22.44%
	4.	(2) x (3)		115,147,902
	5.	Net Subject to Investment (2) - (4)		397,988,914
B.	Delayed Remission of Premium (Agents' Balances)			
	1.	Direct Earned Premium (A-1)		1,030,602,162
	2.	Average Agents' Balances		0.150
	3.	Delayed Remission (1) x (2)		154,590,324
C.	Loss Reserve			
	1.	Direct Earned Premium (A-1)		1,030,602,162
	2.	Expected Incurred Losses and Loss Adjustment Expense (1) x	0.6408	660,409,865
	3.	Expected Mean Loss Reserves (2) x	0.309	204,066,648
D.	Net Subject to Investment (A-5)-(B-3)+(C-3)			447,465,238
E.	Average Rate of Return			3.51%
F.	Investment Earnings on Net Subject to Investment (D) x (E)			15,706,030
G.	Average Rate of Return as a Percent of Direct Earned Premium (F) / (A-1)			1.52%
H.	Average Rate of Return as a Percent of Direct Earned Premium after Federal Income Taxes (G) x		0.776	1.18%

NORTH CAROLINA
MOBILE HOMES INSURANCE - MH-F PROGRAM

ESTIMATED INVESTMENT EARNINGS ON UNEARNED
PREMIUM RESERVES AND ON LOSS RESERVES

EXPLANATORY NOTES

Line A-1

Direct earned premiums are the Homeowners earned premiums for companies writing Mobilehomes insurance in North Carolina; from page 15 of the Annual Statement.

Line A-2

The mean unearned premium reserve is determined by multiplying the direct earned premiums in line (1) by the ratio of the mean unearned premium reserve to the collected earned premium for calendar year ended 12/31/10. These data are from Page 15 of the Annual Statement and represent North Carolina Homeowners data for companies writing mobilehomes insurance.

1. Collected Earned Premium for Calendar Year ended 12/31/10	$1,030,602,162
2. Unearned Premium Reserve as of 12/31/09	484,885,062
3. Unearned Premium Reserve as of 12/31/10	541,402,046
4. Mean Unearned Premium Reserve 1/2 [(2) + (3)]	513,143,554
5. Ratio (4) ÷ (1)	0.4979

Line A-3

Deduction for prepaid expenses:
Production costs and a large part of the other company expenses in connection with the writing and handling of Mobile Homes policies, exclusive of claim adjustment expenses, are incurred when the policy is written and before the premium is paid. The deduction for these expenses is determined from Mobilehomes data provided by the NCRB for the year ended 12/31/10.

Line B-2

Delayed remission of premium:
This deduction is necessary because of delay in remission and collection of premium to the companies, which amounts to approximately 50-75 days after the effective dates of the policies. Therefore, funds for the unearned premium reserve required during the initial days of all policies must be taken from the company's surplus.

1. Agents' balances for premiums due less than 90 days as a ratio to net written premium (based on data for all companies writing Mobile Homes insurance in North Carolina)	14.57%
2. Factor to include effect of agents' balances or uncollected premiums overdue for more than 90 days (based on data provided by A. M. Best)	1.028
3. Factor for agents' balances (1) x (2)	0.150

Line C-2

The expected loss and loss adjustment expense ratio reflects the Mobilehomes expense provisions for the year ended 12/31/10.

Line C-3

The mean loss reserve is determined by multiplying the incurred losses in line (2) by the North Carolina ratio of the mean loss reserves to the incurred losses in 2010. This ratio is based on North Carolina companies' Homeowners Page 15 annual statement data (for companies writing Mobilehomes) and has been adjusted to include loss adjustment expense reserves.

1. Incurred Losses for Calendar Year 2010	608,820,136
2. Loss Reserves as of 12/31/09	164,291,553
3. Loss Reserves as of 12/31/10	184,982,224
4. Mean Loss Reserve 2010: 1/2 [(2) + (3)]	174,636,889
5. Ratio (4) ÷ (1)	0.287
6. Ratio of LAE Reserves to Loss Reserves (a)	0.239
7. Ratio of Incurred LAE to Incurred Losses (a)	0.149
8. Loss and LAE Reserve [(5)x(1.0+(6))/(1.0+(7))]	0.309

(a) Based on 2010 All-Industry Insurance Expense Exhibit (source: A.M. Best)

Line E

The rate of return is the ratio of net investment income earned to mean cash and invested assets. Net investment income is computed for all companies writing Mobile Homes insurance in North Carolina as follows:

Year	Net Investment Income Earned	Mean Cash and Invested Assets	Rate of Return
2010	2,549,525,166	72,648,894,041	3.51%

Line H

The average rate of Federal income tax was determined by applying the average tax rate for net investment income and the current tax rate applicable to realized capital gains (or losses) to the rates of return as calculated above.

	Rate of Return	Federal Income Tax Rate
Net Investment Income Earned	3.51%	0.211

The average rate of Federal income tax was determined by applying current tax rates to the distribution of investment income earned for all companies. These data are for 2010 from Best's Aggregates and Averages, Underwriting and Investment Exhibit, Part 1, Column 8.

Bonds	Taxable	25,945,348	0.350
	Non-Taxable	14,673,797	-
	Sub-Total	40,619,145	0.224
Stocks	Taxable (a)	4,528,540	0.105
	Non-Taxable	1,743,224	-
	Sub-Total	6,271,764	0.076
Mortgage Loans		266,576	
Real Estate		1,783,195	
Collateral Loans		700	
Cash/short term investments		229,717	
		16,349	
All Other		4,958,412	
Sub-Total		7,254,949	0.350
Total		54,145,858	0.224
Investment Deductions		4,901,245	0.350
Net Investment Income Earned		49,244,613	0.211

(a) Only 30% of dividend income on stock is subject to the full corporate income tax rate of 35%. The applicable tax rate is thus 10.5% (.35 x .3 = 10.5%)

NORTH CAROLINA
MOBILE HOMES INSURANCE - MH-F PROGRAM

ESTIMATED INVESTMENT EARNINGS ON UNEARNED PREMIUM RESERVES AND ON LOSS RESERVES

A.	Unearned Premium Reserve		
1.	Direct Earned Premium for Accident Year Ended 12/31/09		904,937,935
2.	Mean Unearned Premium Reserve (1) x	0.5190	469,662,788
3.	Deduction for Prepaid Expenses		
	Commission and Brokerage		15.37%
	Taxes, Licenses and Fees		2.05%
	1/2 General Expenses		2.23%
	1/2 Other Acquisition		2.77%
	Total		22.42%
4.	(2) x (3)		105,298,397
5.	Net Subject to Investment (2) - (4)		364,364,391
B.	Delayed Remission of Premium (Agents' Balances)		
1.	Direct Earned Premium (A-1)		904,937,935
2.	Average Agents' Balances		0.140
3.	Delayed Remission (1) x (2)		126,691,311
C.	Loss Reserve		
1.	Direct Earned Premium (A-1)		904,937,935
2.	Expected Incurred Losses and Loss Adjustment Expense (1) x	0.6356	575,178,551
3.	Expected Mean Loss Reserves (2) x	0.327	188,083,386
D.	Net Subject to Investment (A-5)-(B-3)+(C-3)		425,756,466
E.	Average Rate of Return		3.68%
F.	Investment Earnings on Net Subject to Investment (D) x (E)		15,667,838
G.	Average Rate of Return as a Percent of Direct Earned Premium (F) / (A-1)		1.73%
H.	Average Rate of Return as a Percent of Direct Earned Premium after Federal Income Taxes (G) x	0.791	1.37%

NORTH CAROLINA
MOBILE HOMES INSURANCE - MH-F PROGRAM

ESTIMATED INVESTMENT EARNINGS ON UNEARNED
PREMIUM RESERVES AND ON LOSS RESERVES

EXPLANATORY NOTES

Line A-1
Direct earned premiums are the Homeowners earned premiums for companies writing Mobilehomes insurance in North Carolina; from page 15 of the Annual Statement.

Line A-2
The mean unearned premium reserve is determined by multiplying the direct earned premiums in line (1) by the ratio of the mean unearned premium reserve to the collected earned premium for calendar year ended 12/31/09. These data are from Page 15 of the Annual Statement and represent North Carolina Homeowners data for companies writing mobilehomes insurance.

1. Collected Earned Premium for Calendar Year ended 12/31/09	$904,937,935
2. Unearned Premium Reserve as of 12/31/08	454,372,288
3. Unearned Premium Reserve as of 12/31/09	484,885,062
4. Mean Unearned Premium Reserve 1/2 [(2) + (3)]	469,628,675
5. Ratio (4) ÷ (1)	0.5190

Line A-3
Deduction for prepaid expenses:
Production costs and a large part of the other company expenses in connection with the writing and handling of Mobile Homes policies, exclusive of claim adjustment expenses, are incurred when the policy is written and before the premium is paid. The deduction for these expenses is determined from Mobilehomes data provided by the NCRB for the year ended 12/31/09.

Line B-2
Delayed remission of premium:
This deduction is necessary because of delay in remission and collection of premium to the companies, which amounts to approximately 50-75 days after the effective dates of the policies. Therefore, funds for the unearned premium reserve required during the initial days of all policies must be taken from the company's surplus.

1. Agents' balances for premiums due less than 90 days as a ratio to net written premium (based on data for all companies writing Mobile Homes insurance in North Carolina)	13.58%
2. Factor to include effect of agents' balances or uncollected premiums overdue for more than 90 days (based on data provided by A. M. Best)	1.03
3. Factor for agents' balances (1) x (2)	0.140

Line C-2

The expected loss and loss adjustment expense ratio reflects the Mobilehomes expense provisions for the year ended 12/31/09.

Line C-3

The mean loss reserve is determined by multiplying the incurred losses in line (2) by the North Carolina ratio of the mean loss reserves to the incurred losses in 2009. This ratio is based on North Carolina companies' Homeowners Page 15 annual statement data (for companies writing Mobilehomes) and has been adjusted to include loss adjustment expense reserves.

1. Incurred Losses for Calendar Year 2009	517,618,590
2. Loss Reserves as of 12/31/08	150,756,112
3. Loss Reserves as of 12/31/09	164,291,553
4. Mean Loss Reserve 2009: 1/2 [(2) + (3)]	157,523,833
5. Ratio (4) ÷ (1)	0.304
6. Ratio of LAE Reserves to Loss Reserves (a)	0.265
7. Ratio of Incurred LAE to Incurred Losses (a)	0.175
8. Loss and LAE Reserve [(5)x(1.0+(6))/(1.0+(7))]	0.327

(a) Based on 2009 All-Industry Insurance Expense Exhibit (source: A.M. Best)

Line E
The rate of return is the ratio of net investment income earned to mean cash and invested assets. Net investment income is computed for all companies writing Mobile Homes insurance in North Carolina as follows:

Year	Net Investment Income Earned	Mean Cash and Invested Assets	Rate of Return
2009	2,560,425,871	69,612,255,651	3.68%

Line H
The average rate of Federal income tax was determined by applying the average tax rate for net investment income and the current tax rate applicable to realized capital gains (or losses) to the rates of return as calculated above.

	Rate of Return	Federal Income Tax Rate
Net Investment Income Earned	3.68%	0.196

The average rate of Federal income tax was determined by applying current tax rates to the distribution of investment income earned for all companies. These data are for 2009 from Best's Aggregates and Averages, Underwriting and Investment Exhibit, Part 1, Column 8.

Bonds	Taxable	25,888,575	0.350
	Non-Taxable	16,306,636	-
	Sub-Total	42,195,211	0.215
Stocks	Taxable (a)	4,622,814	0.105
	Non-Taxable	2,743,306	-
	Sub-Total	7,366,120	0.066
Mortgage Loans		280,457	
Real Estate		1,783,122	
Collateral Loans		480	
Cash/short term investments		527,085	
		(55,521)	
All Other		3,236,281	
Sub-Total		5,771,904	0.350
Total		55,333,235	0.209
Investment Deductions		4,759,193	0.350
Net Investment Income Earned		50,574,042	0.196

(a) Only 30% of dividend income on stock is subject to the full corporate income tax rate of 35%. The applicable tax rate is thus 10.5% (.35 x .3 = 10.5%)

NORTH CAROLINA
MOBILE HOMES INSURANCE - MH-F PROGRAM

ESTIMATED INVESTMENT EARNINGS ON UNEARNED
PREMIUM RESERVES AND ON LOSS RESERVES

A.	Unearned Premium Reserve			
	1.	Direct Earned Premium for Accident Year Ended 12/31/08		879,118,672
	2.	Mean Unearned Premium Reserve (1) x	0.5132	451,163,702
	3.	Deduction for Prepaid Expenses		
		Commission and Brokerage		12.87%
		Taxes, Licenses and Fees		1.81%
		1/2 General Expenses		2.56%
		1/2 Other Acquisition		2.94%
		Total		20.18%
	4.	(2) x (3)		91,044,835
	5.	Net Subject to Investment (2) - (4)		360,118,867
B.	Delayed Remission of Premium (Agents' Balances)			
	1.	Direct Earned Premium (A-1)		879,118,672
	2.	Average Agents' Balances		0.139
	3.	Delayed Remission (1) x (2)		122,197,495
C.	Loss Reserve			
	1.	Direct Earned Premium (A-1)		879,118,672
	2.	Expected Incurred Losses and Loss Adjustment Expense (1) x	0.6532	574,240,317
	3.	Expected Mean Loss Reserves (2) x	0.316	181,459,940
D.	Net Subject to Investment (A-5)-(B-3)+(C-3)			419,381,312
E.	Average Rate of Return			4.20%
F.	Investment Earnings on Net Subject to Investment (D) x (E)			17,614,015
G.	Average Rate of Return as a Percent of Direct Earned Premium (F) / (A-1)			2.00%
H.	Average Rate of Return as a Percent of Direct Earned Premium after Federal Income Taxes (G) x		0.781	1.56%

NORTH CAROLINA
MOBILE HOMES INSURANCE - MH-F PROGRAM

ESTIMATED INVESTMENT EARNINGS ON UNEARNED PREMIUM RESERVES AND ON LOSS RESERVES

EXPLANATORY NOTES

Line A-1

Direct earned premiums are the Homeowners earned premiums for companies writing Mobilehomes insurance in North Carolina; from page 15 of the Annual Statement.

Line A-2

The mean unearned premium reserve is determined by multiplying the direct earned premiums in line (1) by the ratio of the mean unearned premium reserve to the collected earned premium for calendar year ended 12/31/08. These data are from Page 15 of the Annual Statement and represent North Carolina Homeowners data for companies writing mobilehomes insurance.

1. Collected Earned Premium for Calendar Year ended 12/31/08	$879,118,672
2. Unearned Premium Reserve as of 12/31/07	448,025,514
3. Unearned Premium Reserve as of 12/31/08	454,372,288
4. Mean Unearned Premium Reserve 1/2 [(2) + (3)]	451,198,901
5. Ratio (4) ÷ (1)	0.5132

Line A-3

Deduction for prepaid expenses:

Production costs and a large part of the other company expenses in connection with the writing and handling of Mobile Homes policies, exclusive of claim adjustment expenses, are incurred when the policy is written and before the premium is paid. The deduction for these expenses is determined from Mobilehomes data provided by the NCRB for the year ended 12/31/08.

Line B-2

Delayed remission of premium:

This deduction is necessary because of delay in remission and collection of premium to the companies, which amounts to approximately 50-75 days after the effective dates of the policies. Therefore, funds for the unearned premium reserve required during the initial days of all policies must be taken from the company's surplus.

1. Agents' balances for premiums due less than 90 days as a ratio to net written premium (based on data for all companies writing Mobile Homes insurance in North Carolina)	13.46%
2. Factor to include effect of agents' balances or uncollected premiums overdue for more than 90 days (based on data provided by A. M. Best)	1.033
3. Factor for agents' balances (1) x (2)	0.139

Line C-2

The expected loss and loss adjustment expense ratio reflects the Mobilehomes expense provisions for the year ended 12/31/08.

Line C-3

The mean loss reserve is determined by multiplying the incurred losses in line (2) by the North Carolina ratio of the mean loss reserves to the incurred losses in 2008. This ratio is based on North Carolina companies' Homeowners Page 15 annual statement data (for companies writing Mobilehomes) and has been adjusted to include loss adjustment expense reserves.

1. Incurred Losses for Calendar Year 2008	472,943,693
2. Loss Reserves as of 12/31/07	126,208,618
3. Loss Reserves as of 12/31/08	150,756,112
4. Mean Loss Reserve 2008: 1/2 [(2) + (3)]	138,482,365
5. Ratio (4) ÷ (1)	0.293
6. Ratio of LAE Reserves to Loss Reserves (a)	0.235
7. Ratio of Incurred LAE to Incurred Losses (a)	0.144
8. Loss and LAE Reserve [(5)x(1.0+(6))/(1.0+(7))]	0.316

(a) Based on 2008 All-Industry Insurance Expense Exhibit (source: A.M. Best)

Line E

The rate of return is the ratio of net investment income earned to mean cash and invested assets. Net investment income is computed for all companies writing Mobile Homes insurance in North Carolina as follows:

Year	Net Investment Income Earned	Mean Cash and Invested Assets	Rate of Return
2008	3,061,150,189	72,883,914,476	4.20%

Line H

The average rate of Federal income tax was determined by applying the average tax rate for net investment income and the current tax rate applicable to realized capital gains (or losses) to the rates of return as calculated above.

	Rate of Return	Federal Income Tax Rate
Net Investment Income Earned	4.20%	0.208

The average rate of Federal income tax was determined by applying current tax rates to the distribution of investment income earned for all companies. These data are for 2008 from Best's Aggregates and Averages, Underwriting and Investment Exhibit, Part 1, Column 8.

Bonds	Taxable	26,065,645	0.350
	Non-Taxable	16,923,546	-
	Sub-Total	42,989,191	0.212
Stocks	Taxable (a)	5,244,126	0.105
	Non-Taxable	1,234,199	-
	Sub-Total	6,478,325	0.085
Mortgage Loans		312,607	
Real Estate		1,772,757	
Collateral Loans		692	
Cash/short term investments		2,660,197	
		(40,046)	
All Other		4,302,167	
Sub-Total		9,008,374	0.350
Total		58,475,890	0.219
Investment Deductions		4,710,400	0.350
Net Investment Income Earned		53,765,490	0.208

(a) Only 30% of dividend income on stock is subject to the full corporate income tax rate of 35%. The applicable tax rate is thus 10.5% (.35 x .3 = 10.5%)

STATISTICAL DATA TO COMPLY WITH NORTH CAROLINA
REQUIREMENTS FOR A MOBILEHOMES-MH-F-FILING
AS PER 11 NCAC 10.1105

11. IDENTIFICATION OF APPLICABLE STATISTICAL PLANS AND PROGRAMS AND A CERTIFICATION OF COMPLIANCE WITH THEM

(a) ISO Personal Lines Statistical Plan (Other Than Automobile)
ISO Minimum Personal Lines Statistical Plan
ISO Personal Lines Statistical Agent Plan (Other Than Automobile)
ISO 2011 Call for Mobilehomes Statistics
ISO 2011 Call for Mobilehomes Statistical Agent Plan Statistics
ISS Personal Lines Statistical Plans - All Coverages
ISS 2011 Mobilehomes Call
AAIS Personal Lines Statistical Plan
AAIS 2011 Call for Mobilehomes Statistics
NISS Statistical Plan - All Coverages - Part IV, North Carolina
NISS 2011 Quarterly Call
NISS 2011 Calendar Year Annual Statement
NISS 2011 Financial Reconciliation Call
Annual Statement for Calendar Year 2011
Insurance Expense Exhibit for Calendar Year 2011
RB Calls for 2007-2011 North Carolina Expense Experience

(b) The North Carolina Rate Bureau certifies that there is no evidence known to it or, insofar as it is aware following reasonable inquiry, to the statistical agencies involved that the data which were collected under the statistical plans identified in response (11)(a) above and used in the filing are not materially true and accurate representations of the experience of the companies whose data underlie such experience. While the Rate Bureau is aware that the collected data sometimes require corrections or adjustments, the Rate Bureau’s review of the data, the data collection process, and the ratemaking process indicates that the aggregate data are reasonable and reliable for ratemaking purposes. See also the prefiled testimony of R. Curry and B. Donlan.

(c) The attached Exhibit (11)(c) contains general descriptions of the editing procedures used for property lines to ensure data were collected in accordance with the applicable statistical plans.

North Carolina Mobilehomes Insurance Statistical Data

ISO Editing Procedures

1. Upon receipt of the data from each reporting company, checks are made to ensure that each record (i.e., the data reported for each exposure) has valid and readable information. This includes a check that the appropriate alpha-numeric codes have been utilized.

2. The records are then checked to ensure that each of the fields has a valid code in it (e.g., company numbers must be entered as four-digit numerals).

3. Relationship edits which evaluate the interrelationship between codes are then performed. For example, if a record indicates North Carolina, Mobilehomes, Form 3, checks are made to ascertain that applicable interrelationships are maintained.

4. Distributional edits are performed to make sure that the reporting company has not erred in miscoding its data into a single class, territory, or other rating criteria due a systems problem or other error.

5. The resulting combined data from all the company records are reconciled with statutory Page 14 Annual Statement data for that company.

6. After all of the ISO data are aggregated, a consolidated review of the data is conducted to determine overall reasonableness and accuracy. In this procedure the data are compared with previous statewide and territory figures. Areas of concern are identified and results are verified by checking back to the source data.

North Carolina Mobilehomes Insurance Statistical Data

ISS Editing Procedures

The following narrative sets forth a general description of the editing procedures utilized by ISS to review North Carolina statistical data. All North Carolina experience submitted to the ISS by affiliated companies undergoes standard procedures to ensure that the data is reported in accordance with the ISS's approved statistical plans.

The ISS review of the data takes place on two levels: analysis of individual company data and analysis of the aggregate data of all ISS reporting companies combined. These two separate functions will be treated in that order.

Analysis of Company Data

Analysis of company data includes: completeness checks, editing for valid coding and checking the distribution of data among the various data elements.

1. Completeness Checks (Balancing and Reconciliation):

   Balancing and reconciliation procedures are used to determine completeness of reporting. Completeness means that the ISS has received and processed all of the data due to be filed with the ISS. First, totals of each company's processed data are compared to separate transmittal totals supplied by the company. This step ensures that ISS has processed completely the experience included in the company's submission of data and that no errors occur during this processing. As a second check for completeness, the reported statistical data is reconciled to Statutory Page 14 totals from the company's Annual Statement. It is a useful procedure in determining completeness because the annual statement represents an independent source of information.

2. Editing of Codes:

   Format and Readability

   Statistical data reported by affiliated companies must be filed in accordance with ISS's approved statistical plans. This includes the requirement that the data must conform to the specific formats and technical specifications in order for ISS to properly read and process these submissions. The initial edit is a test of each company's submission to ensure it has been reported using the proper record format and that it meets certain technical requirements for the line of insurance being reported. Key fields are tested to ensure that only numeric information has been reported in fields defined as numeric, and that the fields have been reported in the proper position in the record.

   Relational Edits

   The data items of information filed with the insurance company's experience are reported by using codes defined under ISS's statistical plans. For example, the various types of Policy Forms written on Mobilehomes policies in North Carolina are defined in the Personal Lines Statistical Plan. Each definition for each data element has a unique code assigned to it which distinguishes it from other definitions. All data items applicable to North Carolina are defined in a similar manner in each of ISS's statistical plans and have codes assigned to properly identify each definition.

   All records reported to ISS are subjected to validation of the reported codes. This validation, called editing, is performed to assure that companies are reporting properly defined ISS Statistical Plan codes for North Carolina experience.

The purpose of the edit is to validate the statistical codes reported in each record. This validation is called a Relation Edit. A relational edit verifies that a reported code is valid in combination with one or more related data items. Relational edit tests are accomplished primarily through the use of specific edit tables applicable to each line of insurance.

In most cases, the experience data in the record is used in conjunction with the related codes and compared to an establishment or discontinued date for the code being validated. This ensures that specific codes are not being utilized beyond the range of time during which they are valid.

An example of a relational edit involves territory coding. Many territory code numbers are available under each statistical plan for various states, with various effective dates. However, only codes defined for North Carolina for the specific line being processed are valid in combination with North Carolina reported experience. Further, if a new code is erected, that code will be considered valid only if the date reported in the statistical record is equal or subsequent to the establishment date of the code.

3. Distributional Analysis:

The validation of the codes is not by itself sufficient to assure the credibility of company data. Having assured the reporting of valid codes, the statistical agent must verify that valid entries are indeed reliable. Therefore, the data is also reviewed for reasonable distributions. The primary focus of this review is to establish that the statistical data reported by the company is a credible reflection of the company’s experience.

The distribution of company experience by specific data elements such as state, territory, policy form, and construction, for example, for the current reporting period is compared to company profiles of prior periods. In addition, ratios relevant to the line of insurance such as average premium, average loss, volume, loss ratio and loss frequency are compared to industry averages. This historical comparison can highlight changes in the pattern of reporting.

The distributional analysis serves as an additional verification that systematic errors are not introduced during the production of data files submitted to ISS by our affiliated companies. Disproportionate amounts of premiums and/or losses in a particular class or territory, for example, can be detected using this technique.

Validation of Aggregate Data

After the individual company has been reviewed, the data for all reporting companies is compiled to produce aggregate reports. The aggregate data represents the combined experience of many companies. This data is also subjected to similar review procedures. To ensure completeness, run to run control techniques are applied. This involves balancing the totals of the aggregate runs to previously verified control totals. In this manner the aggregate data is monitored to ensure the inclusion of the appropriate company data.

The aggregate data is also reviewed for credibility through distributional analysis similar to that performed on the individual company data. Earned exposures (where applicable) and premiums and incurred losses and claims are used to calculate pure premiums, claim frequencies and claim costs for comparison to past averages. The analysis of the aggregate data centers on determining consistency over time by comparing several years of experience, by policy form and territory, for example. Through the application of these techniques, ISS is able to provide reliable insurance statistical data in North Carolina.

North Carolina Mobilehomes Insurance Statistical Data

NISS Editing Procedures

a. Every report received is checked for completeness. Every submission must include (1) an affidavit; (2) a letter of transmittal setting forth company control totals for the data being sent; (3) the data being reported on tape, cartridge, diskette or form to be keyed.

b. Individual company submissions are balanced to the company letter of transmittal to ensure that all data have been received and processed. After all four quarters of data have been received, the company reports are reconciled to the Annual Statement Statutory Page 14 amounts. The NISS Financial Reconciliation identifies any amounts needed to reconcile any differences between the company reported data and Annual Statement amounts.

c. Every company record submitted to NISS is verified through NISS edit software for its coding accuracy and conformance with NISS record layouts and instructions. NISS edits verify the accuracy of each code for each data element. Where possible, each data element is subjected to a relational edit whereby it will be checked for accuracy in conjunction with another field.

d. Individual company submissions are also subjected to a series of reasonability tests to determine that the current submission is consistent with previous company submissions, known changes in this line of business and statewide trends. NISS compares current quarter data to the previous quarter. This comparison is performed and analyzed by grouping data.

e. After all of the NISS data are combined, a review of this consolidated data is also performed. The aggregate data is compared on a year to year basis to again verify its reasonableness, similar to those checks employed on an individual company submission.

North Carolina Mobilehomes Insurance Statistical Data

AAIS Editing Procedures

The American Association of Insurance Services functions as an official statistical agent in the State of North Carolina for a number of lines of insurance, including Mobilehomes. In this capacity, it provides for the administration of statistical programs in accordance with approved statistical plans on behalf of the Commissioner of Insurance. These plans, which were filed according to the requirements of the State of North Carolina, serve to insure a high quality of data reliability.

1. All statistical plans constitute permanent calls for data, which is due at AAIS within 60 days following the close of the period covered by the report.

2. Each data submission is accompanied by a transmittal that summarizes the detail data by state. The transmittal provides control totals to balance to the input and output of each step in our collection procedure. Signature of the company official responsible for data collection is required on the transmittal to certify the accuracy and completeness of the data submission.

3. The AAIS data collection procedure consists of several consecutive steps in order to further verify receipt of accurate and complete data from each company and ultimately aggregate the data into the final experience format.

4. The data collection procedure begins with entering the company number, date, type of media, and transmittal control totals for each line of insurance received into a log file. Company number, record counts, lines of insurance, year, quarter, type and number of media are recorded on a processing log and submitted to the computer room.

5. Operations will load the data into the computer and process all lines through a program which verifies certain key fields. The key fields are company number, line of insurance, transaction code and report period (quarter and year). All invalid key fields must be corrected before proceeding to the next step. Once a valid key field report is generated, Operations will copy all valid key field records to the edit file.

6. Upon receipt of the Moved to Edit report, the statistical department will verify that all records were copied from the stored data file to the edit file. All companies are then released by line and report period for editing.

7. The edit program has several functions and reports. They are:

   a. Data is balanced to transmittal totals.
   b. Each statistical field is edited to the valid codes in the statistical plan for the line being processed. Many fields are also cross edited. An example is deductible type and amount. All invalid codes are identified with an asterisk to the right of the code.
   c. Edit reports consist of a listing of invalid records, error summary report, month report, state report and field error detail report. Mobilehomes has an additional report entitled "Data Consistency Report". This report shows the companies' average premium, pure premium, loss ratio, frequency and severity.

d. In addition to the edit report, we provide the company a distribution report. As you might expect, this report provides a distribution of the reported data for almost every single field of information captured by the statistical plan. This report is not only provided as a courtesy to the company, but it is always reviewed by AAIS staff to identify any reporting irregularities that wouldn't be caught by the edit program.
e. Along with the edit and distribution reports, there are additional review procedures in place to identify procedural reporting errors that may exist (e.g., cancellations and coverage changes). A great deal of time is spent on this item because of it's importance to the validity of the reported data.
f. Our analysis of a company's data are returned to the company with a customized letter indicating the type of action required. Depending on the severity of errors, companies are requested to make corrections or resubmit data.

8. AAIS provides assistance to all of its affiliated companies to ensure a continued high level of data quality. Statistical coding seminars designed to instruct company coders and respond to questions are scheduled annually. In addition to the seminars, AAIS has developed Statistical Training Manuals for some lines and pre-edit programs for company in-house use. Technical Services staff is available to train company personnel in all aspects of data collection, coding, statistical reporting and data processing.

12. INVESTMENT EARNINGS ON CAPITAL AND SURPLUS

Not applicable to mobilehomes insurance.

13. LEVEL OF CAPITAL AND SURPLUS NEEDED TO SUPPORT PREMIUM WRITINGS WITHOUT ENDANGERING THE SOLVENCY OF MEMBER COMPANIES

LEVEL OF CAPITAL AND SURPLUS NEEDED TO SUPPORT PREMIUM WRITINGS WITHOUT ENDANGERING THE SOLVENCY OF MEMBER COMPANIES

(a) The aggregate premium to surplus ratios for the calendar years 2007 - 2012 for the company groups which have written North Carolina mobile homeowners insurance are as follows:

Year	P/S Ratio
2007	1.427
2008	1.225
2009	1.249
2010	1.144
2011	1.230
2012	1.225
Average	1.250

(b) The experience provides the best estimate of the future. See the prefiled testimony of D. Appel.

(c) The actual premium to surplus ratio for the property and casualty industry on a countrywide basis (based upon the latest A. M. Best data available at this time) is as follows:

	(000's omitted)
STATUTORY CAPITAL AND SURPLUS, 2013	$682,106,796
STATUTORY CAPITAL AND SURPLUS, 2012	$611,406,460
AVERAGE STATUTORY CAPITAL AND SURPLUS (2012)	$646,756,628
NET PREMIUMS EARNED (2012)	$477,738,373
PREMIUM/SURPLUS RATIO	0.739

The actual level of capital and surplus needed to support premium writings without endangering the solvency of a company is dependent upon (among others) the financial structure and investments unique to each company, the relationship of the company with affiliated companies as a group (and the experience of the affiliated companies), the mix of business of each company, and the conditions of the economy as they affect each company's individual circumstances. The Rate Bureau is advised that the National Association of Insurance Commissioners, as one of several criteria, generally considers that a premium to surplus ratio for an individual company of 3 to 1 warrants close regulatory attention and monitoring with respect to the company's solvency position.

(d) The Rate Bureau has not allocated surplus by state and by line in preparing this filing. The Rate Bureau has treated surplus in this manner because each dollar of surplus is available to cover losses in excess of premium for each and every line.

STATISTICAL DATA TO COMPLY WITH NORTH CAROLINA
REQUIREMENTS FOR A MOBILEHOMES-MH-F-RATE FILING
AS PER 11 NCAC 10.1105

14. OTHER INFORMATION REQUIRED BY THE COMMISSIONER

See attached Exhibits (14)(a), (b), (c) and (d).

See the pre-filed testimony of D. Appel, J. Vander Weide and R. Curry.

Not applicable to Mobilehomes insurance.

The following changes in methodology from those used in the May 30, 2008 filing have been incorporated into this filing:

- In this filing, the net cost of reinsurance has been treated as a fixed expense, whereas in the prior filing it was treated as a variable expense. This is a more appropriate way to reflect this expense, since the dollar-value net cost of reinsurance to member companies does not depend on the indicated rate.
- The allocation of reinsurance costs and underwriting profit to territory group is based on the average of three alternative risk measures: standard deviation of losses, covariance of losses and probability of ruin. In the previous filing, the three alternative risk measures were standard deviation of losses, variance of losses and probability of ruin.
- In this filing, modeled losses were calculated for the latest year only. In the prior filing, modeled losses were calculated for all five years and were added to non-modeled losses. This change leads to a provision for hurricane losses that is more consistent with the current industry set of policyholders.
- In this filing, the calculations of MH-F owners and tenant forms indicated rate level changes include a provision for the compensation for assessment risk, whereas the prior filing did not include this provision. This provision reflects the cost to voluntary market insurers of maintaining sufficient capital to cover residual market losses to the extent required by law.
- In the wind exclusion credit calculation, the compensation for assessment risk provision is included whereas the prior filing did not include this provision in the calculation.
- In deriving indicated rate level changes by territory group, the statewide non-hurricane pure premium is used as the complement of credibility (for the by-territory-group non-hurricane pure premium) rather than the current territory rate differential times the statewide non-hurricane pure premium.
- There is no tempering factor used in the calculation of the MH(F) owners and tenants forms premium projection factor. In prior filing, the tempering factor of 0.95 was used.
- In the prior filing, the trend applied to losses was based solely on the external cost indices. In this filing, the prospective loss trend (the trend used to project losses from a 5/15/2014 cost level to a 6/1/2017 cost level) was adjusted via a loss trend adjustment factor of 2.5% for owners form and 2.0% for tenant form based on observing that trends in the insurance loss data have been exceeding the external cost indices in more recent years. This change leads to a more accurate estimate of future loss cost levels.
- Data from policies with the deductible amounts of $250, $500, and $1,000 were used to determine trend in current amount and premium projection factors rather than just policies with the deductible amounts of $250 and $500 used in the prior filing.
- The trend periods have been determined assuming that the rates will be in effect for three years rather than one year.

The following describe changes in presentation as compared to prior filings. These are not changes in methodology.

- On RB-15, the net cost of reinsurance continues to be determined on Sheet 1, as in the past. However, on Sheet 2, when the net cost of reinsurance is displayed as a percent of premium at proposed rates, that calculation is now performed by dividing the dollars of net cost of reinsurance in the numerator by the dollars of premium at proposed rates in the denominator which include the provisions for deviations and compensation for assessment risk. Previously, the denominator of the calculation used premium at proposed rates but without provisions for deviations and compensation for assessment risk. This has no impact on the rate indication because the provision for net cost of reinsurance included in the rates is identical to what it would have been without this change.

- On RB-14, the expected cost of compensation for assessment risk is displayed in the calculation of the pro-forma rate of return on pages 1 and 1A. This has no impact on the rate indication; the provision for compensation for assessment risk included in the rates is identical to what it would have been without this change.

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

SECTION F - CALCULATION OF REVISED AMOUNT OF INSURANCE RELATIVITIES

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

OVERVIEW OF ACTUARIAL PROCEDURES - AMOUNT OF INSURANCE RELATIVITIES

INTRODUCTION

This document revises the amount of insurance (AOI) relativities behind the rating tables for the North Carolina mobile home insurance MH(F) program, and describes how the new AOI relativities were calculated. The updated AOI relativities are limited to owners forms 2 & 3 under the MH(F) program.

PURE PREMIUM METHODOLOGY

First, this analysis calculates pure premiums for various amount-of-insurance ranges, and relates them to a selected base pure premium. The assumed base amount of insurance is $25,000for the owners forms. This base amounts is identical to that underlying the concurrent MH(F) rate filing. Second, the analysis fits a line to the indicated combined owners forms 2 & 3 pure premium relativities at the weighted midpoint of the AOI range, and relates the resulting fitted pure premiums to the fitted base pure premium to produce the revised relativities. Finally, interpolated AOI relativities were generated for other AOIs, which correspond to entries in the current rating tables.

The pure premium used in the calculations is:

• Non-Modeled Pure Premium (PP)

The non-modeled pure premiums are calculated as non-modeled incurred losses divided by earned house years. Estimates of actual hurricane losses have been removed for the non-modeled incurred losses. The removed hurricane losses have not been replaced by modeled hurricane losses. The non-modeled pure premiums are solely all other peril losses exclusive of hurricane from the reported experience.

The amount of insurance relativity is the ratio of PP at a specified AOI range divided by the corresponding PP at the base AOI. For a base AOI at b, the relativity at the higher AOI range a as follows:

$$AOI\ REL(a) = \left[\frac{PP(a)}{PP(b)}\right]$$

In this analysis, pure premiums were calculated for AOI ranges rather than individual AOIs. The grouping was necessary to produce smooth indicated relativities (those that don't reverse for higher AOIs). For certain AOIs, the data were too thin for reliable relativities. Additionally, grouping of data into ranges avoids the observed phenomenon of clustering, which is the tendency for data to be reported at round amounts like $10,000, $20,000, $30,000, and so forth.

The AOI ranges were selected to have roughly equal earned house years.

DATA

The reported incurred losses and earned houses by AOI are based on the same data as that underlying the North Carolina mobile homes rate level review for the MH(F) program for owners forms 2 & 3. The only difference is that the latest calendar accident year ending 12/31/2011 has been excluded from the analysis. The reason for that year's removal involved high excess wind losses with no adequate method to adjust the losses by AOI for the excess wind.

The Mobile Home insurance experience for the MH(F) program was compiled on a calendar accident year basis for the years ended December 31, 2010, 2009, 2008, and 2007. For any twelve-month period, the accident year experience brings together AOI losses resulting from accidents occurring during that period with the number of mobile homes “earned” for that AOI during the same period.

LINEAR REGRESSION

The fitting procedure uses a simple linear regression. For the owners forms 2 & 3 combined, a line was fit to the indicated pure premium relativity at the weighted midpoint of the AOI ranges. The weights which determine the midpoint of the range reflect the house years earned in the AOI range. For more stable results, the last amount of insurance range was excluded from the fitting process.

For the MH(F) owners forms, the linear regression provides a good fit to the indicated pure premium relativities by AOI.

Exhibit 1 shows the indicated and selected amount of insurance relativities for the owners forms combined. Also, shown are the amount of insurance ranges, the weighted midpoint of the AOI range, the indicated pure premiums by AOI range, implied AOI relativities based on current rates, and proposed percentage changes by AOI range.

OFF-BALANCE FACTORS

In order to introduce the revised amount of insurance (AOI) relativities on a revenue-neutral basis, "off-balance" factors in the calculation of the revised rates are included in Exhibit 2.

The off-balance factor represents the rate level effect that would result were the revised AOI relativities to be implemented without any adjustment to the current rates. Hence, by dividing out the off-balance factor in the calculation of the revised rates, the revised AOI relativities will have no effect on the average rate for all insureds.

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

EXHBIT 1

CALCULATION OF AMOUNT OF INSURANCE (AOI) RELATIVITY FACTORS

MH(F) - 2,3						
	[1]	[2]	[3]	[4]	[5]	[6]
AOI Range (in thousands)	Weighted Mid Pt	Non-Hurricane Pure Premium	Indicated AOI Relativity Factor {=[2]/base[2]}	Fitted/Selected AOI Relativity Factor	Implied AOI Relativity Factor from Current Rates	Proposed % Change {=[4]/[5]-1}
0 - 10	9.0	108.54	0.692	0.668	0.382	75%
11 - 15	13.7	125.41	0.799	0.767	0.550	39%
16 - 20	18.6	144.41	0.920	0.868	0.722	20%
16 - 20	23.4	149.39	0.952	0.966	0.928	4%
26 - 30	28.4	172.42	1.099	1.070	1.149	-7%
31 - 35	33.2	193.64	1.234	1.170	1.362	-14%
36 - 40	38.4	204.21	1.301	1.277	1.589	-20%
41 - 45	43.2	235.60	1.502	1.377	1.804	-24%
46 - 50	48.6	239.07	1.524	1.490	2.043	-27%
51 - 55	53.3	278.55	1.775	1.586	2.247	-29%
56 - 60	58.5	333.51	2.126	1.694	2.478	-32%
61 - 65	63.3	330.79	2.108	1.794	2.691	-33%
66 - 70	68.3	342.37	2.182	1.897	2.911	-35%
71 - 75	73.3	319.75	2.038	2.000	3.131	-36%
76 - 81	78.6	310.70	1.980	2.111	3.365	-37%
82 - 87	84.5	368.84	2.351	2.232	3.625	-38%
88 - 94	90.8	343.18	2.187	2.364	3.905	-39%
95+	116.7	314.50	3.896	2.899	5.044	-43%
Base 25K		156.91	1.000	1.000	1.000	

NORTH CAROLINA

MOBILE HOMES INSURANCE - MH(F) PROGRAM

EXHBIT 2

CALCULATION OF OFF-BALANCE FACTORS BY TERRITORY GROUP

Forms	Territory Group	[1] Earned Premium at current Level	[2] Earned Premium based on revised AOI Relativities	[3] Off-Balace Factor {=[2]/[1]}
MH(F)-2,3	1	2,069,452	1,562,749	0.755
MH(F)-2,3	2	21,930,348	15,764,498	0.719
MH(F)-2,3	3	17,499,547	13,184,631	0.753
MH(F)-2,3	Total	41,499,347	30,511,878	0.735

North Carolina

Mobile Homeowners Policy Program

MH(F)

NORTH CAROLINA
MOBILE HOMEOWNERS POLICY MH(F) PROGRAM
RULES

1. General Instructions

The Mobile Homeowners Policy Program provides property and liability coverage using the forms and endorsements herein. This manual also contains the rules governing the writing of the Mobile-Homeowners Policy. The rules, rates, forms and endorsements filed by or on behalf of the Company for each coverage shall govern in all cases not specifically provided for herein.

2. Policy and Forms and Description of Coverage

The following is a general description of the coverages provided by the individual Mobile-Homeowners Forms. The Policy and Forms should be consulted for exact contract conditions.

a. Section I Coverages – Property Damage

Coverage A – Dwelling

Coverage B - Other Structures

Coverage C - Personal Property

Coverage D - Loss of Use

(1) Form MH(F)-2 BROAD FORM. Covers dwelling, other structures, personal property and loss of use against loss by:

Fire or Lighting	Falling Objects
Windstorm or Hail	Vandalism or Malicious Mischief
Explosion	Weight of ice, snow or sleet
Riot or Civil Commotion	Collapse of Buildings
Aircraft	Accidental discharge of Water or Steam
Vehicles	Freezing of plumbing, heating systems and appliances
Smoke	Sudden and Accidental injury from electrical currents
Breakage of Glass	Sudden and Accidental tearing apart of heating systems
Theft	and appliances
Flood	

(2) Form MH(F)-3 COMPREHENSIVE FORM. Covers dwelling, other structures, and loss of use against all risks of physical loss, with certain exceptions. Personal property is covered for the same perils as provided in Form MH(F)-2 BROAD FORM.

(3) Form MH(F)-4 CONTENTS BROAD FORM. Covers personal property, including the Insured's interest in building additions and alterations and loss of use, against loss by the same perils as provided in Form MH(F)-2 BROAD FORM.

b. Section II Coverages - Liability - All Forms

Coverage E - Personal Liability

Coverage F - Medical Payments to Others

(1) Personal Liability - Covers payment on behalf of the Insured of all sums which he shall become legally obligated to pay as damages because of bodily injury or property damage caused by an occurrence arising out of his premises or personal activities.

(2) Medical Payments to Others - Covers medical expenses incurred by persons, other than the Insured, who sustain bodily injury caused by an accident arising out of the Insured's premises or personal activities.

3. ELIGIBILITY

a. Form MH(F)-1 not filed or approved under this Program.

b. Form MH(F)-2, MH(F)-3 - A Mobile Homeowners Policy may be issued:

To an owner occupant of a mobile home which is used exclusively for private residential purposes (except as provided in **General** Rule 3.f.) and contains not more than two families and with not more than two boarders or roomers.

c. Form MH(F)-4, A Mobile-Homeowners Policy may be issued only to:

The Tenant (non-owner) of a mobile home; provided the residence premises occupied by the insured is used exclusively for residential purposes (except as provided in General Rule 3.f.) and is not occupied by more than one additional family or more than two boarders or roomers.

d. When a mobile home is occupied by co-owners, a Mobile Homeowners Policy providing coverage A & B may be issued to only one of the co-owners and endorsed to cover the interest of the other co-owner in the mobile home and appurtenant private structures and for premises liability.

Attach Endorsement MH(F)-23 Additional Insured - Residence Premises. A separate Mobile Home Policy with FORM MH(F)-4 may be issued to the second co-owner.

e. It is permissible to extend the Mobile-Homeowners Policy, without additional premium charge, to cover the interest of a non-occupied joint owner(s) in the mobile home(s) and for premises liability.

Attach Endorsement MH(F)-23 - Additional Insured

f. Subject to all other sections of this rule, a Mobile Homeowners Policy may be issued to cover a seasonal mobile home and such mobile home shall be described as 'Seasonal Mobile Home' in the policy.

g. Incidental office, professional, private school and studio occupancies are permitted provided:

(1) the premises is occupied principally for mobile home purposes;

(2) there is no other business conducted on the premises; and

(3) there is no increase in the applicable fire rate for such occupancy.

h. A Mobile-Homeowners Policy shall not be issued covering any property to which farm forms or rates apply under the rules filed by or on behalf of the Company. In no event shall a policy be issued to cover any property situated on premises used for farming purposes, unless farming conducted thereon is only incidental to the occupancy of the premises by the Insured as a mobile home and farming is not the occupation of the Insured.

i. A Travel Trailer which is defined as “a recreational vehicle equipped with temporary living quarters, including cooking and eating facilities” is not eligible for this program.

4. MANDATORY COVERAGES

a. It is mandatory that insurance be written for all coverages provided under both Sections I and II of the Mobile Homeowners Policy, except for those optional coverages provided for under General Rule 8 of this manual.

b. Section II of the policy requires coverage for the following exposures and the additional premium developed must be charged when such exposures exist.

(1) All additional residence premises where the Named Insured or spouse maintain a residence other than business or farm properties;

(2) All residence employees of the Named Insured or spouse not covered or not required to be covered by Workers' Compensation Insurance (charge required for residence employees in excess of two); and

(3) Incidental office, professional private school or studio occupancies by the insured on residential premises of the Insured.

5. OFFICE, PROFESSIONAL, PRIVATE SCHOOL OR STUDIO OCCUPANCY

a. When the Insured maintains an incidental office, professional, private school or studio occupancy in the mobile home or in a separate structure on the premises, which otherwise meets the eligibility requirements, an additional premium for the increased Coverage C limit and for the liability exposure must be charged. Under a Mobile-Homeowners Policy with Form MH(F)-4, the minimum limit of liability for Coverage C shall be $2,000.

Attach Endorsement MH(F)-24 Office, Professional, Private School or Studio Use - Residence Premises

b. When the insured gives professional instruction, such as music, dancing or similar instruction in the mobile home, employs no assistants and there has been no physical alteration of the mobile home to accommodate the occupancy, the additional premium for the liability exposure must be charged.

Attach Endorsement MH(F)-24 Office, Professional, Private School or Studio Use - Residence Premises

c. When the Insured has permissible office, professional, private school or studio occupancy in an additional residential premises occupied by the insured, other than the described mobile home, the additional premium for the liability exposures must be charged.

Attach Endorsement MH(F)-25 Office, Professional, Private School or Studio Use - Other Residence

6. LIMITS OF LIABILITY

a. The limits of liability required under the Mobile Homeowners Policy are as follows:

Section I Coverage	MH(F)-2	MH(F)-3	MH(F)-4
A. Dwelling Minimum Limit	$2,000	$2,000	
B. Other Structures	10% of Mobile Home	10% of Mobile Home	
C. Personal Property	30% of Mobile Home	30% of Mobile Home	
D. Loss of Use	10% of Mobile Home	10% of Mobile Home	10% of Unscheduled Personal Property

Section II Coverage	All Forms
E. Personal Liability	$25,000 Each Occurrence
F. Medical payments to Others	$ 500 Each Person $25,000 Each Accident

b. ALL FORMS - The limit of liability for Coverages C of Section I and E or F of Section II may be increased. See General Rule 8.

c. FORM MH(F)-2, MH(F)-3 - Under Coverage B of Section I an additional amount of insurance may be written on a specific private structure. See General Rule 8.

7. DEDUCTIBLES

a. All Mobile Homeowners Forms contain a $50 Loss Deductible Clause applicable to loss under Section I of the policy except loss under Coverage D, Fire Department Service Charge and Emergency Removal Expense.

b. FORM MH(F)-2, MH(F)-3 & MH(F)-4 - The Mobile Homeowners Policy may be endorsed to provide a flat (non-disappearing) deductible in the amount of $100 or $250 at a premium credit.

c. Optional $100 or $250 Flat Theft Deductible

FORM MH(F)-2, MH(F)-3, MH(F)-4 - The Mobile Homeowners Policy may be endorsed to provide a flat (non-disappearing) deductible in the amount of $100 or $250 applicable to any loss caused by theft of property only covered under Coverage C of the policy. This deductible shall be applied to the amount of each adjusted loss. A premium credit is applicable.

d. Optional Windstorm or Hail Deductibles - Territory 05, 06, 42, 43 Only

In territories 05, 06, 42, 43 only, the Mobile Home Policy may be endorsed to provide an optional Windstorm or Hail Deductible used in conjunction with the deductibles applicable to All Other Perils. This option provides for higher dollar deductible amounts of $1,000, $2,000 and $5,000 when the higher deductible amount selected exceeds the deductible applicable to All Other Perils.

e. Optional Named Storm Percentage Deductible – Territory 05, 06, 42, 43 Only

In territories 05, 06, 42, 43 only, the Mobile-Homeowners Policy may be endorsed to provide a Named Storm Percentage Deductible of 1% of the Coverage A or C limit of liability, whichever is greater, when the dollar amount of the percentage deductible exceeds the deductible applicable to All Other Perils. Use **MH(F)-58**, Named Storm Percentage Deductible.

8. OPTIONAL COVERAGES

a. Section I - Property Damage - The Coverage may be amended as follows:

(1) Other Structures - Increased Limit

An additional amount of insurance may be written on a specific private structure under Coverage B at an additional premium.

Attach Endorsement MH(F)-28 Other Structures.

(2) Credit Card, Forgery and Counterfeit Money Coverage

The Mobile Homeowners Policy may be extended to include coverage against loss by forgery or alteration in connection with credit cards, checks or drafts, or loss due to acceptance of counterfeit paper currency at an additional premium.

Attach Endorsement MH(F)-29 Credit Card , Forgery and Counterfeit Money Coverage

(3) Money and Securities

Increased limits on money, bullion, numismatic property, bank notes, and on securities, accounts, bills, deeds, evidences of debt, letters of credit, notes other than bank notes, passports, railroad and other tickets and stamps, including philatelic property, may be provided at an additional premium.

The $100 limit on money may be increased by an amount not exceeding $400 and the $500 limit on securities may be increased by an amount not exceeding $500.

Attach Endorsement MH(F)-32 - Coverage C - Increased Special Limits of Liability

(4) Theft Coverage Extension

FORM MH(F)-2, MH(F)-3, MH(F)-4 - Coverage may be extended to include loss by theft of property while unattended in or on any vehicle or watercraft at an additional premium.

Attach Endorsement MH(F)-27 - Theft Coverage Extension

(5) Personal Property

(a) Increased Limit - All Forms

The limit of liability for Coverage C may be increased at an additional premium.

(b) Away from Premises - FORM MH(F)-2, MH(F)-3, MH(F)-4 The limit of liability on unscheduled personal property away from premises under Coverage C may be increased at an additional premium.

Attach Endorsement MH(F)-33 - Coverage C - Away from Premises

(6) Earthquake Damage

The Additional Exclusion section may be amended to include direct loss caused by earthquake and volcanic eruption at an additional premium. A deductible in the amount of 2% is mandatory.

Attach Endorsement MH(F)-43 – Earthquake

(7) Fire Department Service Charge

The limit of $100 in the policy may be increased to $250 or $500 at an additional premium.

Attach Endorsement MH(F)-45 Fire Department Service Charge

b. Scheduled Personal Property

Coverage may be provided against all risks of physical loss with certain exceptions on scheduled personal property subject to the rules and rates filed by or on behalf of the Company. This coverage is subject to an annual minimum premium of $15 irrespective of the term of the Mobile Homeowners Policy.

Attach Endorsement MH(F)-31 Scheduled Personal Property Endorsement

c. Lienholder's Single Interest

Coverage may be provided to cover the interest of the lienholder from the loss caused by collision, upset, conversion, embezzlement or secretion at an additional premium. Repossession and return protection is included. This coverage should be provided only when requested by the lienholder.

Attach Endorsement MH(F)-21 Mobile Home Lienholder's Single Interest

d. Trip Collision

This coverage may be provided to protect the Insured from loss caused by collision or upset at an additional premium. A $100 deductible is mandatory.

Attach Endorsement MH(F)-22 Collision

e. Consent to Move Mobile Home

This extension of coverage may be provided to avoid termination of coverage when the Mobile Home is moved and without reduction of coverage while the Mobile Home is away from the described premises (but not for collision or upset) at an additional premium.

Attach Endorsement MH(F)-20 Consent to Move Mobile Home

f. Scheduled Glass

Coverage may be added for specified glass at the premiums filed by the Company.

Attach Endorsement MH(F)-44 Scheduled Glass

g. Section II - Liability

The Limit of Liability for Coverage E or F may be increased at an additional premium and the following coverage may also be added to the Mobile Homeowners Policy:

Note: Workers' Compensation coverage or liability on a non-comprehensive basis shall not be added to the Mobile-Homeowners Policy.

(1) Additional Residence Premises - Rented to Others

Coverage may be provided for additional one or two family residence premises, rented to others, owned by the Named Insured or spouse, at an additional premium.

Attach Endorsement MH(F)-34 Additional Residence - Rented to Others, 1 or 2 Families

(2) Business Pursuits

Coverage may be provided for the liability of an insured arising out of business activities, other than a business of which he is sole owner or a partner, at an additional premium.

Attach Endorsement MH(F)-35 Business Pursuits

(3) Outboard Motors and Watercraft

Coverage is provided for watercraft powered by an outboard motor or combination of outboard motors not exceeding 25 total horsepower. Watercraft not covered under the policy may be insured at an additional premium.

Attach Endorsement MH(F)-36 Watercraft

(4) Owned Snowmobile

Each snowmobile owned by the Named Insured or any other insured who is a resident of the Named Insured's household must be declared. The premium charge shall apply separately to each snowmobile.

Attach Endorsement MH(F)-37 Snowmobile

(5) Farmers Comprehensive Personal Liability

Section II can be amended to provide for this coverage at an additional premium.

Attach Endorsement MH(F)-41 Farmers Comprehensive Personal Liability

9. TIE-DOWN CREDIT

When the mobile home is properly secured in accordance with the regulations of the North Carolina Building Code Council as set forth in the State of North Carolina Regulations for Mobile Homes, a credit of 10% shall be deducted from the applicable basic premium.

Attach Endorsement MH(F)-46 Mobile Home Tie-Down.

10. CHANGE ENDORSEMENT

Endorsement MH(F)-26 Change Endorsement, provides the minimum information requirements for any endorsement or change that takes place during the term of the policy. This endorsement must be used or the equivalent information provided.

11. POLICY TERM

The Mobile Homeowners Policy may be written for a term of one year. It is permissible to extend the policy for successive policy terms by extension certificate based upon the premiums in effect on renewal date. The then current editions of the applicable forms and endorsements must be made a part of the policy.

It is permissible to write for one or three year terms on the following bases:

- An annual policy which may be extended for successive terms by Certificate, subject to the rules, premiums, forms and endorsements then in effect.
- A three year policy with the premium payable in installments at the premium in effect on the anniversary dates.
- A three year policy with the premium prepaid at three times the annual premiums in effect at inception.

Endorsement MH(F)-39 Deferred Premium Payment applies.

12. OTHER INSURANCE

Credit for existing insurance is not permitted, except under Section II as provided for in the rate pages.

13. WHOLE DOLLAR PREMIUM RULE

All premiums shown on the policy and endorsements shall be rounded to the nearest whole dollar. A premium of fifty cents ($.50) or more shall be rounded to the next higher whole dollar. In the event of cancellation by the Company, the return premium may be carried to the next higher whole dollar.

14. INTERPOLATION OF PREMIUMS FOR POLICY AMOUNTS NOT SHOWN ON PREMIUM CHARTS

Premiums for limits of liability in excess of the minimums required, not shown in the premium charts, may be obtained by interpolation.

15. INCREASES IN LIMITS OF LIABILITY OR ADDITION OF COVERAGES

The limits of liability may be increased or coverage may be added during the term of the policy. Any additional premium shall be computed on a pro-rata basis subject to all the rules of this manual.

16. MINIMUM ADDITIONAL PREMIUM

When an endorsement requiring an additional premium is issued subsequent to the inception date of the policy, such total additional premium shall not be less than $6.00 regardless of the unexpired policy period.

17. CANCELLATION OR REDUCTIONS IN LIMITS OF LIABILITY OR COVERAGES

It shall not be permissible to cancel any of the mandatory coverages in the policy unless the entire policy is cancelled.

If insurance is cancelled or reduced at the request of the Company, or in the event of foreclosure of the mortgage or other lien on the insured mobile home, the earned premium shall be computed on a pro-rata basis.

If insurance is cancelled or reduced at the request of the Insured, the earned premium shall be computed on a short rate basis, using the standard short rate tables subject to a minimum retained premium of $25.00 unless rewritten by another Mobile Homeowners Policy in this Company.

18. TRANSFER OR ASSIGNMENT

Subject to all the rules of this manual, any necessary adjustment of premium, and with permission of the Company, a Mobile-Homeowners Policy may be endorsed to effect:

a. transfer to another location within the same state; or

b. assignment from one insured to another in the event of transfer of title of the mobile home.

19. RESTRICTION OF INDIVIDUAL POLICIES

If a Mobile Homeowners Policy would not be issued because of unusual circumstances or exposures, the Named Insured may request a restriction of the policy provided no reduction in the premium is allowed. Such requests shall be referred to the Company and must be handled in accordance with consent to rate statutes.

20. REPLACEMENT COST - COVERAGES A AND B

Coverage may be provided on a replacement cost basis for Coverage A and B, at an additional premium.

Attach Endorsement MH(F)-48 Replacement Cost Loss Settlement

21. INFLATION GUARD ENDORSEMENT

Form MH(F)-2 and MH(F)-3 Limits of Liability on Coverage A, B, C & D are automatically increased by the amount of quarterly increase shown on the endorsement for an additional charge.

Attach Endorsement MH(F)-50

22. Personal Property Replacement Cost

Form MH(F)-2 and MH(F)-3 Coverage C may be extended to include full cost of repair or replacement at an additional premium.

Attach Endorsement MH(F)-51

23. Coverage B - Off Premises

Forms MH(F)-2 and MH(F)-3 Coverage B - Other structures may be extended to cover other structures which are located off the residence premises at an additional charge.

Attach Endorsement MH(F)-52

24. WINDSTORM OR HAIL EXCLUSION - TERRITORY 05, 06, 42 and 43 ONLY

The peril of Windstorm or hail may be excluded if:

a. The property is located in an area eligible for such coverage from the North Carolina Underwriting Association; and

b. A Windstorm or Hail Rejection form is secured and maintained by the company.

Attach Endorsement MH(F)-54 Windstorm or Hail Exclusion.

When Endorsement MH(F)–54 is attached to the policy, enter the following on the Declaration Page:

“This policy does not provide coverage for the peril of Windstorm or Hail.”

25. Mobile Home Stated Value Loss Settlement

For an additional premium, your policy may be changed to reflect a stated value for the covered mobile home. For rate information, see Rate Section.

Attach MH(F)-310 (Ed. 9-97)

26. Optional Rating Characteristics

Companies may use the following optional rating characteristics or any combination of such optional rating characteristics and Bureau filed characteristics to determine rates, as long as applicable legal requirements are satisfied. The resulting premium shall not exceed the premium that would have been determined using the rates, rating plans, classifications, schedules, rules and standards promulgated by the Bureau, except as provided by statute. The rating factor for any combination of the following optional risk characteristics cannot exceed 1.00, unless the resulting premium does not exceed the Bureau premium.

a. Policy characteristics not otherwise recognized in this manual. Examples include: account or multi-policy credit; tiers; continuity of coverage; coverages purchased; intra-agency transfers; payment history; payment options; prior insurance; and new and renewal status.

b. Policyholder/Insured personal characteristics not otherwise recognized in this manual. Examples include: Smoker/non-smoker status; credit information; loss history; loss prevention training/education; age; work status; marital status; number of years owned; owned real estate; household composition; and good student/education.

c. Dwelling characteristics not otherwise recognized in this manual. Examples include: Gated community; retirement community; limited access community; mobile home community; revitalized/renovated home; security, safety or loss deterrent systems or devices; age of home; occupancy; fire protection/distance to fire department; and construction type and quality.

d. Affinity group or other group not otherwise recognized in this manual.

e. Any other rating characteristics or combination of characteristics if filed by a company and approved by the Commissioner.

Installment Payment Plan

When a policy is issued on an installment basis, the following rules apply:

The first installment shall be due on the effective date of the policy and the due date of the last installment shall be no later than one month prior to the policy anniversary date.

An additional charge of $3.00 shall be made for each installment.

The premium calculated for the first installment payment, exclusive of installment charges, shall not be less than the pro rata charge for the period from the inception date of policy to the due date of the next installment.

OWNER FORM
$50 Deductible

Seacoast County Surcharge: Territories 05, 06, 42, 43: Owner Form 25.0%
Territories 32, 34, 36, 38, 39, 41, 44, 45, 46, 47, 53, 57, 60

Amount of Insurance					Premium	
A	**B**	**C**	**D**		**MH(F)2**	**MH(F)3**
$ 2000	$ 200	$ 600	$ 200		$ 46	$ 50
3000	300	900	300		58	63
4000	400	1200	400		70	77
5000	200	1500	200		82	91
6000	600	1800	600		94	104
7000	700	2100	700		106	118
8000	800	2400	800		118	133
9000	900	2700	900		130	146
10000	1000	3000	1000		142	160
11000	1100	3300	1100		154	174
12000	1200	3600	1200		166	187
13000	1300	3900	1300		179	201
14000	1400	4200	1400		190	215
15000	1500	4500	1500		202	228
Each Add'l. $1000 Add					12	14

TENANT FORM
$50 DEDUCTIBLE

Seacoast County Surcharge: Territories 05, 06, 42, 43: Tenant Form 21.4%
Territories 32, 34, 36, 39, 41, 44, 45, 46, 47, 53, 57, 60

Amount of Insurance			Premium
C	D		**MH(F)4**
$ 2000	$ 200		$ 43
3000	300		53
4000	400		63
5000	500		73
6000	600		84
7000	700		95
8000	800		104
9000	900		115
10000	1000		125
Each Add'l. $1000 Add			10

1. DEDUCTIBLES

For the purpose of this rule, premium subject to deductible credits shall be the sum of the following:

(1) the premium developed from the Basic Premium Chart for Section 1 Deductible

(2) the premiums for amended limits of liability for Coverage C; and

(3) the premiums developed for all other Structures, Theft Coverage Extension and Coverage C - Increased Limits - Away from Premises, if applicable.

a. <u>Optional Higher Flat Deductible</u>

ALL FORMS - The Mobile-Homeowners Policy may be endorsed to provide a flat (non-disappearing) deductible applicable to any loss under Section 1 of the policy in an amount and at a premium credit developed as follows. The Percentage of premium credit shall be applied to the premium developed above subject to the maximum premium credit indicated.

Owner – Section I Deductible				
Deductible Amount	**$100**	**$250**	**$500**	**$1,000**
Percentage Credit	10%	20%	27%	34%
Maximum Credit:				
Territories 05, 06, 42, 43	$31.25	$62.50	$125.00	$312.50
Territories 32, 34, 36, 38, 39, 41, 44-47, 53, 57, 60	$25.00	$50.00	$100.00	$250.00

Tenant – Section I Deductible				
Deductible Amount	**$100**	**$250**	**$500**	**$1,000**
Percentage Credit	10%	20%	27%	34%
Maximum Credit:				
Territories 05,06,42,43	$30.35	$60.70	$121.40	$303.50
Territories 32, 34, 36, 38, 39, 41, 44-47, 53, 57, 60	$25.00	$50.00	$100.00	$250.00

b. <u>Optional Flat Theft Deductible</u>

ALL FORMS - The mobile-Homeowners Policy may be endorsed to provide a $100 or $250 Flat Theft Deductible applying to loss by Theft of property covered under Coverage C of the policy at a premium credit developed from the table below. The premium subject to this deductible shall be the sum of:

(1) the premium developed from the Basic Premium Chart;

(2) the premiums for amended limits of liability for Coverage C; and

(3) the premiums developed for Theft Coverage Extension and Coverage C Increased Limits Away from Premises, if applicable.

	Owner		**Tenant**	
Theft Deductible Amount	**$100**	**$250**	**$100**	**$250**
Percentage Credit	3%	5%	3%	5%
Maximum Credit:				
Territories 05, 06, 42, 43	$12.50	$18.75	$12.14	$18.21
Territories 32, 34, 36, 38, 39, 41, 44-47, 53, 57, 60	$10.00	$15.00	$10.00	$15.00

c. **<u>Optional Windstorm or Hail Deductibles TERRITORY 05, 06, 42, 43 ONLY</u>**

The Windstorm or Hail Deductible options are used in conjunction with the deductibles applicable to All Other Perils. This option provides for higher dollar deductible amounts of $1,000, $2,000 and $5,000 when the higher deductible amount selected exceeds the deductible applicable to All Other Perils.

An endorsement is not required. Separately enter on the policy declarations the deductible amounts that apply to Windstorm or Hail and All Other Perils. For example: Deductible - $500 except $1000 for Windstorm or Hail.

The Windstorm or Hail Deductible factor applies to the $50 rate.

$1,000 WINDSTORM OR HAIL DEDUCTIBLE*	
All Other Perils Deductible Amount	**Deductible Factor**
$ 50	0.89
100	0.82
250	0.76
500	0.70
*The amount of insurance on the structure must be at least $10,000.	

The Maximum $1000 Windstorm or Hail Deductible credit is $312.50

$2,000 WINDSTORM OR HAIL DEDUCTIBLE*	
All Other Perils Deductible Amount	**Deductible Factor**
$ 50	0.85
100	0.78
250	0.73
500	0.68
1000	0.60
*The amount of insurance on the structure must be at least $20,000.	

The Maximum $2000 Windstorm or Hail Deductible credit is $625.00.

$5,000 WINDSTORM OR HAIL DEDUCTIBLE*	
All Other Perils Deductible Amount	**Deductible Factor**
$ 50	0.82
100	0.77
250	0.70
500	0.66
1000	0.58
*The amount of insurance on the structure must be at least $50,000.	

The Maximum $5000 Windstorm or Hail Deductible credit is $1000.00.

d. <u>Optional Named Storm Percentage Deductibles Territories 05, 06, 42, 43 ONLY</u>

ALL FORMS - The Mobile-Homeowners Policy may be endorsed to provide a Named Storm Percentage Deductible of 1% of the Coverage A or C limit of liability, whichever is greater, when the dollar amount of the percentage deductible exceeds the deductible applicable to All Other Perils. Use **MH(F)-58**, Named Storm Percentage Deductible.

The credits displayed incorporate the credits for the All Perils Deductibles. Do not use the credits for the All Perils Deductibles when rating a policy with a higher Named Storm Percentage Deductible.

The Named Storm Percentage Deductible factor applies to the $50 Deductible rate.

Section 1 Deductible - Owners					
All Other Perils Deductible Amount	$50	$100	$250	$500	$1,000
Percentage Credit	5%	14%	24%	31%	37%
Maximum Premium Credit	$16.45	$32.89	$65.79	$131.58	$328.95

Section 1 Deductible - Tenants					
All Other Perils Deductible Amount	$50	$100	$250	$500	%1,000
Percentage Credit	5%	14%	24%	31%	37%
Maximum Premium Credit	$15.97	$31.95	$63.89	$127.79	$319.47

2. OPTIONAL COVERAGES

a. Other Structures Increased Limits

When an additional amount of insurance is written on a specific Other Structure, the premiums listed on the following page per $1,000 of insurance shall apply separately to each such structure.

FORM	INCREASED LIMIT RATE PER $1,000
MH(F) 2	$ 9
MH(F) 3	11

Attach Endorsement **MH(F)28** Other Structures

b. Credit Card, Forgery and Counterfeit Money Coverage

When Credit Card, Forgery and Counterfeit Money Coverage is provided the additional premium shall be developed as follows:

Limit of Liability	Premium
$ 2,500	$3
5,000	5
10,000	6

For limits in excess of $10,000 refer to Company

Attach Endtorsement **MH(F) 29** Credit Card, Forgery and Counterfeit Money.

c. Money and Securities - Increased Limit

When the limit of liability is increased on money or securities, the additional premium shall be developed as follows:

All Forms	Money	Securities
Per $100 of Insurance	$6	$4

The special limit of liability for theft of jewelry, watches and furs may be increased to $1,000 but not exceeding $500 for any one article. The additional premium shall be $9.

Attach Endorsement **MH(F) 32** Coverage C - Increased Special Limits of Liability.

d. Theft Coverage Extension

ALL FORMS - When the peril of Theft is extended to cover loss of property from unattended vehicles or watercraft, the additional premium shall be $3.

Attach Endorsement **MH(F) 27** Theft Coverage Extension.

e. Personal Property

(1) Increased Limit

When the limit of liability for Coverage C is increased, the additional premium shall be developed as follows:

Form	Per $1,000 of insurance
MH(F)2 or MH(F)3	$10

(2) Increased Limits - Away from Premises

When the limit of liability on personal property away from the premises under Coverage C is increased, the additional premium shall be developed as follows:

All Forms	Each Additional $1,000
Without Theft Extension	$ 9
With Theft Extension	13

Minimum Premium - $9 Minimum Retained Premium for this endorsement when cancelled separately.

Attach Endorsement **MH(F) 33** - Coverage C Away From Premises

f. Mobile Home Lienholders Single Interest

$10 per year, not subject to Short Rate adjustment. Covers lienholders interest from loss by collision, upset, conversion, embezzlement or secretion and repossession return expense.

Attach endorsement **MH(F) 21** Mobilehome Leinholder's single Interest.

g. Trip Collision Coverage

In consideration of a fully earned premium of $15, the policy is extended to cover loss from collision or upset for a period of 30 days – Subject to a mandatory $100 deductible.

Attach endorsement **MH(F) 22** Collision.

h. Consent to Move Mobile Home

In consideration of a fully earned premium of $10, the on premises limits are extended to wherever the Mobile Home may be, for a period of 30 days.

Attach endorsement **MH(F) 20** Consent to Move Mobile Home.

i. Earthquake Coverage

When Earthquake Coverage is provided it shall apply to all Section 1 Coverages for the same limits as provided under the policy. The premium for each $1,000 of insurance shall be developed as follows:

Form	Frame	Applied to:
MH(F) 2, MH(F) 3	.40	Coverage A Limit
MH(F) 4	.30	Coverage C Limit
MH(F) 2, MH(F) 3	.30	Amount of Coverage C Increase Only
All Forms	.40	Private Structure or Coverage D Increased or added limits

Attach endorsement **MH(F) 43** Earthquake.

j. Fire Department Service Charge

The limit may be increased as follows:

- Increase to $250 $2
- Increase to $500 $5

Attach endorsement **MH(F) 45** Fire Department Service Charge.

k. Tie-Down Credit

See general rule 9.

Attach endorsement **MH(F) 46** Mobile Home Tie-Down.

l. Replacement Cost Coverages A and B

When coverage is provided on a replacement cost basis, charge 5% of the premium from the Basic Premium Chart.

Attach **MH(F) 48** Replacement Cost Loss Settlement

m. Inflation Guard Coverage - Form MH(F) 2 and Form MH(F) 3

When the Limits of Liability on Coverages A, B, C & D are automatically increased in accordance with the provisions of the Inflation Guard Endorsement the annual additional premium shall be developed by applying the following charges to the annual premium for Coverage A.

Amount of Quarterly Increase	Charge
1%	1.5%
1½%	2.25%
2%	3.0%
Each Add'l ½% add	¾%

Minimum Annual Premium $1.00. Additional premium for three year policies shall be three times the annual premium.

Attach Endorsement **MH(F)50** Mobile Homeowners Inflation Guard.

n. Personal Property Replacement Cost MH(F) 2 and MH(F) 3

When Coverage C is extended to include full cost of repair or replacement without deduction for depreciation the additional premium shall be developed as follows:

- Manual charge to increase Coverage C limit to 40% of Coverage A.
- 5% surcharge to the adjusted total base premium (including the additional premium for the increased Coverage C limit). The surcharge shall be applied to the Total Adjusted Basic Premium before credit for optional higher deductible is applied. The minimum additional premium is $20.

Attach Endorsement **MH(F) 51** Personal Property Replacement Cost.

o. Coverage B - Off Premises Form MH(F)-2 and MH(F)-3

When Coverage B - Off Premises is provided to cover other structures which are located off the residence premises, the additional charge shall be $33.

Attach Endorsement **MH(F) 52** Coverage B - Off Premises

p. WINDSTORM OR HAIL EXCLUSION CREDIT - TERRITORY 05, 06, 42 and 43 ONLY

When the perils of windstorm or hail are excluded from coverage under Section I of the policy the following credits shall be deducted from the applicable basic premium.

FORM	Territories 05, 06, 42, 43
MH(F) 2 and MH(F) 3	40%
MH(F) 4	30%

q. Mobile Home Stated Value Loss Settlement

When coverage is provided on a stated value basis, charge 3% of the premium from the premium rate table.

Attach endorsement **MH(F) 310** Stated Value Loss Settlement.

SECTION II COVERAGES - LIABILITY - ANNUAL PREMIUMS

3. GENERAL INSTRUCTIONS

When the limit of liability for Coverage E or F is increased or coverage for additional exposures is provided, the additional premium shall be developed from the following tables. The respective limits of liability for Coverage E and for Coverage F must be uniform for all exposures covered under the policy. Coverage F limits indicated below are "each person" limits and contemplate the basic limit of $25,000 each accident. Refer to Company for Limits in Excess of those shown.

LIMITS OF LIABILITY															
Coverage E	**$25,000**			**$50,000**			**$100,000**			**$200,000**			**$300,000**		
Coverage F	**None**	**$500**	**$1000**	**None**	**$500**	**$1000**	**None**	**$500**	**$1000**	**None**	**$500**	**$1000**	**None**	**$500**	**$1000**
Residence Premises	-	-	3	-	1	4	-	2	5	-	4	7	-	6	9
Additional, Residence Premises															
Occupied by Insured (1 or 2 Family)	-	3	4	-	4	5	-	5	6	-	6	7	-	7	8
Rented to Others***** (1 Family)	3	6	7	4	7	8	5	8	9	6	9	10	7	10	11
Rented to Others***** (2 Family)	5	8	9	6	9	10	7	10	11	8	11	12	9	12	13
Residence Employees**	-	2	3	-	3	4	-	4	5	-	5	6	-	6	7

NOTES:

***** Attach Endorsement **MH(F) 34** - Additional Residence Premises - Rented to Others.

****** Charge for each employee in excess of two other than employees whose time of employment is not more than half of the customary full time or to whom the Worker's Compensation exclusion applies as set forth in Section II of the policy.

When coverage is provided by a Mobile-Homeowners for a Secondary Residence premises of an insured whose Primary Residence is covered by a Homeowners, Farmowners or Mobile Homeowners Policy in the same company, the secondary premises shall be endorsed on Section II of the Primary policy at the appropriate charge, and a $7 credit allowed on the Secondary policy if the Primary policy number is shown on the Declarations page of the Secondary policy.

Office, Professional, Private School or Studio Occupancy

When the insured maintains an incidental office, professional, private school or studio occupancy on the premises, the additional premium shall be calculated by adding the appropriate charge from the following table to the premium developed for any required increased in the Coverage C Limit of Liability.

Submit to Company for Medical Payments charges on incidental day nurseries or nursery schools.

LIMITS OF LIABILITY															
Coverage E	**$25,000**			**$50,000**			**$100,000**			**$200,000**			**$300,000**		
Coverage F	**None**	**$500**	**$1000**	**None**	**$500**	**$1000**	**None**	**$500**	**$1000**	**None**	**$500**	**$1000**	**None**	**$500**	**$1000**
Residence Premises															9
General Rule 5.a.*	9	11	13	10	12	14	11	13	15	12	14	16	13	15	17
General Rule 5.b.*	-	3	4	-	4	5	-	5	6	-	6	7	-	7	8
General Rule 5.c.**	4	6	8	5	7	9	6	8	10	7	9	11	8	10	12

NOTES:

***** Attach Endorsement **MH(F)-24** - Office, Professional, Private School or Studio Use - Residence Premises.

****** Attach Endorsement **MH(F)-25** - Office, Professional, Private School or Studio Use - Other Residence.

Watercraft

Coverage must be written to expiration of the policy, but it is permissible to stipulate for inboard motor boats or inboard-outboard motor boats or sailboats (not outboard motors) the navigational period of each year. Premium shall be adjusted on a short rate basis. For boats not described below, coverage is not permitted under the Mobile-Homeowners policy. The premium applicable in the state in which the insured's initial residence premises is located shall apply except that if the insured owns another premises where he maintains a residence and operates his boat principally from such other premises, the premiums applicable in the state where the latter premises are located shall apply.

	LIMIT OF LIABILITY									
Coverage E	**$25,000**		**$50,000**		**$100,000**		**$200,000**		**$300,000**	
Coverage F	**$500**	**$1,000**	**$500**	**$1,000**	**$500**	**$1,000**	**$500**	**$1,000**	**$500**	**$1,000**
Outboard Motor*										
Less than 50 HP	5	6	6	7	7	8	8	9	9	10
50 HP and over	8	10	10	12	11	13	13	15	14	16
Inboard or Inboard-Outboard Motor Boats and Sailboats **										
• Under 16 MPH										
Less than 26 feet	11	12	13	14	15	16	17	18	19	20
26 to 40 feet	30	33	34	37	39	42	44	47	50	53
Over 40 feet	58	65	67	74	76	83	87	94	99	106
• 16 to 30 MPH										
Less than 26 feet	23	26	27	30	30	33	35	38	40	43
26 to 40 feet	47	53	54	60	61	67	70	76	80	86
Over 40 feet	87	98	100	111	114	125	131	142	149	160
• Over 30 MPH										
Less than 26 feet	58	65	67	74	76	83	87	94	99	106
26 to 40 feet	87	98	100	111	114	125	131	142	149	160
Sailboats No Auxiliary Power 26 to 40 feet	23	26	27	30	30	33	35	38	40	43

NOTES:

***** Where two or more outboard motors are regularly used together in connection with any single watercraft owned by the Insured, the horsepower of all such outboards shall be accumulated for rating purposes.

****** Sailboats 26 to 40 feet inclusive equipped with Auxiliary Power are classed as Inboard Motor Boats.

Attach Endorsement **MH(F) 36** Watercraft

Business Pursuits

Classify and apply charge separately for each person insured:

A - Clerical Office Employees - Defines as those employees whose duties are confined to keeping the books or records, conducting correspondence, or who are engaged wholly in office work where such books or records are kept or where such correspondence is conducted, having no other duty or any nature in or about the employer's premises. This classification applies only to persons who are employed exclusively in separate buildings or on separate floors of buildings or in departments on such floors which are separated from all other work places of the employer by structural partitions and within which no work is performed other than clerical office duties.

B - Salesmen, Collectors or Messengers - Including installation, demonstration or servicing operations.

C - Teachers - Athletic, laboratory, manual training, physical training and swimming instruction, excluding liability for corporal punishment of pupils.

D - Teachers - Not otherwise classified, excluding liability for corporal punishment of pupils.

E - Teachers - Liability for corporal punishment of pupils. Additional premium for this coverage must be added to premium for classification C or D.

Occupations not otherwise classified - Refer to Company.

	LIMITS OF LIABILITY														
Coverage E	**$25,000**			**$50,000**			**$100,000**			**$200,000**			**$300,000**		
Coverage F	None	$500	$1000	None	$500	$1000	None	$500	$1000	None	$500	$1000	None	$500	$1000
Class															
A	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
B	2	3	4	2	3	4	3	4	5	3	4	5	3	4	5
C	3	5	6	3	6	7	4	7	8	5	8	9	6	9	10
D	1	2	3	1	2	3	1	2	3	2	3	4	2	3	4
E		2			3			4			5			6	

Attach Endorsement **MH(F)-35** - Business Pursuits.

Farmers Comprehensive Personal Liability

	LIMIT OF LIABILITY									
Coverage E	**$25,000**		**$50,000**		**$100,000**		**$200,000**		**$300,000**	
Coverage F	**$500**	**$1,000**	**$500**	**$1,000**	**$500**	**$1,000**	**$500**	**$1,000**	**$500**	**$1,000**
Initial Farm Premises	21	23	23	26	26	29	29	32	32	35
Each Additional Farm Premises Occupied or Rented	12	13	14	15	15	16	17	18	19	20
Total Acreage for All Locations Occupied or Rented Over 500	5		6		7		8		9	
Farm Employees *										
Per 100 Days or Fraction	6	7	7	8	8	9	9	10	10	11
Each Farm Employee Part Time **	8	9	9	10	10	11	11	13	12	14
Each Farm Employee Full Time	18	20	20	22	22	25	25	28	28	31
Minimum Premium Per Policy	11	13	13	15	14	17	16	19	18	21
Animal Collision **Coverage G**	$300 Limit - $3									

Attach Endorsement **MH(F)-41** - Farmer’s Comprehensive Personal Liability

Owned Snowmobile

Each snowmobile owned by the Named Insured or any other Insured who is a resident of the Named Insured’s household must be declared. The premium charge shall apply separately to each snowmobile. The minimum charge for each snowmobile for any period of coverage within a policy year shall be as indicated below for the respective Limits of Liability.

	LIMIT OF LIABILITY									
Coverage E	**$25,000**		**$50,000**		**$100,000**		**$200,000**		**$300,000**	
Coverage F	**$500**	**$1,000**	**$500**	**$1,000**	**$500**	**$1,000**	**$500**	**$1,000**	**$500**	**$1,000**
Each Snowmobile	-	-	-	-	-	-	-	-	-	-
Annual Minimum Premium	34	35	39	40	42	44	48	50	54	55

Attach Endorsement **MH(F)-37** – Snowmobile

1. TERRITORY DEFINITIONS – (For all Coverages and Perils Other than Earthquake).

A. Cities

City of	County of	Code
Charlotte	Mecklenburg	38
Durham	Durham	32
Greensboro	Guilford	36
Raleigh	Wake	32
Winston-Salem	Forsyth	36

B. Other Than Cities

County of	Code
Alamance	57
Alexander	60
Alleghany	60
Anson	44
Ashe	60
Avery	60
Beaufort	43
Bertie	45
Bladen	41
Brunswick	42
Buncombe	60
Burke	60
Cabarrus	60
Caldwell	60
Camden	43
Carteret	43
Caswell	46
Catawba	60
Chatham	53
Cherokee	60
Chowan	43
Clay	60
Cleveland	60
Columbus	41
Craven	43
Cumberland	34
Currituck	43
Dare	43
Davidson	57
Davie	60
Duplin	45
Durham	53
Edgecombe	47
Forsyth	57
Franklin	47
Gaston	39
Gates	45
Graham	60
Granville	46
Greene	45
Guilford	57
Halifax	47
Harnett	47
Haywood	60

Beach Area – Localities south and east of the Inland Waterway from the South Carolina Line to Fort Macon (Beaufort Inlet), thence south and east of Core, Pamlico, Roanoke and Currituck Sounds to the Virginia Line, being those portions of land generally known as the "Outer Banks."

County of	Code
Henderson	60
Hertford	45
Hoke	47
Hyde	43
Iredell	60
Jackson	60
Johnston	47
Jones	43
Lee	47
Lenoir	45
Lincoln	60
Macon	60
Madison	60
Martin	45
McDowell	60
Mecklenburg	39
Mitchell	60
Montgomery	44
Moore	47
Nash	47
New Hanover	42
Northampton	47
Onslow	42
Orange	53
Pamlico	43
Pasquotank	43
Pender	42
Perquimans	43
Person	46
Pitt	45
Polk	60
Randolph	57
Richmond	44
Robeson	41
Rockingham	60
Rowan	60
Rutherford	60
Sampson	45
Scotland	47
Stanly	60
Stokes	60
Surry	60
Swain	60
Transylvania	60
Tyrrell	43
Union	39
Vance	46
Wake	53
Warren	46
Washington	43
Watauga	60
Wayne	45
Wilkes	60
Wilson	47
Yadkin	57
Yancey	60

Beach Areas in Carteret, Currituck, Dare and Hyde Counties: 05

Beach areas in Brunswick, New Hanover, Onslow and Pender Counties: 06

PREFILED TESTIMONY
OF
ROBERT J. CURRY

2014 MOBILE HOME MH-F INSURANCE
RATE FILING BY THE
NORTH CAROLINA RATE BUREAU

Q: Please state your name and business address.

A: My name is Robert J. Curry. My business address is Insurance Services Office, 545 Washington Boulevard, Jersey City, New Jersey.

Q: By whom are you employed?

A: I am employed by Insurance Services Office (ISO) and have been employed by ISO since October 8, 1984.

Q: What are your responsibilities at ISO?

A: I am generally responsible for managing and overseeing the operations of the Personal Property Actuarial Division at ISO. The Personal Property Actuarial Division is responsible for ISO's total ratemaking operation as it pertains to personal property insurance, including homeowners, dwelling, mobile home and inland marine coverages. We are generally responsible for doing analyses that pertain to ratemaking for the personal property coverages including reviewing experience, making filings, analysis of classification plans, etc. ISO is involved in ratemaking for the personal property coverages in general in all of the 50 states plus the District of Columbia and Puerto Rico. In jurisdictions other than North Carolina, we make filings for advisory loss costs.

Q: What is your employment background?

A: I have been employed by ISO for over twenty-five years in various actuarial positions. I was hired as an Actuarial Assistant in 1984 in the Data Management and Control area. In 1990, I joined Actuarial Development as an Actuarial Consultant coordinating work on the quarterly Industry Operating Results and several Insurance Issues Series studies. In 1994, I joined Actuarial Government Services as a Regional Actuary. In 1998, I joined the Personal Lines Actuarial Division (PLAD) as a Manager and Associate Actuary. In PLAD, I was responsible for personal auto filings in 25 states and the use of catastrophe models in personal property ratemaking. In 2003 I was appointed Assistant Vice President and Actuary of the Personal Property Actuarial Division.

Q: What is your background in actuarial science and your educational background?

A: I have a Bachelor of Science degree in mathematics from Cook College at Rutgers University. I am a Fellow of the Casualty Actuarial Society (FCAS) and a member of the American Academy of Actuaries. I have met the continuing professional education requirements of the CAS and AAA through the current period. I am a Chartered Property Casualty Underwriter (CPCU). I have also earned the Associate in Insurance Accounting and Finance (AIAF) and Associate in Regulatory Compliance (ARC) designations. I have served on the Casualty Actuarial Society (CAS) Examination Committee, CAS Syllabus Committee, CAS Committee on Special Interest Seminars, CAS Trust Scholarship Committee, CAS Ratemaking and Product Management Seminar Committee and the CAS Continuing Education Committee. I was the chairman of the CAS Predictive Modeling Seminar Committee. I have also served as a member of the American Academy of Actuaries Committee on Automobile Insurance Issues. I am currently a member of the CAS Brand Marketing Task Force.

Q: Are you familiar with mobile home insurance ratemaking in North Carolina and other states?

A: Yes. As part of my duties at ISO, I am familiar with the data collection and ratemaking procedures in use in property insurance, including for mobile homes, in states in addition to North Carolina. I am responsible at the present time for either preparing or supervising the preparation of personal property insurance filings for all of the states and the District of Columbia and Puerto Rico. I have worked on all Bureau property reviews and filings in North Carolina since 2003 including the two 2008 mobile home filings.

This MH-F filing relates to the Rate Bureau's MH-F program which is used by a number of companies to write insurance on mobile homes in North Carolina. There are other manners of writing insurance on mobile homes in North Carolina (including using the MH-C program), but in this filing and my prefiled testimony, references to mobile homes, mobile home coverages and mobile home ratemaking are intended to apply only to the MH-F program that is the subject of this filing, unless otherwise noted.

Q: What work have you performed with respect to the Bureau's 2014 MH-F Rate Filing (hereafter referred to as the filing or the mobile home rate filing)?

A: Through ISO I have been involved in the preparation of the 2014 mobile home rate filing for the Bureau in several respects. First, ISO, as a licensed statistical agent in North Carolina, collects insurance data from a significant number of the companies which write in North Carolina.

Second, ISO collects, reviews and compiles data from two other statistical organizations licensed in North Carolina that collect mobile home data from Bureau member companies. All companies writing mobile home insurance in North Carolina report must report to one of the licensed statistical organizations. The other two organizations are: the Independent Statistical Service (ISS), and the National Independent Statistical Service (NISS).

Third, ISO provides consulting actuarial services directly to the Bureau. I have been directly involved in this aspect of the Bureau's property insurance rate filings for a number of years. As in the past, my staff and I compiled the ratemaking data to be reviewed by the Property Rating Subcommittee, the Property Committee and the Governing Committee in preparation of the filing.

Fourth, under my direction, my staff put together the vast majority of the data, information and calculations contained in Exhibit RB-1. This lengthy process was performed under the ultimate direction of the Bureau committees.

Finally, I have reviewed the filed rates to determine if they are calculated in accordance with the Casualty Actuarial Society's (CAS) Statement of Principles Regarding Property and Casualty Insurance Ratemaking. In accordance with Actuarial Standard of Practice No. 17 Expert Testimony by Actuaries, I conducted my review in terms of reasonableness rather than solely in terms of whether there is precise agreement on each issue. In addition, I applied the rate standards set forth in North Carolina General Statute 58-36-10, i.e., that rates must not be excessive, inadequate or unfairly discriminatory and that certain statutory rating factors must be considered.

Q: What is the source of the data utilized in Exhibit RB-1?

A: The ratemaking experience reflected in Exhibit RB-1 is, in general, supplied by the individual insurance companies that write mobile home insurance policies in North Carolina. Those companies submit their data to one of the three statistical organizations described above. The three statistical organizations subject each company’s data to a series of verification edits and then consolidate the data. The statistical agents then transmit their consolidated data to ISO for final review and consolidation with the ISO data. After consolidating the data, ISO produces exhibits of the combined data in a format and detail necessary for review by the Rate Bureau committees and ultimately for use in rate filings.

The statistical agents are licensed by the Commissioner of Insurance in North Carolina. They have collected, reviewed, compiled and submitted the data underlying this filing as a regular practice and in the regular course of their business responsibilities as licensed statistical agents in North Carolina.

Q: What statistical data supporting the filing are contained in Exhibit RB-1?

A: In general, the supporting data for the rate level changes are contained in Section C. The most recent five years of experience are displayed in Section C.

The loss experience used in the filing is what we call "accident year" experience for the years ended December 31, 2007 through December 31, 2011. I can explain what is meant by accident year experience by providing an example. The losses for the accident year ended December 31, 2011 consist of all losses caused by accidents which occurred during the one year period ended December 31, 2011. If an accident occurred December 29, 2011 and resulted in either a loss being paid or a reserve being established after January 1, 2012, that loss would be a part of the accident year losses for the period ended December 31, 2011. The test for breaking losses down into accident years is the date the accident occurred.

Q: What is the reason for using five years of data to determine the indicated rate level change?

A: Ratemaking is prospective. The objective is to set rates at the level sufficient to pay expected losses, expected expenses and leave a reasonable margin for profit. Rates are set for the period when they will be in effect, which for this filing is assumed to be for three years. Past loss data are generally examined for the purpose of projecting expected losses. For types of loss other than hurricane losses (for which a model is used) and non-hurricane catastrophic wind losses (for which a separate excess wind smoothing procedure is employed), five years of data are considered to be actuarially appropriate to balance the stability of the rates with responsiveness to more recent conditions. The North Carolina statutes allow the Rate Bureau to review five years of experience in its rate level filings in addition to other factors that are to be considered.

Traditional mobile home ratemaking has for many years relied on the consideration of five years of experience with weights of .10, .15, .20, .25 and .30 being given to each year respectively as the way to achieve a balance of stability and responsiveness. Those weights are used in the filing as in past Bureau mobile home filings. The weights used by the Bureau are identical to those used by Insurance Services Office in all other states for property insurance. These weights are generally accepted in all jurisdictions in which ISO makes property filings.

Q: Please turn to page C-1 of Exhibit RB-1. Would you explain what that page shows?

A: Pages C-1 and C-2 are what are called the statewide rate level calculations for mobile home forms for North Carolina. These pages show a determination of what the actuarially indicated rate level changes. The data shown are for all business written in the state on those forms. As will be discussed below, the overall mobile home program to which this filing applies consists of two categories of forms: the forms for owners and the form for tenants. Page C-1 deals with the owners forms, and similar calculations are shown on C-2 for the tenants form. As can be seen in the filing, the owners forms constitute the overwhelming majority of the premium volume. For convenience in explaining the filing in my prefiled testimony, I will primarily explain the data and methodology with respect to the owners forms, but such explanations generally apply to the tenants form as well.

Q: Referring to column 1 on page C-1, what are "Incurred Losses Excl. Hurricane"?

A: The incurred losses in column 1 are the losses from all causes, except those losses identified as being caused by hurricanes or excess wind, from insured events which occurred during each of the respective accident years. The figure includes losses which have already been paid, losses which are not yet paid and are represented by outstanding claim reserves, and losses which have been incurred but for which no individual reserve exists because they have not yet been reported.

Q. Have the losses excluding hurricanes as shown in column (1) been adjusted in any way?

A. Yes, there has been consideration of loss development. Historical loss development data was not available for mobilehome so selected loss development factors of 1.00 were used. We believe that based on loss development for other residential property lines that the losses are probably understated.

Q: What data was used to develop the non-modeled excess factor of 1.055?

A: The development of the non-modeled excess factor is shown on page D-36. Because a long enough history of mobilehome losses was not available, the data from the excess exhibit from the last homeowners filing was used for 1950-1999, 2005-2006 mobilehome data was used for 2000-2004 and 2007-2011.

Q: Was it necessary to exclude hurricane losses for this procedure?

A: Yes. The relationship between excluded hurricane losses and total losses was used.

The method to remove the hurricane losses depends on the detail of the available data. For 1950-1965 only statewide data are available, and it is from dwelling policies for the early years. Consequently for a year in which a hurricane occurred, losses from that year are removed from the calculation of the statewide non-hurricane excess factor.

Since territory data are available (in varying detail) for 1966-2011, the calculation of the non-hurricane losses is done at the territory level for this period. After it has been determined that a particular hurricane is accounted for by the AIR hurricane model, the territories affected (territories exposed to wind speeds of 50 MPH or higher) are determined by the use of recorded wind speeds and central pressures at 6 hour intervals, storm tracks, and wind to non-wind ratios.

For 1966 - 1985, the non-hurricane wind losses for a territory are calculated by replacing the hurricane year wind to non-wind ratio by the average wind to non-wind ratio of the non-hurricane years. Given the revised wind to non-wind ratio for the hurricane year, the reported non hurricane total losses and the reported non hurricane wind losses are then “backed into.” For the years (1966 - 1982) in which the old territory codes (01-04) were in effect, the average wind to non-wind ratios are based on the non-hurricane years from 1966 - 1982. For the years 1983 to 2004 in which the revised territory codes (04, 30-41) were in effect, the average wind to non-wind ratios are based on the non-hurricane years from 1983 to 2004. For the territory codes introduced as part of the 1993 filing, the average wind to non-wind ratios from the predecessor territories have been used.

For 1986-September 1995, territory losses by month are available for ISO data only. The territory non hurricane losses for this period are calculated as follows: first the average losses for the month in which the hurricane occurred are calculated based on the non-hurricane years. The average monthly losses are then added to the eleven remaining months of the hurricane year and divided by the hurricane year annual losses resulting in a non-hurricane adjustment factor. This factor is then applied appropriately to either reported losses or adjusted losses by territory for all statistical agents to obtain non hurricane losses. For severe hurricanes, wind type losses are frequently reported as water losses or all other property damage losses. To accurately estimate the non-hurricane losses, the above non hurricane factors are calculated for water and all other property damage and then applied to the water losses and the all other property damage losses. This procedure is conservative because the mobile home policy forms cover flood losses.

For October 1995-2011, based on information from NOAA and other sources, the specific dates on which a given hurricane was active in North Carolina are determined. The loss experience for ISO is then examined by date and cause-of-loss. Wind losses and losses for other weather-related perils which occurred on these dates are assumed to be hurricane losses. For ISO data, the percentage of hurricane losses to total losses is calculated. To estimate the hurricane losses for statistical agents other than ISO, the percentage of hurricane losses in the ISO data (relative to the ISO yearly total) is applied to the total loss amounts for the other statistical agents.

For 2003-2011, the data described above are also available from ISS and have been examined together with the ISO data. For the combined ISO and ISS data, the percentage of hurricane losses to total losses is calculated. To estimate the hurricane losses for statistical agents other than ISO and ISS, the combined percentage of hurricane losses from ISO and ISS data (relative to the ISO and ISS yearly total) is applied to the total loss amounts for the other statistical agents.

Q. Can you use the year 2011 as an example of how losses have been smoothed and how the smoothing affects the indications?

A. Yes. The year 2011 was a bad year for insurance companies in North Carolina, but the smoothing process reduced its impact significantly. Total losses without any smoothing were $57,127,361. We know that there was a relatively weak Cat. 1 hurricane in 2011 (Irene), and we also know that there were a number of non-hurricane wind events that made 2011 a greater than normal year in terms of such losses. Hurricane losses in the amount of $23,375,602 were removed because we use the long term average hurricane loss costs from the AIR model rather than the actual losses from the five year period. The long term average hurricane losses are $5,260,952. We also analyzed the non-hurricane wind losses and removed a large number of those losses under our excess wind procedure which was described above. By using that excess wind procedure, we removed $16,581,164 in losses and spread those losses over the long run by the use of the excess wind factor. If our ratemaking procedure had not removed the actual hurricane losses and substituted the long term average, and if the ratemaking procedure had not removed the actual excess wind losses and used the excess wind smoothing procedure, then the statewide rate level indications would be +62.2% rather than 31.5%. These smoothing procedures have been consistently applied by the Bureau for many years and serve to keep rate indications significantly lower than they otherwise would be following years with high wind losses.

Q: Do you have an opinion as to whether the incurred losses excluding hurricanes shown in column 1 on page C-1 of Exhibit RB-1 accurately represent the anticipated value of incurred losses excluding actual hurricane losses which resulted from accidents which took place during each of the years ended December 31 in North Carolina?

A: Yes, I do.

Q: What is that opinion?

A: I believe that the losses shown in column 1 do accurately represent the expected ultimate value of those losses excluding actual hurricane losses.

Q: What other adjustments must be made to the losses?

A: The losses need to be adjusted by trend to reflect the cost levels anticipated to prevail during the period that the proposed rates are expected to be in effect. For this filing the assumed effective date is June 1, 2015. This date is relevant for trending purposes as explained in my testimony. If the filing were to become effective on a date later than the June 1, 2015 assumed effective date, then the rate indications would be even higher than those set forth in the filing.

Q: Could you please describe how the loss trend is developed and applied?

A: The loss trend is developed in a two-step process. The first step is the development of a current cost factor which brings the losses up to the cost level of the external Current Cost Index that is used as the basis of loss trend. The second step is the development of a loss projection factor based upon an exponential fit of the last twelve quarters of the Current Cost Index and the actual pure premium trend. The loss projection factor projects the losses from May 15, 2014 (the midpoint of the latest quarter of the external index) to June 1, 2017, the average date of loss for policies which will be written at the proposed rates which are expected to be in effect for three years (i.e. two years beyond the assumed effective date of June 1, 2015).

Q: You mentioned that the loss trend is based on a Current Cost Index. What are the components of the Current Cost Index used for the owners forms?

A: The Current Cost Index is a weighted average of the Modified Consumer Price Index (MCPI) and the Boeckh Residential Index (BRI), with the MCPI receiving 45% weight and the BRI receiving 55% weight. The intent of the weights is to reflect the split between contents type losses and buildings type losses. The weights and methodology are the same as used in prior filings.

Q: How are the weights of 55% to the Boeckh Residential Index and 45% to the Modified Consumer Price Index determined?

A: The weights were based on an examination of losses by cause of loss and apportioning the losses between buildings and contents. For example, if we were to examine the North Carolina homeowners losses (normalized for catastrophe losses) by cause and split them into percentages that correspond to buildings and contents, we would get:

Cause	% of Total	Building %	Contents %
Fire	29.1	75-80	20-25
Wind & Hail	39.0	80-90	10-20
Water Damage & Freezing	19.5	40-45	55-60
Theft	5.6	5-10	90-95
All Other PD	4.3	50	50
Liability	2.5	0	100
		63-70	30-37

Q: What is the Boeckh Residential Index?

A: The Boeckh Residential Index is an index of construction costs compiled by Marshall & Swift/Boeckh. The particular index used in this filing is based on information compiled specifically for construction costs in North Carolina.

Q: What is the Modified Consumer Price Index?

A: The Modified Consumer Price Index is composed of selected components of the Consumer Price Index which correspond to the items for which mobile home insurance provides coverage. The components used and the weights given to them are House Furnishings (48%), Medical Care (20%), Apparel Commodities (16%) and Entertainment Commodities (16%).

Q: Please illustrate what factors would be applied to trend the losses for the year ended December 31, 2011.

A: The losses from the accident year ended December 31, 2011 are first adjusted by the Current Cost Factor for 2011 of 1.051 which is found on page D-12. The Current Cost Factor is the ratio of the Current Cost Index from the quarter ending June 30, 2014 to the Current Cost Index value for the full year 2011. The Current Cost Factor brings the losses from the cost levels corresponding to an average date of loss of June 30, 2011 to the cost levels corresponding to the midpoint of the latest quarter (May 15, 2014). Since the average date of loss for policies which will be written at the proposed rates is assumed to be June 1, 2017 (two years past the assumed effective date) it is necessary to project the losses from the May 15, 2014 cost level to that assumed effective date. This is accomplished by projecting the losses at the annual rate of change of 1.6% (as determined by an exponential fit of the Current Cost Index) for 36.5 months. This factor is calculated on page D-11.

Q: You mentioned that the actual pure premium trend was considered in the selection of trend factors. How was this data used?

A: The pure premium experience was examined. A pure premium is the ratio of the losses to the number of insured house years. These data were fit to an exponential curve and an annual rate of change was calculated. This rate of change was compared to the annual rate of change of the Current Cost Index. In reviewing the loss trends, the annual rates of change in mobile home pure premium during the 2007-2011 experience period are higher than the observed annual changes in the external indices. Therefore, to project losses to a 2015 level, a 2.5% additional annual loss trend adjustment was selected by the Bureau. This results in the 4.1% annual rate of change used to trend the prospective losses.

Q: Where on page C-1 are these two factors applied?

A: The Current Cost Factor for each year is applied as part of the current cost/current amount factor in column 5. For example, for the year ended December 31, 2011 the Current Cost/Current Amount Factor of 0.977 is the ratio of the Current Cost Factor of 1.051 (shown on page D-10) and the Current Amount Factor of 1.076(shown for that year on page D-27). The Loss Projection Factor is combined with the Premium Projection Factor and the trend from first dollar to produce the Composite Projection Factor. This Composite Projection Factor is applied in column 7 in the development of the Trended Base Class Loss Cost in column 9 on page C-1.

Q: You mentioned the trend from first dollar. Could you describe what that is and how it is developed and applied?

A: The index is a first dollar index. Losses are at different deductible levels. As such, increases in cost as measured by the current cost index would affect losses below the deductible and cause an additional increase as losses below the deductible increase above it. For example, a loss of $1,000 subject to a $250 deductible results in a payment of $750 to the insured. If there is 10% inflation the $1,000 loss grows to $1,100. This results in a payment to the insured of $850, which is a resulting effective inflation of 13.3%, an incremental trend of 3%. The procedure used in the filing accounts for this effect. The procedure in essence converts all the losses to a first dollar basis before the trend factor is applied. To obtain the resulting trended losses, the deductible portion of the trended losses are subtracted out. The trend from first dollar factor as shown on page D-18 is the incremental difference in the trend factor resulting from the application of our procedure. Using our example from before, and the formula for trend from first dollar on page D-18 results in a trend from first dollar factor of 1 + (((.1) (250))/((1.1)(750))) = 1.03, which matches what was calculated earlier.

Q: Please refer to column 4 of page C-1. With reference to the column headed "losses with LAE," please tell us what the figure $20,832,225 represents.

A: These are the losses and loss adjustment expenses associated with claims or accidents that occurred in the accident year ended December 31, 2011. The losses are the sum of the adjusted incurred losses excluding hurricane losses found in Column 1, minus the non-modeled adjusted excess losses in Column 2, all multiplied by the non-modeled excess factor of 1.055 adjusted by a trended loss adjustment expense factor of 1.15.

Q: How is the trended loss adjustment expense factor of 1.15 developed?

A: Each year the Rate Bureau sends a call to its member companies for expense-related data. These calls showed that loss adjustment expenses for the calendar years December 31, 2007, December 31, 2008, December 31, 2009, December 31, 2010 and December 31, 2011, after dropping the high and low values averaged 14.6% for the period as shown on page D-34.

This factor of 14.6% must be adjusted for the change in cost levels of the items that go into loss adjustment expenses. These expenses include items like adjuster's salaries, rents and overhead items related to claims settlement. In essence, these items will vary as general economic trends vary. We adjust the loss adjustment expense factor by taking a ratio of the expense trend to the loss trend on page D-35. This adjustment results in a trended loss adjustment factor of 1.15.

Q: Could you please explain how the expense trend used to adjust the loss adjustment expense factor is developed?

A: The expense trend used to adjust the loss adjustment expense factor is based on an analysis of the Current Expense Index, which is an index based on a 50/50 weighting of the all items CPI (less energy) and the compensation cost index, which were the latest available when the selection was made, for marine, fire and casualty insurance. The data for this index are shown on pages D-29-32. Based on an analysis of these data, an annual rate of change of 2.0% was selected by the Bureau.

Q: Please explain the development and application of the expense projection factor in adjusting the loss adjustment expense factor?

A: The five year (excluding the high and low values) average loss adjustment expense factor of 14.6% reflects an averaging of the five years 2007, 2008, 2009, 2010 and 2011. As such the factor is representative of the time period corresponding to 2009.

The expense projection factor uses the 2.0% annual rate of change based on an exponential curve of the Current Expense Index. Since the loss adjustment expense ratio is at the cost level corresponding to July 1, 2009, it is necessary to project this cost to the average date of accident for the period which our rates are assumed to be effective, June 1, 2017 (two years beyond our assumed effective date). This calculation is displayed on page D-35.

Q: What other adjustments must be made to the loss adjustment expense factor in order to use it?

A: The loss adjustment expense factor is determined as the ratio of loss adjustment expenses to losses. Having adjusted the expense portion of the factor in the numerator, we need to adjust the losses in the denominator by the loss trend to reflect both the current cost factor and the loss projection factor.

Q: Could you please describe what is being done in Column 5 on page C-1?

A: In Column 5 the current cost factors and current amount of insurance factors are combined into the current cost/current amount factors. This is done by taking the ratio of the current cost factor to the current amount factor. For example, the current cost/current amount factor of 0.977 for 2011 is the ratio of the 2011 current cost factor of 1.051 to the 2011 current amount factor of 1.076. In combining these steps the losses and average rating factor have been brought to the cost level of May 15, 2014.

Q: Please describe the development of the current amount factor.

A: The current amount factor is calculated by taking the ratio of the average policy size relativity for each year to the projected policy size relativity as of May 15, 2014, the same projection date as is used for the losses in the development of the current cost factor. The average policy size relativity is calculated by taking a weighted average of the policy size relativity curve for each amount of insurance using the exposures for each amount of insurance as weights. By taking the ratio of these relativities for each year to the May 15, 2014 value, we are in effect measuring the percentage growth in the premiums at present rates from year to year caused by changes in amount of insurance. These changes in average amount of insurance are not based on a consistent set of insureds, since some of the growth is due to the addition of new mobile homes. Selections of annual growth of 2.1% for $250 deductibles, 1.6% for $500 deductibles and 3.7% for $1,000 deductibles were made by the Bureau.

Q: How is the current amount factor used in the calculation of the indicated rate level change?

A: The current amount factor for each year is the denominator in the current cost/current amount factor for that year shown in column (5) of page C-1. The premium projection factor is the denominator in the composite projection factor used in column (7) of page C-1. The combined effect of these two factors is to bring the average rating factor to the level for the amount of insurance expected to prevail during the period for which these rates are expected to be in use. For example, for 2011 the current cost factor is 1.051 and the current amount factor is 1.076. The ratio of these two factors results in a current cost/current amount factor of 0.977 which appears in column 5 on page C-1 in the 2011 row.

Q: Could you please describe what is being done in Column 7 of page C-1?

A: Column 7 combines all of the elements in Columns 1 to 6. In Column 7, the losses and loss adjustment expenses are trended to the cost level expected to prevail during the period in which the policies written at the proposed rates will be providing coverage (average date of accident of June 1, 2017. The house years in column 6 are also projected to reflect the anticipated amounts of insurance for business written between June 1, 2015 and May 31, 2018. As an example, the calculation of column 7 for 2011 is:

(1) Adjusted Incurred Losses Inc. LAE (C-1, Col 1): 33,751,759

(2) Excess Losses (C-1, Col. 2): 16,581,164

(3) Incurred Losses-Excess Losses
(C-1, Col.3): 18,114,978

(4) Losses * LAE Factor (C-1, Col 4): 20,832,225

(5) Current Cost/Amount Factor
(C-1, Col.5 from page D-16): 0.977

(6) Earned House Years (C-1, Col. 6): 69,896

(7) Trended Average Loss Cost
(C-1, Col. 7)(4)*(5)*(CPF)/6): 315.65

Q: Please describe the development of the premium projection factor.

A: As I mentioned earlier, for each year we have an average policy size relativity which is calculated as a weighted average of each amount of insurance relativity. The premium projection factor is calculated by fitting an exponential curve to the average policy size relativities. This curve is used to develop an annual rate of change for the policy size relativities. Since the current amount factor has been calculated as the value up to May 15, 2014, the premium projection factor will be calculated as the expected growth from May 15, 2014 to December 1, 2016 (which is eighteen months beyond the assumed effective date of June 1, 2015). This date of December 1, 2016 represents the midpoint of the three years for which policies are assumed to be written using the proposed rates. This results in a premium projection factor of 1.057 which is shown on Page D-28.

Q: Could you please explain column 8 on page C-1?

A: Column 8 is the average rating factor for the policies purchased in each year. The average rating factor is the ratio of the average rate at manual level to the average current base rate. For example, let's assume that the current territory base rate for a $25,000 mobilehome is $100, that the rating factor for a $500 deductible is .90 and that the rating factor to purchase replacement cost coverage is 1.2. Then the average rating factor for this policy is calculated as:

$$(100 * 1.2 * 0.9) / 100 = 1.08$$

This factor is needed to adjust the average trended loss costs in column (7) to a base class level. Since most policyholders do not purchase exactly the base amount of coverage, the average trended loss cost is divided by the average rating factor to convert this average trended loss cost into a trended base class loss cost which is shown in column 9.

Q: Could you please explain line 11 on page C-1?

A: Line 11 is the resulting weighted trended non-hurricane loss cost obtained by applying the accident year weights shown in Column 10 to the trended base class loss cost for each year shown in Column 9. This weighted trended base class loss cost is the forecasted base class non-hurricane loss cost for policies written during the three-year period after the assumed effective date of June 1, 2015, if there were no changes in rate level.

Q: Could you please explain line 12 on page C-1?

A. Line 12 is the reflection of the credibility of the experience based on the number of house years during the five year period. The MH-F review used the homeowners credibility standards. The homeowners full credibility standard is based on a procedure considering the frequency of claims and the variability of the size of those claims. The procedure is explained in a CAS Proceedings Paper "Credibility of the Pure Premium" by Mayerson, Jones and Bowers. The full credibility standard is based on a normal distribution with a 90% probability of the pure premium being within 5% of the expected value. The full credibility standard for the owners forms is 240,000 house years.

Q: Could you please describe the figures contained in Line 13 labeled "Trended Modeled Hurricane Base-Class Loss Cost" on page C-1?

A: These are the prospective hurricane losses resulting from the model used by AIR Worldwide Inc. (AIR).

Q: How are these losses for each year derived?

A: The AIR model simulates 100,000 years of hurricane losses and develops a mean hurricane loss cost per $1,000 of coverage by territory. The model's aggregate demand surge accounts for the expected additional cost for supplies and labor if a very large hurricane event occurs. The modeled hurricane losses also include a loading for storm surge losses since the mobile home policy covers flood losses. However it should be noted that the AIR model only generates storm surge losses for the coastal areas and not for the inland areas. To produce the modeled hurricane losses, the Rate Bureau has multiplied the hurricane loss cost per $1000 of coverage times the amounts of insurance in effect. The calculations of the 2011 modeled hurricane losses are shown on pages D 39-40.

Q. How is the amount of insurance that is in effect determined?

A. For the purpose of developing the hurricane loss cost for the owners forms, the amount of insurance in effect is determined as the sum of the various internal limits found in a mobilehome policy -- the Coverage A amount (building coverage), the Coverage B amount (other structures), the Coverage C amount (contents) and the Coverage D amount (loss of use). In terms of the buildings coverage amount, the amount of insurance in effect is:

Coverage A	100%
Coverage B	10%
Coverage C	30%
Coverage D	10%
	150%

Therefore, for the purpose of determining the hurricane loss cost, the amount of insurance in effect is 150% of the Coverage A amount. This is also often referred to as the total sum insured.

Q: Why was a simulation model used to develop the hurricane losses?

A: A simulation model was used to develop the hurricane losses because it is a more accurate way of including the exposure than using traditional insurance statistics. Hurricanes are highly variable in frequency, intensity and place of occurrence. The simulation model allows for the smoothing out of the hurricane losses as well as better reflecting a more complete distribution of the types of hurricanes that could occur and the potential for losses from these hurricanes at a given location. For example, since we are using the losses from five years of data in the basic ratemaking calculation, if a very large loading for hurricanes like Fran or Floyd hit a certain part of the state during those years, it would be reflected only in those areas of the state, with little or no loading for other areas of the state. Conversely, if there was a five year period without any hurricane activity, it would not be actuarially appropriate to assume that would be the expectation for the future time period. The simulation model produces a more accurate estimate of the loss potential both in terms of territory and dollar value than is possible using any analysis of the insurance data alone.

ISO relies upon the results of the AIR model in the normal course of its making loss cost filings for the other hurricane-prone states and for making commercial property loss cost filings in North Carolina.

Q: What role did you play with respect to the model?

A: As part of my role as a consultant to the Bureau, as well as part of my role as an ISO actuary who relies upon AIR's hurricane model for ratemaking purposes in numerous states, I have participated in several detailed examinations of the AIR model over the years. Other actuaries at ISO and I review changes when new versions of the AIR model are introduced, in order to make sure that our use of the model complies with actuarial standards of practice.

AIR developed version 14.0.1 of its hurricane model in 2013 and it is employed in the filing. This version has been extensively examined and approved by the Florida commission that extensively examines hurricane models. I participated in a due diligence type of analysis with respect to the newest version of the model and its use in this filing. We examined many aspects and changes to the model including those affecting the number of storms that cause loss in North Carolina and the prospective loss costs by territory in North Carolina.

I also examined and considered actual hurricane losses in North Carolina in connection with excluding those losses from the incurred losses in the filing. I determined that the limited amount and the age of much of the available loss data call into question the validity of employing such data for a number of reasons. For one thing, much of the past loss data is quite old and of limited utility. It includes losses from hurricanes that occurred decades ago when mobile home location patterns were different, when they were built differently, when building codes were different, when construction prices were different, when they had very different contents, when labor costs and practices were different, etc. The most recent five years do not constitute a valid sample. Indeed, there is not enough insurance loss experience from hurricanes since accurate records began to be maintained for actuaries to employ actual events as opposed to models. Actual events are not properly predictive of the range of hurricane events that can occur next year and the probability of occurrence of those events.

On the other hand, I have concluded that the AIR model is robust, is scientifically based and is far more fair and accurate than employing actual past loss data. It accounts for the risk and likelihood of future losses from hurricanes based on scientific principles rather than on the happenstance of when and where past hurricanes happened to occur. After reviewing the changes to the model that are contained in version 14.0.1, it was my conclusion, as well as that of my company and the Rate Bureau, that this latest version is based on scientific advances, is accurate, is appropriate for use in this filing and constitutes the best available information as to prospective hurricane losses.

Q: What did ISO furnish to AIR to enable AIR to perform its analysis?

A: ISO furnished to AIR the North Carolina mobilehome insurance exposure data on the total number of earned house years and earned insurance years by territory for the most recent year in the experience period. These data included ISO, NISS and ISS data and were compiled by ISO. These data are correct to the best of my knowledge, information and belief.

This procedure of sending data to AIR in order to run the hurricane model is similar to the procedure that ISO uses in its loss cost reviews for every other hurricane-prone state. AIR then uses its industry database to distribute the territory data to individual zip codes.

An additional improvement in accuracy occurs when a zip code is in both a beach and inland territory. In this situation AIR employs a split zip code procedure to more accurately model the losses. This treatment has been in general use for other states and is now used in North Carolina. The procedure results in a more appropriate reflection of the expected hurricane losses.

Q: How are these modeled hurricane losses derived?

A: The AIR model simulates many years of hurricane losses and develops hurricane losses for the portfolio of North Carolina exposures provided. The development of the modeled hurricane losses is shown on page D-39.

Q: Could you please explain what line 17 entitled "fixed expense per policy" on page C-1 refers to and what it represents?

A: Line 17 "fixed expense per policy" refers to the dollars of the prospective premium that the general expenses will be on policies written between June 1, 2015 and May 31, 2018. General expenses along with other acquisition expenses constitute the so-called fixed expenses. They are fixed in that they do not vary as a direct function of the premium dollar. For example, the cost of office equipment, rent and other overhead-type expenses would be among the items classified as either general expenses or other acquisition expenses. Those expenses are fixed in the sense that they do not vary directly as a function of premium. Such things as commissions and premium taxes, on the other hand, are examples of expenses which do rise or fall directly with premium. The number shown on line 17 - $18.27- represents the dollars of general expenses trended to the levels anticipated to prevail during the periods from June 1, 2015 to May 31, 2018 (the average date of which is December 1, 2016) and the projected premiums for business written during the same period. This is appropriate because general expenses are generally incurred at the time a policy is written.

Q. Could you explain how the figure $18.27 on line 17 of page C-1 was derived?

A. The derivation of the 18.27 is shown on page D-35 in line (4) "Factor for trending GE, OP expenses based on Current Expense Index." It starts out with an untrended general expense ratio of .0296 which is based on the rounded average of the 2009, 2010 and 2011 general expense ratios. These are shown on page D-25. The average of these represents the average expense ratio corresponding to 2010. In order to trend these to the cost levels anticipated to prevail between June 1, 2015 and May 31, 2018, we project these by using the Current Expense Index described earlier. This is done by means of a two-step process. First the expenses are trended by a factor based on the annual rate of change in the Current Expense Index. This is the factor of 1.135 shown under Section (4) next to the label "All Forms" on page D-27. Since we are dealing with a ratio of expenses to premium we must project the amount of insurance from 2010 levels to the level anticipated to be in effect on business written between June 1, 2015 and May 31, 2018. This is done by using the current amount factor for 2010 of 1,125 and the premium projection factor of 1.057. The resulting calculation is

$$\frac{.0296 \times 1.135}{1.125 \times 1.057} = .028.$$

A similar calculation is done in order to get the trended other acquisition (OA) expenses ratio. The sum of these two fixed expense ratios (.028 and .038) is then multiplied by the average current base rate of 276.85. The result is a statewide fixed expense loading of 18.27.

Q: What does Line 18 show on page C-1?

A: Line 18 is a combination of the trended base class loss cost and the trended general expense and other acquisition expenses. The figure $185.89 is the dollar amount that is required to cover the portion of the insurance base rate that covers losses, loss adjustment expenses, general expenses and other acquisition expenses.

Q: What does line 19 on page C-1 show?

A: This line takes into account the expenses and other items to which I just referred. If you look at page D-28 of the filing, you can see that the commissions and brokerages round to 15.65% of the premium dollar, and you can further see that taxes, licenses and fees round to 2.74% of the premium dollar. The provision utilized in this filing for underwriting profit is 9.0% statewide. The underwriting profit provision was selected by the Bureau's committees based on reviewing the profit analysis by Dr. Appel and Dr. Vander Weide. This filing also contains a 1% margin for contingencies. All those items add up to 28.39%. These items are what are known as variable expenses. They vary in direct proportion with the premium dollar. You know that out of every dollar of premium, 28.39 cents will have to go to pay for these expenses and you are left with 71.61 cents to pay for losses, loss adjustment expenses and general expenses and other acquisition expenses. The expected loss and fixed expense ratio shows the percentage of the premium dollar you will have available to pay for trended losses, trended loss adjustment expenses and trended general expenses and other acquisition expenses.

Q: What is the source of the percentages on page D-33 with respect to commissions and brokerage and taxes, licenses, and fees?

A: They were calculated from the 2009, 2010 and 2011 North Carolina expense call for 2009, 2010 and 2011 data undertaken by the North Carolina Rate Bureau.

Q: What is the source of the percentage on page D-33 for contingencies?

A: The Bureau committees selected that factor. A 1% factor has been consistently employed in past Bureau property insurance rate filings. A 1% contingency factor is a standard factor that has been used for many years across the country in property insurance ratemaking. The factor was selected by the Bureau committees based upon recognition of the systematic bias that causes actual underwriting experience to be worse than the provision assumed in the rates. Reasons for this bias are many.

One reason is that property insurance involves many risks, but not all of them are observable in the experience or are adequately recognized in normal ratemaking. An example is the potential for conflagration such as could result from large brush fires. The state is particularly at risk for several years following hurricanes that blow down thousands of trees, particularly pine trees in the eastern part of the state. Those trees become the tinder for brush fires. The risk is particularly significant if droughts occur in years subsequent to the hurricane. Widespread brush fires have destroyed many mobile homes in other states and constitute an exposure in North Carolina, but, while there are losses from relatively minor and localized brush fires in the data, the exposure to widespread brush fires that exposure is not reflected in the five years of loss data underlying this filing. Similarly, since the mobile home policy covers flooding, the exposure to widespread inland flooding is not reflected in the five years of loss data underlying this filing.

In addition, the writing of property insurance in North Carolina is subject to law changes, court interpretations, jury determinations and judicial determinations that expand losses beyond what was contemplated when the policies were written. For example, under rules of legal construction of insurance policies, ambiguity in policy language, although unintended, will result in the courts construing policy provisions in favor of greater coverage than was envisioned by the insurance industry when it drafted the policy and priced its coverage. An unexpected ruling as to coverage in one case may then be compounded many times by similar results as to numerous other policyholders.

Further, delay and difficulty in obtaining needed rate increases is a factor. In North Carolina and a very few other states, insurance companies writing property insurance are required to go through rating bureaus in order to achieve needed rate increases. This regulatory system can cause significant delay in obtaining needed rate level increases and differs from states that rely more on competition to set rates. The system in this state requires that data be collected from numerous and then be aggregated and analyzed prior to making a filing for needed higher rates on behalf of all companies. Additionally, there can be significant further delays in the setting of hearings and in obtaining regulatory approval before revised rates can be charged and premiums collected. For example, in the recent homeowners filing, it took approximately a year from the time when the filing was made to the order was issued following a hearing.

Q: Would you explain line 20 on page C-1 entitled "Base Rate Excluding Comp. for Assess. Risk, Net Reinsurance Cost, Deviations"?

A: The net base rate per policy is calculated by dividing the Loss and Fixed expenses in line 18 by the expected loss and expense ratio in line 19. This is the net base rate before incorporating the factors for deviations, the compensation for assessment risk and the net cost of reinsurance per policy.

Q: Would you explain line 21 on page C-1 entitled "Compensation for Assessment Risk Per Policy"?

A: Compensation for assessment risk is a provision which is calculated by Dr. Appel (see his prefiled testimony and exhibits) to reflect the cost to voluntary market insurers of maintaining sufficient capital to pay the assessments for residual market losses to the extent required by law. If the residual market (commonly called the “Beach Plan”) does not have sufficient capital, reinsurance and reserves to pay losses for a catastrophic event, then companies writing insurance in the voluntary market will be assessed for such losses even if they do not write in the coastal or beach areas. In effect the voluntary market companies are being required to provide free reinsurance to the policyholders who can only find coverage in the residual market. The voluntary market companies must therefore maintain capital sufficient to cover such losses, even though those companies have not elected voluntarily to write the policies that give rise to those losses. The compensation for assessment risk factor is the provision for compensation that must be paid to voluntary market insurers for bearing this risk of assessments from the Beach Plan i.e., it is the cost of the capital required to support the exposure to potential residual market assessments.

A factor to reflect this exposure has been incorporated to reflect the extremely rapid growth in the exposure to losses that has occurred in the last decade or so in the Beach Plan. As a result of legislative action in 2009, the exposure of the voluntary market companies to residual market assessments has now been capped at one billion dollars. Dr. Appel's analysis of the necessary compensation for the risk of residual market assessments incorporates this new cap and, as a result, the 4.4% factor in this filing for compensation for assessment risk.

The compensation for assessment risk of is calculated by first multiplying the 4.4% provision by the current average statewide base rate of 276.85, resulting in a value of 12.18. To be incorporated in the rates, however, this provision must be adjusted to account for the commissions and taxes, licenses and fees that the companies will need to pay on this additional premium. That is done by dividing the by 1 minus the sum of commission and brokerage expense and taxes, licenses and fees expense as shown below.

$$\frac{12.18}{1-.1565 - .0274} = 14.93$$

Q: What is the source of the net cost of reinsurance in line 22?

A: The source of the net cost of reinsurance is an analysis performed for the Bureau by Dr. Appel. In that analysis he determines the net cost of reinsurance incurred by the composite of insurers writing in North Carolina resulting from the need to buy catastrophe reinsurance. The net cost of reinsurance is the expense and profit component of the reinsurance premium paid by these insurers (the loss component is in the direct losses used in the overall rate determination). More details of the analysis are included in Dr. Appel's testimony.

To calculate the net cost of reinsurance per policy, the total dollars of reinsurance is divided by the number of house years for 2011 times the 2011 average rating factor, current amount factor and premium projection factor. This quantity is then divided by the expected loss and fixed expense ratio. The actual calculation is:

$$\frac{9,442,267}{69,896 * 2.325 * 1.076 * 1.057 * 0.7161} = 71.34$$

Q: What is the source of the percentages used on line 24 for anticipated deviations?

A: As done in past property filings, the Bureau has elected to use a total provision for deviations of 5%. This provision reflects consideration by the Bureau of the magnitude of the deviations and consent to rate. This 5% factor corresponds to the magnitude of the amount found by the Commissioner in several previous automobile insurance cases to be the appropriate amount of deviations and dividends to policyholders to anticipate when setting manual rates.

However, while the Commissioner did not explicitly include the 5% provision in his rate calculations, the Bureau does explicitly include the 5% provision in the rate calculations in this filing. The explicit inclusion of deviations in the rate calculations is necessary in order for the target profit to be achieved. The actual net level of deviations, even after being reduced by consent to rate, will be greater than 5%. The selection of the 5% provision is therefore conservative and represents an attempt by the Bureau to reach a compromise on this issue.

Q: Would you explain line 25 on page C-1 entitled "Deviation Amount per Policy"?

A: Line 25 is the dollar amount of deviation that needs to be in the final rate to ensure that the selected 5.0% deviation amount is accounted for.

Q: Would you explain line 26 on page C-1 entitled "Required Base Rate per Policy"?

A: Line 26 is the required base rate that is needed to ensure that sufficient revenue is collected to cover the losses and expenses that are expected to result from the policies written during the year following the effective date of this filing.

Q: Would you explain line 27 on page C-1 entitled "Current Base Rate"?

A: Line 27 is the current base rate for all of the owners policies included in the review. This rate assumes that each policyholder is buying only the base coverage.

Q: Would you explain line 28 on page C-1 entitled "Indicated Rate Level Change"?

A: Line 28 is the percentage change in the current rates which will be necessary to make the rates adequate for the cost levels that are expected to prevail in the three year period following the effective date of the filing. It is determined by taking the required base rate per policy on line 26 and dividing it by the current base rate from line 27. This results in an indicated rate level change of 31.5%.

Q. Does the filing contain a revision of the present territory definitions and rate levels?

A. Yes. In connection with the overall rate level change we have been discussing, new territory group definitions and rates are displayed; these are shown on page A 3. Currently there are two territory groups for rating purposes: coastal (composed of statistical reporting territories 5, 6, 42, 43) and remainder of state (composed of the remainder of the statistical reporting territories). This filing is introducing rates that vary for three territory groups. The three territory groups are: territory group 1 (5, 6, 42, 43), territory group 2 (32, 34, 41, 44, 45, 46, 47, 53) and territory group 3 (36, 38, 39, 57, 60). The data on pages C-4 and C-5 show that there are noticeable differences between territory group 2 and 3 for various components of the rate that support these new territory groupings. The Rate Bureau's Governing Committee determined that the territory rate level changes should be capped at a maximum of 75%. As a result, the new territorial rates for the owners forms were determined such that the overall statewide filed rate level change is reduced from 31.5% to 20.5%.

The development of the indicated relative change by territory is computed in such a way that the overall effect of the revised territory relativities is to balance to no overall change before application of the statewide rate level change. This is shown in Column 10 of page C-5. In calculating the indicated rate levels by territory, these indicated changes are then multiplied by the overall statewide rate level change.

Q: How has the Bureau treated general and other acquisition expense differently by territory?

A: The Bureau has treated general expense and other acquisition expense as not varying by territory.

Q. Thus far in your prefiled testimony, you have been primarily describing the data and calculations for the owners forms. In general, are the calculations for tenants form on page C-2 the same or similar to the calculations you have described for the owners forms on Page C-1?

A. Yes they are, with a few exceptions as generally noted. For tenants there is no non-hurricane excess wind procedure used in determining the statewide rate level change. The external indices used for tenants reflect the items insured under those types of policies. Other parts of the calculations are the same or similar.

Q. Are the calculations for MH F Tenants, on page C-2 similar to the calculations you have described for Page C-1?

A. Yes they are, except that for MH-F Tenants there is no long term non-modeled excess procedure used in determining the statewide rate level change.

Q: What other changes does the filing make?

A: The filing revises the rates by amount of insurance. ISO performed an analysis of the rates by policy amount and reported the results of the analysis to the Bureau. Section F of the filing explains the methodology and revised relativities, and the resulting changes are shown on pages B-1 to B-3. These changes are being introduced on a revenue neutral basis via off-balances. These off-balances are applied to the base rates to ensure that the same amount of revenue is generated by the new amount of insurance factors and base rates as for the current. The off-balances by territory are shown on page F-5.

The filing also revises the credit for the Windstorm or Hail Exclusion that is available in Territories 5, 6, 42 and 43. The derivation of these credits is shown on pages C-12 and C-13. These credits are used when policies are written “ex. wind;” i.e., referring to those situations where companies voluntarily write policies covering perils other than wind and hail, and the Beach Plan writes the wind and hail coverage.

Q: Please turn to page A-1 of Exhibit RB-1 and explain what is shown on that page?

A: Page A-1 of Exhibit RB-1 shows the indicated and filed statewide rate level changes. The differences between these percentages are due to capping.

Q: Do you have an opinion as to whether the data utilized and the method of calculating the indicated rate level changes contained in the filing are sound and actuarially reliable and if so, what is that opinion?

A: Yes, I have an opinion. In my opinion, the data utilized and the ratemaking methodologies used by the Bureau are based on and consistent with generally accepted actuarial procedures, and the indicated rates are actuarially sound and reliable. In my opinion the ratemaking methodology is actuarially sound and produces indicated rates that meet the standard of being not excessive, inadequate or unfairly discriminatory. The filed rates differ from the indicated rates because of territory caps of 75%. The filed rates are a reasonable step toward an adequate level.

Q: Do you have an opinion as to whether the indicated rate level changes contained in Exhibit RB-1 are fully justified and, if so, what is that opinion?

A: In my opinion, the indicated rate level changes are fully justified and are not excessive or unfairly discriminatory in any respect.

Q: Are there any qualifications you wish to attach to your opinion?

A: Yes. In reaching my opinion, I have, as in the past and as is customary in the general course of my work, relied on the accuracy of the data supplied by the Bureau, by ISS, NISS and by the individual companies that reported their data to ISO and the other statistical agents. I have relied on Dr. Vander Weide and Dr. Appel for the determination of the appropriate profit, reinsurance and compensation for assessment risk components of the rates. Additionally I have relied upon the model output provided by AIR. I have applied appropriate actuarial standards when reviewing these various data sources.

Q: Does that conclude your testimony?

A: Yes, it does.

Exhibit RB-4

PREFILED TESTIMONY
OF
BRIAN MICHAEL DONLAN
2014 MOBILE HOME MH-F INSURANCE
RATE AND TERRITORY DEFINITION FILING BY THE
NORTH CAROLINA RATE BUREAU

Q: Please state your name and your employer.

A: My name is Brian Michael Donlan. I work at Allstate Insurance Company at 2775 Sanders Road, Northbrook, IL 60062.

Q: What is your educational background?

A: I received a Bachelor of Arts in Economics with High Distinction from the University of Minnesota, Morris Campus in 1994. I received a Masters of Arts in Economics from the University of Iowa in Iowa City, Iowa in 1996.

Q: Do you have any additional certifications or qualifications?

A: I have been a Fellow of the Casualty Actuarial Society since 2005. I have participated in several committees of the organization. I was on the Examination Committee of the Casualty Actuarial Society between 2005 and 2008. I volunteered as a University Liaison for the Casualty Actuarial Society from 2003 until 2011. I have been a member of the Committee on Professionalism Education for the Casualty Actuarial Society since 2009. I am a member of the American Academy of Actuaries, and meet all of the continuing education requirements. I also serve as a volunteer for the Actuarial Foundation.

Q: What is your employment background?

A: I worked as a Pricing Analyst at GEICO Insurance Company in Washington, DC from 1996 until 1998. At GEICO, my primary responsibilities included developing the pricing strategies for Private Passenger Auto in a variety of states. From 1998 until 1999 I worked as an analyst at PricewaterhouseCoopers (PwC) in Chicago, Illinois. At PwC my responsibilities included assisting in the evaluation of the adequacy of reserves for several insurance companies. In the fall of 1999 I began my career at Allstate. From 1999 until 2006, I served several different Allstate regions developing rates. In 2007 through 2012, I served as a State Manager (Product Manager) for Encompass Insurance. Encompass is the Independent Agency channel in the Allstate Corporation. I determined the pricing, product and underwriting strategies for 12 states. Most recently I am serving as the Pricing Director for Encompass Insurance. I have the actuarial responsibility for the pricing in the 42 states where Encompass is licensed, including North Carolina.

Q: Do you have experience with Property Insurance?

A: Yes. From 1999 until 2006 I assisted in the analysis and development of actuarially sound property rates in several states for Allstate companies. From 2007 until 2012, my responsibilities included the determination of property pricing for Encompass Insurance Company in several key regions. I am currently the responsible actuary for property rates across the states where Encompass is licensed, including North Carolina.

Q: What is your role with respect to with Mobile Home Insurance in North Carolina?

A: I am currently the Chairman of the Property Rating Subcommittee of the North Carolina Rate Bureau ("Bureau"). I am on the Property Committee of the Bureau. I am also on the Governing Committee of the Bureau. I represent Allstate on these committees.

Q: Can you explain the role of the Bureau?

A: The Bureau was set up in 1977. According to the NCRB Constitution, its role includes the establishment of rates for residential Property Insurance in North Carolina. This filing relates to the MH-F program which is under the NCRB's jurisdiction. While there are other programs that can be used to write mobile homes, references in this testimony to mobile homes and this filing refer to the MH-F program unless otherwise noted. The rates established in this filing are for all companies that write insurance on mobile homes in the state using the MH-F program. The NCRB files rates on behalf of the industry. The rates are subject to approval by the Commissioner of Insurance. Individual companies can charge more or less than the approved rates subject to the procedures approved by the Commissioner.

Q: Can you explain the responsibilities of the Property Rating Subcommittee of the Bureau?

A: The Property Rating Subcommittee is involved in the development of rates, rating plans and territories for the Bureau (NCRB), including the mobile home rates. Current companies that have representation on the subcommittee include American Bankers Insurance Company, American Modern Home Insurance Company, Foremost Insurance Company, Horace Mann Insurance Company, Nationwide Mutual Insurance Company, North Carolina Farm Bureau Mutual Insurance Company, State Farm Mutual Automobile Insurance Company, Travelers Insurance Company, United Services Automobile Association and Allstate Insurance Company. Allstate Insurance Company chairs the Subcommittee. All representatives on the Subcommittee are actuaries or have extensive experience in ratemaking.

Q: Please describe how the Property Rating Subcommittee was involved in this particular filing.

A. The Property Rating Subcommittee has been involved in developing various aspects of the indication methodology that is used. The approach in this filing is consistent with recent property rate filings for homeowners insurance and dwelling insurance. The Subcommittee analyzes the data that is prepared by Insurance Services Office ("ISO").

This includes premium, loss and expense data. The committee makes selections based on the data and the expertise provided by Rob Curry of ISO, Dr. David Appel of Milliman and Dr. Jim Vander Weide of Duke University. Dr. Appel reviews the required profit, reinsurance expense and compensation for assessment risk from the residual market. Ultimately the Subcommittee develops recommendations to the Property Committee and the Governing Committee as to rate levels that meet the statutory requirement that rates not be excessive, inadequate or unfairly discriminatory.

Q: Please describe the overall ratemaking methodology in the filing.

A: The approach in this filing is consistent with the recent homeowners insurance and dwelling insurance filings of the Bureau. Premiums should equal expected losses, plus expected expenses, and a margin for a fair and reasonable profit. In this filing, the required base rate per policy is developed by adding the appropriate profit and contingencies to the estimated costs associated with the policy. The required base rate is then compared to the current base rate to determine the indicated rate change.

Q: How does the methodology account for the loss experience of all of the insurance companies and entities that write mobile home insurance in North Carolina on the forms involved in the filing?

A: For purposes of Bureau rate filings, all of the loss data in the state is consolidated to essentially assume a single insurance entity. ISO aggregates the data that it receives directly from various insurers as well as the data compiled by other licensed statistical organizations. In 2011, the total premium received from writing mobile home insurance using the forms relevant to this filing is approximately $42 million.

Q: How are the expected losses determined?

A: This filing uses the loss experience of five accident years from December 31, 2007 through December 31, 2011. Using five years is consistent with prior property filings, North Carolina statutes, and generally accepted property ratemaking practices. A factor for excess wind losses of 5.5% was determined based on historic experience and applied to each accident year. The excess wind factor was determined based on ISO's standard excess wind procedure. Under that procedure the long-term excess factor is the ratio of the long-term average of the excess loss ratios to the average of the long-term normal loss ratios. Historical non-hurricane wind experience back to 1950 is considered. In situations where mobile home data were not available, homeowners data were employed.

Losses are also trended to reflect the change in costs. The Current Cost Index reflects this trend and is based on a Modified Consumer Price Index and the Boeckh Residential Index. In determining the Current Amount Factor, the Subcommittee reviewed pure premium experience and determined that loss trends outpaced the Modified Consumer Price Index and the Boeckh Residential Index. Therefore, an additional trend adjustment of 2.5% was selected. The trended losses and loss adjustment expenses are divided by the house years to determine the average trended loss cost. That cost is then converted to the trended base-class loss cost by dividing the average rating factor for each accident year. Ultimately the five years are each applied a weight. Accident year 2011, the most recent year for which data is available, is applied a weight of 30%. Accident year 2010 is applied a weight of 25%. Accident year 2009 is applied a weight of 20%. Accident year 2008 is applied a weight of 15%. Accident year 2007 is applied a weight of 10%. These weights are consistent with past filings. The use of differing weights is a longstanding procedure in property filings that is intended to reflect responsiveness to changes while incorporating multiple years of data. The number of house years determines the credibility of trended base loss costs. For mobile home the data is considered fully credible. Since it is expected that mobile home rate filings will be made every three years, the trend periods have been determined assuming that the rates will be in effect for three years.

Q: How is hurricane exposure reflected?

A: As in past filings, the Bureau uses a catastrophe model from AIR Worldwide to determine the expected hurricane losses. The Bureau has been using hurricane modeling from AIR Worldwide (or its predecessor) since 1993.

The Subcommittee made a decision that led to a lower estimate of hurricane loss costs than could otherwise have resulted. The Subcommittee chose not to incorporate the warm sea surface temperature event set in developing the underlying loss costs. The warm sea surface event set reflects the fact that the current sea temperatures are warm and that warm sea surfaces lead to more hurricanes. By using the standard model rather than the warm sea surface event set that is used by many companies, the risk of hurricanes is understated. The Subcommittee made the decision to utilize the storm surge component of the model since mobile home policies cover flood losses. However, the storm surge component only models flood losses in coastal areas and does not model flood losses inland.

The current model used is Version 14.0.1. The model was run with aggregate demand surge included. This option accounts for the expected additional cost for supplies and labor if a very large hurricane event or series of events occurs. Experience demonstrates that, when such catastrophic events have occurred, there is significant increase in demand for the limited supply of plywood, shingles, labor, hotel rooms and other necessities, and as a result the costs increase. Also, in such situations there is significant delay caused by supply and demand imbalances, requiring companies to pay larger claims for hotels, food and other such matters.

Q: How is the expense data compiled and reviewed?

A: The Bureau conducts special expense data calls annually. Companies complete the special expense call, which includes reporting expense dollars as well as premiums at collected level and adjusted to manual level. The Bureau checks and compiles this information for all companies and sends it to ISO for use in the filing.

Commissions and brokerage, taxes, licenses, and fees are a function of written premium. The ratios for these expenses from the North Carolina special calls from 2009 to 2011 were used. The three year average was selected. For Commissions & Brokerages, the selection was 15.65%. For Taxes, Licenses and Fees, the selection was 2.74%. General and other acquisition expenses are determined based on a ratio to earned premium at manual level. The North Carolina special calls from 2009 to 2011 were used for these also. The three year average was selected. The selected General Expense was 2.96%. The selected Other Acquisition Expense was 3.94%.

The loss adjustment expenses, both allocated and unallocated, are included with the losses in calculating the indication. Similar to the other expenses, the Subcommittee reviewed the data from NCRB's data calls. Experience from calendar years 2007 through 2011 was reviewed. The ratio of loss adjustment expenses to incurred losses was analyzed. Consistent with past filings, the highest and lowest years were removed. This allows for more stability due to the variable nature of incurred losses. The selected loss adjustment expense was 14.6 %. The Subcommittee reviewed expense index trends, including the All Items CPI Index (both with and without Energy) and the Total Compensation Cost Index – Insurance Carriers, Agent Brokers and Service from the Bureau of Labor Statistics. These measures varied from 1.66% to 3.00% based on different time periods. Based on the review, the Subcommittee selected a 2.0% expense trend. This factor was then used to trend expense dollars from the midpoint of the base period to the midpoint of the trend period.

Q: Did the Subcommittee consider the profit provision?

A: Yes. Like past filings, the Subcommittee picked a conservative underwriting profit provision. Dr. Vander Weide provided a range for the current cost of capital, which was relied on by the Subcommittee. The range varied from 9.0% on net worth using a Risk Premium Analysis, which was reported by Dr. Vander Weide as being abnormally low due to actions of the Federal Reserve Bank to stimulate the economy, to 12.7% using a Discounted Cash Flow methodology for the S&P 500.

The committee selected an underwriting profit provision of 9.0% of premium. Based on Dr. Appel's analysis, this would generate a statutory return of 7.4% on net worth. This is significantly below Dr. Vander Weide's abnormally low lower bound of 9.0%. It is the statutory return that should be considered when determining the underwriting profit in North Carolina because it does not take into account investment income on surplus, so clearly the Subcommittee is being very conservative with our selection. Even if the 9.0% underwriting profit is combined with both investment income from insurance operations and investment income from surplus, the estimated return on net worth is 10.2%. This is well within Dr. Vander Weide's range, and thus the selected underwriting profit provision cannot be excessive.

Q: Did the Subcommittee consider a contingency provision?

A: Yes, the Subcommittee chose to reflect a 1% contingency provision. This is consistent with past filings and is common across the country. The contingency provision reflects the systematic bias that causes actual losses to be higher than reflected in the rates. There are multiple reasons for the bias.

Sources of this systematic bias in property insurance include, but are not limited to, judicial decisions that extend policy coverage beyond what was anticipated in the rates, legislative changes, and regulatory delay or reduction of rate filings and other factors.

Rate filings are generally not approved prior to their intended effective date or for more than requested. Courts rarely restrict coverage to less than intended in the policy forms and frequently expand coverage beyond what was intended. In addition, major unexpected losses can come from large and infrequent events of a type and magnitude that are not reflected in the experience period.

Thus, estimated premium that does not reflect a provision for these contingencies will fall short of needed premium very frequently. When these premiums are inadequate and underwriting losses are observed, an insurer must borrow from surplus to properly indemnify its policyholders or claimants. According to the Actuarial Standard of Practice #30, "the actuary should include a contingency provision if the assumptions used in the ratemaking process produce cost estimates that are not expected to equal average actual costs, and if this difference cannot be eliminated by changes in other components of the ratemaking process." The Subcommittee believes that a contingency provision is appropriate and necessary, and it has conservatively selected a 1% factor in this filing, the same as with all recent property insurance filings.

Q: Has the risk of a residual market assessment been considered in the filing?

A: Yes. As will be discussed in greater detail below, a potential residual market assessment is a cost of doing business in the state and is a condition for writing mobile home insurance. In the event that hurricanes require the residual market ("Beach" Plan and FAIR Plan) to deplete its surplus after reinsurance recoveries, a non-recoupable assessment may be imposed of up to $1 billion dollars on the voluntary companies. This is a condition of doing business in the state. The voluntary companies need to have and retain capital in order to contemplate these potential assessments. The Subcommittee reviewed an analysis done by Dr. Appel on the compensation for this assessment risk. The analysis is explained in the testimony of Dr. Appel. Based on this analysis the Subcommittee determined that a factor of 4.4% of premium is appropriate to include in the filing to provide compensation for this risk. It is important to note that this factor would be higher if the exposure for the voluntary market companies was greater than $1 billion per year, as it was prior to legislative changes several years ago.

Q: Was the cost of reinsurance considered in the filing?

A: Yes. There are numerous scenarios where the potential losses due to a single hurricane are far greater than the entire premium collected by all the companies for the entire state of North Carolina for the line of insurance involved. In order to remain viable long-term, the industry must purchase reinsurance. The costs associated with such reinsurance are costs of doing business in the state.

Q: What is reinsurance?

A: Simply, reinsurance is insurance for insurers. When insurers are aware of situations in which the potential losses are greater than the company is willing or able to tolerate, they will frequently purchase reinsurance or catastrophe bonds to mitigate those situations. Essentially the insurers will use a portion of the premium to purchase reinsurance. This is common across the industry, including at Allstate.

Q: How are the reinsurance costs reflected in the filing?

A: The costs of reinsurance are incorporated through the work of Dr. Appel. The Subcommittee provided the parameters to Dr. Appel to use for the estimation of the cost of reinsurance for the hypothetical one company reflected in the rate filing. The parameters included the attachment and exhaustion points, the placement percentage and the inclusion of one reinstatement. The parameters were determined to essentially reflect a typical reinsurance program for companies writing mobile home insurance in North Carolina. Consistent with prior filings, the Subcommittee recommended the use of AIR Worldwide' s warm sea surface temperature event set as the basis for determining the provision for reinsurance costs. This is necessary as reinsurers use warm sea surface temperature event sets to determine their rates.

Q: Why were actual reinsurance costs not used?

A: It is necessary to include the costs in the manner that Dr. Appel calculates because it is not feasible to incorporate the actual reinsurance costs of the various insurance companies. The individual insurance companies have different contracts that affect different lines, state combinations and perils. Reinsurance contracts often involve confidential pricing and underwriting information between primary companies and their reinsurers. Some reinsurance contracts may be specific to North Carolina, while others may apply to several states or even the entire country. It is not feasible to determine the reinsurance costs specific to North Carolina in each individual contract. It is not appropriate for North Carolina insureds to assume the reinsurance costs of exposure in other states, and vice-versa. Some reinsurance contracts may be specific to hurricane risk, while others may include hurricane risk and other risks such as earthquake or terrorism. Some reinsurance contracts may be specific to mobile home insurance, while others may also include homeowners, dwelling or property losses, or even auto or commercial property losses. All of these complexities, plus confidentiality considerations, have made it not feasible to use the actual reinsurance costs.

Q: Have dividends to policyholders been considered in the filing?

A: Yes. According to the Statement of Principles Regarding Property and Casualty Insurance Company Ratemaking, the rates should contemplate the cost of policyholder dividends. The Subcommittee determined that dividends have been negligible in recent years and therefore chose to include a factor of zero with this filing.

Q: Have deviations been considered in the filing?

A: Yes. Deviations, or savings to policyholders, are a cost of doing business in North Carolina for the insurers that have them approved. They are a cost of the risk transfer and therefore need to be contemplated according to the Statement of Principles Regarding Property and Casualty Insurance Company Ratemaking. Companies are required to reflect their approved deviations. If rates are set without contemplating them, the industry would not achieve the profit provision included in the rates. The Subcommittee chose to include a 5% provision for deviations in this filing. A 5% deviation provision has been incorporated into past property filings. It is consistent with past findings by the Commissioner of Insurance in auto rate cases that 5% of premium is an appropriate amount of deviations to anticipate when determining manual rate levels. While the Commissioner did not ultimately include the provision in the ordered rates, it is appropriate to reflect this cost of doing business.

Q: What would happen if deviations were not considered?

A: The removal of deviations would limit the competitive marketplace in North Carolina. Deviations allow for companies to better attract and retain policyholders that they believe best fit their specific business model. If the overall deviations were not considered in the indication, it would lead to overall rate inadequacy. This could cause companies to pursue removing their deviations and ultimately leave them less well positioned to attract and retain their target policyholders. This could lead to companies ultimately choosing not to do business in North Carolina.

Q: Are the data in the filing reliable and accurate for ratemaking purposes?

A. Yes. The data underlying the filing are reliable, accurate and appropriate for ratemaking. Individual insurance companies employ extensive procedures to assure the quality and reliability of ratemaking data used in the filing. When individual companies submit their data to their statistical agents, the statistical agents review the data for possible errors and compliance with approved statistical plans. If an error is suspected, the statistical agents ask the company to review the data and to correct the data if necessary.

When ISO consolidates premium, loss and expense data from the statistical agents, it reviews the accuracy of the data and similarly requests that the data be reviewed and corrected if errors are suspected. These data include data for business written at or below the Bureau manual rates, business written under consent to rate procedures and business written in the residual market. When the Bureau assembles expense data and furnishes it to ISO, there are checks to determine the data's accuracy. Sometimes, if it is not feasible for a company to correct its data, that company's data is excluded from the filing and that fact is noted in the filing.

An additional check is that the Bureau requested the statistical agents to produce exhibits for writers displaying exposure distributions for key factors (such as territory, amount of insurance and protection class) for the years in the filing. Companies were asked to review and evaluate the accuracy of their data as reported to their statistical agents. Companies have confirmed that they have performed these reviews and that to the best of their knowledge their data are correct in all material respects.

Q. Did the Subcommittee consider the territorial definitions and determine that they should be revised?

A. Yes, it did. While companies currently report their data based on a system involving numerous territories, rates are determined based on just two combinations of those territories, or "territory groups." One such territory group consists of territories at the beach and coast (5, 6, 42 and 43), and the other territory group consists of the territories in the remainder of the state.

Based on the differing risk characteristics across the state, the Subcommittee determined that it is actuarially appropriate to establish three territory groups instead of two. The filing therefore subdivides the large "remainder of state" territory group into two territory groups to reflect differing risk characteristics. The resulting three territory groups, and the territories within them for data reporting, are displayed on page A-2 of the filing.

Once the three territory groups were established, ISO was asked to prepare the indicated rate level changes for each territory group. The indicated change for each territory group was determined by comparing the required base class rate to the existing base class rate.

Q. In determining how base class rates should be revised by territory group, did the Subcommittee consider the relative risk in each territory group?

A. Yes, it did. The Subcommittee requested Dr. Appel to prepare a detailed analysis of the risk, including volatility of that risk, for each territory group. That analysis showed the need to allocate the net cost of reinsurance, the underwriting profit and the contingency provision based on the differences in risk across the state. As in several past property filings, he analyzed the risk based on three zones. He employed several widely accepted measures of risk in his analysis, and his results reflect the fact that the relative levels of risk for the three zones are significantly different. Based on these significant differences in risk between the zones, the Subcommittee concluded that allocating the reinsurance costs, underwriting profit and contingency provisions to zones as shown in the filing would appropriately reflect the risk in the different areas of North Carolina.

While the allocation of these provisions according to the measures of risk that were developed by Dr. Appel results in differing amounts for reinsurance costs and in differing underwriting profit and contingency factors for each zone, there is no overall statewide rate level impact of this methodology. Its general effect is to increase the needed premium on the coast (territory group 1) and to decrease the needed premium in the western part of the state (territory group 3). The resulting indicated changes by territory group set forth the rate levels by territory group that are needed to fairly and equitably spread the overall rate level.

Q: **Please describe the difference between the "indicated" rate level and the "filed" rate level?**

A: The indicated rate level is the actuarially sound and correct rate level. It is the rate level necessary in order that rates cover prospective losses and expenses and leave a fair and reasonable profit. The indicated rate level is the one that complies with the statutory standard that the rates be neither excessive, nor inadequate, nor unfairly discriminatory.

The "filed" rates represent the amount actually proposed by the Bureau. The filed rates have been determined using a "capping" procedure. The Bureau elected not to file the full indicated rates in each territory and instead capped the filing at +75% by territory.

The Bureau's Governing Committee elected to cap in order to mitigate the impact of this filing on policyholders. This has often been done with large indications where the goal is to have rates eventually reach the full indicated rate level. Since the indicated changes generally were the largest in the beach and coastal territories, the impact of caps was greatest in those areas.

Q. **From the standpoint of individual companies, how does mobile home ratemaking in North Carolina differ from other states?**

A. In almost every other state, each company files its own rates independently. However, in North Carolina, the Bureau has the responsibility to file rates on behalf of the entire industry. The filing process in North Carolina establishes a system of "Bureau rates" (often called "manual" rates) on behalf of all of the companies that are members of the Bureau. The regulatory scheme in North Carolina requires an analysis of the composite book of business, loss experience and expense experience of all those companies.
In essence, the Bureau makes rates for a hypothetical one company that is composed of the aggregate book of business and experience of all the policies written in the state on the mobile home form which is the subject of this filing. Those policies include attributes such as the amount of insurance written on each mobile home, the territory in which each mobile home is located, the type of construction, the deductible level, the type of coverage, etc. A more technical term for book of business is "exposure."

Once the Bureau rate has been set through the filing and approval process, Bureau companies must charge that rate unless they obtain approval to charge either more (through consent to rate) or less (through downward deviations).

Q. You stated earlier that premiums are established at a level equal to expected losses plus expected expenses and a margin for a fair and reasonable profit. Does this mean that mobile home insurance ratemaking is a simple matter of adding up past losses, past expenses and past profit and then putting them into a simple equation to equal premium?

A. That is not at all the case, for numerous reasons. A primary reason is that ratemaking is prospective. The ratemaking process requires the determination of the expected future losses and the expected future expenses of the composite company. While it is important to consider past losses and expenses in determining expected future losses and expenses, the process is much more complex than that. There may be many reasons why past losses and expenses are not expected to occur at the same level in the future. Even if they were expected to occur at about the same level as in the past, past losses and expenses have to be extended into the future when the rates are going to be in effect in order to reflect factors such as underlying trends and cost of living changes.

Further, it is particularly difficult to estimate prospective losses for property lines of business such as mobile home insurance because losses in those lines are so volatile and varied. For numerous reasons, it is more difficult in property lines than in other personal lines to determine prospective losses because policies cover so many different situations and events. For instance, mobile home policies must pay for losses to buildings and contents for fires, weather events (including flood), theft and lawsuits. Even putting aside the potential impact of hurricanes, property lines are highly dependent upon weather events, including tornado outbreaks, winter storms, hail storms, freezing temperatures, etc.

Such volatility is greatly compounded in hurricane prone states such as North Carolina. In North Carolina and other hurricane prone states a significant percentage of the prospective long term average annual losses in certain regions of the state are caused by intense hurricanes which are relatively infrequent but are devastating when they do occur. It would be actuarially unsound to rely on a few years of actual hurricane losses to estimate prospective hurricane losses because of the extreme volatility of such losses.

The volatility of property insurance in a hurricane prone state can be explained in part by a statistical concept of “independence” that is useful to consider in distinguishing between different lines of property casualty insurance. If one mobile home is damaged by a hurricane, it is very likely that many other mobile homes in the same geographic region will be damaged at the same time. The risk of damage for each individual mobile home is not independent of the risk of damage to the other mobile homes because a single event can cause widespread damage. By way of contrast, in auto liability insurance, when there is one devastating auto collision, there generally is not a greater likelihood of there being numerous other devastating auto collisions in the same geographic region at the same time. While the amount paid for a personal injury claim arising out of that single auto collision may far exceed the premium collected for the individual policy involved, that fact is not replicated to numerous other policies because auto collisions are generally random events. However, when intense hurricanes occur, there are likely to be payments far in excess of the premium collected on a large number of policies.

Q: Please describe the nature and the operations of the Beach and FAIR Plans as they relate to mobile home insurance in North Carolina.

A. The Beach and FAIR Plans are both residual market mechanisms set up by the legislature to write property insurance in situations where policyholders cannot obtain insurance through the competitive market. The FAIR Plan writes dwelling fire and extended coverage policies that provide essential property coverage on homes and mobile homes. The FAIR Plan writes those policies throughout the state. The FAIR Plan and Beach Plan do not write insurance on mobile homes using the forms that are the subject of this filing.

By statute the Beach Plan writes property insurance only in the 18 coastal counties. In addition to writing homeowners and dwelling fire and extended coverage insurance, it writes commercial property insurance.

The 18 coastal counties are statutorily divided into the "beach" area and the "coastal" area. The beach area generally consists of areas south and east of the Inland Waterway, often called the Outer Banks or barrier islands. The coastal area consists of the remainder of those 18 counties.

Insurance companies that desire to write mobile home policies anywhere in North Carolina are required to be members of the Beach Plan. However, since companies are statutorily prohibited from receiving a distribution from the Beach Plan's surplus, they are prohibited from profiting on business written by the Beach Plan. In effect, the companies give up any opportunity to make a profit by allowing policyholders to be written in the Beach Plan. Even though the companies give up a chance to make a profit, they are nevertheless exposed to the losses of the Beach Plan when those losses exceed the ability of the Beach Plan to pay.

The Beach Plan writes policies in situations where policyholders cannot obtain such policies from companies writing in the competitive market. Essentially, the reason that those companies are unwilling to write the policy is that the rates they are permitted to charge in the voluntary market are inadequate.

Q. Please comment on the size and financial condition of the Beach Plan as those factors impact mobile home ratemaking.

A. I will provide a brief summary of the financial condition of the Beach Plan. First, it is noteworthy that a very large percentage of property insurance premium in the 18 coastal counties goes to the Beach Plan. For instance, in the "beach" territories, approximately 72% of the homeowners premium is written by the Beach Plan, and in "coastal" territories over 40% of the homeowners premium is written in the Beach Plan. On a statewide basis, approximately 12% of homeowners premium is written in the Beach Plan even though the Beach Plan is only able to write policies in the 18 coastal counties. Similarly, large portions of dwelling fire and extended coverage policies are written in the Beach Plan and FAIR Plan. Thus, while the Beach Plan was statutorily set up to be the market of last resort, it appears to be the market of first resort in many instances. As stated above, the reason for this fact is largely that the rates are inadequate for the risk.

Otherwise, normal competitive market forces would come into play, and companies would write voluntarily.

The Beach and FAIR plans' reinsurance program assumes a surplus of approximately $900 million to pay losses for all types of policies written. That amount has built up as a result of the fact that there have not been any intense hurricanes to strike North Carolina in approximately the last fifteen years. However, that amount must be considered in comparison with the potential exposure to loss following a single catastrophic hurricane. Losses in the Beach Plan following a catastrophic hurricane could be over $20 billion. While the $20 billion estimate is for a storm that would be extremely rare, there are many other hurricanes and combinations of hurricanes that are much more likely to occur and that would far exceed the surplus of the Beach Plan.

In 2011 the Beach Plan's surplus was diminished by a relatively small hurricane, Irene. Even though Irene was barely a Category 1 hurricane when it made landfall in North Carolina, it caused approximately $160 million in residual market losses and depleted the Beach Plan's and Fair Plan's combined surplus by that approximate amount.

The fact that rates at the beach and coast are significantly inadequate creates a dilemma for the Beach Plan. On the one hand, the Beach Plan cannot build up sufficient surplus in the "good" years where there are no hurricanes to provide a cushion to pay losses in the "bad" years when severe hurricanes occur. Even in the good years, the Beach Plan has to pay claims for traditional insured events such as fires, thefts, personal injury claims, etc.

One approach by the Beach Plan is to purchase reinsurance and catastrophe bonds. Dr. Appel goes into detail as to the Beach Plan's current reinsurance program. Whatever amounts the Beach Plan spends in the reinsurance and catastrophe bond markets is at the expense of building up surplus.

Q. Please explain what can happen when a catastrophic hurricane hits the coastal area and exceeds the surplus and reinsurance of the Beach Plan.

A. When a truly catastrophic hurricane next occurs, the inadequacy of rates at the beach and coast will lead to one and possibly two types of assessments: "non-recoupable assessments" on the companies that voluntarily write property insurance throughout the state and "catastrophe recovery charges" on policyholders throughout the state. These assessments are set forth by statute.

As I noted earlier, companies writing any mobile home insurance in North Carolina are subject to a non-recoupable assessment for Beach Plan losses in a given year up to a total of $1 billion dollars. Dr. Appel has quantified the cost of this potential assessment to the companies, and it is reflected in the factor called the "compensation for assessment risk." Since the assessment is imposed in accordance with a formula reflecting each company's pro rata property insurance writings across the entire state, a company will be assessed even if it elected not to write any policies in the beach and coastal counties. Each company makes an individual decision as to the extent that it writes throughout the state, not just in the beach and coastal territories. The prospect of an assessment affects the willingness and extent of each company's decision.

The other assessment is the catastrophe recovery charge. Statutes require the assessment of policyholders throughout the entire state after their insurance companies have paid the $1 billion non-recoupable assessment discussed above. The catastrophe recovery charge on policyholders throughout the state could be up to 10% of their premium per year on their property insurance policies. The voluntary companies will be required to administer the charge. The 10% charge would continue annually as long as necessary to collect the amounts that were paid out for Beach Plan losses in excess of the $1 billion non-recoupable assessment.

In addition to the indications in the filing as to beach and coastal areas, the fact that the Beach Plan's rates are too low for the risk involved is demonstrated by the large number of policies in the residual market. It is in the nature of the catastrophe recovery charge that the greater the inadequacy of the rates that the Beach Plan is permitted to charge, the greater the potential that policyholders across the state will be required to pay charges for Beach Plan losses. As stated above, since the rates are inadequate, the Beach Plan is not able to use annual premiums to accumulate a sufficient surplus to pay losses or alternatively to use those premiums to purchase an adequate amount of reinsurance. This means, in turn, that there is a greater chance that Beach Plan losses will have to be paid by policyholders throughout the state in the form of the catastrophe recovery charge.

The ultimate effect of the regulatory system in North Carolina is that rates for policyholders in the Beach Plan area are being subsidized, both explicitly and implicitly. The explicit subsidy arises from the fact that insurance companies have to pay the first $1billion of losses over and above the Beach Plan's ability to pay, and the filing passes along this cost in the form of the 4.4% factor for the compensation for assessment risk. This factor is paid by policyholders throughout the state, not just those in the Beach Plan. In addition, there is an implicit subsidy in that policyholders across the state face the possibility of imposition of the 10% catastrophe recovery charge. Another way of looking at the situation is that the insurance industry and policyholders across the state are providing free reinsurance to policyholders in the Beach Plan.

Q. Is the reason that the Beach Plan purchases reinsurance similar to the reason that private companies purchase reinsurance?

A. Yes. For the same reason that the Beach Plan purchases reinsurance, the hypothetical "one company" for which the Bureau files rates must purchase reinsurance. That hypothetical one company is faced with numerous realistic hurricane loss scenarios that far exceed its ability to pay. It would be irresponsible and imprudent for that one company not to purchase reinsurance. The need of that hypothetical one company to purchase and maintain reinsurance is reflected in the net cost of reinsurance analysis prepared by Dr. Appel. As discussed earlier, that analysis was reviewed and approved by the Rating Subcommittee. However, unlike the Beach Plan, that hypothetical one company (i.e., the voluntary insurance industry) does not have a backstop of free reinsurance.

The hypothetical one company today receives approximately $42M in premium annually in North Carolina for writing mobile home insurance on the forms subject to this filing. In comparison, the largest simulated hurricane loss in the AIR standard catalogue model was $1.1 billion combined for the MH-F program and the MH-C program. Of course, this would be an extremely rare event with a remote probability of occurrence, but it could occur. If that hypothetical company experienced a catastrophic loss, it would first look to its surplus and reinsurance. If there is insufficient surplus and reinsurance, then that hypothetical company would go insolvent. There has been a history of multiple company insolvencies following major hurricanes in the United States. Following Hurricane Hugo that hit Charleston, South Carolina and Hurricane Andrew that hit Florida, there were multiple insolvencies. Unlike the Beach Plan, the hypothetical one company does not have the right to recoup losses from policyholders across the state.

Q. Does the filing in any manner require policyholders in North Carolina to pay the losses or subsidize the rates of policyholders in other states, particularly hurricane prone states such the Gulf Coast states?

A: No. It would not be actuarially appropriate to do so, as each state is evaluated separately and rates are to be based only on its own loss potential. Imposing a subsidy would not be fair to North Carolina policyholders and would not be permitted by North Carolina regulators. There is a greater risk of hurricane losses in Florida and some other Gulf states than in North Carolina, but it would not be fair or actuarially sound for North Carolina policyholders effectively to be asked pay for their losses or subsidize the insurance costs for persons in those areas. For the same reason, it would not be fair or actuarially sound for the Bureau to attempt to spread the hurricane exposure of the hypothetical one company in North Carolina to persons in other states or in the Midwest where there is little hurricane exposure. Policyholders and regulators in Iowa, for example, would not be willing to do that.

Q. Can you identify Exhibit RB-1?

A. Yes. This is a large portion of the filing submitted by the Bureau to the Honorable Wayne Goodwin, Commissioner of Insurance, with respect to revised mobile home insurance rates and territory definitions in North Carolina. Exhibit RB-1 includes numerous exhibits and voluminous data responses and explanations pertaining to the indicated and filed rate level changes and the revised territory definitions. The filing also includes the rate manual and representative policy forms (Exhibit RB-2), as well as the prefiled testimony of four witnesses in addition to mine (Exhibits RB-3 through RB-17). When printed out in hard copy, the filing fills a large three ring binder.

Q. Can you identify the document marked Exhibit RB-2?

A. Yes. As I mentioned, Exhibit RB-2 includes the current manual of rules, rates and classifications used to write mobile home insurance in North Carolina on the forms relevant to this filing. It also includes representative forms and endorsements used in the program. The forms, manual and any amendments have been approved and are on file with the Department. Copies are maintained at the offices of the Bureau.

Q. Does the filing make changes to the policy amount relativity factors?

A. Yes. The filing revises the rates by amount of insurance. The changes are being introduced on a revenue neutral basis via off-balances. The off-balances are applied to the base rates to ensure that the same amount of revenue is generated by the new amount of insurance factors and base rates as currently generated.

Q. Do you have an opinion as to whether the indicated rate level changes, the territorial definition changes and the policy amount relativity changes in the filing are appropriate and result in mobile home insurance rates that are not excessive, inadequate or unfairly discriminatory?

A. Yes.

Q. What is that opinion?

A. First let me note that I have relied upon the accuracy of the data and analysis supplied by the statistical agents, the Bureau and AIR Worldwide as reviewed and checked, and I have also relied on the reinsurance and profit analyses performed by Dr. Appel and Dr. Vander Weide. With these qualifications, it is my opinion that the indicated rates and territorial definition changes in the filing are actuarially sound and meet the legal standard of producing rates that are not excessive, inadequate or unfairly discriminatory. I qualify my opinion by noting that the filed rates have been developed by applying territory caps to the indicated rates. The filed rates are a reasonable step toward an adequate level.

Q. Does this conclude your prefiled testimony?

A. Yes.

Exhibit RB-5

PREFILED TESTIMONY of ROBERT NEWBOLD

2014 MOBILE HOME (MH-F) INSURANCE RATE FILING BY THE NORTH CAROLINA RATE BUREAU

1. Q. What is your name and business address?

A. My name is Robert Newbold. My business address is 131 Dartmouth St, Boston, MA 02116.

2. Q. What is your occupation?

A. I am Senior Vice President of AIR Worldwide Corporation, a corporation in Boston, Massachusetts.

3. Q. What is AIR Worldwide Corporation?

A. AIR Worldwide Corporation (AIR) is a scientific leader and respected provider of risk modeling software and consulting services. AIR founded the catastrophe modeling industry in 1987 and today models the risk from natural catastrophes and terrorism in more than 90 countries. AIR is headquartered in Boston with additional offices in North America, Europe, and Asia.

4. Q. How many employees does AIR have?

A. AIR has over 500 employees. Of those over 200 have graduate degrees and over 70 have PhDs. Their disciplines include meteorology, wind engineering, actuarial, computer science and statistics.

5. Q. Could you describe your duties as Senior Vice President of AIR?

A. As Senior Vice President, I am responsible for AIR's Consulting and Client Services Group in the Americas. The Consulting and Client Services group provides model and software support and service to AIR's clients. This includes performing analyses using the AIR models, assisting clients in the interpretation of results generated by the AIR models, and training clients on the most efficient way to interact with AIR's software products and solutions. As Senior Vice President, I am also responsible for all of AIR's internal and external training and education, and I am responsible for regulatory work.

6. Q. What is your educational background?

A. I have a Bachelor of Science in Systems Engineering from the University of Virginia. I have a Master of Science in Information Systems (High Honors) from Boston University, and a Master of Business Administration (High Honors) from Boston University. I have completed the requirements of the AIR Institute Certified Catastrophe Modeler Program to achieve the designation of Certified Catastrophe Modeler (CCM).

The Certified Catastrophe Modeler Program is an educational program offered to AIR's clients. The program includes a week of classroom education focusing on both models and software, as well as providing insight into how the models are created and how results from the models should be interpreted. Over the course of my AIR career, in addition to completing the Program, I have also designed course content and materials, acted as an Instructor, and most recently, I have taken a role of preparing other AIR staff to act as Instructors in the Program.

7. Q. What has been your experience since obtaining your initial degree?

A. I was employed at EDS Corporation from 1996-99 as an Information Analyst. From 1999-2001, I attended Boston University Graduate School of Management in pursuit of two Master's degrees. From 2001-02, I was employed at Deloitte Consulting where I was a Senior Risk Consultant.

In 2002 I was employed by AIR Worldwide Corporation. I have now been employed by AIR for nearly 12 years, during which time I have had extensive experience with the AIR models performing the functions described in the Consulting and Client Services Group in the response to Question 5 above.

8. Q. Please describe your technical publications and speaking engagements relating to computer models and insurance.

A. I present regularly at the AIR's Client Conferences on various catastrophe risk management topics involving modeling. Further, I travel often to AIR clients and prospects, and have made numerous presentations directly to individual insurers, reinsurers, investment bankers, rating agencies and regulators.

9. Q. Please describe your experience with respect to the issue of computer modeling of windstorms, including tornadoes, hurricanes, hailstorms and other storms.

A. I have been working with AIR's models since joining the company in 2002. In addition to performing analyses using the model and presenting results to clients, I have been charged by AIR with the responsibility for explaining the model in external settings such as in global investor settings as part of AIR's Securitization practice. I have also presented the model in front of the Florida Commission on Hurricane Loss Projection Methodology's Professional Team, who perform an extensive scientific review of hurricane models on an bi-annual basis.

10. Q. Could you characterize your familiarity with the AIR hurricane model that is used by the North Carolina Rate Bureau in this filing?

A. As described above, I have worked with AIR's hurricane model since 2002. I am familiar with all aspects of AIR's hurricane model. I work closely with members of AIR's staff involved in the development, maintenance and application of AIR's hurricane model. I feel that I am well-suited to the task of testifying about the model as a result of my many years of modeling experience and my knowledge of all of the scientific components of the model and how they interrelate with each other.

11. Q. What has been your relationship with the scientific and technical staff at AIR that has allowed you to gain personal knowledge as to AIR's U.S. Hurricane model?

A. Over many years I have had extensive exposure to the technical details of the model components throughout the processes of development and updating the model. I work closely with internal staff members who utilize the model on a day-to-day basis on behalf of AIR clients. I have also presented the model to the Professional Team of the Florida Commission, which includes meteorologists, wind engineers, programmers and others who develop, implement, enhance and explain AIR's model.

12. Q. What has been your role in explaining the model to regulators?

A. AIR clients using the AIR hurricane model to file insurance rates often receive inquiries from state departments of insurance that include questions on the models used to generate the rates. I have prepared responses to such inquiries for a number of states, including Alabama, Louisiana, South Carolina, Florida, Mississippi and Texas. I have presented the hurricane model to the Massachusetts Office of the Attorney General and the Massachusetts State Rating Bureau in connection with rate filings of the

Massachusetts Property Insurance Underwriting Association. I have offered expert testimony in past rate filings before the North Carolina Department of Insurance on behalf of the North Carolina Rate Bureau. I have also offered expert testimony on the AIR hurricane model before the Maryland Insurance Administration.

13. Q. Please describe the types of companies and organizations for which you have consulted in connection with the computer modeling of windstorm losses.

A. More than 400 organizations obtain AIR's services. AIR provides catastrophe risk assessment products and services to primary insurance companies, to reinsurers, to intermediaries, to coastal Beach and FAIR plans and other residual market organizations, to state funds, and to other insurance related organizations. We also provide services to investment banks and investors in catastrophe bonds, as well as to bond rating agencies that analyze and rate those bonds.

14. Q. Please explain what those various entities are.

A. "Primary insurers" are the companies with which the members of the public interact when they purchase homeowners insurance policies that cover hurricanes. The members of the Bureau are primary insurers, and they sell mobile home insurance policies to their policyholders.

"Reinsurers" write insurance to cover primary insurers, and that transaction is called reinsurance. Primary insurers purchase reinsurance in part to ensure that they are able to remain solvent in the case of a major industry catastrophe such as a hurricane, and therefore will be able to meet their obligations to their owners and policyholders. The contractual relationship between the primary insurer and reinsurer is typically called a "reinsurance treaty."

"Intermediaries" include reinsurance brokers and other experts in catastrophe risk who assist primary insurers in locating reinsurers that are willing to write reinsurance and in negotiating terms and rates with those reinsurers.

"Residual market organizations" are involuntary market mechanisms that have been set up by state law to write insurance in high risk situations where the primary insurers are unable or unwilling to write policies at the rates that can be charged for the risk involved. Catastrophe losses have to be paid by someone, and complex state laws typically provide that losses will be paid by some combination of insurers, reinsurers, policyholders and others. The so-called "Beach" and "FAIR" plans in North Carolina are residual market mechanisms.

"State funds" are similar to residual market organizations in that they arise by state law to write insurance in high risk situations where the primary insurers are unable or unwilling to write policies. State funds typically involve the situation in which the state ultimately assumes responsibility for payment of catastrophe losses, such as the case of Citizens Property Insurance Corporation in Florida.

"Investment banks" are sophisticated financial advisers that, in the context of hurricane modeling, analyze the risk of catastrophes and provide advice and assistance to entities that issue and purchase bonds covering catastrophes. Catastrophe bonds frequently serve as an alternative to reinsurance.

"Investors" are parties that invest in catastrophe bonds in order to gain a financial return. In the event of a catastrophe triggering the bond, they are responsible for covering the financial loss indicated in the bond's agreement.

"Rating agencies" are independent organizations such as AM Best, Moody's, Fitch's and Standard and Poor's that analyze the risk of companies and financial instruments. They rate the level of risk involved in instruments such as catastrophe bonds as well as the solvency of primary insurers, reinsurers and investment banks. Investors and issuers of catastrophe bonds rely upon rating agencies in connection with the issuance and purchase of catastrophe bonds.

15. Q. Have these various entities described above relied upon AIR's hurricane model?

A. Yes, over 400 such entities have relied upon our model and methodology in many different contexts and in many situations over many years.

16. Q. Please explain how primary companies and reinsurers have relied upon your computer simulated hurricane loss estimates?

A. Reinsurers use AIR Software Systems (CATRADER®, CLASIC/2™, CATSTATION ™, Touchstone®), which all utilize the same underlying models, such as AIR's hurricane model that was used for this analysis, to estimate expected and potential large losses on the reinsurance treaties that they write with the primary companies. Based on these expected loss estimates as well as other economic and underwriting information, reinsurers develop the rates that they charge for catastrophe reinsurance treaties with primary companies.

Primary companies use our services and software systems to estimate their loss potential to catastrophic events such as hurricanes and earthquakes for multiple reasons. One reason is to estimate catastrophe pure premiums and loss costs in various geographical areas for the purpose of setting rates. They are also interested in estimating large loss potential in order to help them to decide how much catastrophe reinsurance they need to buy to protect their company's solvency and pay losses. Particularly after Hurricane

Andrew, which caused numerous primary companies to become insolvent, primary companies want to make sure that they are not overly exposed to a single catastrophic event.

As a practical matter, reinsurers and primary insurers have competing economic interests with regard to the output of the catastrophe models. A model which overstated hurricane exposure would prejudice primary insurers through the elevation of reinsurance costs. A model which understated hurricane exposure would result in reinsurers collecting inadequate premiums for the risk undertaken. AIR's ability to serve clients with such competing economic interests is dependent on the rigorous peer review and ongoing updates to the model with the most recent scientific and meteorological data available, to maximize the accuracy of outputs from all AIR models.

17. Q. What is a reinsurance treaty?

A. It is a contract negotiated between a primary insurer and a reinsurer. These treaties come in many different forms and are negotiated between the parties often using the AIR hurricane model as an input in the negotiations. The different primary companies choose to expose their surplus to very different levels of risk based upon factors such as the areas where they choose to write insurance, the types and numbers of policies that they write in high risk areas, the policy terms that they employ, the lines of insurance that they write, their ability to cover major losses using their own funds, etc. There are several hundred primary companies writing property insurance in North America, and each has a unique "book of business" as to the policies it writes and its exposure to catastrophes. Catastrophes can occur in many forms, including earthquakes, severe thunderstorms (hail, wind, and tornados), winter storms, flood, terrorism and fires, as well as hurricanes.

When primary insurers analyze their book of business, they use AIR models to assist them in determining their exposure to various catastrophes and their reinsurance needs to protect their financial security and ability to pay losses when a catastrophe occurs. Each primary insurer has unique exposure to catastrophes, and each needs to analyze its own exposure and determine its reinsurance program based upon its examination of that exposure and its ability to take on risk.

A primary insurer's reinsurance program can be written to cover a single hurricane or a season of hurricanes. It can involve other wind events such as a tornado outbreak or a winter storm. It can involve an entire season of all wind events including tornadoes, hurricanes, straight line winds, hail, winter storms, etc.

Of course, catastrophes can be caused by events other than wind. For instance, some areas are more prone to earthquake than others, and some primary companies are therefore more exposed to earthquake losses than others. Primary companies may purchase reinsurance coverage for most or all risks, including earthquakes, terrorism, brush fires, volcanic eruption and other perils in addition to wind. This can all be done in the same reinsurance treaty or in separate treaties.

It is often the case that large primary insurers will have treaties with numerous different reinsurers, and they may also rely upon catastrophe bonds as well. Primary companies may purchase reinsurance for a single region such as North America, the United States, the hurricane-prone southeastern United States, the Mid-Western United States, the West Coast of the United States, a single state, etc.

The financial terms of reinsurance treaties and catastrophe bonds can vary widely and depend on the needs, ingenuity and willingness of the parties. The AIR models are a vital tool when the parties are negotiating the terms of reinsurance treaties. A primary company can enter into a reinsurance treaty that covers the company above a stated dollar amount, a concept that is similar to a deductible in a typical policy. Primary companies generally must purchase reinsurance that is capped such that there will be no reinsurance payments beyond a certain dollar amount that is negotiated between the primary insurer and the reinsurer. Such a cap involves a concept similar to a maximum policy amount in a typical automobile liability insurance policy. A reinsurance treaty can provide for the purchase of reinsurance on a pro-rata or quota-share basis where the reinsurer pays a percentage of the catastrophe losses and the primary insurer retains the remaining percentage. Such a basis is similar to a percentage copayment in some health insurance policies. There are a virtually infinite number of possibilities, and the AIR models provide consistent detailed information on the risk to both parties, allowing the parties to negotiate and reach agreement.

18. Q. Please explain how coastal residual market plans rely upon your model.

A. These plans typically operate in a manner similar to primary companies, and they often purchase reinsurance to cover some of their catastrophe exposure. As with primary insurers, coastal plans use models in analyzing their risk to catastrophic hurricanes and in placing reinsurance or obtaining catastrophe bonds. The coastal boards then use AIR's analyses to decide on levels of surplus to maintain, reinsurance to purchase and sometimes the rates that should be charged to their policyholders. They also use AIR's analyses to advise primary companies and the public as to potential assessments that they may face in the event that a hurricane exceeds the plan's surplus and reinsurance. The same type of analysis is typically performed with respect to state funds. They sometimes rely on intermediaries to provide some or all of these services.

19. Q. Please explain how the investment community relies upon your model.

A. AIR provides hurricane loss estimation services to the investment community in conjunction with various catastrophe bond offerings that are issued. Both issuers and purchasers of catastrophe bonds are typically advised by investment bankers. As with the analysis that underlies the negotiation and pricing of reinsurance treaties, these parties in the investment community use the probabilistic estimates derived from the AIR catastrophe models as the primary basis for pricing and investing in catastrophe bonds. Bond rating agencies provide objective opinions of the bonds using the results of the AIR models, and those ratings in turn affect the price and terms of those bonds that are issued.

20. Q. Have you been asked by the Bureau to prepare an analysis based on AIR's model of hurricane loss potential for the state of North Carolina?

A. Yes.

21. Q. What reports has AIR prepared for the Bureau relating to North Carolina mobile home insurance?

A. We have prepared two reports for the bureau that are based on two analyses portraying the hurricane loss potential based on different views of hurricane risk. The first report, attached hereto as Exhibit RB-6A, is based on the analysis using a simulated sample of 100,000 "years" of potential hurricane experience based on our standard view of the hurricane risk. The second report, attached hereto as Exhibit RB-6B, is based on the analysis using a simulated sample of 100,000 "years" of potential hurricane experience based on our Warm Sea Surface Temperature or "WSST" catalog simulation. The WSST catalog simulations provide a view of risk from hurricanes including estimates of the potential impact of elevated sea surface temperatures (SSTs) in the North Atlantic.

A simulated "year" in this context represents a hypothetical year of hurricane experience that could happen in the prospective year. This includes years where there is no hurricane activity affecting North Carolina, years where one hurricane impacts North Carolina and years in which multiple events cause loss to North Carolina. For this analysis, AIR used exposures based on 2011 data-- the most recent year available. The large samples of 100,000 "years" of simulated loss experience enabled us to estimate hurricane pure premiums and loss costs as well as the probabilities of losses of various magnitudes.

22. Q. In the context of Exhibits RB-6A and RB-6B, what is meant by the term "pure premiums"?

A. Pure premiums are calculated by dividing the estimated long run average annual aggregate losses by the number of risks, i.e., the house years. The resulting pure premium values are a measure of the expected value of loss for each individual risk.

23. Q. In the context of those reports, what is meant by the term "loss costs"?

A. Loss costs are calculated by dividing the estimated long run average annual aggregate losses by the insurance in force, i.e., the insurance years plus the liabilities for contents and other coverages. The resulting values are a measure of the expected value of loss for each dollar of insured value.

24. Q. Please describe the approach that AIR used to develop these reports.

A. Our approach is that of a computer simulation model. Specifically, in the Touchstone® software version 1.5.2, we ran our Standard Atlantic Tropical Cyclone Model, version 14.0.1("AIR Hurricane Model" or "AIR model" or "the model"). The Bureau provided exposure information used to generate the loss estimates. The exposure file contained information on the number of risks, coverage, policy form group, construction type, geography, and amounts of insurance. This data was reviewed for reasonableness and input into the model. The territory level exposure was distributed to an appropriate granularity for hurricane modeling. This was completed using a disaggregation technique, in which all policy values were distributed proportionally to 90m x 90m grid points based on the mobile home exposures contained in AIR's proprietary Industry Exposure Database. The detailed process is outlined in question 117 of this pre-filed testimony. Finally, the model was run, simulating potential future hurricane losses and in the process applying policy conditions. The output of the model contains information such as average annual loss which is used in developing rates.

25. Q. What is the role of modeling in projecting future hurricane losses in the insurance context?

A. Many years ago modeling became a widely accepted method of analyzing the loss potential of future hurricanes in the insurance context. In recent years it has become the method that is almost exclusively used. AIR was the first company to develop probabilistic catastrophe modeling of hurricanes over 25 years ago as an alternative to the "rule of thumb" approaches on which insurance companies previously had to rely for the estimation of potential catastrophe losses from hurricanes. In 1987, AIR introduced to the insurance industry a modeling methodology based on simulation techniques and mathematical approaches that had been long-accepted in a wide variety of scientific disciplines. Since the inception of this new approach, the AIR hurricane model has undergone a comprehensive and continuous process of refinement, enhancement, validation, and review. The current version of the model contained in this filing was recently updated based on a comprehensive process of scientific review that began in

2007 and continued into 2010. It was further updated in 2013 to account for two additional years of historical hurricane activity that were included in the National Hurricane Center's (NHC) HURDAT database.

Prior actuarial techniques had by necessity relied on loss data of past hurricanes to project future losses, but that methodology was inadequate for many reasons. A prime reason is that the period of time for which insurance data was available was not sufficiently long to be representative of the long term climatology of hurricanes. Significant hurricanes are relatively infrequent events, and the sample was too small to have predictive capability. Efforts to use the limited insurance loss data from previous decades required complicated and highly inexact assumptions and other factors that must be considered in order to relate such data to current conditions. The usefulness of the limited loss data that did exist was significantly limited because of the constantly changing landscape of insured properties. Property values change significantly over the years, along with the costs of repair and replacement of buildings and contents. Building materials, design and construction practices change, as do the types and costs of personal property located in those buildings. New structures may be more or less vulnerable to catastrophe events than were the old ones. New properties continue to be built in areas of high hazard. Therefore, the limited loss information that was available from recent hurricanes was not suitable for estimating future losses.

While it was widely recognized that insurance loss information from the limited number of historical hurricanes did not provide a complete indication or adequate sample of what may occur in the future, there was no alternative until modeling became feasible. Modeling became feasible with the advent of high speed computerization and the enhancement of detailed scientific knowledge of how hurricanes work based on radar, satellites and other advancements. Numerous scientific advancements led to modeling becoming a widely accepted method of analyzing the risk of hurricanes. Modeling employs the available historical data as to meteorological characteristics of actual hurricanes and then allows for combinations and permutations of the parameters and locations of such historical data in order to model future events in accordance with their probability. Doing so provides a robust picture of the expected average loss potential in North Carolina and other hurricane prone states. During the period when modeling replaced the prior actuarial techniques, AIR has been a scientific leader in the catastrophe modeling industry.

26. Q. Does the AIR model produce an unbiased estimate of expected hurricane losses in North Carolina?

A. Yes. While the AIR model has been developed and updated by AIR's internal team of scientists and engineers, it has also been peer reviewed by independent experts in the relevant scientific and academic fields. Examination of modeled versus historical losses has validated the model and has revealed no systematic bias in terms of overestimation or underestimation. Our model is relied upon by parties with diametrically opposite financial interests, including both primary insurers and reinsurers, and both catastrophe bond issuers and investors in those bonds.

27. What is your opinion as to whether the limited years of mobile homeowners insurance data adequately represents the state's likely exposure to hurricanes?

A. In my opinion, that period of insurance loss data is not sufficient to estimate the true hurricane loss potential in North Carolina for numerous reasons. One reason is that hurricanes, particularly intense hurricanes, are low frequency events. The absence or presence of even one Category 4 or 5 hurricane (under the Saffir-Simpson scale) can dramatically influence the loss potential calculated over the short time horizon in which insurance rates are examined in connection with non-catastrophe causes of loss. There has been one Category 4 storm that has made a landfall in North Carolina since 1900 (Hazel in 1954). However, several others could easily have done so if slightly different weather conditions had been present to steer those storms into North Carolina.

Furthermore, as stated previously, the validity and utility of the historical loss data that does exist is limited because of the constantly changing landscape of insured properties. For instance, since Hurricane Hazel devastated southeastern North Carolina in 1954, there are many more mobile homes and they have been built according to more modern construction practices and contain different levels of contents. Policy forms in use today provide different coverage than those many years ago. It is highly questionable whether the cost data for repairing and replacing mobile homes and their contents many years ago can validly be compared with cost levels today.

For these reasons, the best available measure of North Carolina's current exposure to hurricanes can be gained by using a computer simulation model, which is grounded in a longer period of meteorological history and documented science. Modeling reflects the broad range of events that could occur in the next hurricane season, with those events modeled in accordance with their probability.

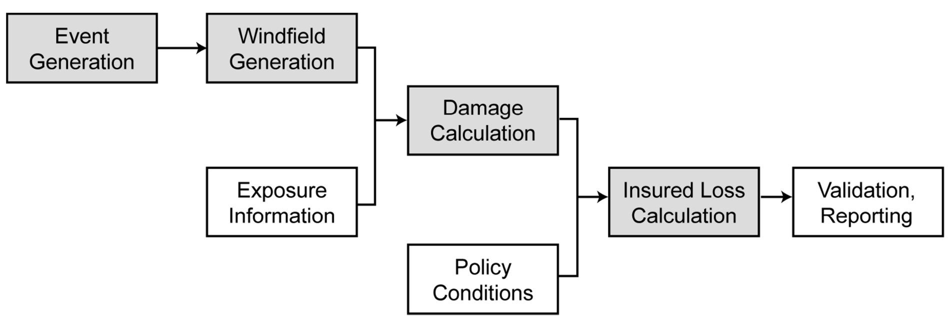
28. Q. What is a computer simulation model?

A. Basically, a computer simulation model is a series of computer programs which describe or model the particular system under study. All of the system’s significant variables and interrelationships are included. A high-speed computer then "simulates" the activity of the system and outputs the measures of interest, such as the average expected loss costs.

As is appropriate in probabilistic modeling, AIR's hurricane simulation model incorporates random variables. Numbers are generated from the probability distributions of random variables to assign values to the variables for each model simulation. The probability distributions are usually standard statistical distributions selected on the basis of good fits with empirical data from actual hurricanes and are consistent with and supported by such data and published literature from accepted academic, scientific and governmental sources.

A very large number (100,000) of simulations or iterations of what could happen in the following year are performed in order to derive average loss costs from simulation models. Average values derived from these 100,000 simulations are calculated and put into exhibits RB-6A and RB-6B. Many simulations are necessary so that the output distribution converges to the true distribution and that model-derived estimates are "stable."

The figure below illustrates the component parts of the AIR model (gray boxes). Each component represents both the ongoing efforts of the research scientists and engineers who are responsible for its design and the computer processes that occur as the simulations are run.



29. Q. Is computer modeling commonly used and relied on in meteorology and other fields?

A. Yes. Computer simulation models are universally used and relied upon every day in meteorology and many other fields. They are particularly useful tools for the analysis of complex problems involving the combination of multiple variables whose underlying distributions do not have closed form analytical solutions. In current operational hurricane forecasting practice, experts in the National Hurricane Center (NHC) rely heavily on various kinds of computer models. These models range in complexity from simple statistical models to three-dimensional primitive equation models. The statistical and two-dimensional models are maintained by the Tropical Prediction Center (TPC). The three-dimensional models are maintained by the National Centers for Environmental

Prediction's (NCEP) Environmental Modeling Center (EMC), a governmental organization which monitors meteorological conditions.

There are numerous advantages of the computer simulation approach. Such an approach is able to capture the effects on the catastrophe loss distribution of changes over time in population patterns, building codes, amounts insured, construction costs, personal property insured and other factors. Further, since the historical record is limited, the stochastic catalog of events is designed to capture the potential of experiencing loss from events which have not yet happened. These events are nevertheless realistic and possible and are simulated in accordance with their probabilities. Also, simulation models provide a good means to analyze the impact of new scientific understanding.

30. Q. How long have computer simulation models been used in insurance?

A. AIR pioneered the probabilistic catastrophe modeling technology that is used today by the world's leading insurers, reinsurers, regulators and financial institutions. The AIR hurricane model has been in use by clients since 1987.

31. Q. What different sizes of catalogs does AIR have available for hurricane loss estimation?

A. AIR has three different sized catalogs, distinguished by the number of simulated "years" of hurricane activity in the Atlantic Basin. Our catalogs consist of ten thousand, fifty thousand, and one hundred thousand simulated "years." As more simulations are used, the loss estimates become more robust and can be used at an increasingly granular level to provide accurate estimates of hurricane risk.

32. Q. What catalog did you use for your study on North Carolina mobile homeowners insurance?

We performed two analyses, each using a catalog 100,000 "years" of simulations. The 100,000 year catalog is the most robust catalog, and is commonly used in property insurance rate making. The first analysis is based on a standard view of the hurricane risk. This analysis formed the bases of the prospective hurricane losses employed by the Bureau in its filing.

The second analysis incorporates the impact of warm sea surface temperatures (WSSTs) in the North Atlantic on hurricane activity. This analysis formed the basis of the analyses by Dr. Appel who has noted in his testimony that reinsurers and catastrophe bond issuers price reinsurance for the forthcoming year based on the existence of warm sea surface temperatures. This comports with my understanding and personal observation of what reinsurers and catastrophe bond issuers do.

33. Q. What is a Monte Carlo simulation model and what are its uses?

A. Our approach was based on the Monte Carlo simulation method which is a generally accepted and frequently used mathematical technique. This technique has been used extensively in the fields of operations research, nuclear physics, insurance and many other fields. With the advent of powerful computers that enable many simulations to be run quickly and relatively cheaply, the uses for this technique have expanded greatly.

One of the first uses of a Monte Carlo simulation as a research tool was for work on the atomic bomb during World War II. With the advent of powerful computers, the uses for this technique expanded. Computer simulation models are particularly useful tools for the analysis of problems that involve solutions that are difficult to obtain analytically.

As noted authorities, Law and Kelton have stated: "Most complex, real-world systems cannot be accurately described by a mathematical model which can be evaluated analytically. Thus, a simulation is often the only type of investigation possible." The natural hazard loss-producing system involving the analysis of potential hurricanes is one such system.

34. Q. What is a natural hazard simulation model?

A. A natural hazard simulation model is a model of the natural disaster "system." The primary variables are meteorological in nature. As to hurricanes, the AIR research team collects the available scientific data pertaining to the meteorological variables critical to the characterization of hurricanes and therefore to the simulation process. These primary model variables include landfall location, central pressure, radius of maximum winds, gradient wind reduction factor, peak weighting factor, forward speed, and track direction. Data sources used in the development of the AIR hurricane model include the most complete databases available from various agencies of the National Weather Service, including the National Hurricane Center.

Based on a rigorous data analysis of the model variables of all past hurricanes in the data period, AIR researchers develop probability distributions for each of the variables, testing them for goodness-of-fit and robustness. The selection and subsequent refinement of these distributions are based not only on the expert application of standard statistical techniques, but also on well-established scientific principles and the latest scientific studies of how hurricanes behave.

These probability distributions are then used to produce a large catalog of simulated hurricane events. By sampling from the various probability distributions, the model generates simulated "years" of event activity. A simulated year in this context represents a hypothetical year of hurricane experience that could happen in the next hurricane season. The AIR model also allows for the possibility of no hurricane event or of multiple events occurring within a single year. That is, each simulated year may have zero, one, or multiple hurricanes. Each of the 100,000 simulated years has an equal probability of occurrence.

By generating 100,000 of these scenario years, the model produces a complete and stable range of potential annual experience of tropical cyclone activity. The pattern and distribution of the simulated years is based upon the pattern of historical years because their derivation is based on a scientific extrapolation of actual historical data. The pattern and distribution represent the broad range of events that could occur in the next hurricane season in accordance with their likelihood of occurrence. Thus, the next season could have no storms affecting North Carolina or multiple storms affecting North Carolina. It could have a Category 1 storm or a rare Category 5 storm. The model simulates these events in proportion to their likelihood based on the underlying science and actual meteorological data as to historical hurricanes.

Once values for each of the important meteorological characteristics have been stochastically assigned, each simulated storm is propagated along its track. Peak wind speeds and wind duration are estimated for each geographical location affected by the storm. Based on peak winds and duration, damages are estimated at each location for different types of structures. Also, policy conditions are applied to estimate the insured losses resulting from each event.

As opposed to purely deterministic simulation models, probabilistic simulation models such as the AIR model enable the estimation of the complete probability distribution of losses from hurricanes. Based on this probability distribution, average annual hurricane losses are derived and provided to the Bureau in the form of loss costs.

35. Q. What are the meteorological data sources that underlie your model?

A. The following are key data sources that underlie the AIR model.

Source	Years of Data
Tropical Cyclone Data Tape for the North Atlantic Basin, HURDAT	1900-2010
NOAA Technical Memorandum NWS NHC-6	1851-2010
Monthly Weather Review	1900-2012
NWS-23	1900-1976
NWS-38	1900-1984
Neumann, Charles J., "Tropical Cyclones of the North Atlantic Ocean, 1871-1998." NCDC, NOAA	1900-1998
National Hurricane Center Preliminary Reports for Specific Hurricanes	1977-2006
National Land Cover Dataset	1999-2001
DeMaria Extended Best Track Dataset	1988-2008
NOAA/AOML/Hurricane Research Division GPS Dropsonde data	2002-2005
http://weather.unisys.com/hurricane/index.html	1900-2012

36. Q. Are all of these sources governmental reports?

A. All are except for the Monthly Weather Review, which is a peer-reviewed journal published by American Meteorological Society; the DeMaria Extended Best Track Dataset, which is an academic dataset maintained by researchers at the University of Colorado; and the Unisys web site which is maintained by Unisys Corporation.

37. Q. Are these sources all generally accepted and relied upon in the meteorological and insurance communities?

A. Yes.

38. Q. Has AIR provided a document that describes the technical aspects of the AIR hurricane model in detail?

A. Yes. Attached as Exhibit RB 6-C is a lengthy document entitled “AIR Hurricane Model for the United States.” It explains technical aspects of the AIR model and is incorporated into my testimony.

39. Q. What steps were taken to assure that the meteorological data underlying the model were correctly input into the model?

A. When the meteorological and other data are input into the model, we consistently follow the policy of carefully cross-checking and verifying the numbers for accuracy. We continually review our model and the underlying meteorological data to make sure that the data have been input correctly. We also compare our model-generated data with the actual historical data to make sure that there is a close match. For example, we overlay maps of our simulated wind speeds on maps of the actual wind speeds for actual historical events.

For example, Exhibit RB-6D, pages 1, 2 and 3 consists of three representative maps where we have compared data from actual wind speed measurements of hurricanes that have affected North Carolina with the modeled-generated data to make sure that there is a close match. These maps show the actual wind observations and location points for Hurricanes Charley, Floyd, and Ophelia, overlaid on the modeled wind speed footprint of the same events. Charley made landfall in South Carolina as a Category 1 hurricane after passing through Florida as a Category 4 hurricane. Floyd made landfall in the Cape Fear area as a strong Category 2 storm. Ophelia never made landfall, but bypassed close enough to the North Carolina coast as a Category 1 hurricane to cause damaging winds onshore.

40. Q. Turning to basic meteorological concepts, how do hurricanes form?

A. Hurricanes form when warm ocean water evaporates, is further warmed by the sun, and rises to create a high, thick layer of humid air. This rising of warm, dense air creates an area of low pressure, known as a depression, near the ocean’s surface. Surface winds converge to the area of low pressure and, due to the earth’s Coriolis force, display a clear cyclonic pattern.

The inward rush of peripheral surface winds toward the central area of low pressure, the rise of warm humid air in the center, and the subsequent outflow away from the system at high altitude, combine to create a self-sustaining heat engine. The warmer the water temperature, the faster the air in the center of the system rises. The faster this air rises, the greater will be the difference between the surface air pressures inside and outside the vortex.

Air flows from areas of relative high pressure to areas of relative low pressure. The greater the difference between peripheral and central pressures, the faster the inflow. When sustained wind speeds reach 40 miles per hour, the depression reaches tropical storm status. When sustained wind speeds reach 74 miles per hour, the storm is designated a hurricane.

41. Q. What is meant by sustained wind speed?

A. The term sustained wind speed refers to the wind speed averaged over a given period of time, such as one or ten minutes, or an hour. Generally for the purpose of this testimony as to hurricanes, a one minute sustained wind speed is used, and surface wind speed is defined as the wind speed at 33 feet (10 meters) above ground. The speed of shorter period gusts or lulls may be considerably higher or lower than the sustained wind speed.

42. Q. What are the categories of hurricanes?

A. Under the Saffir-Simpson Hurricane Wind Scale, there are five categories of hurricanes. These categories are useful to the public in describing the general intensity of storms and in issuing warnings to the public, but they are not relevant to AIR's modeling, which generates a continuous distribution of wind speeds rather than placing hurricanes into categories. Under the Saffir-Simpson scale, hurricanes are categorized according to sustained wind speeds as follows:

Saffir-Simpson Hurricane Wind Scale

Category	Wind Speed (mph)
1	74-95
2	96-110
3	111-129
4	130-156
5	>156

These category definitions were changed by the National Hurricane Center prior to the 2012 hurricane season for ease of calculation between different measures of wind speed. Since modeling uses a continuous distribution, it has not been necessary that these changes in category definition be implemented in the event descriptions in AIR's stochastic catalog, and it should be noted again that the category designations have no bearing on the loss results produced by the model. They are used to categorize one parameter of hurricanes and ignore many more parameters that can also greatly impact the damage caused by hurricanes. Since Saffir-Simpson categories are simply a descriptor for the wind speeds of hurricanes, and there is no change to the underlying wind speeds in AIR's model that are modeled on a continuous distribution, there will be no change to estimated loss costs as a result of the NHC's change to the Saffir-Simpson Category definitions.

The name "hurricane" is commonly employed for tropical cyclones of certain strength in the Atlantic basin. Categories 3, 4 and 5 hurricanes are commonly called "major" hurricanes. It should be noted that various other names and labels are given to tropical cyclones of different intensities when they occur in different parts of the world. For instance, the term "typhoon" is often used in the Pacific basin, and the term "super-typhoon" is used for tropical cyclones that reach maximum sustained 1-minute surface winds of at least 249 km/h, which is the equivalent of a strong Category 4 or Category 5 hurricane in the Atlantic basin.

43. Q. How many hurricanes made landfall in the United States in the historical experience period?

A. A total of 183 hurricanes made landfall in the U.S. during the sample period of 111 years of hurricane experience (1900-2010). A single hurricane may comprise several landfalls. For example hurricane Donna in 1960 had three landfall points including one in North Carolina. When accounting for multiple landfalling events, there were 209 hurricane landfalls in the U.S. during the same period, 25 of which are North Carolina landfalls. By landfall point, I mean the latitude and longitude coordinates of the place where the center of the wind circulation of the hurricane (commonly called the eye) crossed from the ocean to land.

Due to significant advances in satellites and other observational methods, much more is known with certainty about storms in recent years than about storms that occurred many years ago. The tracks and intensities of older storms often have to be pieced together by researchers based on limited data points. Many years ago, there were relatively few locations that measured storm parameters such as wind speed and central pressure, and often the instruments were destroyed in powerful storms. From time to time, governmental and academic researchers have reexamined the underlying data as to past hurricanes. For instance, as part of an organized reanalysis of historical hurricane data performed by government and academic researchers several years ago, it was determined that additional hurricanes had made landfall in North Carolina during the period of 1900-2010, and these storms and their meteorological parameters were therefore added to AIR's historical data base. However, more recent storms like Hurricane Irene or Hurricane Sandy are not yet included in AIR's historical database, because they were not included in the HURDAT database as of August 15, 2011, upon which the current version of the model is based. These storms will be added to the model when more data becomes available as to these storms and the model is updated.

In addition to landfalling hurricanes, scientists have analyzed historical data on the storm tracks of "bypassing" events. In the context of the AIR model, a bypassing event is defined as a hurricane that does not make landfall but causes damaging winds over land. In other words, it is an event where the center of wind circulation does not cross over land but the outlying winds away from the center are strong enough over land to cause damage to structures. Because North Carolina juts out into the Atlantic, bypassing hurricanes are more frequent in North Carolina than many other states. Bypassing hurricanes are generally not counted in the number of landfalling hurricanes; however, hurricanes that make landfall in states other than North Carolina but are strong enough to cause damaging winds in North Carolina as bypassing storms are counted in the number of landfalling hurricanes in the United States.

44. Q. The model results in approximately 59,000 events causing loss to the mobile home exposure in North Carolina during the 100,000 "years" simulated. Does that conform closely with historical meteorological data?

A. Yes. It is important to point out that this number consists of numerous different types of events, many of which are quite small in impact. A small number of those events are "major hurricanes" making landfall in North Carolina and causing significant losses in North Carolina. Historical examples of major hurricanes include Hurricane

Hazel, which was a Category 4, and Hurricane Fran, which was a Category 3. Hurricane Floyd was also a large and memorable Category 2 even though it was not a "major" hurricane at landfall in North Carolina. A small number of the approximately 59,000 events are major hurricanes that make landfall elsewhere and then continue on to make an impact in North Carolina. An historical example of this type of event is Hugo, which hit Charleston as a Category 4 before continuing through North Carolina with weakened but still powerful winds. "Famous" historical storms such as Hazel, Fran, Hugo and Floyd caused large losses and deservedly receive a great deal of publicity, but they do not constitute a large percentage of the total number of storms causing loss in North Carolina.

The total number of storms causing loss in North Carolina is predominantly comprised of many other types of events, most of which are small in terms of losses. Some examples of the types of events that can impact North Carolina with relatively modest levels of loss include:

- Storms that make landfall in the Gulf of Mexico and travel north, typically through central or western North Carolina, resulting in minimal wind losses in those areas of North Carolina.
- Storms that make landfall in Florida, Georgia or South Carolina, continue inland and cause losses in various areas throughout North Carolina.
- Storms that make landfall in Florida, go back out to sea and make landfall in North Carolina.
- Storms that bypass North Carolina. These can be of several types. Some are bypassing storms that never make landfall anywhere in the United States. Others can be storms that bypass North Carolina and make landfall in Virginia, New England or some other location to the north of North Carolina. Still others can be storms that made landfall in a state to the south of North Carolina (often in Florida) and then travel north just off the coast of North Carolina.

These examples are not intended to represent the complete list of types of storms that could impact North Carolina, but rather are designed to show the diverse nature of events that result in losses in the state.

In addition, there have been numerous years in which multiple hurricanes caused losses in North Carolina. For instance, in 1955 three storms made a direct landfall in North Carolina, and in 2004 more than three storms made landfall in the Gulf of Mexico or Florida and caused losses in North Carolina as they moved north.

Similarly, there have been many years in which the model does not report any losses for North Carolina's mobile home exposure due to hurricane activity. In fact, only approximately 43% of the years in the 100,000 year simulation involve some loss due to hurricane activity for North Carolina's mobile home exposures.

Exhibit RB-6E compares the historical frequency of events that made landfall in North Carolina, that made landfall outside North Carolina and impacted North Carolina inland and that bypassed North Carolina, with the corresponding frequency from the AIR modeled stochastic catalog. As can be seen, there is a close relationship between the model and the historical record, both for the entire period and for the period when warm sea surface temperatures have been in existence. As can be seen, the model simulates fewer hurricanes than have actually affected North Carolina in the historical record.

It is in the very nature of modeling that differences between the model and the historical record are expected. The nature of modeling is to take the limited number of data points in the historical record and apply accepted mathematical distributions to those data points in order to simulate thousands of equally likely events for the following year.

45. Q. What was the most intense hurricane to directly strike North Carolina during the period 1900-2014?

A. Hazel, a Category 4 hurricane, in 1954 was the most intense hurricane to hit North Carolina during this period from a meteorological standpoint. Several other strong hurricanes of intensity similar to Hazel were "near misses" during this period. Of course, North Carolina may experience much more severe storms than Hazel at some point in the future. Hazel was by no means the worst case scenario for the state, even though it was the worst storm during the period during which good records are available.

46. Q. How are bypassing storms handled in the AIR model?

A. As described above, bypassing storms are hurricanes which do not actually make landfall (i.e., where the center of the hurricane eye never actually comes on shore) but which come close enough to the coastline to cause damaging winds over land. For the purpose of categorization, those storms that are identified as North Carolina by-passers are ones that originate in the Atlantic basin and do not make landfall as hurricanes anywhere in the United States. They can, however, make landfall as tropical storms further north along the US coastline and still be counted as bypassing storms.

Recent changes to the AIR model reflect an increase in the number of bypassing storms that have been identified by government and academic researchers, based upon their continuing analysis and reanalysis of the storm frequency in the Atlantic basin. A recent example of a bypassing storm is Hurricane Earl in 2010. Earl had the potential to make a direct landfall in North Carolina. However, in 2010 the location and influence of the so-called "Bermuda High" caused many storm tracks, including Earl, to curve northward without making a landfall. Had conditions been different, Earl could have made a landfall and caused significant loss in North Carolina. There have been numerous other powerful bypassing storms that, if steering currents had been slightly different, could have made landfall in North Carolina and have caused significant losses.

Another example is Hurricane Helene in 1958. Helene was a strong Category 4 hurricane which came very close to making landfall in North Carolina but bypassed the coast. Even though it did not make landfall, it caused damage in some parts of the state in excess of that caused by Hazel four years earlier in those areas.

47. Q. Has AIR produced any comparisons of historical event frequencies to the frequencies that are incorporated in the model?

A. Yes, Exhibit RB-6F to this testimony compares the historical frequency by Saffir-Simpson category of events making landfall in North Carolina to the corresponding frequency from the modeled stochastic catalog. As stated earlier, AIR models a continuous distribution of hurricane wind speeds using a distribution that is based on the actual wind speeds of historical hurricanes, and this procedure does not depend on or employ assumptions as to the Saffir-Simpson categories of past or modeled storms. Analyzing storm data by first placing storms into certain categories and then measuring the number of storms in each such category is not a robust manner to review the validity of the model because the presence or absence of a single storm on the borderline between two categories could affect the review inappropriately; however, even by forcing storms into Saffir-Simpson categories, it can be seen that the AIR model conforms with history using that type of popularized analysis.

As stated above, it is the nature of modeling that the limited amount of historical data can be analyzed and, by the use of mathematical distributions, can be extended to create combinations and permutations that can and will occur but have not occurred in the past. For example, as can be seen from the small bar on Exhibit RB-6F for Category 5 storms, the model simulates a very small number of Category 5 storms even though there has never been a Category 5 storm to strike North Carolina in recorded history. This is appropriate. Scientists know that there is no meteorological reason and no reason in physics that a Category 5 storm cannot strike North Carolina, and there is a mathematical probability that one will strike someday. Academic and governmental sources confirm that a Category 5 storm can strike North Carolina. Accordingly, the model simulates such storms as extremely low probability events even though they have never occurred in the period of time for which consistent historical data has been collected.

48. Q. Are there any climatological factors influencing hurricane frequency and intensity in general and with respect to North Carolina in particular?

A. Yes. There are a number of climate "signals" that are correlated with mechanisms within the earth's environment that impact hurricane activity in the Atlantic Basin. These include the Atlantic Multidecadal Oscillation (AMO), the El Nino Southern Oscillation (ENSO), the Quasi-Biennial Oscillation (QBO), and the North Atlantic Oscillation (NAO).

The AMO is the oscillation of sea surface temperatures in North Atlantic, which fluctuates over a period of several decades. We are currently in a period of warmer than average sea surface temperatures.

The ENSO is the oscillation of sea surface temperatures in the Eastern Pacific Ocean, which fluctuates over a period of approximately 2.5 to 7 years. "El Nino" conditions result in stronger than average wind shear over the Atlantic Ocean. Wind shear is detrimental to hurricane development. Wind shear is a measure of how much winds vary by height. High wind shear has the effect of preventing hurricane development by disrupting the structure of a tropical cyclone. In contrast to El Nino conditions, "La Nina" conditions are more conducive for hurricane formation due to lower wind shear over the Atlantic.

The QBO is the oscillation in wind directions over the tropics in the upper atmosphere, which fluctuates about every 2 years.

The NAO is the large scale oscillation in atmospheric pressure in the Atlantic Ocean between the subtropical high and the polar low pressure system. The NAO fluctuates over short periods of time, such as days, weeks, or months. The changing location of the high and low pressure systems over the Atlantic has different impacts on hurricane activity in the Atlantic basin. NAO movements can affect steering currents that direct hurricanes to various areas in the Atlantic basin. For instance, the location of the "Bermuda high" can have a significant effect on whether a storm makes landfall along the east coast of the United States.

In addition to these four climate signals, there is always variation in any given hurricane season. The random occurrence of factors such as sandstorms in West Africa, the timing of frontal systems coming across the northern United States and periodic fluctuations in jet stream activity that have been shown to impact the formation, development and landfall of hurricanes in states such as North Carolina.

49. Q. How are these factors incorporated into the AIR model?

A. The four climate signals and other factors are not explicitly accounted for in the standard 100,000 “year” hurricane catalog. The standard catalog is a catalog that is based on the past 111 years of historical hurricane activity which includes multiple observations of each of these climatological signals and oscillations. The 111 year period used in the Standard Catalog captures the effects of all of these factors.

As stated earlier, AIR has developed a WSST hurricane catalog which incorporates the impact of elevated sea surface temperatures (SSTs) in the North Atlantic on hurricane activity. Loss costs from this catalog are contained in Exhibit RB-6B.

A correlation has been drawn between sea surface temperature and hurricane activity in the Atlantic basin. There is an increased probability of hurricane activity during warm periods, and a decreased probability of hurricane activity during cool periods. This correlation is logical because it is known as a matter of physics that warm sea surface temperatures provide the necessary "fuel" for hurricanes. As with many meteorological matters, this correlation is subject to uncertainty and continues to be an area of active research. The WSST Catalog is created by adjusting the frequency and severity of the Standard Catalog based on historical periods of known above-average sea surface temperature.

It is important to recognize that AIR’s WSST catalog is not a near-term or medium-term model, but still a long-term model. It represents risk conditioned on periods of warmer than average sea surface temperatures, and thus models the long term average annual loss resulting from hurricane activity during time periods with warmer than average sea surface temperatures.

Exhibit RB-6E shows how the frequency of events in years with warmer than average SSTs differs from the average frequency for the entire historical period in terms of hurricanes affecting North Carolina.

50. Q. Based on this information, what conclusions can be drawn about the probability of hurricane activity in the Atlantic basin in the coming years?

A. As noted above, we are currently in a period of above-average sea surface temperatures. If the warmer than average sea surface temperatures persist into the coming years, the Atlantic hurricane activity is likely to be elevated. While the other three cycles might oscillate to result in either an increased or decreased level of hurricane activity from one season to the next, and while other factors may increase or decrease activity in given years, the SST varies over a much longer period of time and thus results in an overall increased probability of hurricane activity in North Carolina in the coming years.

51. Q. Is the AIR modeling methodology a sound and appropriate method of projecting the prospective hurricane losses used in the filing for mobile home insurance in North Carolina?

A. Yes. AIR's simulation methodology is based on mathematical/statistical models that are derived from and that represent real-world systems. The methodology is founded in and consistent with documented science. As with all models, these representations are not exact; however, simulation methodology is the best available technique for estimating potential hurricane losses and is far superior to referencing actual dollars of losses paid by insurance companies following hurricanes, whether recently or many years ago. The best approach is to consider the longest period of consistently maintained and reported meteorological data available and to use that data to establish the range and probability distributions of events that could occur. That is what AIR's model does for 100,000 iterations, and the results are averaged for the determination of loss costs used by the Bureau.

AIR's standard hurricane catalog incorporates data beginning in 1900, which AIR scientists have concluded is the best and longest period of consistent and reliable data available. While some data is maintained on hurricanes that have occurred prior to 1900, the data is not of the consistency and quality of data following that date.

AIR's analyses using the standard catalog produces the long run average hurricane loss costs for the modeled exposure set. AIR's WSST hurricane catalog also incorporates the best and longest period of data available, with modifiers applied to account for the impact of elevated sea surface temperatures on hurricane activity. The differences in historical hurricane data between periods of warm and cold sea surface temperatures are reflected in the WSST catalog. Analyses using the WSST catalog also yield the average hurricane loss costs, assuming the continuation of elevated sea surface temperatures.

52. Q. What is the sequence in which the AIR model simulates hurricanes affecting the U.S. and North Carolina?

A. For each simulated year, the model first determines the number of landfalls that occur during that year. This frequency variable is based upon and reflects the historical pattern and probability of hurricanes over the long term. In those years in which a landfall occurs, the landfall location is generated using a probability distribution for landfall location. This landfall location also is based upon and reflects the historical probability of landfall locations.

Having simulated the location, values for landfall angle, forward speed, central pressure, radius of maximum wind, gradient wind reduction factor, and peak weighting factor are generated using probability distributions derived from historical data and meteorological knowledge. As a hurricane moves from its landfall location, its track is simulated using probability distributions derived from historical data and meteorological knowledge. This is done by using a Markov procedure with transition probabilities estimated using historical data.

53. Q. How is hurricane frequency modeled?

A. The model uses a negative binomial distribution to generate the number of hurricane landfalls per year. Actual historical data from 1900-2010 is compared to the modeled distribution for the entire Gulf and East Coasts. The modeled distribution fits the historical data very closely. The average number of hurricanes per year making landfall in the United States is 1.65. However, considering that a storm may make more than one landfall, the average number of hurricane landfalls is 1.88. Since the negative binomial distribution models individual landfalls, it has a mean of 1.88, reflecting the historical average of hurricane landfalls.

As discussed above, Exhibit RB-6E to this testimony shows comparisons of AIR's modeled event frequency to the corresponding frequency from the historical record for North Carolina.

54. Q. How is landfall location modeled?

A. For the United States, there are 62 potential landfall segments each representing 50 nautical miles of smoothed shoreline along the Gulf and East Coasts, including the Florida Keys. A cumulative distribution of landfall locations within each coastal boundary segment is used to estimate the probability of a hurricane landfall occurring at a point along a segment. Once a segment is chosen in accordance with its probability, the landfall location within that segment is drawn at random from a uniform distribution along that segment; that is, a storm can make landfall anywhere on that segment with equal probability.

55. Q. How is hurricane severity modeled?

A. The AIR hurricane model generates values for the severity variables based on historical meteorological data. There are seven primary variables which account for hurricane severity. These variables are: the minimum central pressure, the gradient wind reduction factor, the peak weighting factor, the radius of maximum winds, the forward speed, the angle at which the storm enters the coast and the track of the storm once on shore. The most recent version of the model reflects new scientific findings as to these variables.

56. Q. What is the central pressure variable?

A. Central pressure is defined as the minimum atmospheric pressure measured in a hurricane. The central pressure distribution is based on the historical database and is determined for each 100-nautical-mile coastline segment, as well as for larger regional segments.

Exhibit RB-6G shows a comparison of the modeled central pressure values in AIR's stochastic catalog to the same values in the historical catalog for events which make landfall in North Carolina.

There is good agreement for the mean central pressure at landfall. The mean central pressure for North Carolina landfalls is 968.5Mb, which falls within the 95% confidence interval based on the historical record. The 95% confidence interval is a range of values in which we can be 95% sure that the true mean lies, based on the observed historical data. The fact that the modeled mean lies within this range means that there is no statistical reason to suspect that the modeled mean is not the true mean.

57. Q. What is meant by the radius of maximum winds?

A. The radius of maximum winds (Rmax) is the radial distance from the storm's center, or center of the eye, to the location in the eye wall where the highest cyclonic wind speeds occur. The radius distribution is based on the historical database and is dependent on the central pressure of the storm. The radius of maximum winds also varies after landfall, in accordance with values in the historical data.

There is uncertainty in the historical data since this storm parameter is a difficult parameter to measure. This is particularly true for storms that made landfall during the first half of the 20th century, before reconnaissance flight data or high-resolution radar data was available. The model is based on widely accepted Rmax values and distributions in the scientific literature.

58. Q. What are the gradient wind reduction and peak weighting factors?

A. These two factors are used to translate the flight-level winds to the land surface. The wind speed of a hurricane varies both with the lateral distance from the eye and the vertical distance from the land surface to the flight level. The gradient wind reduction factor varies by distance from the eye of the storm and translates the flight-level winds horizontally to the land surface where buildings are affected by hurricane winds. The peak weighting factor also adjusts the gradient wind reduction factor for the vertical slant in the hurricane eye. These two factors are generated jointly for each modeled storm based on algorithms founded in historical data and accepted meteorological principles.

59. Q. What is forward speed?

A. Forward speed is the speed at which the center of a hurricane moves from point to point along its track. In general, hurricanes pick up speed as they move further north in latitude. The forward speed distribution is based on the historical database of forward speeds at landfall and is determined for each 100-nautical-mile segment

Exhibit RB-6H shows a comparison of the modeled forward speed values in AIR's stochastic catalog to the same values in the historical catalog for events which make landfall in North Carolina.

There is good agreement for the different bands of forward speed at landfall, and in fact the mean forward speed for North Carolina landfalls is 16.2 mph, which falls within the 95% confidence interval based on the historical record. The 95% confidence interval is a range of values in which we can be 95% sure that the true mean lies, based on the observed historical data. The fact that the modeled mean lies within this range means that there is no statistical reason to suspect that the modeled mean is not the true mean.

60. Q. Does the combination of forward speed and wind speed affect the damage caused by a given hurricane?

A. Yes, this is what is referred to as the "asymmetrical effect" of hurricane winds. Hurricane winds move in a counter clockwise direction around the eye of the hurricane, which means that winds on the right side of the hurricane are moving with the forward direction of the storm, thereby combining to create higher wind speeds at locations on the right side of the hurricane. Conversely, the wind speed at any given location on the left side of the storm is reduced by the combined effect of the hurricanes rotational winds being offset by the translational winds. The faster the forward speed of the hurricane, the greater are the effects of this asymmetry. Also, the faster the forward speed, the less time that damaging winds affect a given location.

61. Q. What is the track angle at landfall?

A. Track angle at landfall is the angle between track direction and due north at landfall location. Track angles at landfall in the model reflect the underlying meteorological data.

62. Q. What is the storm track?

A. Storm track is the path the hurricane takes. AIR has developed a procedure to simulate storm tracks, which is described in more detail under question 70 below This procedure allows the tracks to curve and re-curve in the same way and to the same extent that actual historical storms do.

63. Q. Does the latitude of the hurricane make a difference?

A. Yes. Hurricane intensity and frequency vary by latitude. In general, as latitude increases, average hurricane intensity decreases, and we model this effect accordingly. In general, water tends to be cooler in higher latitudes. When a hurricane moves over cooler waters, its primary source of energy (latent heat from warm water vapor) is reduced so that the intensity of circulation decreases, in the absence of outside forces. For this reason, the parameters of the severity variable probability distributions were estimated separately for each of the thirty-one 100-mile coastal segments using state-of-the-art statistical techniques combined with published scientific information. The result is that the model reflects the historical data that hurricanes tend to lose some of their intensity as they move north. Likewise, the model reflects the historical data that hurricanes tend to have higher land speed as they move north.

64. Q. How does the AIR model generate values for the distribution of hurricane central pressures?

A. The AIR hurricane model utilizes central pressure as the primary hurricane intensity variable. Based on the historical data, Weibull distributions are employed so that the parameters are estimated for each of the thirty-one 100-nautical-mile coastal segments, as well as for larger regional segments, with the final distribution being a mixture of the two. The Weibull form was selected based on “goodness-of-fit” tests with actual historical data. The use of the Weibull distribution for storm central pressure is documented in and supported by the scientific literature.

As discussed earlier, Exhibit RB-6G shows a comparison of the modeled central pressure values in AIR's stochastic catalog to the same values in the historical catalog for events which make landfall in North Carolina.

65. Q. How does the AIR model generate values for the radius of maximum winds?

A. The radius of maximum wind (Rmax) is simulated using a regression model that relates the mean radius to central pressure and latitude. The deviations from the mean in this model are simulated from a Normal distribution. The parameters are estimated using the least squares method, and standard diagnostic tests are used to evaluate the adequacy of the fit. The resulting values are bounded based on central pressure to produce a final distribution for the radius. The radius of maximum wind also varies after landfall, following an autoregressive model.

The model is based on Rmax values and distributions that are widely accepted in the scientific literature.

66. Q. How does the AIR model generate values for the gradient wind reduction factor and the peak weighting factor?

A. The model computes the maximum wind speed at upper levels and then adjusts this wind speed to the surface level (10 meters) via a conversion factor. This factor, called the gradient wind reduction factor, represents a model parameter which varies stochastically by storm. For a particular storm it varies by location as a function of the central pressure and distance from Rmax. The peak weighting factor adjusts the gradient wind reduction factor to reflect the vertical slant in the hurricane eye. The peak weighting factor and gradient wind reduction factor are generated jointly using a bounded bivariate normal distribution. These factors are based on accepted meteorological studies and principles.

67. Q. How does the AIR model generate values for forward speed?

A. Probability distributions are estimated for forward speed for each 100-nautical-mile segment of coastline with bounds based on the historical record. Separate distributions are estimated for each of these segments to capture the dependence of this variable upon geographic location, particularly latitude. Based on the historical record, forward speed varies after landfall according to an autoregressive model. The bounds on forward speed are latitude dependent; i.e., storms tend to pick up speed the further north they travel.

As discussed earlier, Exhibit RB-6H shows a comparison between the modeled forward speed values in AIR's stochastic catalog and the same values in the historical catalog for events which make landfall in North Carolina.

68. Q. How does the AIR model generate values for track angle at landfall?

A. Separate distributions are used for different 50-nautical-mile coastal segments to allow for variation in the coastal orientation of each segment. In the historical record, certain coastal segments seem to be characterized by bimodal track angles. To preserve consistency with the historical distribution, the track angle at landfall is modeled using a mixture of two normal distributions. That is, the track angle at landfall is drawn from the first normal distribution with probability p, or it is drawn from the second normal distribution with probability 1-p. The final distributions are bounded based on the historical record, the coastline orientation, geographical constraints, and meteorological expertise.

69. Q. How does the AIR model generate values for storm tracks?

A. Storm tracks are generated by successively drawing track direction and forward speed. AIR uses a Markov chain model with estimated transition matrices to simulate track direction. Our scientists have analyzed historical data on the tracks of more than 1,000 Atlantic tropical cyclones, both those that made landfall and those that did not. Using this data, AIR has created transition matrices from which successive track directions are generated. There are 16 primary directional probabilities. Within each primary direction there is a uniform, continuous probability distribution, resulting in an infinite number of potential track directions. For each of 16 directional probabilities of storm arrival, these matrices specify the probability of a directional change at each time step. Having determined the new track direction, the next track point is determined by drawing forward speed using a procedure that incorporates time series dependence between successive drawings. The methodology produces realistic tracks that represent the full range of diverse storm tracks that have been observed historically across the Atlantic basin and the U.S. mainland in accordance with their historical probability.

In older versions of the AIR hurricane model, storms were terminated after the tracks evolved for 24 hours after making U.S. landfall. In Version 12 of the model and newer versions, including Version 14.0.1, each storm is terminated only when its wind speed along the path decreases to below 40 mph. The number of storms causing loss in North Carolina has therefore increased because of this change, but the potential for damage is more appropriately reflected than before. The dollar value of losses associated with this increased event persistence is not great.

It is also the case that a single landfalling hurricane may produce multiple landfalls or subsequent bypasses. A number of historical storms that have affected North Carolina fall into these categories. Since the AIR model follows each simulated hurricane from inception until dissipation, multiple landfalls and bypassing hurricanes are included in the simulation. The simulated frequency of these events is consistent with their historical frequency by coastal region.

70. Q. How does the AIR model calculate maximum wind speeds?

A. Once values are obtained for all of the severity variables, the maximum sustained wind speed is calculated using generally accepted meteorological formulas. For each simulated event, the model simulates the storm's movement along its track. A complete time profile of wind speeds is developed for each location affected by the storm, thus capturing the effect of duration of wind on structures, as well as the effect of peak wind speed. Calculations of local intensity also take into account the effects of the asymmetric nature of the hurricane windfield, the effects of the storm "filling" or dissipating in intensity over land, the directional effects of surface friction, the gustiness effects of surface friction, the effect of wave height on wind speed, and the relative wind speeds as the distance from the radius of maximum winds increases.

In AIR's continuing effort to reflect scientific advancements, recent versions of the model much more accurately reflect these factors. For instance, Version14.0.1 explicitly computes the effects of land cover on windspeed by wind direction. In previous versions (prior to version 12), the model assumed an average land cover and an average frictional effect, but as a result of the ability to geocode actual land cover characteristics, the model is now much more precise. Thus, less deterioration of wind speeds occurs to storms that make landfall in areas that have nearby low dunes or sounds and other bodies of water, as opposed to areas that have tall trees, hilly or mountainous terrain, or tall buildings. This change means that the model now more accurately reflects the deterioration of storms in various locations in North Carolina based on the actual land cover in those locations.

As mentioned previously, Exhibit RB-6D shows the actual wind observations for Hurricanes Charley, Floyd, and Ophelia, which each affected North Carolina, overlaid on the modeled wind speed footprint of the same events. Hurricane Irene is not included in this exhibit because it is not included in the HURDAT database as of August 2011, and is not yet included in AIR's historical catalog.

Additionally, Exhibit RB-6I shows a comparison of the modeled maximum wind speed values at landfall in AIR's stochastic catalog to the same values in the historical catalog for events which make landfall in North Carolina.

There is good agreement for the different bands of maximum wind speed at landfall, and in fact the mean maximum wind speed for North Carolina landfalls is 96.0 mph, which falls within the 95% confidence interval based on the historical record. The 95% confidence interval is a range of values in which we can be 95% sure that the true mean lies, based on the observed historical data. The fact that the modeled mean lies within this range means that there is no statistical reason to suspect that the modeled mean is not the true mean.

71. Q. You have explained how the AIR model generates values determining the frequency and severity of hurricanes. Now please explain how insured damages are computed?

A. AIR scientists and engineers have developed mathematical functions, called damageability relationships, which describe the interaction between buildings (both their structural and nonstructural components as well as their contents) and the local wind intensity to which they are exposed. Damageability functions have also been developed for estimating time element losses (generally, coverage for loss of use which requires the owner to rent elsewhere). These functions relate the mean damage level as well as the variability of damage to the measure of storm intensity at each location. Because different structural types (e.g., frame or masonry) will experience different degrees of damage, the damageability relationships vary according to construction materials and occupancy. The AIR model estimates a complete distribution around the mean level of damage at a given intensity and structural type, and from there the model constructs an entire family of probability distributions. Losses are calculated by applying the appropriate damage function to the replacement value of the insured property.

The AIR damageability relationships incorporate the results of well-documented engineering studies, tests, and structural calculations. AIR employs a team of nine engineers who continually survey the engineering literature and state and/or regional building codes and other sources as to wind engineering. They also consult with other experienced engineers to verify our damage functions, and if necessary, they refine these relationships.

AIR engineers perform post-disaster field surveys and analyses for all U.S. landfalling hurricanes. Additionally, AIR has analyzed billions of dollars of actual insurance claims data from hurricanes in order to validate damageability relationships in the model. The loss information is typically reviewed in numerous manners, including by zip code, coverage and construction.

72. Q. Specifically, how is the damage for mobile homes estimated in the model?
A. The AIR hurricane model includes four damage functions for mobile homes: mobile home with no tie-downs, mobile home with partial tie-downs, mobile home with full tie-

downs, and mobile homes with unknown tie-down information. This last classification would be used when the tie-down information is unknown and represents a weighted average of tie-down types, including no tie-downs. Similar to other residential risks the damage estimation module develops a complete time profile of wind speeds for each location affected, thus capturing the effects wind duration and peak wind speed have on structures.

73. Q. How often has the AIR model been updated and refined since it was originally created?

A. The AIR hurricane model was first developed in 1985. Since that time the model has typically been updated in each year. In some years, routine matters such as the zip code database are the only updates performed. On such occasions, for each new zip code centroid, the following are re-estimated: distance from coastline, elevation, surface terrain, and any other special topographical features.

In other years there can be a large number of model updates. As new data and research about hurricanes become available, such information is also added to the model. The probability distributions for all of the meteorological variables have been re-computed approximately every two or three years to reflect additional years of new hurricane experience. Damageability relationships have been continually reviewed and validated as actual hurricanes have occurred and new loss data has become available.

Other revisions to the model represent one-time refinements to various model components, and these typically are undertaken when significant new data or research becomes available. AIR prides itself on keeping up with the newest developments of science.

During the period of 2009-2010 there was a major and comprehensive update of many components of the model to reflect significant new data and research. These updates were implemented into Version 12 and carried through the newer model versions, including Version 14.0.1. Some of these updates are described in detail throughout this testimony. The 2011-2013 update to Version 14.0.1 represents the most recent of the ongoing model update efforts. Over the years these efforts brought about some significant improvements to the model and its output. As will be discussed below, these changes were extensively thought out, peer reviewed and validated.

74. Q. Has the AIR model been independently peer reviewed?

A. Yes, it has been extensively peer reviewed by independent scientists since it was first created in 1985, and it has been subject to periodic peer review thereafter. Independent reviews of the model have been conducted by many experts in multiple fields, including meteorology, engineering, computer science, insurance, statistics, and finance. As a result of this review and scrutiny, it is correct to state that the AIR hurricane model has been extensively vetted by independent, outside parties as well as AIR's own technical staff.

Meteorological components of the model were reviewed in 1986, 1994, 2009 and 2010. The derivation and application of vulnerability functions used in the model have undergone independent review for each of the past ten years, particularly following hurricane loss reports becoming available after analysis of each hurricane. Computer science reviews have been conducted in 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2010 and 2012 to validate that AIR's modeling software complies with the standards of the Florida Commission on Hurricane Loss Projection Methodology.

75. Q. Please describe the peer review process.

A. As described below, over many years, the AIR model has undergone extensive external review by independent scientists, and it has been examined in scientific literature. It has also been reviewed in depth by independent rating agencies and regulators.

The following are independent peer reviews that have been performed, broken down by the components of the AIR model. As will be noted, peer reviews were particularly extensive as to the 2009-2010 changes that are reflected in this filing.

Meteorology – In 2010 the meteorology component of the model was extensively reviewed by three meteorologists, Dr. Kerry Emanuel, Dr. Peter Black, and Dr. Robb Contreras.

Dr. Black has spent over 40 years conducting hurricane research at NOAA's Hurricane Research Division as a research meteorologist using observations provided by aircraft and satellite platforms. Among many other accomplishments, Dr. Black has been a lead project scientist on various NOAA research aircraft, involving over 400 hurricane eye penetrations in 300 hurricane flights. He has been responsible for conducting investigations of the hurricane boundary layer structure, ocean response to a hurricane, microwave remote sensing of surface winds, hurricane convective clusters, and most recently, hurricane air-sea interaction processes.

Dr. Contreras has spent over sixteen years doing research in academic departments such as the University of Massachusetts, Amherst, the University of Washington, Seattle and UC San Diego. Recently Dr. Contreras has worked as a scientist to implement physical models of signatures, environments, and sensors based on first principles. He has developed physics-based algorithms for robust detection and tracking.

Dr. Emanuel has been a professor at the Massachusetts Institute of Technology since 1997 in both the Program in Atmospheres, Oceans, and Climate and the Center for Meteorology and Physical Oceanography, where he was also the director for eight years. Dr. Emanuel has received numerous awards including The Carl-Gustaf Rossby Research Medal and the Louis J. Battan Author's Award, from the American Meteorological Society in 2007.

The WSST catalog generation process has also been reviewed by well-respected meteorological experts. The research used to develop the WSST catalog was peer reviewed and published in the American Meteorological Society's *Journal of Applied Meteorology and Climatology*. In 2010 the WSST catalog generation process was also reviewed by Dr. Kerry Emanuel of MIT, Dr. James Elsner of Florida State University, and Dr. Timothy Hall of the NASA Goddard Institute for Space Studies.

Vulnerability - The vulnerability functions have been reviewed by Dr. Joseph Minor, P.E. in 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008 and 2009, by Dr. Marc Levitan in 2009 and by Dr. Carol Friedland in 2009 and 2013.

Dr. Friedland has been engaged in wind and hurricane engineering research, practice, and education for over nine years and in civil engineering and construction for over fourteen years. She is an Assistant Professor in the Department of Construction Management and Industrial Engineering at Louisiana State University. She has been a registered professional engineer since 2003. She has studied wind and hurricane effects on buildings and structures through structural analysis and post-storm investigations. Recent field investigations include documenting performance of buildings and other structures after Hurricanes Isaac, Gustav, Ike, Katrina, and Ivan and the April 2011 tornado outbreaks in Alabama and Mississippi.

Dr. Levitan has been actively engaged in wind and hurricane engineering research, practice, and education for over 27 years. He is currently leading research and development to improve model codes, standards, design guidance, and practices for the construction and rehabilitation of buildings, structures, and lifelines at the National Institute of Standards and Technology. At the time of his review of the model, he was an Associate Professor in the Department of Civil and Environmental Engineering at Louisiana State University. He was the driving force behind the creation of the LSU Hurricane Center. Under his direction for a period of 10 years, that Center became one of the premiere interdisciplinary research facilities, addressing hurricanes and other natural hazards and their impacts on the natural, built, and human environments. He has provided national leadership through: chairing national technical and policy committees; chairing national and international conferences and workshops; serving as President of the American Association for Wind Engineering, and testifying a number of times before Congress and in state legislatures on topics related to wind and hurricane hazards and mitigation. He has several dozen publications in journals, conference proceedings, and other venues.

Computer Science - The software engineering components of the model have undergone independent peer review by Dr. Mark Wolfskehl in 2002, Dr. John Kam in 2003, 2004 and 2005, and by Narges Pourghasemi in 2006, 2007, 2008, 2010 and 2012.

Ms. Pourghasemi has been an independent software consultant for over eight years. She has extensive experience in software engineering, development and testing.

Actuarial - The model underwent an actuarial review in 2010 and 2012 by John Rollins, FCAS, MAAA.

Mr. Rollins is an experienced property-casualty actuary. His qualifications include over twenty-two years of property and casualty insurance experience in a variety of positions including a leading catastrophe modeling firm, Florida property insurers, Florida residual market property insurers, global consulting and software firms, and advisory organizations. He has the highest actuarial qualifications, and has extensive authorship and speaking experience.

76. Q. What are examples of outside reviews that have been performed on behalf of independent third parties?

A. One significant example is the testing conducted by four bond rating agencies in 1996 and 1997 in conjunction with their rating of the USAA catastrophe bond. Those agencies were Duff & Phelps, Fitch, Moody's and Standard & Poor's. Their review was particularly extensive because the USAA catastrophe bond was the first such bond to be assigned a corporate bond rating by all four agencies. The probabilistic estimates derived from the AIR hurricane model formed the primary basis for the assigned ratings.

Over a period of 18 months, AIR staff met with employees and consultants hired by the rating agencies representing many fields, including insurance, statistics, meteorology and finance, to explain the AIR hurricane model in extensive detail. In addition, a number of sensitivity analyses and stress tests were performed at the request of the rating agencies during this period of time.

These tests, performed by outside experts whose primary interest was the protection of prospective investors, confirmed the robustness of the AIR model. Moody's wrote: "Moody's did not simply accept AIR's modeling results at face value. Rather, we followed an examination and calibration procedure, aiming to provide Moody's with a high degree of confidence in the reliability and stability of the simulation results."

Similarly, Fitch wrote in approving the model: "Fitch evaluated the underlying technical integrity of the AIR model on the basis of model specification and model structure."

Due to the first-time nature of such a large catastrophe bond issuance, the rating agencies very carefully scrutinized model assumptions, data, and methodology. These rating agencies have continued their scrutiny of the model in the course of subsequent catastrophe bond transactions, including every property catastrophe bond transaction that came to market in 2011 through 2014.

77. Q. What information does AIR provide outside reviewers about its methodology?

A. In the review of the AIR model in 1996 and 1997 by the bond rating agencies, review took place as to the probability distributions used in the model and the estimation methods employed to fit the parameters of those distributions. Also the consultants employed by the bond rating agencies reviewed the mathematical functions used in the model to estimate the interactions between simulated storm parameters. For the validation testing and sensitivity analysis, the rating agencies reviewed model output under various distributional assumptions.

For the meteorology peer reviews in 2010, we provided Dr. Emmanuel, Dr. Black and Dr. Contreras the data sources, the references of data and the published research used, as well as detailed explanations of the actual implementation which AIR scientists used to develop and/or update the model. The review was conducted iteratively so that suggestions and feedback from the peer reviewers early on was incorporated in subsequent model updates.

For their review of the vulnerability component of the model in 2010 and 2012, Dr. Friedland and Dr. Levitan were provided the Florida Commission vulnerability standard submissions and comprehensive detail on all changes to the vulnerability component of the model. The peer review team conducted an extensive review of the damage functions and research used in the development of those functions.

The computer science peer reviewers were provided information on the software development and testing processes, including insights into the software and underlying code to ensure that the software complies with the software standards and requirements established by the Florida Commission, as well as current industry-standard software engineering practices.

AIR provided the 2010 and 2011 actuarial peer reviewer with model software, input data, output files, and work papers used in assembling the response document and forms for the Florida Commission. The review proceeded step by step based on these items.

78. Q. You have mentioned on several occasions that the AIR model has been reviewed by the Florida Commission. Please describe what that Commission is and what AIR has done in connection with that Commission.

A. The Florida Commission was established in 1995 by the Florida legislature with the mission to "assess the effectiveness of various methodologies that have the potential for improving the accuracy of projecting insured Florida losses resulting from hurricanes and to adopt findings regarding the accuracy or reliability of these methodologies for use in residential rate filings." The Commission has established 37 standards that need to be met before a catastrophe model is acceptable for ratemaking purposes in the state of Florida. The AIR hurricane model was the only model approved under the original standards in 1996, and it has consistently been approved under the standards in every subsequent year. Once approved, the model can be used in rate filings in Florida. The modeled losses supporting rate filings must be used without any alteration due to individual claims experience.

In addition, AIR has been working with insurance departments in other states for a number of years in meeting their informational requirements in connection with rate reviews and solvency reviews. No other state legislature has elected to set up and fund a commission that does a comprehensive ongoing review of models as exists in Florida, but it appears that many other states in the hurricane prone southeast rely upon the extensive review and approval process performed in Florida. South Carolina conducted an independent review of all major catastrophe models in 2013 and approved the AIR Hurricane Model for use in rate making in South Carolina. Some states have performed less extensive and more piecemeal or informal examinations of the AIR model. For instance, representatives of the North Carolina Insurance Department have visited AIR at its headquarters in Boston on several occasions. AIR provided information to a consulting meteorologist retained by the North Carolina Department who visited AIR in Boston in 1993. On two subsequent occasions actuaries from the North Carolina Department traveled to AIR's offices in Boston for a review of the model. Also, AIR responded to numerous questions and provided extensive information to a professor of mathematics from North Carolina State University who was hired by the North Carolina

Department to review AIR's methodology. He reviewed the distributions and algorithms underlying AIR’s model and how they conformed with historical data and published literature.

79. Q. What sorts of scientists and specialists comprise the Florida Commission’s professional team?

A. The Florida Commission’s professional team includes two persons from each of the following professions: actuary, computer scientist, statistician, structural engineer, and meteorologist. In each area the Florida Commission requires extensive documentation and explanation of the AIR model prior to approval. It is a very time consuming and expensive undertaking for AIR, but the AIR model has always been approved.

It is important to reiterate that the same model that is certified in Florida is used in North Carolina and other states. Over the years, the Bureau has specifically requested AIR to use model versions that have been approved by the Florida Commission. The loss costs modeled are naturally much lower for North Carolina than for Florida because of the greater level of hazard that Florida is exposed to relative to North Carolina.

80. Q. Does AIR have staff meteorologists, wind engineers, actuaries and software engineers?

A. Yes, as discussed above, AIR has numerous staff meteorologists, wind engineers, actuaries and software engineers.

81. Q. In addition to the outside validation of modeling that you have just described, do AIR’s staff scientists internally validate the model on a continuing basis?

A. Yes. AIR scientists and engineers validate the model at every stage of development. We compare model results with actual data from historical events. We ascertain that the simulated event characteristics parallel patterns observed in the historical record and that resulting loss estimates correspond closely to actual claims data provided by clients. Internal peer review is a standard operating procedure and is conducted by the AIR professional staff of scientists and engineers.

82. Q. You have described the extensive external and internal review that occurred in the period 2009-2012. Please describe how that review, as well as new data and science led to improvements in the model over what had been available in older Bureau filings.

A. First let me reiterate that the Bureau has specified that AIR use the latest available version of the hurricane model approved by the Florida Commission, and AIR has done so. AIR employs a numbering system to identify different versions of the hurricane model, and it is useful to identify which version of the model was used in older filings. In the 2008 mobile home filing, version 8.5 of CLASIC/2 and version 8.0 of the AIR US Hurricane Model were the latest available versions. The current filing uses version 15 of CLASIC/2 and version 14.0.1 of the AIR US Hurricane Model. There was a major update of the hurricane model when AIR released version 12, which have been discussed in previous filings, especially the homeowners dwelling filing in 2011. The main updates to the AIR US Hurricane Model since 2007 are detailed below:

2007 (updates incorporated into version 9):

- Updates to the historical storm set to include storms through 2006
- Revision of the bounds on the distribution governing central pressure in the northeast
- Refinements to the distributions governing the day of hurricane landfall
- Refinements to the damage functions for residential contents
- Updates to secondary risk modifiers for pool enclosures, based on claims data
- Enhancements to the business interruption damage function
- Updates to the demand surge function
- Update to the WSST catalog

2008 (updates incorporated into version 10):

- Updates to ZIP Code databases and population-weighted centroids
- Updates to the historical storm set to incorporate track information from hurricanes through 2007
- Updates to the stochastic catalog, including annual frequency, landfall location and intensity probability distributions.
- Refinements to the inland decay functions

2009 (updates incorporated into version 11):

- Updates to ZIP Code databases and population-weighted centroids
- Updates to the historical storm set to incorporate track information from hurricanes through 2008 for Florida and adjacent states

2010 (incorporated into version 12):

- Significantly more precise risk differentiation based on Geography, Construction, Occupancy, Year Built
- Basin-wide Catalog enables more accurate loss estimates for portfolios spanning over multiple countries
- Model domain includes 29 states to provide complete coverage of inland risk
- Updates to Rmax estimation and addition of Rmax Evolution based on High Resolution Radar Imagery
- Explicit modeling of the influence of wave action on surface roughness
- Refinements in vulnerability relationships and explicit modeling of the evolution of Building Codes

2013 (updates incorporated into version 14.0.1):

- Updates to the Stochastic Catalog based on HURDAT and NOAA Databases valid as of August 2011, which include data from 1900 through 2010

In addition to the enhancements described above, as part of our continued efforts to incorporate the most current and best available data into our models, AIR engineers are finalizing updates to our vulnerability functions for mobile homes based on an analysis of claims experience from recent hurricanes. It is my understanding that, all other things being equal, these updates will likely lead to an increase in modeled loss costs for mobile homes. It is expected these enhancements will be available to AIR clients in the summer of 2015.

83. Q. Could you please explain in more detail the changes to the wind field and vulnerability components of the model?

A. Recent research in atmospheric science has enabled wind modeling with unprecedented fidelity and accuracy. Improved knowledge of the full 4-D structure of hurricanes – from the temporal evolution of the storm footprint, to the radial wind profile, to the vertical relationship between winds aloft and winds at the surface – was in 2010 integrated into the model to more accurately estimate wind speeds and their distribution.

On the engineering front, the 2010 updates to the model reflect new findings from recent loss experience data, wind engineering studies and damage surveys. The model incorporates the results of a new and exhaustive analysis of the evolution and enforcement of building codes across all states including North Carolina and their impact (as a continuous function of time after the 1990s) on the existing building inventory.

The additional level of detail in both the hazard and vulnerability components of the model enables better differentiation between risks. This differentiation applies to both the location and the structural attributes of properties.

84. Q. With respect to updates to the model that are reflected in –Model Versions 12 and newer, including Version 14.0.1, which is used in this filing, please explain the general effects of those updates on prospective loss costs used in the filing.

A. Different updates had different effects. The combined effect was that loss costs are now more accurately modeled than ever before as a result of these changes. In this connection, let me describe AIR's motivation as to the peer review and resulting updates. The AIR hurricane model has long been considered the industry standard, and AIR desires to maintain that position. To maintain that position, the model must reflect the latest science and engineering research, and take into account recent loss experience.

Over the years leading up to the substantial peer review described above, numerous scientific studies of hurricanes as well as additional and more detailed claims and exposure data became available, and a number of scientific studies of hurricanes had advanced the knowledge of hurricanes significantly in the preceding several years. AIR therefore decided to incorporate those scientific advances in the hurricane model.

We also decided that because so many changes were being considered, we should have the changes peer reviewed by independent experts. A good deal of that peer review has been described earlier in my testimony. Naturally, changes to the model can affect loss costs in different directions. Some of the changes that may have affected loss costs in North Carolina include the following:

- Updates to ZIP Code databases and population-weighted centroids. These updates did not in and of themselves cause significant changes in loss costs in North Carolina.
- Updates to the historical storm set to incorporate information from the HURDAT database as of August 2011. Over the years, incorporation of this database, which now includes the period 1900-2010, sometimes involved inclusion of additional hurricanes that were determined by governmental sources to have affected North Carolina as well as modified parameters of previously-known hurricanes. The addition of these storms to the data base increased the modeled frequency of North Carolina storms. However, since these storms were relatively weak, they did not have a significant impact on loss costs.
- Updates to the model's wind field formulation. This update incorporated the latest available data and scientific literature, including the latest research on the radial decay of winds from the eye wall to the storm's periphery and the conversion of

surface winds from winds aloft. This update improved the model's accuracy as to where damages occur and the extent of those damages.

- Modeling storms longer than 24 hours after landfall. In regard to North Carolina, this improvement in the model meant that more storms that made landfall to the south of North Carolina (such as in the Gulf of Mexico or Florida) are reflected since they typically affect North Carolina more than 24 hours after landfall. Such storms cause relatively modest losses in North Carolina.

- Incorporation of new data from satellites as to ground cover. Such data was incorporated in the wind field calculations. This improvement was significant because there is a large difference in the degradation of hurricane winds depending on the terrain that they are passing over. For instance, storms passing over forests or mountainous terrain dissipate much more quickly than storms passing over flat or marshy areas. The inclusion of accurate ground cover data meant that areas such as the sounds of North Carolina were no longer assumed to have caused storms to dissipate to the same extent as in past model runs for North Carolina. On the other hand, this change reduced wind speeds in areas of North Carolina with extensive tree cover to reflect the fact that trees reduce wind speeds as storms travel over land.

- Updates to the wind damage functions. Such updates were based on the latest findings from AIR's ongoing analysis of detailed claims data from recent hurricane seasons and have improved the accuracy of modeled losses.

- Enhancements to individual risk modifiers (secondary risk characteristics). Such enhancements reflect newly acquired data and analysis.

85. Q. What are the specific updates regarding the risk for mobile homes between version 8 of the Atlantic Hurricane Model and the current version used in this filing?

A. The vulnerability and damage functions for mobile homes have been updated according to new observation and claims data that had been analyzed. During multiple iterations of model updates, both the wind and the storm surge damage functions have been updated.

86. Q. As relates to the current filing, did AIR receive exposure data from Insurance Services Office on which AIR relied in preparing its analyses?

A. Yes, we received data reflecting the number of earned house years and earned insurance years for 2011 for mobile home policies in North Carolina. It was broken down by subline (MH-C and MH-F), policy form (MH-F only), coverage form (MH-C only), status (MH-C only), construction class and territory. It was furnished to AIR by Insurance Services Office (ISO), which had compiled the data. Additionally, AIR received a shape file that included Territory and ZIP Code boundaries to distribute the data across the territories to allocate the exposure to an appropriate granularity for hurricane modeling. The process of disaggregation is described in response to question 117 of this pre-filed testimony.

AIR routinely receives and relies upon data of this type in the ordinary course of its business of modeling and did so in this instance. AIR routinely reviews such data submissions for consistency and reasonableness and notifies the producer of such data if there are questions as to the data.

87. Q. Can you explain what is displayed on Pages 14-23 of RB-6A?

A. Yes, these pages contain the Project Information and Assumptions Forms (PIAFs) that we prepared before completing our analysis and releasing the reports contained in RB-6A to the Bureau. These contain a summary of the exposures to be modeled as well as the assumptions that are to be used in the course of the analysis.

88. Q. What information is contained on Page 14 of RB-6A?

A. This page shows the contact information for some key personnel responsible for the project, both at AIR and at the Bureau. It shows the version of the software and the model catalogs that is to be used in the analysis. Finally, it shows the reports and loss results that we are going to provide to the Bureau.

89. Q. What information is contained on Page 15 of RB-6A?

A. This page contains a summary of the exposure data that was provided to us by the Bureau, including the date the data was received, and the total values of various aspects of that data. This page then provides information on how the various values have been changed based on the assumptions to be made before carrying out the loss analysis. The item under the "Added/Excluded Records" section displays the changes in the total records that result from disaggregating the data to a granularity that can be used for modeling as described in question 117 of this testimony. However, this did not impact the total insured value provided by ISO.

90. Q. What information is contained on Page 16 of RB-6A?

A. This page provides a summary of the geocoding process that occurs in Touchstone. Due to the disaggregation to individual grid-points prior to modeling, as described in question 117 of this testimony, all records were geocoded prior to importing into the software. All records already have latitude and longitude information assigned.

91. Q. What information is contained on Page 17 of RB-6A?

A. This page describes the assumptions that are made with regards to replacement value, limits, and deductibles for the various coverages for each line of business individually. The MH-C Subline has records split out for Coverage A and D and separate records for Coverage B and Coverage C. The MH-F Subline has records for all Coverages and separate records for Coverage C and D only. The Analysis Options sections describe the specific analysis options that were utilized when running our models.

92. Q. What information is contained on Page 18 of RB-6A?

A. This page shows the number of records which included information on each of the various secondary modifiers that are able to be modeled in Touchstone. For this analysis, no records included information regarding specific secondary characteristics.

93. Q. What information is contained on Page 19 of RB-6A?

A. This page describes in detail the specific assumptions that were made in the process of carrying out the analysis.

94. Q. What information is contained on Page 20 of RB-6A?

A. The tables summarize the total value and number of risks by construction and occupancy for each line of business.

95. Q. What information is contained on Pages 21-22 of RB-6A?

A. The table summarize the total value, number of risks, and average deductible within each territory for each line of business. The information was provided by ISO.

96. Q. What information is contained on Page 23 of RB-6A?

A. This map displays the total replacement value for all lines of business by county as extracted from the Touchstone User Interface. Light blue shaded areas reflect lower total replacement values, while dark red areas reflect higher total replacement values.

97. Q. Is the information on Pages 14-23 of RB-6A the same information contained in Pages 15-24 of RB-6B?

A. Yes.

98. Q. How is the PIAF used?

A. The PIAF is provided to the Bureau prior to performing the analysis and allows the Bureau the opportunity to examine the data and assumptions that will be used during the course of the AIR analysis to ensure that they comport with the data and assumptions intended to be modeled. The Bureau provides a signed copy back to us so that we can be assured that both parties understand the data and assumptions to be used for the analysis.

99. Q. What use did you make of such data?

A. For each territory, subline, policy form, coverage, status, and construction class, the insurance years were used as the primary insured value (depending on coverage type either for the building value, appurtenant structures value, contents value or time element value). Appropriate assumptions were also applied to account for deductibles.

The data was then analyzed in AIR's Touchstone® software application using the model and catalogs referenced previously in order to yield loss estimates. These loss estimates were rolled up to the territory level for reporting purposes.

100. Q. What are the areas of the state with the highest hurricane risk in North Carolina?

A. The highest risk areas are the beach and coastal areas. A hurricane is typically at its maximum force in those areas just as it crosses over land. As it travels inland, the storm dissipates because of the elimination of its primary energy source (heat and moisture from the sea) and because of surface frictional effects.

101. Q. As between portions of the coast of North Carolina, which areas experience the greatest hurricane frequency?

A. The highest frequency of hurricanes occurs in a 100-mile segment which includes Cape Lookout, Cape Hatteras, and Pamlico Sound. The coastline in this area juts out into the Atlantic Ocean where it is exposed as storms move up the coastline. The far northern coast towards Virginia suffers relatively few hurricane landfalls because of the more westerly location of the coastline in this region, but hurricanes frequently come through that area after making landfall to the south.

102. Q. Has AIR examined North Carolina's building code?

A. Yes. AIR engineering experts have undertaken an extensive, peer-reviewed study to understand the large number of building codes and wind standards that exist in hurricane-prone states, specifically including North Carolina. In addition to major code changes, there are continuous changes in vulnerability due to changes in building materials, enforcement, structural aging and upgrading. The model accounts for the spatial and temporal variations in vulnerability for all hurricane states including North Carolina. Manufactured home design and constructions are not bound to the building code requirements, they are regulated by the Housing and Urban Development (HUD) codes.

103. Q. Are there any changes that you have made to your model just for North Carolina?

A. No. AIR has a single, integrated U.S. hurricane model which reflects historical regional differences in hurricane risk. In the model development and validation process, North Carolina is treated in the same way as all other states in determining regional variations in vulnerability at the state and local level, through examination of both the regional building stock and state and local building regulations, codes and practices. AIR has performed a detailed review of, and continues to monitor, the building codes in North Carolina. AIR's implementation of this information allows its model to accurately estimate the vulnerability of buildings in North Carolina based on the specific nature of the building codes they are subjected to. Additionally, the model adjusts its vulnerability for structures in North Carolina based upon the year in which they were constructed and the codes which were enforced at the time of their construction. While the model looks at each state's building code situation individually, if there were two identical buildings in different states which were both subject to equivalent building codes and enforcement, those two buildings would be subject to the same vulnerability calculation.

As discussed previously, while there is a single hurricane model, each state's prospective losses are computed individually based on the circumstances in that state. While the model version, settings and assumptions used for North Carolina were the same as those accepted by the Florida Commission, Florida's higher vulnerability to losses is not in any way imputed to North Carolina, and losses in Florida are not in any way spread to North

Carolina. Florida has higher expected loss costs than North Carolina because it has a greater exposure to hurricanes than North Carolina, but those higher expected losses in Florida do not have the effect of making expected loss costs higher in North Carolina than they otherwise should be.

Inputs to the model include detailed land cover data that affect the wind speeds being calculated at every location in the modeled portfolio, as well as detailed building code examinations for every state which adjust the vulnerability of buildings based on the year of construction and location. The land cover data used in the model reflects, in detail, the currently existing land cover in North Carolina, and the building code information used in the model reflects the actual building codes and practices of North Carolina. The model reflects both the fact that different building code standards apply in different regions of North Carolina and the fact that the building code standards have changed at various times over the years.

104. Q. What is demand surge and how is it calculated in the AIR model?

A. The results were provided with aggregate demand surge as directed by the Bureau. Demand surge is defined as a sudden and usually temporary increase in the cost of materials, services and labor due to the increased demand for them following a catastrophe. Historical evidence from major catastrophic events in past 20 or more years shows that, after a major event, increased demand for materials and services to repair and rebuild damaged property can put pressure on prices, resulting in temporary inflation. This phenomenon is often referred to as demand surge and it results in increased losses to the insurers.

After Hurricane Andrew in 1992, AIR developed a rudimentary demand surge function to allow companies the capability to assess the potential impact on losses due to demand surge. In order to develop an initial demand surge function, AIR reviewed several studies on the impact on prices of material and labor after Hurricane Andrew and the Northridge Earthquake. It was commonly accepted that the demand surge from a Hurricane Andrew sized event ($15.5 billion) was 8-12 %.

AIR continued to review the impact that catastrophic events have had on material and labor prices. We found that in 1989 Hurricane Hugo, for example, caused a significant temporary impact on personal incomes in the construction industry in South Carolina. Analyses performed after the 2004 hurricane season in Florida revealed that demand surge had a significant impact on insured losses. Among other findings, empirical data specifically revealed that roof rebuilding costs increased substantially in the period following the hurricane season, and losses resulting from the additional living expense provisions in the policy (referred to as the “time element” which reflects the need of the policyholder to find alternative lodging after a house has been damaged) were significantly impacted due to the increased amount of time it took to repair damages from the multiple events.

105. Q. How did AIR validate its Demand Surge function?

A. While Demand Surge is an economic phenomenon of supply and demand, the historical hurricane events of 2004 and 2005 provide a useful data set on which we were able to validate AIR's demand surge function. These included Charlie, Frances, Ivan, Jeanne, Katrina, Rita and Wilma, which predominantly affected the Gulf region including Florida, Louisiana, Alabama, Texas and Mississippi. AIR used quarterly cost index data collected by a company called Xactware. Comparing the cost indices in the quarter before and the quarters after the event happened, we see very clearly that demand surge is occurring.

106. Q. Was demand surge used for the analyses you performed for the Bureau?

A. Yes, demand surge was used for both analyses (standard and WSST).

107. Q. How is the demand surge factor calculated, and how is it applied?

A. Demand surge effects do not occur following the majority of hurricanes, and the demand surge component of the model reflects this fact. Small hurricane events are not accompanied by demand surge. AIR's demand surge function relates the level of demand surge to the amount of industry loss. Each event is assigned demand surge factors by coverage based on the amount of industry loss caused by the given event, as well as by other events that occur close to the given event in both time and space. AIR's demand surge begins at an industry loss amount of $5.5 billion. The demand surge factors are applied to losses from the specific exposure set to calculate the loss with demand surge.

108. Q: What is the estimated impact of the application of demand surge on the loss estimates for the Bureau?

A. To quantify the impact of demand surge on the Bureau portfolio, AIR performed a high-level analysis without demand surge in addition to the detailed analysis that was used to generate the results for the Bureau. These analyses showed that there is an increase of 7.11% in gross losses when demand surge is applied.

109. Q. What is storm surge?

A. Storm surge describes the abnormal sea-level rise accompanying hurricane activity. Storm surge is the water forced ashore by a hurricane. Virtually every hurricane is accompanied by a surge of some magnitude.

The dominant pattern of the tide in virtually every coastal region of the world is well known and predictable. Sometimes, however, the regular tidal pattern is modified by meteorological events, producing extreme water level that can cause coastal flooding. Storm surge is the difference between these storm-induced extremes and normal levels.

Physically, two effects contribute to the sea level increase during a storm: direct wind interacting with the sea, and low barometric pressure within the storm system. The direct action of wind stress on the sea surface produces a flux of water away from, and generally at an angle to, the direct of the wind. Low barometric pressure, while small in its effect, can cause an increase in water level beneath low-pressure centers of the storm. The combined effects of these forces cause water to "pile up," producing water levels that can far exceed local tide levels.

Storm surge flooding is a complex process, influences by wind-sea interaction, the propagation of waves in shallow coastal regions, tidal effects, and the effectiveness of man-made sea defenses subjected to high water and wave attack.

110. Q. How is it modeled in the AIR Model?

A. AIR's storm surge module, is a fully probabilistic component of the AIR U.S Hurricane Model. Storm surge modeling is based on the key meteorological variables of simulated hurricanes, such as central barometric pressure, radius of maximum winds, and forward speed. In addition, it incorporates detailed databases of coastal elevation, orientation, tide height and bathymetry (the slope of the continental shelf below the sea level).Some of these parameters are discussed below:

- *Central Barometric Pressure:* Low barometric pressure relative to standard sea level barometric pressure raises the sea surface level. In terms of hurricane pressures, this increase in sea surface level forms as a dome beneath the hurricane and travels with the hurricane.
- *Forward Speed:* Storm surge is not only caused by low barometric pressure in the eye, but also by winds pushing the ocean's surface ahead of the storm. Friction of ocean water with the ocean floor inhibits the water from moving around and out

of the way of the oncoming winds. Water begins to pile up in a dome on the right side of the storm track. The faster the forward speed of the storm the more pronounced this effect will be.

- *Storm Track Angle at Landfall:* Hurricanes that make landfall perpendicular to the coastline cause greater levels of surge than hurricanes that make landfall more oblique angles or that skirt along the coast. Storm surge forms primarily on the right side of the storm track because on the right-hand side of the storm, the circulating winds of the hurricane and the winds that determine the storm's forward speed are moving in the same direction. This combined effect produces higher "effective" winds to the right of the storm center. A perpendicular track brings this enormous volume of water on shore. A parallel track exposes the coast to the weaker side of the storm system and the effects of storm surge are thus diminished.

- *Coastline Orientation:* The geographic configuration of the coastline relative to the landfall angle can exacerbate high surge levels. For example, high surge levels may result from minor surges that are forced into narrow inlets or bays.

- *Bathymetry (Water Depth):* Another factor that affects the potentials for destructive storm surge is the depth of the ocean. The shallower the ocean, the easier it is for significant storm surges to be formed.

- *Tide Height:* The total sea surface elevation is the product of the storm surge generated by the hurricane and the height of the astronomical tide. The higher the tide, the greater the sea level elevation. This is the reason that some minor hurricanes have had associated high surge levels reported.

- *Bays and Estuaries:* The orientation (relative to hurricane track angle) and bathymetry of bays and estuaries can amplify the impact of storm surge. Specifically, the wave heights may be amplified because a larger volume of water is forced into a smaller area.

The variables above dictate the likely maximum storm surge generated from a hurricane. There are additional variables that dictate damage and loss caused. The levels of damage caused by surge are evaluated by construction type for each class of occupancy. Damage is caused by the momentum, or force, of the water pushed onshore, damage due to the water itself and, at the component level, damage due to the corrosive effects of salt. The main intensity parameter in the storm surge component of the AIR model is water depth.

Specific parameters that dictate the damage are discussed below:

- *Overland Elevation and Surge Attenuation:* The height of storm surge is calculated, taking into account the hurricane intensity and the physical parameters at the location of interest, namely coastline orientation, bathymetry and tide height. As the surge comes onshore, its progress is impeded by the friction is experiences with the local terrain. This loss of momentum is referred to as attenuation. Steeper slopes lead to more rapid attenuation, as does rougher terrain; gradual slopes and smoother terrain lead to slower attenuation.

- *Damage calculation:* The height of the surge is the main parameter used in the loss calculation. Observation data available from FEMA, the Army Corps Engineers and AIR's post-disaster surveys was used in the development of the damage functions.

Building damage from storm surge is modeled as a function of construction type, height and occupancy. Contents damage is a function of occupancy, as occupancy gives insight into the kinds of contents present. For time element, the model estimates the effective downtime (days of loss of use) before the facility is replaced, restored or made usable. Time element damage is a function of both construction type and occupancy, as some occupancy types may be usable before full restoration.

The storm surge module estimates losses only from water forced ashore at the coast by a hurricane. It does not consider flooding of rivers and creeks throughout the state such as often occurs from the heavy rains that typically accompany a hurricane, nor does it consider flooding from dam failures or levee breaks (e.g., Hurricane Katrina flooding sections of New Orleans) that might occur as a result of a hurricane.

111. Q. What are the sources that underlie the storm surge component of AIR's Atlantic Hurricane Model?

A. AIR used observation data available from the Federal Emergency Management Agency (FEMA) and the Army Corps of Engineers in the development of the model's surge damage functions.

112. Q. How is the storm surge component validated?

A. The damage functions have been calibrated using historical observation data and output from NOAA's SLOSH (Sea, Lake, and Overland Surges from Hurricanes) model. Additionally, it has been validated through findings from AIR's post-disaster surveys and loss experience data from several historical storms.

113. Q. Was the storm surge component used for the analyses you performed for the NCRB?

A. Yes. The NCRB instructed AIR to run the analyses with storm surge applied, since MH-C and MH-F policies cover flood.

114. Q. Now let me ask you several questions concerning Exhibit RB-6A to your pre-filed testimony. What is the significance of the figure from the column called "Loss Cost (Per 100)" on pages 11 to 13 of Exhibit RB-6A?

A. The figures show the estimated loss costs per $100 of exposure, including contents and all other coverages.

115. Q. On page 7 of Exhibit RB-6A entitled "Exposure Information and Assumptions," there is reference to "insured values and number of risks by sub-line, policy form, status coverage, construction class and territory." Please explain these terms.

A. The term "insurance-years" refers to the insured values under mobile homeowners policies. The source of this data is ISO. The data were provided by each of the elements listed. Sub-line refers to the different lines of business: MH-C and MH-F. The construction classes provided are full tie-down and no tie-down.

116. Q. On the same page there is reference to a process of disaggregation. Please explain this term and its relevance to the modeled losses contained in Exhibit RB-6A.

A. To analyze the NCRB mobile home exposure, the data needed to be disaggregated from a territory level to a more detailed granularity for modeling purposes.

In understanding this treatment, it is important to understand how the model works with respect to the geographic placement of risks. When a risk is analyzed in Touchstone, its geocode placement determines the relative severity of each simulated event. Items such as elevation, proximity to the coast and land cover are determined based on the geocode coordinates assigned to the location.

The information provided to AIR for the Bureau analysis was at the territory level. AIR was also provided a shape file which contained the ZIP Code assignments for each territory; however, since ZIP Codes may cross territory boundaries, AIR needed to distribute the insured values proportionally to the portion of each ZIP Code that is contained in each territory.

Using AIR's proprietary Industry Exposures Database (IED), AIR distributed the values provided by the NCRB proportionally to each grid point in North Carolina that contained mobile home exposure in the IED.

AIR's Industry Exposure Database contains exposure information (insured values) by line of business, construction class, occupancy class and five-digit ZIP Code, as well as latitude and longitude information distributed to a 90m by 90m grid.

Based on the proportion of insured value for mobile homes at each grid point within a Territory, the NCRB insured values were allocated to each individual grid point. This technique refined the modeled loss costs for each ZIP Code and each territory and improved the accuracy of the loss estimated to promote fair rates.

As shown on page 15 of RB-6A, distributing the insured value to the proportional grid points artificially increased the apparent number of risks and records based on software requirements. This is due to the fact that each grid point is now considered its own record, as well as the fact that Touchstone requires that the risk count must be at least 1. However, it is important to note that the artificial increase in the risk count does not impact the modeling or the resulting loss costs. The original risk count by territory, as provided by ISO, was preserved throughout the analysis and was used in the calculation of the pure premiums.

117. Q. Page 8 of Exhibit RB-6A shows the long term average annual aggregate losses by territory. Please explain what is shown on this page and how it was computed.

A. Page 8 displays the average annual aggregate loss for each territory (for this purpose, "territory" refers to the geographic units for which data is collected under mobile home statistical plans rather than to the territories used for rating purposes). This figure is the sum of all losses caused by all simulated events, divided by the number of simulation years for each such territory. It represents the long run average annual hurricane loss potential by each such territory. As can be seen, the territory with the highest average annual aggregate loss for the MH-C line is territory 43 and the territory with the highest average annual loss for the MH-F line is territory 45. This fact is a function of the number of mobile homeowners policies in those territories as well as each territory's high exposure to hurricanes.

118. Q. What does the table on page 9 of Exhibit RB-6A show?

A. It shows the distribution of exposures and average annual losses by territory. Territories along the coast account for a much higher percentage of losses than exposures because there is a greater hurricane hazard nearer the coast. For instance, the table on page 9 demonstrates that territory 60 in the western part of the state has 34.07% of the statewide insurance in force, but accounts for only 6.88% of total annual hurricane losses. Territory 5 on the beach, on the other hand, accounts for only 0.30% of the statewide insurance in force, but its average annual hurricane loss is 8.04% of the statewide total annual hurricane losses.

119. Q. What is the source of the insured values, risk count and average annual loss on pages 11 to 14 of Exhibit RB-6A?

A. The source of the insured values and risk counts shown on pages 11 to 13 is provided on pages 21 to 22 of Exhibit RB-6A (the PIAFs), and page 8 is the source of the average annual loss.

120. Q. What do the last two columns on pages 11 to 13 of Exhibit RB-6A show?

A. They show the estimated hurricane pure premiums and loss costs per $100 of exposure by territory, both overall for all lines (Exhibit 3) and individually for each policy form group (Exhibits 4 and 5). As can be seen from these exhibits, loss costs are highest in territories 5 and 6 and are high in territories 42 and 43.

121. Q. On page 11 of Exhibit RB-6A, please explain the significance of the number "575.04" for territory 5 in the column entitled "Pure Premium."

A. The number $575.04 is the amount, exclusive of expenses and provisions for profit and contingencies, that on average needs to be collected each year to cover the long run average hurricane loss potential on each risk on mobile home policies in territory 5. By comparison, only $6.33 needs to be collected to cover that same potential in territory 60.

122. Q. Do the explanations set forth above for Exhibit RB-6A also follow for similar pages in Exhibit RB-6B?

A. Yes. The exhibits and explanations follow the same format. The loss costs and pure premiums in Exhibit RB-6B reflect those appropriate to the view of risk that incorporates the impact of the current elevated sea surface temperatures (SSTs) in the North Atlantic on hurricane activity.

123. Q. In 2011, Hurricane Irene passed through eastern NC and hence caused losses. Has AIR been able to do any detailed validation of Hurricane Irene as yet?

A. No. Validation on Hurricane Irene is still undergoing. Due to the extensive requirements for validation based on claims data and due to the fact that the meteorological parameters of this storm were not included in the 2011 HURDAT database at the time the model was being updated, Hurricane Irene will not be included until the next model update. .

124. Q. Are the data, information and numbers used in the AIR hurricane model true and accurate to the best of your knowledge, information and belief?

A. Yes. The AIR research team collects the available scientific data pertaining to the meteorological variables critical to the characterization of hurricanes and therefore to the simulation process. Data sources used in the development of the AIR hurricane model include the most complete databases available from various agencies of the National Weather Service, including the National Hurricane Center. All data is cross-verified. If data from different sources conflict, a detailed analysis and the use of expert judgment is applied to prepare the data for modeling purposes. Furthermore, to the extent possible, we cross-check and verify the numbers that go into the AIR model as well as the numbers that come out of the model. To the best of my knowledge, information and belief, the data that we use are the most reliable and accurate data that is publicly available.

125. Q. Are the Exhibits to your pre-filed testimony true and accurate to the best of your knowledge, information and belief?

A. Yes.

126. Q. Do you have an opinion as to whether your model is a reasonable method of projecting the prospective hurricane loss costs used in the filing to set mobile home rates in North Carolina that are not excessive, inadequate or unfairly discriminatory, and if so what is that opinion?

A. Yes, I have an opinion. It is a reasonable, consistent, and reliable method of doing so. The prospective hurricane losses in the AIR reports and used in the filing are reasonable and appropriate projections of insured hurricane losses on the policy forms reviewed.

127. Q. Is AIR willing to allow the Insurance Commissioner and/or any personnel from the North Carolina Department of Insurance to visit your offices in Boston and examine any areas of the model that they wish?

A. Yes, subject only to a non-disclosure agreement that will protect the proprietary and confidential information possessed by AIR Worldwide from being used by our competitors, we welcome the Commissioner and/or any associates or consultants appointed by him to again visit our offices, where they can examine any information related to the model that they would like. With the encouragement and permission of AIR, we understand that the Bureau offered the Department the opportunity to make such a visit in the summer of 2012. This offer was also extended in connection with the Dwelling hearing in 2011 and with the Homeowners hearing in 2014. If the Commissioner or his Department would like to arrange such a visit, we ask that they contact the Bureau to organize a date and time that is convenient for all parties. We strongly encourage the Commissioner and Department to do so to help educate them on the benefits and validity of the use of hurricane modeling in ratemaking for North Carolina.

RB-6A

Catastrophe Loss Analysis Service
Atlantic Tropical Cyclone

Prepared for: North Carolina Rate Bureau

AIR WORLDWIDE®

June 4, 2014

Contact Information

If you have any questions regarding this document, contact:

AIR Worldwide Corporation
131 Dartmouth Street
Boston, MA 02116-5134
USA

Tel: (617) 267-6645
Fax: (617) 267-8284

Table of Contents

Introduction

This report contains the results of the Catastrophe Loss Analysis Service (CLAS™) for Mobile Homes policies in the state of North Carolina as requested by the North Carolina Rate Bureau (NCRB). Loss estimates are provided using AIR Worldwide's (AIR) Atlantic Tropical Cyclone model.

The NCRB provided AIR with information that represents the exposures analyzed. AIR reviewed and reformatted the exposure data as necessary and used them as input to the AIR hurricane model, which generated the loss estimates that form the core of this analysis. The AIR model is a system of computer programs that incorporate the fundamental physical characteristics, expressed mathematically, of hurricanes. These characteristics are then overlaid on the geographical distribution of the NCRB's exposures. Building, contents, and time element damage are estimated by applying AIR's proprietary damageability relationships. Finally, insured losses are calculated by applying policy conditions to the total damage estimates.

The AIR model simulated 100,000 years of potential hurricane experience. The results of the model are expressed in terms of probability distributions of event losses. These distributions represent a range of possible losses and the relative likelihood of occurrence of various levels of loss.

All aspects of the AIR hurricane model undergo extensive validation tests. The stochastic model variables have been compared to the actual characteristics of historical hurricanes occurring in North Carolina since 1900. The simulated event characteristics parallel patterns seen in the historical record, and resulting loss estimates correspond closely to actual claims data provided by clients.

The model has also undergone extensive internal and external peer review. Internal peer review is a standard part of AIR's operating process and is conducted by AIR's technical staff of over 400 professionals, over 60 of whom hold Ph.D. credentials in their fields of expertise. The AIR hurricane model has also undergone extensive external review, beginning with Dr. Walter Lyons' systematic review in 1986. Dr. Lyons, a Certified Consulting Meteorologist, was contracted by the E.W. Blanch Company. A further independent review was conducted by engineer Dr. Joseph E. Minor. During 1996 and 1997, Duff & Phelps, Fitch, Moody's and Standard & Poors reviewed all aspects of AIR's hurricane model in conjunction with their rating of the USAA catastrophe bond.

One of the most extensive peer reviews of the AIR Atlantic Tropical Cyclone hurricane model is conducted by the Florida Commission on Hurricane Loss Projection Methodology (FCHLPM). The Commission was established in 1995 with the mission to "assess the effectiveness of various methodologies that have the potential for improving the accuracy of projecting insured Florida losses resulting from hurricanes and to adopt findings regarding the accuracy or reliability of these methodologies for use in residential rate filings." The Commission has established more than 40 standards that need to be met before a catastrophe model is acceptable for ratemaking purposes in the state of Florida. The AIR model has been reviewed and has met the standards of the Commission since 1996. As part of the certification effort, AIR has asked independent reviewers to evaluate various components of the model and provided the peer reviews to the Commission.

Catastrophe modeling has become widely used and accepted. AIR was the first organization to have its model approved under the rigorous standards of the Florida Hurricane Commission. AIR's simulation methodology is a robust technique for estimating potential hurricane losses. It is based on mathematical/statistical models that represent real-world systems. As with all models, these representations are not intended to represent specific prior or future events.

The hurricane model used in this report is Atlantic Tropical Cyclone v14.0.1, as implemented in Touchstone v1.5.2.

Executive Summary

To estimate the hurricane loss potential for NCRB, AIR simulated 100,000 years of potential hurricanes. The simulation included aggregate demand surge, which is demand surge caused by a given event as well as by other events that occur close to the given event in both time and space. Additionally, the simulation included storm surge, which simulates the abnormal sea-level rise accompanying hurricane activity and estimates the maximum surge depth experienced at each coastal location.

The long-term average annual aggregate hurricane loss for the NCRB Mobile Homes policies is $12.0 million including aggregate demand surge and storm surge. In the 100,000-year sample, 59,359 hurricanes resulted in losses to North Carolina's insured properties net of deductibles. Given that a hurricane has occurred, the estimated average hurricane loss is $20.3 million.

The largest simulated hurricane loss is $1.1 billion, including aggregate demand surge and storm surge. This loss resulted from a category 5 hurricane with landfall in Carteret County, North Carolina. Note that higher occurrence losses, that is, losses in excess of $1.1 billion, are possible. They have, however, a very low probability of occurrence. Nevertheless, it should be understood that the largest simulated hurricane losses do not represent the worst possible scenarios.

Hurricane events of specified probabilities of exceedance and estimated return times appear below.

Table 1. Annual Maximum Occurrence Loss

Hurricane Occurrence Loss ($ millions)	Estimated Probability of Exceedance	Estimated Average Return Time (years)
24	10.0%	10
60	5.0%	20
135	2.0%	50
210	1.0%	100
322	0.4%	250
423	0.2%	500
522	0.1%	1,000

Actual hurricane losses are influenced by a number of characteristics, the most important of which is intensity as measured by wind speed, commonly expressed in terms of Saffir-Simpson (SS) category. Given the same landfall point, storms with higher wind speeds typically result in larger losses than do storms with lower wind speeds. Other characteristics that influence loss amounts include radius of maximum winds, forward speed, and storm track. Additionally, storm surge losses are influenced by the abnormal sea-level rise accompanying hurricane activity. The main intensity parameter in the storm surge component of the AIR model, is water depth. The damage function takes into account damage of the water itself, as well as damage due to movement of the water, as functions of water velocity and water height.

Actual losses also depend on the geographical distribution of exposures in relation to the area affected by the storm. That is, a severe hurricane could result in a smaller overall loss than a less severe hurricane if the less severe hurricane strikes an area of higher property value.

Exposure Information and Assumptions

The NCRB provided exposure information used to generate the loss estimates. The exposure file contained information on insured value and number of risks by sub-line, policy form, status, coverage, construction class and territory as defined by the NCRB.

NCRB requested that AIR allocate territory exposure to an appropriate granularity for hurricane modeling. This was completed using a disaggregation technique, in which all policy values were distributed proportionally to 90m x 90m grid points based on the Mobile Home exposures in the AIR industry exposure database. The following information was used in the process of disaggregation:

- AIR’s proprietary database of industry exposure by line of business, construction class, and five-digit ZIP Code, distributed to a 90m by 90m grid. This database was developed using U.S. Census data supplemented with additional research of industry insured exposures.
- A ZIP Code to NCRB defined Territory shape file mapping algorithm. The shape file was provided by ISO and includes ZIP Code and Territory boundary definitions for North Carolina.

The information on house-years and insurance-years by sub-line, form, status, construction class, coverage, and territory was provided by the Insurance Services Office (ISO) and represents the full statistical plan experience of companies reporting to either ISO or the National Association of Independent Insurers.

The final, disaggregated data set was analyzed by AIR in order to yield loss estimates. Appendix A, Exhibit II shows total insured values, number of risks (rounded), original number of risks and average values by territory.

Long-Term Average Losses

Exhibit 1 shows the long run average annual hurricane loss potential by territory including aggregate demand surge and storm surge.

Exhibit 1: Average Annual Loss by Territory in North Carolina

Territory	MH-C	MH-F	Total
5	951,112	15,972	967,083
6	444,514	40,655	485,169
32	51,728	17,125	68,853
34	103,590	93,924	197,514
36	21,715	6,838	28,553
38	13,034	3,133	16,167
39	63,259	81,262	144,521
41	347,803	500,700	848,503
42	1,098,382	556,837	1,655,220
43	1,164,185	736,966	1,901,151
44	35,823	44,242	80,065
45	759,500	1,313,254	2,072,753
46	191,282	241,009	432,291
47	756,394	906,320	1,662,715
53	133,718	175,621	309,338
57	169,870	160,326	330,195
60	461,318	366,770	828,088
Total	6,767,227	5,260,952	12,028,178

Currency: US Dollars

Exhibit 2 shows North Carolina's distribution of all sub-lines combined average annual hurricane losses including aggregate demand surge and storm surge and total insurance in force by territory. The coastal territories account for much higher shares of loss than exposure due to their vulnerability to the hurricane peril.

Exhibit 2: Distribution of Exposure and Loss by Territory in North Carolina

Territory	Insured Value	Percent of Total	Est. Avg. Annual Loss	Percent of Total
5	34,282,175	0.30%	967,083	8.04%
6	26,489,676	0.23%	485,169	4.03%
32	100,222,538	0.87%	68,853	0.57%
34	185,408,188	1.62%	197,514	1.64%
36	83,841,853	0.73%	28,553	0.24%
38	48,005,128	0.42%	16,167	0.13%
39	399,454,890	3.49%	144,521	1.20%
41	535,761,944	4.67%	848,503	7.05%
42	325,188,806	2.84%	1,655,220	13.76%
43	369,320,697	3.22%	1,901,151	15.81%
44	153,616,042	1.34%	80,065	0.67%
45	1,281,243,701	11.18%	2,072,753	17.23%
46	863,895,729	7.54%	432,291	3.59%
47	1,837,401,594	16.03%	1,662,715	13.82%
53	464,487,716	4.05%	309,338	2.57%
57	847,951,343	7.40%	330,195	2.75%
60	3,904,169,590	34.07%	828,088	6.88%
Total	**11,460,741,609**	**100.00%**	12,028,178	100%

Currency: US Dollars

Estimated Pure Premiums and Loss Costs

Exhibits 3, 4, and 5 show the estimated hurricane loss costs and pure premiums by territory for all sub-lines combined and for each sub-line separately. The coastal territories are most vulnerable to hurricane losses. The estimated loss costs are highest in coastal territories 5 and 6, as well as territories 42 and 43. These territories form part of the eastern tip of North Carolina, an area of relatively high hurricane frequency.

For all exhibits, the estimated loss costs are per $100 of exposure. The estimated hurricane pure premiums are calculated by dividing the estimated average annual losses by the number of risks. The estimated hurricane pure premiums show the amounts, exclusive of expenses and provisions for profit and contingencies, which need to be collected each year to cover only the long run hurricane loss potential.

Exhibit 3: North Carolina Loss Costs by Territory- All Lines

Territory	Insured Value	Risk Count	Average Annual Loss	Pure Premium	Loss Cost (Per $100)
5	34,282,175	1,682	967,083	575.04	2.8210
6	26,489,676	1,261	485,169	384.79	1.8315
32	100,222,538	4,317	68,853	15.95	0.0687
34	185,408,188	6,851	197,514	28.83	0.1065
36	83,841,853	4,092	28,553	6.98	0.0341
38	48,005,128	2,362	16,167	6.84	0.0337
39	399,454,890	10,529	144,521	13.73	0.0362
41	535,761,944	18,041	848,503	47.03	0.1584
42	325,188,806	12,403	1,655,220	133.45	0.5090
43	369,320,697	14,098	1,901,151	134.85	0.5148
44	153,616,042	5,759	80,065	13.90	0.0521
45	1,281,243,701	38,495	2,072,753	53.84	0.1618
46	863,895,729	22,035	432,291	19.62	0.0500
47	1,837,401,594	51,950	1,662,715	32.01	0.0905
53	464,487,716	12,099	309,338	25.57	0.0666
57	847,951,343	28,343	330,195	11.65	0.0389
60	3,904,169,590	130,742	828,088	6.33	0.0212
Total	**11,460,741,609**	**365,058**	12,028,178	32.95	0.1050

Currency: US Dollars

Exhibit 4: North Carolina Loss Costs by Territory- MH-C Sub-Line

Territory	Insured Value	Risk Count	Average Annual Loss	Pure Premium	Loss Cost (Per $100)
5	33,748,388	1,670	951,112	569.47	2.8182
6	24,355,195	1,219	444,514	364.58	1.8251
32	76,627,564	4,064	51,728	12.73	0.0675
34	102,121,443	5,670	103,590	18.27	0.1014
36	64,754,944	3,821	21,715	5.68	0.0335
38	39,490,073	2,244	13,034	5.81	0.0330
39	181,765,543	8,044	63,259	7.86	0.0348
41	234,593,737	13,683	347,803	25.42	0.1483
42	219,978,793	10,888	1,098,382	100.88	0.4993
43	231,704,680	12,132	1,164,185	95.96	0.5024
44	73,052,007	4,491	35,823	7.98	0.0490
45	511,929,031	29,093	759,500	26.11	0.1484
46	397,161,959	17,573	191,282	10.89	0.0482
47	877,367,860	40,898	756,394	18.49	0.0862
53	209,282,775	9,175	133,718	14.57	0.0639
57	450,204,704	22,417	169,870	7.58	0.0377
60	2,220,456,571	107,357	461,318	4.30	0.0208
Total	**5,948,595,268**	**294,439**	6,767,227	22.98	0.1138

Currency: US Dollars

Exhibit 5: North Carolina Loss Costs by Territory- MH-F Sub-Line

Territory	Insured Value	Risk Count	Average Annual Loss	Pure Premium	Loss Cost (Per $100)
5	533,787	12	15,972	1,378.85	2.9921
6	2,134,482	42	40,655	977.32	1.9047
32	23,594,974	253	17,125	67.56	0.0726
34	83,286,745	1,181	93,924	79.56	0.1128
36	19,086,909	271	6,838	25.27	0.0358
38	8,515,055	119	3,133	26.34	0.0368
39	217,689,347	2,485	81,262	32.71	0.0373
41	301,168,207	4,358	500,700	114.90	0.1663
42	105,210,012	1,515	556,837	367.43	0.5293
43	137,616,017	1,966	736,966	374.88	0.5355
44	80,564,035	1,267	44,242	34.91	0.0549
45	769,314,670	9,402	1,313,254	139.67	0.1707
46	466,733,770	4,462	241,009	54.01	0.0516
47	960,033,734	11,052	906,320	82.00	0.0944
53	255,204,940	2,924	175,621	60.06	0.0688
57	397,746,639	5,926	160,326	27.05	0.0403
60	1,683,713,019	23,385	366,770	15.68	0.0218
Total	**5,512,146,341**	**70,619**	5,260,952	74.50	0.0954

Currency: US Dollars

Appendix A- Project Information & Assumptions Form

Project Information & Assumptions Form

Version 2009061919.1.0

Project Summary & Contact Information

Subscriber: NCRB
Contact: Tim Lucas
Email: ftl@ncrb.org
Phone: 919-582-1021
Fax:

AIR Contact: Peter Bingenheimer
Email: pbingenheimer@air-worldwide.com
Phone: (617) 267-6645
Fax: (617) 267-8284

Contract #:
Analysis Type: Property - Mobile Home/Personal

Exposure Summary Sent: May 28, 2014
Report Due: June 6, 2014

☑ Initial Analysis ☐ Follow-up

Perils & Models

#	Peril	Model	Implementation	Version	Simulation Years
1	Tropical Cyclone	U.S. Hurricane Standard - 100K_Standard_ATL_Hur_10 (15.00.0409)	Touchstone	1.5.2	100,000
2	Tropical Cyclone	U.S. Hurricane WSST - 100K_WSST_ATL_Hur_11 (15.01.0409)	Touchstone	1.5.2	100,000

Reports & Deliverables

Report Options

Report Format: ☑ PDF ☐ Paper Copy/Bound Report
☐ Flat file ☐ CSV
☑ Electronic File

Standard Reports

☑ Distribution of Potential Catastrophe Losses - Exceedance Probability
- ☑ Portfolio ☐ State ☐ Line of Business

☑ Average Annual Losses
- ☐ State ☐ County ☐ ZIP ☐ Location ☐ Line of Business
- ☑ Territory

☑ Loss Costs and Pure Premiums
- ☐ State ☐ County ☐ ZIP ☐ Location ☐ Line of Business
- ☑ Territory

☐ Selected Event Scenarios - specific events from a stochastic/historical event set
- ☐ Rank ☐ Return Period ☐ Line of Business

Customized Reports

☐ Company Loss File (CLF) ☐ UNICEDE/2
☐ UPX

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AIR WORLDWIDE

Original Data File Information

Original file name(s): C'11 NC MH AIR INPUT FILE.xlsx, NCZIPTerrIntersectH.zip

Date Received:	February 21, 2014	**Data in-force Date:**	December 31, 2011
Date Logged:	February 21, 2014	**Data Media:**	Excel Attachment

File Format: ☐ MS Access ☑ MS Excel ☐ Text

Level of Location Deta ☐ Geocode ☐ 9-Digit ZIP ☐ Street ☐ 5-Digit ZIP ☐ City ☐ County ☐ State ☑ Territory

Original Value Summary

Total Deductible Value	Total Records	Total Risks	Total Replacement Value	Total Insured Value	Max. TIV	Avg. TIV
n/a	204	365,058	15,285,250,564	11,460,741,609	105,302	31,394

Added/Excluded Records

Reason for Addition/Exclusion	Records	Risks	Insured Value
Number of records and risks increased for modeling due to disaggregation of exposure to 1km by 1km grid level. See Exposure Notes and Customized Assumptions for details	3,522,360	3,157,506	-
	-	-	
Total Excluded:	**-**	**-**	**-**
Total Added	**3,522,360**	**3,157,506**	**-**
Added Number of Records due to Disaggregation:	**3,522,360**	**3,157,506**	**-**
Net Exposures to be Modeled:	**3,522,564**	**3,522,564**	**11,460,741,609**

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AIR WORLDWIDE

Geocode Record Summary		
Number of zipcodes remapped prior to geocoding:	-	
Exposure View Name:	NCRB_MH_2014	
Geocoded Level of Location Detail	**Records**	
Matched at Exact Address:	-	
Matched at 9-digit Zip:	-	
Matched at Relaxed Address:	-	
Matched at Postal Code:	-	
Matched at City:	-	
Matched at County:	-	
Records already geocoded:	3,522,564	
Total number of records:	**3,522,564**	

Note: In pre-processing the original territory level data, all records were disaggregated into a 90m x 90m grid. These grid points are already mapped to specific latitude/logitude coordinates. Therefore, all data was already geocoded prior to import.

Line of Business & Coverage Summary													
Subline/Policy or Coverage Form/Status	Limits Apply	A Building			B Other Structures			C Contents			D Loss of Use		
		Rep	Lim	Ded	Rep	Lim	Ded	Rep	Lim	Ded	Rep/d*	Lim	Ded
MH-C/1/1	C	L	P	BA	N/A	N/A	N/A	N/A	N/A	N/A	$10 / day	P	NO
MH-C/2/1	C	N/A	N/A	N/A	L	P	CA	N/A	N/A	N/A	N/A	N/A	N/A
MH-C/3/1	C	N/A	N/A	N/A	N/A	N/A	N/A	L	P	CA	N/A	N/A	N/A
MH-C/3/2	C	N/A	N/A	N/A	N/A	N/A	N/A	L	P	BA	$10 / day	P	NO
MH-F/3	C	L	P	BA	L	P	BA	L	P	BA	$150 / day	P	NO
MH-F/4	C	N/A	N/A	N/A	N/A	N/A	N/A	L	P	BA	$150 / day	P	NO

** Loss of Use Replacment (Rep/d) is a per diem value.*

CLASIC/2 Key:

Limit Application Code ("Limits Apply"):
N = None
C = Applies by Coverage
S = Applies to sum of all coverages

Replacement Value ("Rep"):
P = As Provided
L = Equal to limit

Limit Value ("Lim"):
P = As Provided
TLF = Total Limit Factor (see Exhibit III)

Deductible Application Code ("Ded"):
NO = None
AA = Annual Amount
SA = Combined flat
SP = Combined percent of coverage
SL = Combined percent of loss
CA = By coverage flat
CP = By coverage percent
BA = Combined flat, excluding time element loss
BP = Combined percent of coverage, excluding time
MA = Mini-policy flat
MP = Mini-policy percent

Analysis Options

Aggregation of Input Data: ☐ Modeled as provided ☑ Aggregated by: GridPoint, LOB, Construction Code, Zip Code

Geographic Resolution of Analysis: Event Total

Analysis Save Results: ☑ Contract ☐ Contract/Summary ☐ Layer ☑ Coverage ☐ Injury

Analysis Specifications:
☐ Reinsurance Quota Share
☐ Reinsurance Surplus Share
☐ Reinsurance Per Risk XOL
☐ Reinsurance Facultative
☑ TC Storm Surge (Flooding, default is 10% of separately modeled surge loss)
☐ Average Properties
☑ Demand Surge (Aggregate)
☐ Uncertainty
☐ Global Overrides

Analysis Notes: Loss estimates for both catalogs will be provided both including and excluding aggregate demand surge. 100% of modeled storm surge loss will be reported.

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AIR WORLDWIDE

Location Detail Characteristics			
Peril	*Characteristic*	*# Provided*	*% of Total Provided*
	Age		
	Appurtenant Structures		
	Avg Height of Adjacent Buildings		
	Bldg Foundation Connection		
	Building Condition		
	Building Orientation		
	Building Shape		
	Exterior Doors		
	Floor of Interest		
	Foundation Type		
	Glass Percent		
	Glass Type		
	Height		
	Internal Partition Walls		
	Large Missile Source		
	Proximity Exposure		
	Retrofit Measures		
	Roof Anchorage		
	Roof Attached Structures		
	Roof Covering		
	Roof Covering Attachment		
	Roof Deck		
	Roof Deck Attachment		
	Roof Geometry		
	Roof Pitch		
	Small Debris Source		
	Soft Story		
	Special Earthquake Resistant Systems		
	Structural Irregularity		
	Terrain Roughness		
	Torsion Elements		
	Tree Exposure		
	Wall Attached Structures		
	Wall Siding		
	Wall Type		
	Window Protection		
	Year Roof Built		
	Total Records:	0	0%

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AIR WORLDWIDE

Exposure Notes & Customized Assumptions

1) Insured value and number of risks were provided to AIR by Subline, Policy Form, Coverage Form, Status, construction class and territory as defined by NCRB. AIR used a ZIP code to territory shape file provided by the NCRB, along with information from its proprietry database of industry exposures, to distribute exposures to a 90m by 90m grid level for modeling. All policy values were distributed proportionally to the Mobile Home grid-point exposures in AIR's proprietry industry exposure database to disaggregate the data to a geographic resolution that can be modeled. This increases the total number of records and risks; however, due to proportionality it will not affect policy values and results.

2) Separate Risk counts were provided for each MH-C Coverage Form, Status Form and for each MH-F Policy Form for every applicable coverage. Results will be reported separately for MH-C and MH-F using the Mobile Home territories.

3) When exposures were distributed to the grid, the number of risks at each point were rounded to the nearest whole number, except where the number of risks was <1. In these instances, the number of risks was rounded up to 1, which increased the total number of risks from the original 365,058 risks to 3,522,564 risks. This will not have an impact on the results, as the number of risks is not a field used in the analysis.

4) For MH-C policies, the Coverage D replacement value is assumed to be $10/day and for the MH-F policies, the coverage D replacement value is assumed to be $150/day. For all policies, Coverage D limit was used as provided.

5) A flat deductible of $250 per risk was used. For the MH-C, Status 1 policies, the deductible is applied separately to Coverage B and Coverage C; for the combined Coverage A and Coverage D, the deductible is applied exclusive of Coverage D. For the MH-C, Status 2 policies, for the combined Coverage C and Coverage D, the deductible is applied exclusive of Coverage D. For the MH-F policies, the deductible is applied to combined coverages exclusive of Coverage D.

6) All replacement values, limits, and deductibles were scaled up by a constant factor to maintain modeling precision because the disaggregation of exposures to the grid resulted in values less than $1. This will not have an impact on the results, as it will be scaled back for reporting purposes.

7) Coverage B- Other Structures will be modeled as the same construction type used for Coverage A.

Attachments & Exhibits

Construction/Occupancy Information and Data Mapping: ☑

Insured Value Summary by LOB: ☐ State ☐ County ☐ Coverage ☑ Territory

Replacement Value Summary by LOB: ☐ State ☐ County ☐ Coverage

Deductible Summary by LOB: ☐ State ☐ County ☐ Coverage

Premium Summary: ☐ State ☐ County

Deductible by Coverage: ☐ State ☐ County

Construction Summary: ☐

Exposure Summary & Modeling Assumption Approval

Subscriber Signature: ______________________ *Date:* ______________

Print Name: ______________________ *Title:* ______________

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AIR WORLDWIDE

Exhibit I

Construction/Occupancy Information and Data Mapping

Subline/ Policy or Coverage Form/Status	*AIR CC*	*AIR OC*	*AIR Construction*	*AIR Occupancy*	*Risks*	*Insured Value*
MH-C/1/1	194	302	Mobile Homes: Full Tie Down	Permanent Dwelling: Single-Family	102,817	4,106,153,541
MH-C/1/1	192	302	Mobile Homes: No Tie Down	Permanent Dwelling: Single-Family	1,033	25,357,448
MH-C/2/1	194	302	Mobile Homes: Full Tie Down	Permanent Dwelling: Single-Family	88,870	371,635,934
MH-C/2/1	192	302	Mobile Homes: No Tie Down	Permanent Dwelling: Single-Family	783	2,250,884
MH-C/3/1	194	302	Mobile Homes: Full Tie Down	Permanent Dwelling: Single-Family	97,139	1,401,336,204
MH-C/3/1	192	302	Mobile Homes: No Tie Down	Permanent Dwelling: Single-Family	780	6,325,148
MH-C/3/2	194	302	Mobile Homes: Full Tie Down	Permanent Dwelling: Single-Family	2,823	32,345,089
MH-C/3/2	192	302	Mobile Homes: No Tie Down	Permanent Dwelling: Single-Family	193	3,191,020
MH-F/3	194	302	Mobile Homes: Full Tie Down	Permanent Dwelling: Single-Family	68,394	5,366,347,643
MH-F/3	192	302	Mobile Homes: No Tie Down	Permanent Dwelling: Single-Family	1,539	131,729,794
MH-F/4	194	302	Mobile Homes: Full Tie Down	Permanent Dwelling: Single-Family	572	11,286,631
MH-F/4	192	302	Mobile Homes: No Tie Down	Permanent Dwelling: Single-Family	113	2,782,273
				Total Insured Value to be Modeled:	**365,058**	**11,460,741,609**

Notes:
Currency: US Dollars

Exhibit II

Insured Value by Territory - All Coverages
Hurricane Peril

North Carolina

Territory	Coverage A	Coverage B	Coverage C	Coverage D	Total
5					
Value	23,729,970	1,615,930	8,542,217	394,057	34,282,175
Num. Risks	603	513	584	607	1,682
Avg Value	39,326	3,149	14,617	649	20,385
Avg. Ded $	250	250	250	-	250
6					
Value	18,347,999	1,279,231	6,458,528	403,919	26,489,676
Num. Risks	472	415	453	476	1,261
Avg Value	38,871	3,084	14,249	849	21,009
Avg. Ded $	250	250	250	-	250
32					
Value	68,221,323	6,608,161	22,924,030	2,469,023	100,222,538
Num. Risks	1,709	1,474	1,631	1,742	4,317
Avg Value	39,908	4,482	14,058	1,417	23,215
Avg. Ded $	250	250	250	-	250
34					
Value	125,590,326	10,691,766	42,220,709	6,905,388	185,408,188
Num. Risks	3,299	2,772	3,123	3,428	6,851
Avg Value	38,067	3,857	13,521	2,014	27,064
Avg. Ded $	250	250	250	-	250
36					
Value	57,067,846	5,265,727	19,413,052	2,095,228	83,841,853
Num. Risks	1,612	1,443	1,573	1,640	4,092
Avg Value	35,404	3,649	12,343	1,278	20,491
Avg. Ded $	250	250	250	-	250
38					
Value	32,808,939	3,104,254	11,040,309	1,051,625	48,005,128
Num. Risks	905	797	894	924	2,362
Avg Value	36,251	3,893	12,347	1,138	20,320
Avg. Ded $	250	250	250	-	250
39					
Value	268,506,087	26,660,311	88,030,181	16,258,311	399,454,890
Num. Risks	5,316	4,966	5,193	5,387	10,529
Avg Value	50,511	5,369	16,951	3,018	37,940
Avg. Ded $	250	250	250	-	250
41					
Value	359,796,503	32,878,120	119,887,072	23,200,250	535,761,944
Num. Risks	9,335	8,142	9,183	9,526	18,041
Avg Value	38,544	4,038	13,055	2,436	29,698
Avg. Ded $	250	250	250	-	250
42					
Value	222,790,796	19,702,484	73,265,750	9,429,775	325,188,806
Num. Risks	5,414	4,728	5,260	5,530	12,403
Avg Value	41,150	4,167	13,928	1,705	26,218
Avg. Ded $	250	250	250	-	250
43					
Value	247,843,499	24,263,921	85,417,340	11,795,937	369,320,697
Num. Risks	6,153	5,678	6,149	6,314	14,098
Avg Value	40,277	4,273	13,892	1,868	26,196
Avg. Ded $	250	250	250	-	250
44					
Value	104,006,558	9,095,364	34,113,042	6,401,077	153,616,042
Num. Risks	2,900	2,523	2,858	2,978	5,759
Avg Value	35,859	3,605	11,938	2,150	26,676
Avg. Ded $	250	250	250	-	250
45					
Value	854,085,829	81,610,534	287,704,747	57,842,590	1,281,243,701
Num. Risks	19,677	17,859	19,479	20,210	38,495
Avg Value	43,406	4,570	14,770	2,862	33,283
Avg. Ded $	250	250	250	-	250
46					
Value	583,039,146	57,123,515	188,709,098	35,023,971	863,895,729
Num. Risks	10,733	9,682	10,484	10,953	22,035
Avg Value	54,322	5,900	17,999	3,198	39,206
Avg. Ded $	250	250	250	-	250

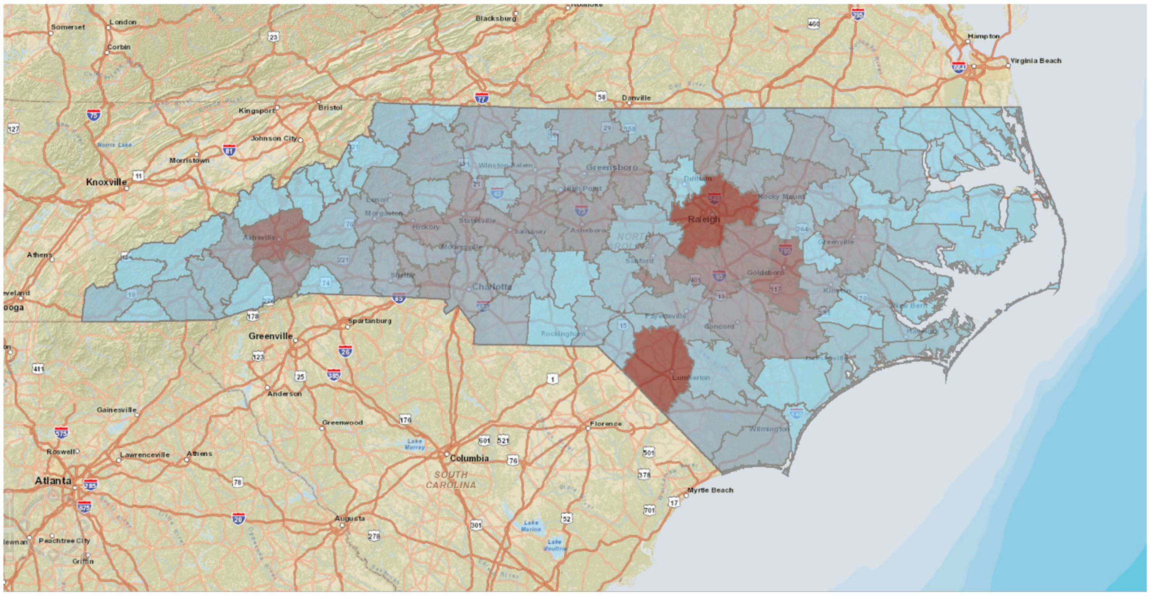
(continued)

47							
Value			1,237,909,411	119,513,245	406,805,417	73,173,521	1,837,401,594
Num. Risks			25,615	23,198	24,996	26,235	51,950
Avg Value			48,327	5,152	16,275	2,789	35,369
Avg. Ded $			250	250	250	-	250
53							
Value			311,496,637	30,438,800	103,512,401	19,039,879	464,487,716
Num. Risks			6,137	5,698	6,059	6,275	12,099
Avg Value			50,756	5,342	17,084	3,034	38,391
Avg. Ded $			250	250	250	-	250
57							
Value			567,851,607	55,969,808	192,809,895	31,320,033	847,951,343
Num. Risks			13,639	12,878	13,576	13,894	28,343
Avg Value			41,635	4,346	14,202	2,254	29,917
Avg. Ded $			250	250	250	-	250
60							
Value			2,651,493,628	254,604,142	862,939,540	135,132,281	3,904,169,590
Num. Risks			60,263	56,822	60,060	61,367	130,742
Avg Value			43,999	4,481	14,368	2,202	29,862
Avg. Ded $			250	250	250	-	250
Total							
Value			7,734,586,103	740,425,314	2,553,793,327	431,936,864	11,460,741,609
Num. Risks			173,783	159,587	171,554	177,485	365,058
Avg Value			44,507	4,640	14,886	2,434	31,394
Avg. Ded $			250	250	250	-	250

Notes:
Currency: US Dollars

Exhibit III

Concentration of Mobile Home Exposure by Replacement Value
Hurricane Peril



Notes: Map extracted from Touchstone V1.5.2 Exposure Summary Dashboard

About AIR Worldwide Corporation

AIR Worldwide Corporation (AIR) is the scientific leader and most respected provider of risk modeling software and consulting services. AIR founded the catastrophe modeling industry in 1987 and today models the risk from natural catastrophes and terrorism in more than 50 countries. More than 400 insurance, reinsurance, financial, corporate and government clients rely on AIR software and services for catastrophe risk management, insurance-linked securities, detailed site-specific wind and seismic engineering analyses, agricultural risk management, and property replacement cost valuation. AIR is a member of the ISO family of companies and is headquartered in Boston with additional offices in North America, Europe and Asia. For more information, please visit www.air-worldwide.com.

RB-6B

Catastrophe Loss Analysis Service
Atlantic Tropical Cyclone
WSST Catalog

Prepared for: North Carolina Rate Bureau

AIR WORLDWIDE®

June 4, 2014

Contact Information

If you have any questions regarding this document, contact:

AIR Worldwide Corporation
131 Dartmouth Street
Boston, MA 02116-5134
USA

Tel: (617) 267-6645
Fax: (617) 267-8284

Table of Contents

Introduction

This report contains the results of the Catastrophe Loss Analysis Service (CLAS™) for Mobile Homes policies in the state of North Carolina as requested by the North Carolina Rate Bureau (NCRB). Loss estimates are provided using AIR Worldwide's (AIR) Atlantic Tropical Cyclone model.

The NCRB provided AIR with information that represents the exposures analyzed. AIR reviewed and reformatted the exposure data as necessary and used them as input to the AIR hurricane model, which generated the loss estimates that form the core of this analysis. The AIR model is a system of computer programs that incorporate the fundamental physical characteristics, expressed mathematically, of hurricanes. These characteristics are then overlaid on the geographical distribution of the NCRB's exposures. Building, contents, and time element damage are estimated by applying AIR's proprietary damageability relationships. Finally, insured losses are calculated by applying policy conditions to the total damage estimates.

The AIR model simulated 100,000 years of potential hurricane experience. The results of the model are expressed in terms of probability distributions of event losses. These distributions represent a range of possible losses and the relative likelihood of occurrence of various levels of loss.

All aspects of the AIR hurricane model undergo extensive validation tests. The stochastic model variables have been compared to the actual characteristics of historical hurricanes occurring in North Carolina since 1900. The simulated event characteristics parallel patterns seen in the historical record, and resulting loss estimates correspond closely to actual claims data provided by clients.

The model has also undergone extensive internal and external peer review. Internal peer review is a standard part of AIR's operating process and is conducted by AIR's technical staff of over 400 professionals, over 60 of whom hold Ph.D. credentials in their fields of expertise. The AIR hurricane model has also undergone extensive external review, beginning with Dr. Walter Lyons' systematic review in 1986. Dr. Lyons, a Certified Consulting Meteorologist, was contracted by the E.W. Blanch Company. A further independent review was conducted by engineer Dr. Joseph E. Minor. During 1996 and 1997, Duff & Phelps, Fitch, Moody's and Standard & Poors reviewed all aspects of AIR's hurricane model in conjunction with their rating of the USAA catastrophe bond.

Catastrophe models combine the latest scientific and engineering knowledge with computer simulation technology to develop probability distributions of long-run potential losses. They are not forecasting tools.

Forecasting hurricane activity on a short term time horizon, such as a year or a few years ahead, is difficult because of the many climatological factors that influence hurricane activity—and landfall activity in particular—in the North Atlantic. There are several important mechanisms within the earth's environment that are reported to affect hurricane activity. These mechanisms are correlated with a variety of climate signals, which are measurements of the natural feedback systems of the earth in its effort to maintain equilibrium. Climate signals are typically presented as a measurement of anomalies.

For example, the energy source of the hurricane "engine" is heat and moisture from the ocean's surface. The warmer the ocean, the more heat energy is available to tropical storms. Scientists have observed that sea surface temperatures (SSTs) in the North Atlantic undergo fluctuations above and below their mean values in phases lasting multiple decades. (Some scientists refer to this fluctuation as the Atlantic Multi-Decadal Oscillation, or AMO.)

Other climate signals include the:

- El Niño Southern Oscillation (ENSO), which measures sea surface temperature anomalies in the Pacific Ocean off the coast of Peru. These SSTs alternate over an approximate three- to eight-year cycle with an opposite cold phase known as "La Niña." Certain researchers have concluded that the presence of El Niño has a mitigating effect on the frequency of hurricane activity in the Atlantic and the opposite effect in the Pacific.

- Quasi-Biennial Oscillation (QBO), a signal tracking the direction of the equatorial winds in the stratosphere. One theory hypothesizes that when these winds blow from west to east, they have a positive impact on hurricane formation. The QBO has an approximate two-year cycle.

- North Atlantic Oscillation (NAO), a pressure pattern between the high pressure system near the Azores and the low pressure system near Iceland. Scientists have observed that the large-scale general circulation associated with the NAO steers North Atlantic tropical cyclones in a characteristic pattern to the west and eventually to the north. Informally known as the "Bermuda High," when it is in a more southwesterly position, hurricanes are more likely to make landfall than when it is further north and east, off the northern African Coast. The location of the Bermuda High can change several times during a single hurricane season.

Since 1995, SSTs in the North Atlantic have been in a warm phase characterized by elevated SSTs and above-normal hurricane activity. However, there is significant uncertainty associated with quantifying the time horizon and magnitude of this elevated risk and its impact on insured losses.

While recognizing these challenges, AIR has reviewed current scientific research and conducted extensive internal analyses. Based on this research, AIR has developed an alternative catalog of simulated hurricanes ("warm sea surface temperature conditioned catalog") that incorporates the impact of SST anomalies on hurricane.

Statistical analyses were then performed to assess the impact of warm SST anomalies in the North Atlantic on hurricane landfall frequency and intensity. Although this analysis shows that the correlation between SST anomalies and landfall hurricane frequency is relatively weak, a hurricane index is defined as the ratio of mean frequency of hurricanes under warm SST anomalies relative to mean frequency of hurricanes in all years. The index has been developed by hurricane intensity and for four regions along the U.S. coastline. The final index values are guided by statistical assessment of the impact of SSTs and a physical understanding of the varying regional impact warm SST anomalies have along the coastline. The index values developed by AIR were used to develop a revised landfall frequency distribution by coastal segment, which ultimately results in a warm sea surface temperature conditioned stochastic catalog.

The results presented in this report are provided as one view of the uncertainty in a warm sea surface temperature environment. However, the interaction of other shorter-term climate fluctuations, such as those listed above (ENSO, QBO and NAO), can affect the likelihood that hurricanes will make landfall in any given year. This analysis is limited by a number of other additional factors, including but not limited to:

- Uncertainty in forecasting SST conditions.
- Fewer years of data from periods of warm SST conditions compared to more than 100 years of data used in creating the standard catalog.
- Random events that influence climate (for example, volcanic eruptions) and that cannot be predicted or accounted for.

The AIR model simulated 100,000 years of potential hurricane experience. The results of the model are expressed in terms of probability distributions of event losses. These distributions represent a range of possible losses and the relative likelihood of occurrence of various levels of loss.

The hurricane model used in this report is Atlantic Tropical Cyclone v14.0.1, as implemented in Touchstone v1.5.2.

Executive Summary

To estimate the hurricane loss potential for NCRB, AIR simulated 100,000 years of potential hurricanes using AIR Worldwide's warm sea surface temperature conditioned hurricane catalog. The simulation included aggregate demand surge, which is demand surge caused by a given event as well as by other events that occur close to the given event in both time and space. Additionally, the simulation included storm surge, which simulates the abnormal sea-level rise accompanying hurricane activity and estimates the maximum surge depth experienced at each coastal location.

The long-term average annual aggregate hurricane loss for the NCRB Mobile Homes policies is $17.0 million including aggregate demand surge and storm surge. In the 100,000-year sample, 71,642 hurricanes resulted in losses to North Carolina's insured properties net of deductibles. Given that a hurricane has occurred, the estimated average hurricane loss is $23.7 million.

The largest simulated hurricane loss is $1.1 billion, including aggregate demand surge and storm surge. This loss resulted from a category 5 hurricane with landfall in Carteret County, North Carolina. Note that higher occurrence losses, that is, losses in excess of $1.1 billion, are possible. They have, however, a very low probability of occurrence. Nevertheless, it should be understood that the largest simulated hurricane losses do not represent the worst possible scenarios.

Hurricane events of specified probabilities of exceedance and estimated return times appear below.

Table 1. Annual Maximum Occurrence Loss

Hurricane Occurrence Loss ($ millions)	Estimated Probability of Exceedance	Estimated Average Return Time (years)
40	10.0%	10
87	5.0%	20
174	2.0%	50
253	1.0%	100
372	0.4%	250
481	0.2%	500
575	0.1%	1,000

Actual hurricane losses are influenced by a number of characteristics, the most important of which is intensity as measured by wind speed, commonly expressed in terms of Saffir-Simpson (SS) category. Given the same landfall point, storms with higher wind speeds typically result in larger losses than do storms with lower wind speeds. Other characteristics that influence loss amounts include radius of maximum winds, forward speed, and storm track. Additionally, storm surge losses are influenced by the abnormal sea-level rise accompanying hurricane activity. The main intensity parameter in the storm surge component of the AIR model is water depth. The damage function takes into account damage of the water itself, as well as damage due to movement of the water, as functions of water velocity and water height.

Actual losses also depend on the geographical distribution of exposures in relation to the area affected by the storm. That is, a severe hurricane could result in a smaller overall loss than a less severe hurricane if the less severe hurricane strikes an area of higher property value.

Exposure Information and Assumptions

The NCRB provided exposure information used to generate the loss estimates. The exposure file contained information on insured value and number of risks by sub-line, policy form, status, coverage, construction class and territory as defined by the NCRB.

NCRB requested that AIR allocate territory exposure to an appropriate granularity for hurricane modeling. This was completed using a disaggregation technique, in which all policy values were distributed proportionally to 90m x 90m grid points based on the Mobile Home exposures in the AIR industry exposure database. The following information was used in the process of disaggregation:

- AIR's proprietary database of industry exposure by line of business, construction class, and five-digit ZIP Code, distributed to a 90m by 90m grid. This database was developed using U.S. Census data supplemented with additional research of industry insured exposures.
- A ZIP Code to NCRB defined Territory shape file mapping algorithm. The shape file was provided by ISO and includes ZIP Code and Territory boundary definitions for North Carolina.

The information on house-years and insurance-years by sub-line, form, status, construction class, coverage, and territory was provided by the Insurance Services Office (ISO) and represents the full statistical plan experience of companies reporting to either ISO or the National Association of Independent Insurers.

The final, disaggregated data set was analyzed by AIR in order to yield loss estimates. Appendix A, Exhibit II shows total insured values, number of risks (rounded), original number of risks and average values by territory.

Long-Term Average Losses

Exhibit 1 shows the long run average annual hurricane loss potential by territory including aggregate demand surge and storm surge.

Exhibit 1: Average Annual Loss by Territory in North Carolina

Territory	MH-C	MH-F	Total
5	1,288,628	21,602	1,310,230
6	609,182	55,678	664,859
32	74,939	24,848	99,786
34	148,992	135,288	284,281
36	32,128	10,139	42,267
38	18,917	4,556	23,473
39	91,514	117,757	209,271
41	491,778	708,909	1,200,687
42	1,520,741	771,240	2,291,981
43	1,610,659	1,019,385	2,630,044
44	51,740	64,025	115,765
45	1,083,720	1,876,356	2,960,077
46	276,984	349,348	626,333
47	1,086,566	1,303,555	2,390,121
53	193,943	255,051	448,995
57	249,739	236,060	485,799
60	672,427	535,780	1,208,207
Total	9,502,597	7,489,577	16,992,174

Currency: US Dollars

Exhibit 2 shows North Carolina's distribution of all sub-lines combined average annual hurricane losses including aggregate demand surge and storm surge and total insurance in force by territory. The coastal territories account for much higher shares of loss than exposure due to their vulnerability to the hurricane peril.

Exhibit 2: Distribution of Exposure and Loss by Territory in North Carolina

Territory	Insured Value	Percent of Total	Est. Avg. Annual Loss	Percent of Total
5	34,282,175	0.30%	1,310,230	7.71%
6	26,489,676	0.23%	664,859	3.91%
32	100,222,538	0.87%	99,786	0.59%
34	185,408,188	1.62%	284,281	1.67%
36	83,841,853	0.73%	42,267	0.25%
38	48,005,128	0.42%	23,473	0.14%
39	399,454,890	3.49%	209,271	1.23%
41	535,761,944	4.67%	1,200,687	7.07%
42	325,188,806	2.84%	2,291,981	13.49%
43	369,320,697	3.22%	2,630,044	15.48%
44	153,616,042	1.34%	115,765	0.68%
45	1,281,243,701	11.18%	2,960,077	17.42%
46	863,895,729	7.54%	626,333	3.69%
47	1,837,401,594	16.03%	2,390,121	14.07%
53	464,487,716	4.05%	448,995	2.64%
57	847,951,343	7.40%	485,799	2.86%
60	3,904,169,590	34.07%	1,208,207	7.11%
Total	11,460,741,609	100%	16,992,174	100%

Currency: US Dollars

Estimated Pure Premiums and Loss Costs

Exhibits 3, 4, and 5 show the estimated hurricane loss costs and pure premiums by territory for all sub-lines combined and for each sub-line separately. The coastal territories are most vulnerable to hurricane losses. The estimated loss costs are highest in coastal territories 5 and 6, as well as territories 42 and 43. These territories form part of the eastern tip of North Carolina, an area of relatively high hurricane frequency.

For all exhibits, the estimated loss costs are per $100 of exposure. The estimated hurricane pure premiums are calculated by dividing the estimated average annual losses by the number of risks. The estimated hurricane pure premiums show the amounts, exclusive of expenses and provisions for profit and contingencies, which need to be collected each year to cover only the long run hurricane loss potential.

Exhibit 3: North Carolina Loss Costs by Territory- All Lines

Territory	Insured Value	Risk Count	Average Annual Loss	Pure Premium	Loss Cost (Per $100)
5	34,282,175	1,682	1,310,230	779.08	3.8219
6	26,489,676	1,261	664,859	527.31	2.5099
32	100,222,538	4,317	99,786	23.11	0.0996
34	185,408,188	6,851	284,281	41.50	0.1533
36	83,841,853	4,092	42,267	10.33	0.0504
38	48,005,128	2,362	23,473	9.94	0.0489
39	399,454,890	10,529	209,271	19.88	0.0524
41	535,761,944	18,041	1,200,687	66.55	0.2241
42	325,188,806	12,403	2,291,981	184.79	0.7048
43	369,320,697	14,098	2,630,044	186.55	0.7121
44	153,616,042	5,759	115,765	20.10	0.0754
45	1,281,243,701	38,495	2,960,077	76.89	0.2310
46	863,895,729	22,035	626,333	28.42	0.0725
47	1,837,401,594	51,950	2,390,121	46.01	0.1301
53	464,487,716	12,099	448,995	37.11	0.0967
57	847,951,343	28,343	485,799	17.14	0.0573
60	3,904,169,590	130,742	1,208,207	9.24	0.0309
Total	11,460,741,609	365,058	16,992,174	46.55	0.1483

Currency: US Dollars

Exhibit 4: North Carolina Loss Costs by Territory- MH-C Sub-Line

Territory	Insured Value	Risk Count	Average Annual Loss	Pure Premium	Loss Cost (Per $100)
5	33,748,388	1,670	1,288,628	771.55	3.8183
6	24,355,195	1,219	609,182	499.63	2.5012
32	76,627,564	4,064	74,939	18.44	0.0978
34	102,121,443	5,670	148,992	26.28	0.1459
36	64,754,944	3,821	32,128	8.41	0.0496
38	39,490,073	2,244	18,917	8.43	0.0479
39	181,765,543	8,044	91,514	11.38	0.0503
41	234,593,737	13,683	491,778	35.94	0.2096
42	219,978,793	10,888	1,520,741	139.67	0.6913
43	231,704,680	12,132	1,610,659	132.76	0.6951
44	73,052,007	4,491	51,740	11.52	0.0708
45	511,929,031	29,093	1,083,720	37.25	0.2117
46	397,161,959	17,573	276,984	15.76	0.0697
47	877,367,860	40,898	1,086,566	26.57	0.1238
53	209,282,775	9,175	193,943	21.14	0.0927
57	450,204,704	22,417	249,739	11.14	0.0555
60	2,220,456,571	107,357	672,427	6.26	0.0303
Total	5,948,595,268	294,439	9,502,597	32.27	0.1597

Currency: US Dollars

Exhibit 5: North Carolina Loss Costs by Territory- MH-F Sub-Line

Territory	Insured Value	Risk Count	Average Annual Loss	Pure Premium	Loss Cost (Per $100)
5	533,787	12	21,602	1,864.96	4.0470
6	2,134,482	42	55,678	1,338.46	2.6085
32	23,594,974	253	24,848	98.02	0.1053
34	83,286,745	1,181	135,288	114.60	0.1624
36	19,086,909	271	10,139	37.47	0.0531
38	8,515,055	119	4,556	38.31	0.0535
39	217,689,347	2,485	117,757	47.39	0.0541
41	301,168,207	4,358	708,909	162.67	0.2354
42	105,210,012	1,515	771,240	508.91	0.7330
43	137,616,017	1,966	1,019,385	518.55	0.7407
44	80,564,035	1,267	64,025	50.53	0.0795
45	769,314,670	9,402	1,876,356	199.56	0.2439
46	466,733,770	4,462	349,348	78.29	0.0748
47	960,033,734	11,052	1,303,555	117.95	0.1358
53	255,204,940	2,924	255,051	87.23	0.0999
57	397,746,639	5,926	236,060	39.83	0.0593
60	1,683,713,019	23,385	535,780	22.91	0.0318
Total	5,512,146,341	70,619	7,489,577	106.06	0.1359

Currency: US Dollars

Appendix A- Project Information & Assumptions Form

Project Information & Assumptions Form

Version 2009061919.1.0

Project Summary & Contact Information

Subscriber: NCRB
Contact: Tim Lucas
Email: ftl@ncrb.org
Phone: 919-582-1021
Fax:

AIR Contact: Peter Bingenheimer
Email: pbingenheimer@air-worldwide.com
Phone: (617) 267-6645
Fax: (617) 267-8284

Contract #:
Analysis Type: Property - Mobile Home/Personal
Exposure Summary Sent: May 28, 2014
Report Due: June 6, 2014

☑ Initial Analysis ☐ Follow-up

Perils & Models

#	Peril	Model	Implementation	Version	Simulation Years
1	Tropical Cyclone	U.S. Hurricane Standard - 100K_Standard_ATL_Hur_10 (15.00.0409)	Touchstone	1.5.2	100,000
2	Tropical Cyclone	U.S. Hurricane WSST - 100K_WSST_ATL_Hur_11 (15.01.0409)	Touchstone	1.5.2	100,000

Reports & Deliverables

Report Options

Report Format: ☑ PDF ☐ Paper Copy/Bound Report
☐ Flat file ☐ CSV
☑ Electronic File

Standard Reports

☑ Distribution of Potential Catastrophe Losses - Exceedance Probability
☑ Portfolio ☐ State ☐ Line of Business

☑ Average Annual Losses
☐ State ☐ County ☐ ZIP ☐ Location ☐ Line of Business
☑ Territory

☑ Loss Costs and Pure Premiums
☐ State ☐ County ☐ ZIP ☐ Location ☐ Line of Business
☑ Territory

☐ Selected Event Scenarios - specific events from a stochastic/historical event set
☐ Rank ☐ Return Period ☐ Line of Business

Customized Reports

☐ Company Loss File (CLF) ☐ UNICEDE/2
☐ UPX

5/28/2014

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AIR WORLDWIDE

Original Data File Information			
Original file name(s):	C'11 NC MH AIR INPUT FILE.xlsx, NCZIPTerrIntersectH.zip		
Date Received:	February 21, 2014	**Data in-force Date:**	December 31, 2011
Date Logged:	February 21, 2014	**Data Media:**	Excel Attachment

File Format: ☐ MS Access ☑ MS Excel ☐ Text

Level of Location Deta ☐ Geocode ☐ 9-Digit ZIP ☐ Street ☐ 5-Digit ZIP ☐ City ☐ County ☐ State ☑ Territory

Original Value Summary

Total Deductible Value	Total Records	Total Risks	Total Replacement Value	Total Insured Value	Max. TIV	Avg. TIV
n/a	204	365,058	15,285,250,564	11,460,741,609	105,302	31,394

Added/Excluded Records

Reason for Addition/Exclusion	Records	Risks	Insured Value
Number of records and risks increased for modeling due to disaggregation of exposure to 1km by 1km grid level. See Exposure Notes and Customized Assumptions for details	3,522,360	3,157,506	-
	-	-	
Total Excluded:	-	-	-
Total Added	**3,522,360**	**3,157,506**	-
Added Number of Records due to Disaggregation:	**3,522,360**	**3,157,506**	-
Net Exposures to be Modeled:	**3,522,564**	**3,522,564**	**11,460,741,609**

5/28/2014
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AIR WORLDWIDE

Geocode Record Summary		
Number of zipcodes remapped prior to geocoding:	-	
Exposure View Name:	NCRB_MH_2014	
Geocoded Level of Location Detail	**Records**	
Matched at Exact Address:	-	
Matched at 9-digit Zip:	-	
Matched at Relaxed Address:	-	
Matched at Postal Code:	-	
Matched at City:	-	
Matched at County:	-	
Records already geocoded:	3,522,564	
Total number of records:	**3,522,564**	

Note: In pre-processing the original territory level data, all records were disaggregated into a 90m x 90m grid. These grid points are already mapped to specific latitude/logitude coordinates. Therefore, all data was already geocoded prior to import.

Line of Business & Coverage Summary													
Subline/Policy or Coverage Form/Status	Limits Apply	A Building			B Other Structures			C Contents			D Loss of Use		
		Rep	Lim	Ded	Rep	Lim	Ded	Rep	Lim	Ded	Rep/d*	Lim	Ded
MH-C/1/1	C	L	P	BA	N/A	N/A	N/A	N/A	N/A	N/A	$10 / day	P	NO
MH-C/2/1	C	N/A	N/A	N/A	L	P	CA	N/A	N/A	N/A	N/A	N/A	N/A
MH-C/3/1	C	N/A	N/A	N/A	N/A	N/A	N/A	L	P	CA	N/A	N/A	N/A
MH-C/3/2	C	N/A	N/A	N/A	N/A	N/A	N/A	L	P	BA	$10 / day	P	NO
MH-F/3	C	L	P	BA	L	P	BA	L	P	BA	$150 / day	P	NO
MH-F/4	C	N/A	N/A	N/A	N/A	N/A	N/A	L	P	BA	$150 / day	P	NO

* *Loss of Use Replacment (Rep/d) is a per diem value.*

CLASIC/2 Key:

Limit Application Code ("Limits Apply"):
N = None
C = Applies by Coverage
S = Applies to sum of all coverages

Replacement Value ("Rep"):
P = As Provided
L = Equal to limit

Limit Value ("Lim"):
P = As Provided
TLF = Total Limit Factor (see Exhibit III)

Deductible Application Code ("Ded"):
NO = None
AA = Annual Amount
SA = Combined flat
SP = Combined percent of coverage
SL = Combined percent of loss
CA = By coverage flat
CP = By coverage percent
BA = Combined flat, excluding time element loss
BP = Combined percent of coverage, excluding time
MA = Mini-policy flat
MP = Mini-policy percent

Analysis Options

Aggregation of Input Data: ☐ Modeled as provided ☑ Aggregated by: GridPoint, LOB, Construction Code, Zip Code

Geographic Resolution of Analysis: Event Total

Analysis Save Results: ☑ Contract ☐ Contract/Summary ☐ Layer ☑ Coverage ☐ Injury

Analysis Specifications:
☐ Reinsurance Quota Share
☐ Reinsurance Surplus Share
☐ Reinsurance Per Risk XOL
☐ Reinsurance Facultative
☑ TC Storm Surge (Flooding, default is 10% of separately modeled surge loss)
☐ Average Properties
☑ Demand Surge (Aggregate)
☐ Uncertainty
☐ Global Overrides

Analysis Notes: Loss estimates for both catalogs will be provided both including and excluding aggregate demand surge. 100% of modeled storm surge loss will be reported.

5/28/2014
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AIR WORLDWIDE

Location Detail Characteristics			
Peril	*Characteristic*	*# Provided*	*% of Total Provided*
	Age		
	Appurtenant Structures		
	Avg Height of Adjacent Buildings		
	Bldg Foundation Connection		
	Building Condition		
	Building Orientation		
	Building Shape		
	Exterior Doors		
	Floor of Interest		
	Foundation Type		
	Glass Percent		
	Glass Type		
	Height		
	Internal Partition Walls		
	Large Missile Source		
	Proximity Exposure		
	Retrofit Measures		
	Roof Anchorage		
	Roof Attached Structures		
	Roof Covering		
	Roof Covering Attachment		
	Roof Deck		
	Roof Deck Attachment		
	Roof Geometry		
	Roof Pitch		
	Small Debris Source		
	Soft Story		
	Special Earthquake Resistant Systems		
	Structural Irregularity		
	Terrain Roughness		
	Torsion Elements		
	Tree Exposure		
	Wall Attached Structures		
	Wall Siding		
	Wall Type		
	Window Protection		
	Year Roof Built		
	Total Records:	0	0%

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AIR WORLDWIDE

Exposure Notes & Customized Assumptions

1) Insured value and number of risks were provided to AIR by Subline, Policy Form, Coverage Form, Status, construction class and territory as defined by NCRB. AIR used a ZIP code to territory shape file provided by the NCRB, along with information from its proprietry database of industry exposures, to distribute exposures to a 90m by 90m grid level for modeling. All policy values were distributed proportionally to the Mobile Home grid-point exposures in AIR's proprietry industry exposure database to disaggregate the data to a geographic resolution that can be modeled. This increases the total number of records and risks; however, due to proportionality it will not affect policy values and results.

2) Separate Risk counts were provided for each MH-C Coverage Form, Status Form and for each MH-F Policy Form for every applicable coverage. Results will be reported separately for MH-C and MH-F using the Mobile Home territories.

3) When exposures were distributed to the grid, the number of risks at each point were rounded to the nearest whole number, except where the number of risks was <1. In these instances, the number of risks was rounded up to 1, which increased the total number of risks from the original 365,058 risks to 3,522,564 risks. This will not have an impact on the results, as the number of risks is not a field used in the analysis.

4) For MH-C policies, the Coverage D replacement value is assumed to be $10/day and for the MH-F policies, the coverage D replacement value is assumed to be $150/day. For all policies, Coverage D limit was used as provided.

5) A flat deductible of $250 per risk was used. For the MH-C, Status 1 policies, the deductible is applied separately to Coverage B and Coverage C; for the combined Coverage A and Coverage D, the deductible is applied exclusive of Coverage D. For the MH-C, Status 2 policies, for the combined Coverage C and Coverage D, the deductible is applied exclusive of Coverage D. For the MH-F policies, the deductible is applied to combined coverages exclusive of Coverage D.

6) All replacement values, limits, and deductibles were scaled up by a constant factor to maintain modeling precision because the disaggregation of exposures to the grid resulted in values less than $1. This will not have an impact on the results, as it will be scaled back for reporting purposes.

7) Coverage B- Other Structures will be modeled as the same construction type used for Coverage A.

Attachments & Exhibits

Construction/Occupancy Information and Data Mapping: ☑

Insured Value Summary by LOB: ☐ State ☐ County ☐ Coverage ☑ Territory

Replacement Value Summary by LOB: ☐ State ☐ County ☐ Coverage

Deductible Summary by LOB: ☐ State ☐ County ☐ Coverage

Premium Summary: ☐ State ☐ County

Deductible by Coverage: ☐ State ☐ County

Construction Summary: ☐

Exposure Summary & Modeling Assumption Approval

Subscriber Signature: ____________________ *Date:* ____________________

Print Name: ____________________ *Title:* ____________________

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Exhibit I

Construction/Occupancy Information and Data Mapping

Subline/ Policy or Coverage Form/Status	*AIR CC*	*AIR OC*	*AIR Construction*	*AIR Occupancy*	*Risks*	*Insured Value*
MH-C/1/1	194	302	Mobile Homes: Full Tie Down	Permanent Dwelling: Single-Family	102,817	4,106,153,541
MH-C/1/1	192	302	Mobile Homes: No Tie Down	Permanent Dwelling: Single-Family	1,033	25,357,448
MH-C/2/1	194	302	Mobile Homes: Full Tie Down	Permanent Dwelling: Single-Family	88,870	371,635,934
MH-C/2/1	192	302	Mobile Homes: No Tie Down	Permanent Dwelling: Single-Family	783	2,250,884
MH-C/3/1	194	302	Mobile Homes: Full Tie Down	Permanent Dwelling: Single-Family	97,139	1,401,336,204
MH-C/3/1	192	302	Mobile Homes: No Tie Down	Permanent Dwelling: Single-Family	780	6,325,148
MH-C/3/2	194	302	Mobile Homes: Full Tie Down	Permanent Dwelling: Single-Family	2,823	32,345,089
MH-C/3/2	192	302	Mobile Homes: No Tie Down	Permanent Dwelling: Single-Family	193	3,191,020
MH-F/3	194	302	Mobile Homes: Full Tie Down	Permanent Dwelling: Single-Family	68,394	5,366,347,643
MH-F/3	192	302	Mobile Homes: No Tie Down	Permanent Dwelling: Single-Family	1,539	131,729,794
MH-F/4	194	302	Mobile Homes: Full Tie Down	Permanent Dwelling: Single-Family	572	11,286,631
MH-F/4	192	302	Mobile Homes: No Tie Down	Permanent Dwelling: Single-Family	113	2,782,273
				Total Insured Value to be Modeled:	**365,058**	**11,460,741,609**

Notes:
Currency: US Dollars

Exhibit II

Insured Value by Territory - All Coverages
Hurricane Peril

North Carolina

Territory			*Coverage A*	*Coverage B*	*Coverage C*	*Coverage D*	*Total*
5							
Value			23,729,970	1,615,930	8,542,217	394,057	34,282,175
Num. Risks			603	513	584	607	1,682
Avg Value			39,326	3,149	14,617	649	20,385
Avg. Ded $			250	250	250	-	250
6							
Value			18,347,999	1,279,231	6,458,528	403,919	26,489,676
Num. Risks			472	415	453	476	1,261
Avg Value			38,871	3,084	14,249	849	21,009
Avg. Ded $			250	250	250	-	250
32							
Value			68,221,323	6,608,161	22,924,030	2,469,023	100,222,538
Num. Risks			1,709	1,474	1,631	1,742	4,317
Avg Value			39,908	4,482	14,058	1,417	23,215
Avg. Ded $			250	250	250	-	250
34							
Value			125,590,326	10,691,766	42,220,709	6,905,388	185,408,188
Num. Risks			3,299	2,772	3,123	3,428	6,851
Avg Value			38,067	3,857	13,521	2,014	27,064
Avg. Ded $			250	250	250	-	250
36							
Value			57,067,846	5,265,727	19,413,052	2,095,228	83,841,853
Num. Risks			1,612	1,443	1,573	1,640	4,092
Avg Value			35,404	3,649	12,343	1,278	20,491
Avg. Ded $			250	250	250	-	250
38							
Value			32,808,939	3,104,254	11,040,309	1,051,625	48,005,128
Num. Risks			905	797	894	924	2,362
Avg Value			36,251	3,893	12,347	1,138	20,320
Avg. Ded $			250	250	250	-	250
39							
Value			268,506,087	26,660,311	88,030,181	16,258,311	399,454,890
Num. Risks			5,316	4,966	5,193	5,387	10,529
Avg Value			50,511	5,369	16,951	3,018	37,940
Avg. Ded $			250	250	250	-	250
41							
Value			359,796,503	32,878,120	119,887,072	23,200,250	535,761,944
Num. Risks			9,335	8,142	9,183	9,526	18,041
Avg Value			38,544	4,038	13,055	2,436	29,698
Avg. Ded $			250	250	250	-	250
42							
Value			222,790,796	19,702,484	73,265,750	9,429,775	325,188,806
Num. Risks			5,414	4,728	5,260	5,530	12,403
Avg Value			41,150	4,167	13,928	1,705	26,218
Avg. Ded $			250	250	250	-	250
43							
Value			247,843,499	24,263,921	85,417,340	11,795,937	369,320,697
Num. Risks			6,153	5,678	6,149	6,314	14,098
Avg Value			40,277	4,273	13,892	1,868	26,196
Avg. Ded $			250	250	250	-	250
44							
Value			104,006,558	9,095,364	34,113,042	6,401,077	153,616,042
Num. Risks			2,900	2,523	2,858	2,978	5,759
Avg Value			35,859	3,605	11,938	2,150	26,676
Avg. Ded $			250	250	250	-	250
45							
Value			854,085,829	81,610,534	287,704,747	57,842,590	1,281,243,701
Num. Risks			19,677	17,859	19,479	20,210	38,495
Avg Value			43,406	4,570	14,770	2,862	33,283
Avg. Ded $			250	250	250	-	250
46							
Value			583,039,146	57,123,515	188,709,098	35,023,971	863,895,729
Num. Risks			10,733	9,682	10,484	10,953	22,035
Avg Value			54,322	5,900	17,999	3,198	39,206
Avg. Ded $			250	250	250	-	250

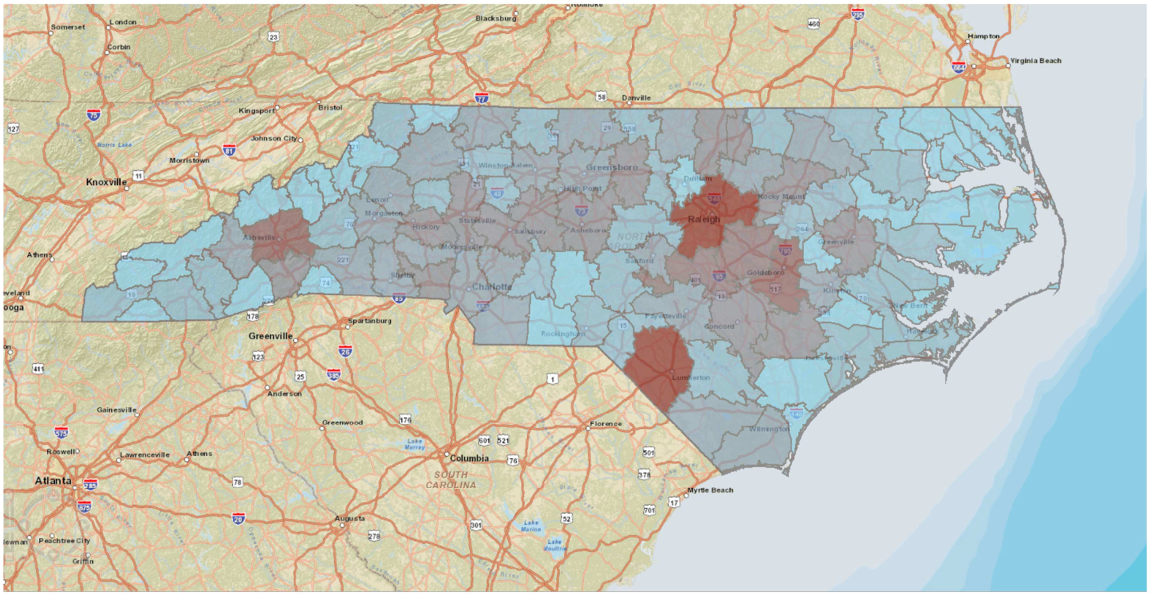
(continued)

47					
Value	1,237,909,411	119,513,245	406,805,417	73,173,521	1,837,401,594
Num. Risks	25,615	23,198	24,996	26,235	51,950
Avg Value	48,327	5,152	16,275	2,789	35,369
Avg. Ded $	250	250	250	-	250
53					
Value	311,496,637	30,438,800	103,512,401	19,039,879	464,487,716
Num. Risks	6,137	5,698	6,059	6,275	12,099
Avg Value	50,756	5,342	17,084	3,034	38,391
Avg. Ded $	250	250	250	-	250
57					
Value	567,851,607	55,969,808	192,809,895	31,320,033	847,951,343
Num. Risks	13,639	12,878	13,576	13,894	28,343
Avg Value	41,635	4,346	14,202	2,254	29,917
Avg. Ded $	250	250	250	-	250
60					
Value	2,651,493,628	254,604,142	862,939,540	135,132,281	3,904,169,590
Num. Risks	60,263	56,822	60,060	61,367	130,742
Avg Value	43,999	4,481	14,368	2,202	29,862
Avg. Ded $	250	250	250	-	250
Total					
Value	7,734,586,103	740,425,314	2,553,793,327	431,936,864	11,460,741,609
Num. Risks	173,783	159,587	171,554	177,485	365,058
Avg Value	44,507	4,640	14,886	2,434	31,394
Avg. Ded $	250	250	250	-	250

Notes:
Currency: US Dollars

Exhibit III

Concentration of Mobile Home Exposure by Replacement Value
Hurricane Peril



Notes: Map extracted from Touchstone V1.5.2 Exposure Summary Dashboard

About AIR Worldwide Corporation

AIR Worldwide Corporation (AIR) is the scientific leader and most respected provider of risk modeling software and consulting services. AIR founded the catastrophe modeling industry in 1987 and today models the risk from natural catastrophes and terrorism in more than 50 countries. More than 400 insurance, reinsurance, financial, corporate and government clients rely on AIR software and services for catastrophe risk management, insurance-linked securities, detailed site-specific wind and seismic engineering analyses, agricultural risk management, and property replacement cost valuation. AIR is a member of the ISO family of companies and is headquartered in Boston with additional offices in North America, Europe and Asia. For more information, please visit www.air-worldwide.com.

AIR Hurricane Model for the United States

AIR WORLDWIDE

Revision History

Revision Date	Description
June 15, 2013	Document release.
June 21, 2013	The model version number was incorrectly stated as 15.0. It is, in fact, Version 14.0.1. This error has been corrected.

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Contact Information

If you have any questions regarding this document, contact:

AIR Worldwide
131 Dartmouth Street
Boston, MA 02116-5134
USA
Tel: (617) 267-6645
Fax: (617) 267-8284

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1 Facts at a Glance

1.1 Model Facts

Model Name: AIR Hurricane Model for the United States (AIR Model 27)

AIR Model Version: 14.0.1 (released in Version 1.5 of Touchstone and Version 15.0 of CLASIC/2, CATRADER, and CATStation)

Release Date: June 2013

Modeled States: Alabama, Arkansas, Connecticut, Delaware, Washington DC, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Mississippi, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Virginia, and West Virginia

Modeled Perils: Hurricane winds and storm surge. The effects of levee failure are not modeled, nor are losses arising from contamination and associated clean-up costs. Precipitation is not explicitly modeled; however, because modeled losses have been calibrated to and validated against actual reported losses, the impact of wind-driven rain and saturated soils on modeled losses is captured implicitly.

Model Abstract: The AIR Hurricane Model for the United States is a fully stochastic model that captures the effects of hurricane winds and storm surge on insured properties in the United States (see list of modeled states above). Wind intensity computations are based on a storm's intensity, size, location, forward speed and direction, as well as the underlying terrain and land use in the region. Storm surge estimation is based on the hurricane's meteorological parameters, coastal elevation and geometry, tide heights, and bathymetry. In the local intensity component of the model, the effects of surface friction, filling, and gustiness on wind intensity and attenuation on storm surge are considered in order to properly calculate damage to onshore properties. The model is designed to meet the wide spectrum of hurricane risk management needs of all stakeholders, including the insurance and reinsurance industries, and accounts for insurance policy conditions specific to the United States.

1.2 United States — Country Facts

Population: 313.8 million (est. 2012)

GDP (purchasing power parity): USD 15.04 trillion (est. 2011)

Per Capita GDP: USD 48,100 (est. 2011)

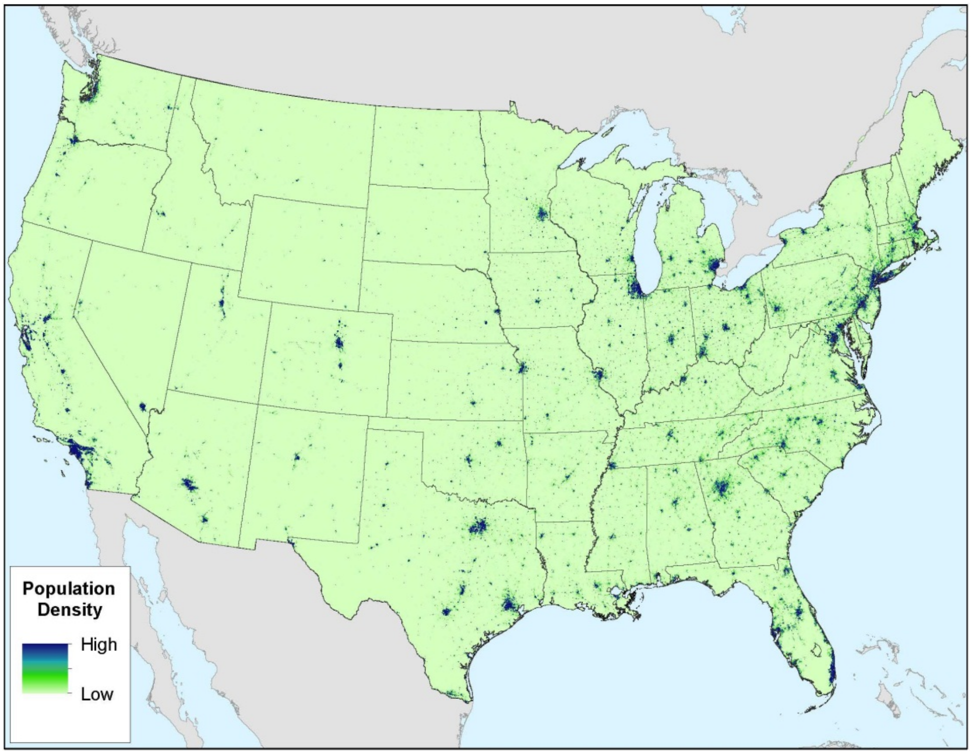

Figure 1. Population density in the United States

Figure 2 illustrates the density of ZIP Codes in the eastern United States, with a zoom of the ZIP Codes in Florida.

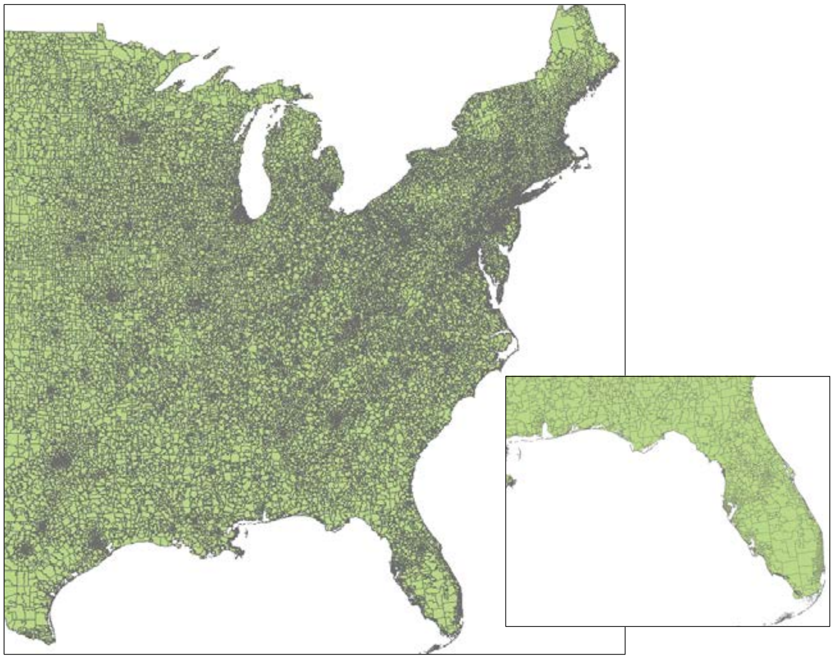

Figure 2. ZIP Code density in the eastern United States with zoom of Florida

Figure 3 shows the counties and county equivalents in the eastern United States. County equivalents include 64 parishes in Louisiana, 42 independent cities (one in MD, one in MO, one in NV, and the remainder in VA, and one district (District of Columbia).

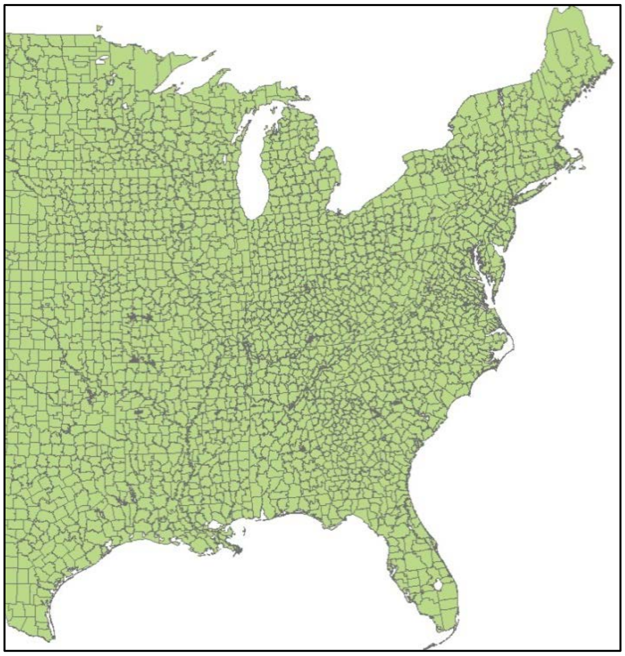

Figure 3. Counties and county equivalents in the eastern United States

1.3 Historical Catalog

Historical data on more than 1,000 storms in the Atlantic basin has been thoroughly analyzed to generate the simulated tracks. The model leverages information from the North Atlantic Hurricane Database (HURDAT), published August 1, 2011, for the period of 1900 to 2010. In addition to hurricanes that bypass land sufficiently close to the coast to cause damage, there were 209 U.S. landfalls during this period[1]. For modeling purposes, landfalling hurricanes are defined as those in which the center of the eye crosses the coastline. Bypassing storms are defined as hurricanes that pass close enough to land to produce damaging winds (≥ 40 mph) onshore, although they do not actually make landfall.

The Atlantic basin includes the Gulf of Mexico and the Caribbean Sea. Henceforth, the North Atlantic, Gulf of Mexico, and Caribbean Sea will be referred to as the Atlantic.

1.4 Stochastic Catalog

The model incorporates a 10,000-year catalog of simulated hurricanes with wind speeds of at least 74 mph.[2] This is a unified catalog covering the Caribbean, Mexico, and the Gulf of Mexico.

Note that two stochastic catalogs are provided with the AIR Hurricane Model for the United States:

- a standard catalog that reflects hurricane risk under average climate conditions
- a warm sea-surface temperature (Warm SST) catalog that reflects hurricane risk under warmer-than-average sea-surface temperature conditions.

Unless otherwise specified, the information provided in this document refers to the standard 10,000-year catalog. For details about the Warm SST catalog and the methodology used to develop it, please refer to *Climatological Influences on Hurricane Activity: The AIR Warm SST Conditioned Catalog*, which is available on the AIR website.

[1] Note that U.S. landfalls include events that make landfall in some portions of northern Mexico.
[2] Note that stochastic catalogs of 50,000 and 100,000 years are also available.

There are 50,011 simulated tropical cyclones in the standard 10,000-year catalog, which the model shares with the AIR Tropical Cyclone Model for the Caribbean, the AIR Tropical Cyclone Model for Mexico, and the AIR U.S. Hurricane Model for Offshore Assets. Of these, 19,067 are U.S.-only events, 17,084 of these make landfall in the United States, and 1,983 bypass the mainland. The maximum number of hurricane landfalls in a single simulated year is thirteen. Note that a single storm can make multiple landfalls.

Table 1 provides summary statistics about the standard and Warm SST 10,000-year stochastic catalog utilized in the model. Each event that makes landfall is indicated in the "U.S. Landfalling Events" row, and each U.S. landfall is indicated by the "U.S. Landfalls" row, which includes multiple landfalls from individual storms. "Total U.S. Events" is the sum of "U.S. Bypassers" and "U.S. Landfalling Events".

Table 1. 10,000-Year stochastic catalog statistics

	Standard Catalog	Warm SST Catalog
U.S. Landfalls	18,989	20,831
U.S. Landfalling Events	17,084	18,823
U.S. Bypassers	1,983	2,199
Total U.S. Events	19,067	21,022

Figure 4 shows the simulated landfall counts by intensity for the standard catalog.

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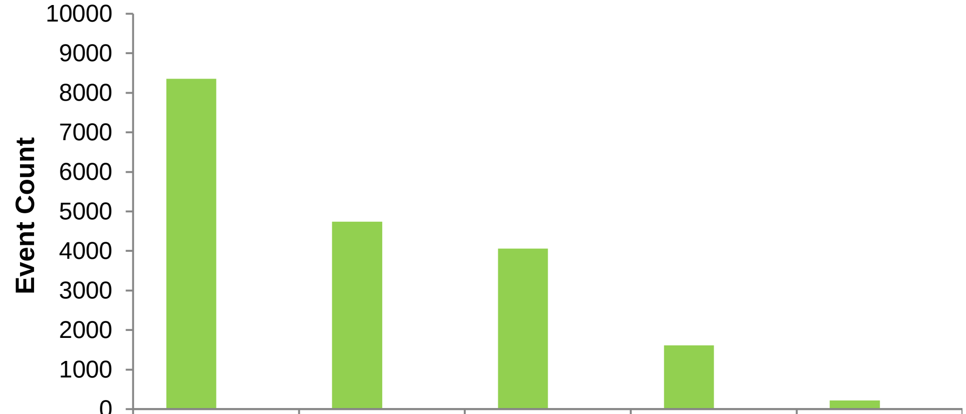
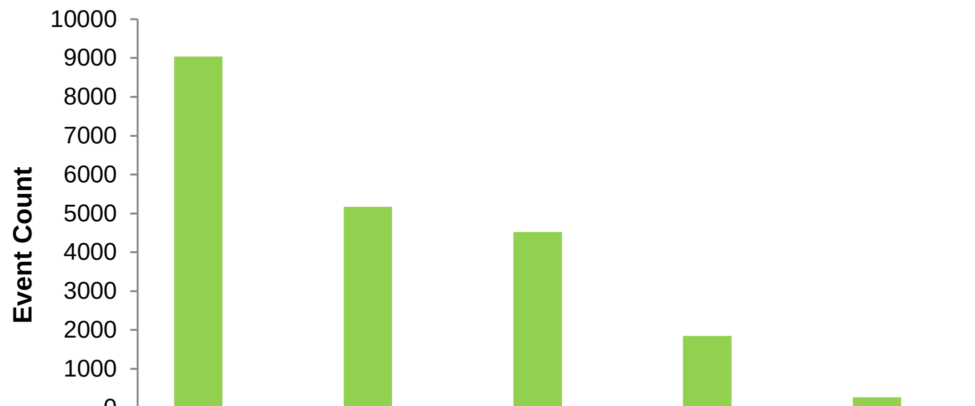


	SS1	SS2	SS3	SS4	SS5
EventCount	8356	4740	4063	1614	216
EventPercentage	44.00%	24.96%	21.40%	8.50%	1.14%

Figure 4. Simulated landfall counts by intensity (Saffir-Simpson) category at landfall (standard catalog)

Figure 5 shows the simulated landfall counts by intensity of the WSST catalog.



	SS1	SS2	SS3	SS4	SS5
EventCount	9035	5166	4517	1849	264
EventPercentage	43.37%	24.80%	21.68%	8.88%	1.27%

Figure 5. Simulated landfall counts by intensity (Saffir-Simpson) category at landfall (WSST catalog)

In the Atlantic basin, July through October is the most active time of year for tropical cyclones. This seasonal frequency, which is reflected in the AIR Hurricane Model for the United States, is derived from historical data. Figure 6 shows the frequency of events by month in the 10,000-year standard stochastic catalog.

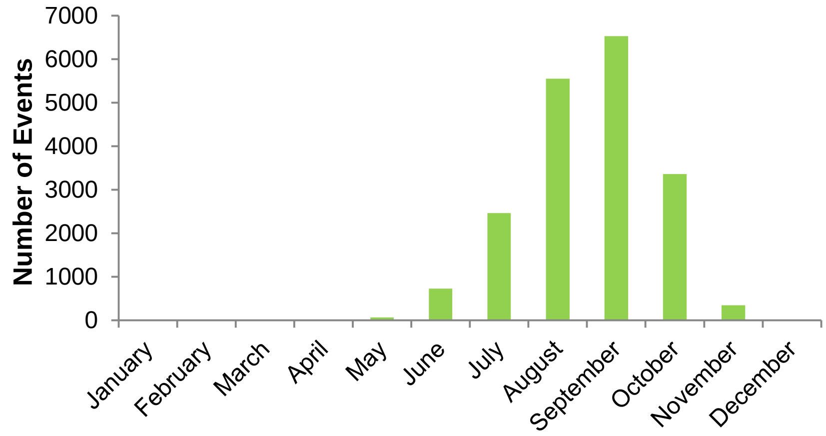


Figure 6. Number of simulated events by month in the 10,000-year catalog

Figure 7 displays the frequency of single-, double- and triple-landfalling events in the 10,000-year standard stochastic catalog.

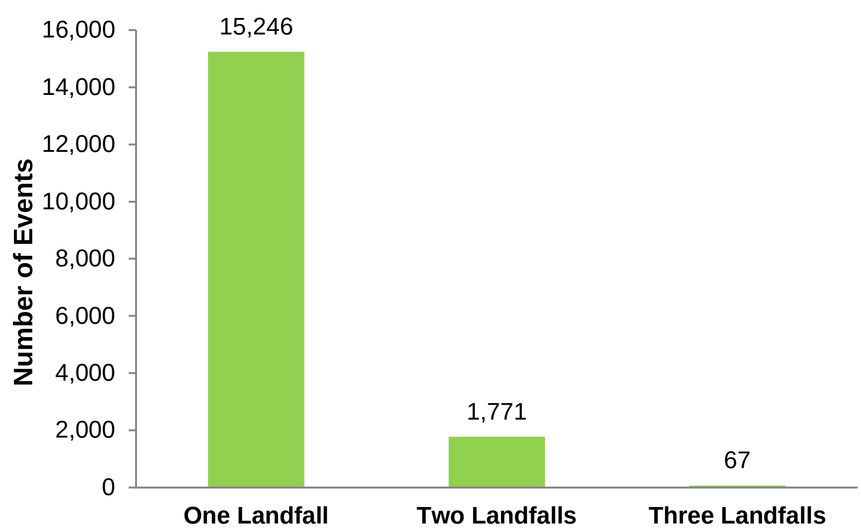


Figure 7. Distribution of simulated single-, double-, and triple-landfalling events in the 10,000-year standard catalog

1.5 Catalog Optimization

To reduce sampling variability among the losses produced by the 10,000-year, 50,000-year, and 100,000-year stochastic catalogs, these catalogs must exhibit highly similar frequency and intensity distributions of tropical cyclones by 100-nautical-mile coastal segment. This similarity is achieved by placing caps on the number of storms in each catalog that are drawn for each coastal segment, and drawn by Saffir-Simpson category. Additional constraints are imposed to expedite the convergence of the total annual landfall frequency for the entire United States coastline.

These caps on central pressure are generated by running the AIR Hurricane Model for the United States for 1 million years with no caps imposed and scaling the resulting frequencies down to a 10,000-year simulation. The result is expected frequencies for each Saffir-Simpson (SS) category, in each coastal segment.

The annual frequency for each year in these 1,000-year periods of the catalog is constrained to be within a small range around the expected value. The frequency for each of these 1,000-year periods is drawn from a negative binomial distribution, and if the total frequency for that set of years doesn't fall within the expected range, the frequency for all 1,000 years is re-drawn from the distribution.

In addition, in cases where the target frequencies are exceeded, the intensity or landfall segments are resampled. In addition, convergence tests on losses are also conducted, to ensure negligible differences among the 10,000-year, 50,000-year, and 100,000-year catalogs.

As shown in Figure 8, the exceedance probability curve for the 10,000-year standard catalog is similar to the exceedance probability curve for the 50,000-year catalog.

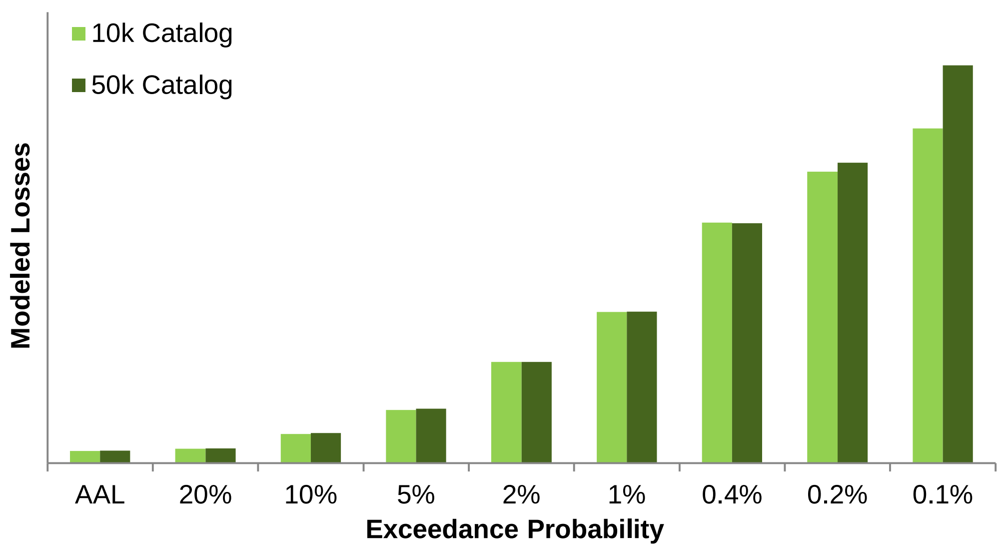


Figure 8. Exceedance probability curves for the 10,000-year and the 50,000-year stochastic catalog

1.6 Model Resolution and Physical Properties

Model resolution is 0.002 degree (220 meters) within five miles of the coastline, 0.01 degree (1 km) five to ten miles from the coastline, and 0.05 degree (5 km) ten or more miles from the coastline.

The AIR model uses United States Geological Survey (USGS) land use/land cover (LULC) classifications by category, and assigns appropriate roughness lengths based upon available scientific literature. The USGS classifications are provided at 30-meter resolution. The data are resampled at 0.002-degree (220 meter) resolution. Local roughness factors are used to define an effective roughness for a given location. The effective roughness is the average surface roughness for an area within a radius of 10 km (6.2 miles) for the time-averaging (gust) factor and 15 km (9.3 miles) for the friction factor, and is representative of the average land-surface acting on the wind field.

The effective roughness is used to develop a time-averaging or gust factor that is used to convert 10-minute sustained winds to one-minute sustained winds, and a friction factor to adjust the wind speed based on the local surface roughness. These conversions are based on accepted engineering relationships. The gust (friction) factor varies from 1.12 to 1.26 (0.69 to 1.00), as a function of LULC (Cook, 1985; Simiu et al., 1996; ESDU, 1994). Friction and gust factors are then aggregated to the ZIP Code level for use in CATRADER and to the previously mentioned variable grid-resolution in CLASIC/2 and Touchstone.

1.7 Construction and Occupancy Classes

Number of Supported Construction Classes: 68

Number of Supported Occupancy Classes: 111, of which 63 are occupancy classes for large industrial facilities.

Please see Section 8.4 for details on supported construction and occupancy classes in CLASIC/2 and Touchstone.

1.8 Modeled Industry Losses

It is important to distinguish between insurable and insured losses when modeling the industry exposure. To that end, some definitions are in order:

Insurable exposure: Total replacement value and number of properties (risk count) that are eligible for insurance. Certain building types are extremely vulnerable to natural perils and consequently are unlikely to be insured. Such properties are identified in each modeled region and are excluded from the industry database of insurable properties.

Insured exposure: Although eligible for insurance, "take-up" or purchase of insurance coverage for eligible properties varies by peril and region. For example, coverage for some natural perils may be mandatory in a region, and consequently the insurance take-up rate would be 100%. For other natural perils, insurance may be voluntary and take-up may be in single-digit percentage values. Based on available information, AIR provides estimates of take-up rates for each modeled region and simulated peril. Insured exposure is calculated by multiplying the take-up rate by the insurable risk count and replacement values.

Insurable loss: Estimated losses to insurable exposure (as though the take-up rate is 100%).

Insured loss: Estimated losses to insured exposure.

Modeled occurrence loss estimates for all states combined are provided below, for selected annual exceedance probabilities. Please note that the losses *include* demand surge. In addition, note that these losses are calculated using late 2011 industry exposures.

Insured and Insurable Occurrence Losses

Modeled Insured and Insurable Occurrence Losses, Standard U.S. Hurricane Catalog:
1% Exceedance Probability (100-year): USD 117.3 billion
0.4% Exceedance Probability (250-year): USD 186.8 billion

Modeled Insured and Insurable Occurrence Losses, Warm Sea-Surface Temperature Conditioned U.S. Hurricane Catalog:
1% Exceedance Probability (100-year): USD 125.2 billion
0.4% Exceedance Probability (250-year): USD 205.4 billion

Insured and Insurable Aggregate Losses

Average annual insured and insurable aggregate losses from the standard catalog are shown in Figure 9 for the entire United States and the five most at-risk states.

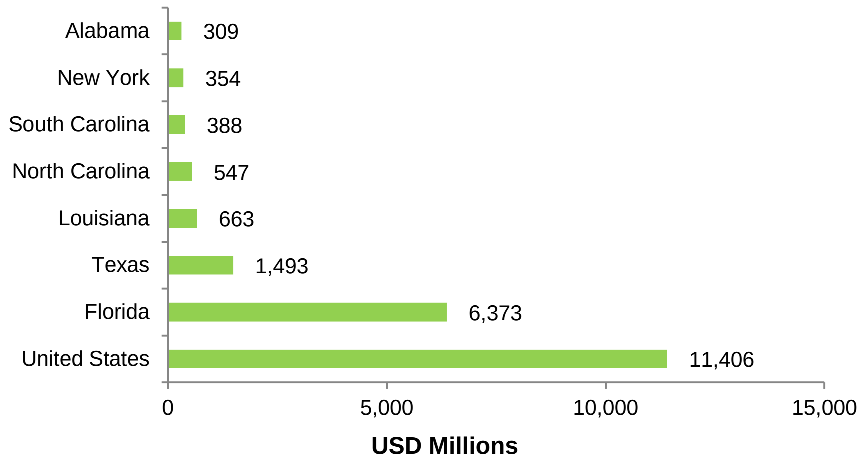


Figure 9. Modeled average annual insured and insurable aggregate losses, standard catalog (USD millions)

Figure 10 shows the average annual insured and insurable aggregate losses for the entire United States and the five most at-risk states under Warm SST conditions.

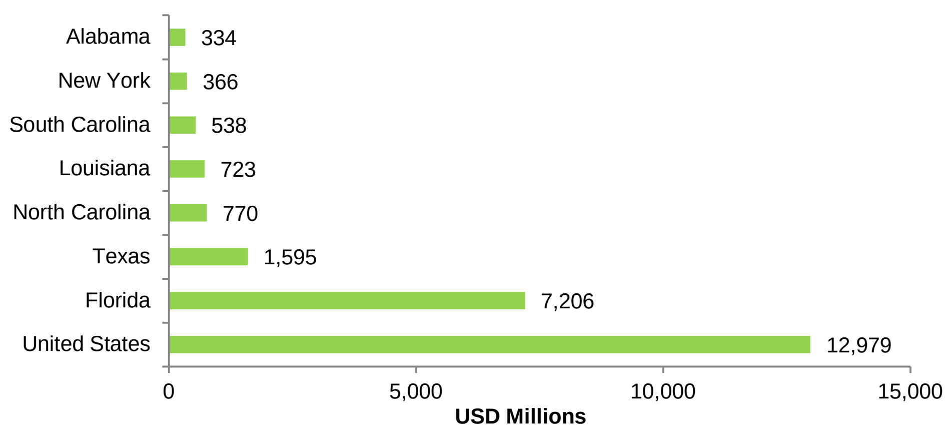


Figure 10. Modeled average annual insured aggregate losses, warm SST catalog (USD millions)

A loss cost map for the wind and storm surge perils combined is shown in Figure 11. The AIR modeled hurricane risk extends far inland from the immediate coast, and even to interior states such as Illinois, Oklahoma, Kentucky, and Ohio.

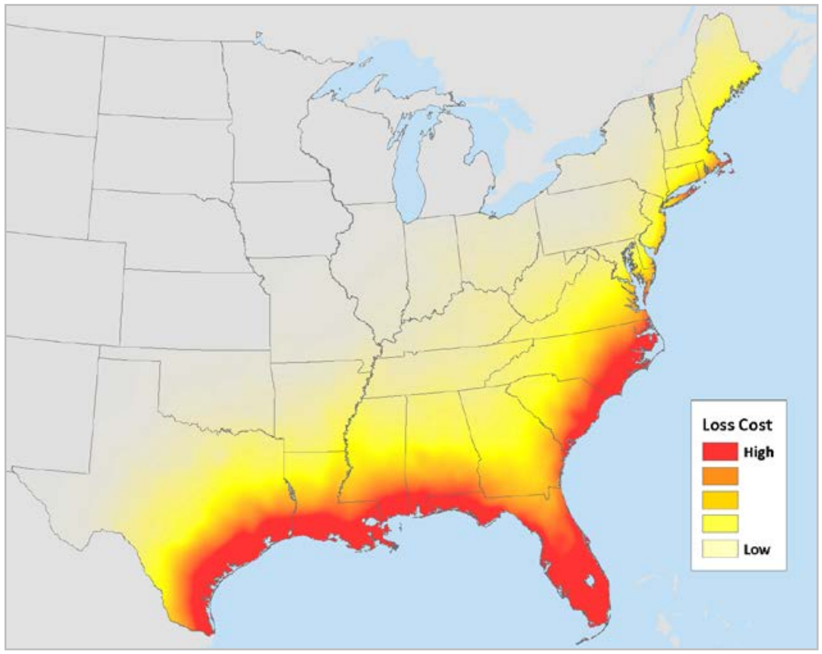


Figure 11. Hurricane risk (loss cost) in the United States

1.9 Modeled Losses for Historical Tropical Cyclones

Table 2 lists the modeled insured and insurable loss estimates for significant historical hurricanes affecting the United States, based on 2011 industry exposures. Note that modeled losses include loss to onshore property and contents, business interruption, and additional living expenses. A comparison between modeled losses for historical events and actual reported losses can be found in Section 6.3. For further details about these historical hurricanes, please refer to Section 2.3. Note that the losses in the table include demand surge.

Table 2. Modeled losses (USD millions) for historical hurricanes – insured and insurable exposures

Year	Event Name	Residential	Mobile Home	Com/Ind	Auto	Total
1900	Galveston, Texas Hurricane	18,992.1	404.5	17,820.9	1,630.0	38,847.6
1926	Miami, Florida Hurricane	49,637.8	1,383.2	69,101.5	5,644.5	125,767,0
1928	Okeechobee, Florida Hurricane	30,271.9	1,559.9	23,980.2	2,384.3	58,196.3
1938	Great New England Hurricane	18,265.1	121.7	14,212.8	715.4	33,315.0
1947	Fort Lauderdale, Florida Hurricane	23,926.9	1,001.0	25,907.6	1,854.5	52,690.0
1960	Hurricane Donna	19,088.0	980.7	13,457.8	989.0	34,515.5
1965	Hurricane Betsy	21,132.8	1,145.9	20,044.2	2,563.5	44,886.4
1992	Hurricane Andrew	28,291.1	314.9	24,647.8	3,447.4	56,701.2
2005	Hurricane Katrina	21,768.8	890.0	19,712.3	2,661.6	45,032.8

1.10 The U.S. Insurance Market

The following information is derived primarily from an AXCO Non-life Property and Casualty Report, which contains information current through 2010-2011, depending on the type of data.

The United States insurance market is the largest in the world, and property and casualty (P&C) premiums totaled approximately USD 480.7 billion in 2011, an increase from USD 455.9 billion in 2010. The United States non-life insurance market has around 2,402 companies, but the top 150 account for approximately 90% of the market.

As of 2010, the largest non-life line of businesses is motor with 41% of the market share, followed by property with 30% of the market share. Exposure to natural perils is the main feature of the United States property insurance. In 2008, overall P&C market premium income declined due to a soft market and increase in natural catastrophe losses from a collection of events, including Hurricane Ike and Gustav. Only in 2011 did rates finally stabilize, and in some cases, even rise.

Insured losses from catastrophic events totaled approximately USD 35.9 billion in 2011, compared to an average of USD 23.8 billion for the period 2000-2010. These high losses are due to the significant number of severe thunderstorms and associated tornados, winter storms, as well as Hurricane Irene, which alone racked in approximately USD 5 billion in losses.

With respect to the hurricane peril, standard homeowner’s policies and most commercial policies include wind coverage. Flood insurance is provided by the National Flood Insurance Program (NFIP), a public program, and there is no plan to privatize it. The risk of insured losses due to hurricanes has increased in recent years due to the ever-increasing insured value of coastal properties. Due to major hurricane losses, insurers are transitioning from imposing a flat-rate deductible for damage to a set percentage, typically 1% of the replacement value. This change is occurring quickly along Gulf and Atlantic coastal areas, where the new norm is for tiered coverage with a percentage-based deductible for hurricane damage, another for other wind, and another deductible for everything else. Coastal counties account for 17% of U.S. land area, but around 53% of the nation’s population resides here.

1.11 Navigating the Document

Figure 12 illustrates the components of the AIR Hurricane Model for the United States. Section 2 provides a brief overview of hurricanes and hurricane risk in the United States. Section 3 details the generation of simulated events that populate the stochastic catalog, and Section 4 describes how wind and storm-surge intensity are modeled at each affected site. Section 5 discusses the model's damage functions for both wind and storm surge, and includes information on estimating damage to industrial facilities. Section 6 provides a discussion of the financial module.

For details on the implementation of the AIR Hurricane Model for the United States in CATRADER, and in CLASIC/2 and Touchstone, please refer to Section 7 and Section 8, respectively. Section 9 offers selected references and Section 10 provides an overview of AIR Worldwide.

Figure 12. Components of the AIR Hurricane Model for the United States

2 Tropical Cyclones in the United States

2.1 Tropical Cyclones: An Overview

There are six essential elements for tropical cyclone formation. First, the sea surface temperature (SST) must be at least 26° C (78.8° F) to a depth of at least 50 meters (164 ft) below the ocean surface. Warm water provides the necessary heat energy for tropical cyclone development. Second, vertical wind shear, which is a measure of how much winds vary by height, is typically weak. A weak wind shear will not interfere with the structure of a tropical cyclone, thus allowing deep, vertical clouds to develop. Warm ocean temperatures and weak wind shear are critical to the formation and intensification of tropical cyclones.

Third, the atmosphere must have some degree of instability for a tropical cyclone to form. That is, air that is forced upward should continue to rise on its own. In a stable atmosphere, air does not rise and therefore water vapor in the air will not condense into cloud droplets and precipitation. Fourth, there must be a high level of relative humidity from the ocean surface up to at least the mid-levels of the atmosphere, allowing deep clouds to form without being diluted by surrounding dry air. Fifth, a developing tropical cyclone has to be far enough away from the equator so that the Coriolis force can impart spin towards the center of the storm's circulation. Finally, even if all of the conditions previously mentioned are met, a tropical cyclone may not develop unless a pre-existing disturbance in the atmosphere triggers its organization. Disturbances of low air pressure periodically arrive in an area and can trigger the formation of tropical depressions and tropical storms, which can evolve into tropical cyclones.

Many tropical cyclones actually begin as tropical disturbances, which can form without the six elements necessary for tropical cyclone development. Tropical disturbances can arise when other weather features, such as fronts or easterly waves, move across tropical ocean waters. The underlying ocean surface provides a source of heat and moisture, thereby destabilizing air and forcing it directly above the disturbance. Cold fronts act like snow plows, lifting warm, moist air out ahead of the front into an unstable environment. Lifting air in an unstable atmosphere allows for the formation of clouds and showers, but without an organized cyclonic circulation at the surface. Multiple tropical disturbances exist in the tropics at any given time.

Storm intensification depends on environmental conditions just as storm genesis does. Depending on the characteristics of the environment into which a tropical disturbance moves, intensification may occur over several hours or several days. A tropical cyclone is named when it reaches tropical storm strength. At this stage, there is a well-defined cyclonic circulation at the surface with maximum sustained winds exceeding 39 mph, with the sea-level pressure at the center of the tropical storm typically lower than 1,000 millibars (mb).

Further intensification into a tropical cyclone with sustained winds greater than 74 mph may occur if the environment permits deep, moist clouds to form an eyewall surrounding the center of circulation. The formation of an eyewall and a cloud-free eye typically indicates that the maturing storm has achieved tropical cyclone intensity. The eyewall is a region of very heavy precipitation, with rainfall rates often exceeding 2 inches per hour. The eye of a tropical cyclone represents a region of relatively calm weather because the air is actually sinking, not rising as in more unstable parts of the storm. As the air sinks, it becomes warmer and less dense, which further reduces the surface pressure in the center of the storm.

Wind speeds are intensified by the difference between the lower-than-normal surface pressure and the higher pressure of the ambient air around the storm. Air at the periphery of the storm responds to the reduced pressure in the storm center. As the air moves inward, it is deflected to the right by the Coriolis force, resulting in an inward cyclonic spiral of air. Air moves counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere. Just like an ice skater pulling in his or her arms, the spiraling winds in a tropical cyclone spin faster as they approach the storm's center. The strongest winds are typically at the edge of the eye, just prior to being forced up within the most intense thunderstorm cells that encompass the eyewall.

Classifying Hurricanes: The Saffir-Simpson Hurricane Wind Scale

Since the early 1970s, hurricane-strength tropical cyclones that form in the Atlantic and the North Pacific east of the International Date Line have been categorized according to the Saffir-Simpson Hurricane Scale. The scale suggests the potential destruction a hurricane could cause when it makes landfall. The chief causes of damage to onshore properties are high winds and storm surge—the wall-like swell of water that accompanies the storm as it moves onshore. In 2010, the National Hurricane Center revised the scale to better suit its immediate purpose of warning people of the expected threat posed by an approaching hurricane. The wind scale was further revised in 2012, to mitigate rounding errors in wind speeds during unit conversions from knots to mph[3]. The Saffir-Simpson

[3] Note that while the AIR model's reporting of tropical cyclones incorporates the 2010 revision, the 2012 revision of the Saffir-Simpson scale is not yet included in the model. However, the 2012 revision does not affect the SS

Hurricane Wind Scale (Table 3) uses sustained wind speed, the single best predictor of potential danger and damage due to wind from a hurricane[4], to place tropical cyclones into five distinct categories of increasing intensity.

Table 3. The Saffir-Simpson Hurricane Wind Scale

Saffir-Simpson Category	Maximum Sustained Wind Speed (mph)	Potential Damage
Category 1	74-95	Minimal
Category 2	96-110	Moderate
Category 3	111-129	Extensive
Category 4	130-156	Extreme
Category 5	Over 157	Catastrophic

"Maximum Sustained Wind Speed" is defined differently by different agencies and countries around the world. The U.S. National Hurricane Center (NHC) defines it as the mean of multiple wind-speed measurements taken over one-minute time periods at a height of ten meters above the ground.

2.2 United States Tropical Cyclone Risk

The Hazard

Approximately 80 tropical cyclones form each year worldwide, of which more than half develop into hurricanes. Figure 13 shows the average annual frequency of tropical cyclone formation in each of the world's ocean basins.[5]

Tropical cyclones are less likely to intensify into hurricanes in the Atlantic basin than the Pacific because waters in the Atlantic tend to be cooler. Also, the Atlantic has no monsoon trough (a low-pressure channel associated with intense rainfall), which is climatologically preferred for tropical cyclone formation.

Category of any storms of the historical catalog, as described by NOAA here: http://www.nhc.noaa.gov/pdf/sshws_2012rev.pdf

[4] Note that other hurricane-related perils such as precipitation-induced flooding and storm surge can pose significant risks even with lower wind speeds.

[5] Averages are based on the following data: for the North Atlantic Ocean, the North Atlantic Storm Database (HURDAT), 1950-2006; for the Southeast Indian and Southwest Pacific Oceans, the Australia Bureau of Meteorology, the Fiji Meteorological Service, and the Meteorological Service of New Zealand, 1955-2008 (the Australia season extends from July of a given year through June of the following year); for the Northwest Pacific Ocean, the Japanese Meteorological Agency (JMA) and the Shanghai Typhoon Institute (STI), 1951-2005; for the Northeast Pacific Ocean, NOAA and the East Pacific Storm Database (HURDAT), 1949-2006; for the Southwest Indian Ocean, the Joint Typhoon Warning Center (JTWC), 1945-2006; for the North Indian Ocean, the India Meteorological Department and JTWC, 1949-2009.

Although some hurricanes that form off the Pacific coast of Mexico turn north and head toward California, they lose intensity as they enter the colder waters of more northern latitudes. There is no record of a hurricane making landfall in California.

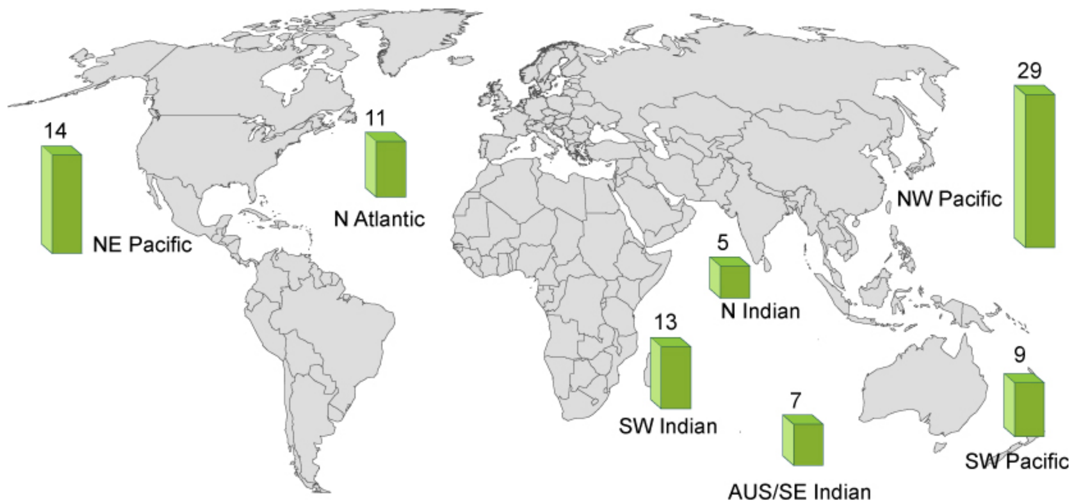


Figure 13. Average number of tropical cyclone worldwide that form annually

The Exposure

Due to topography and population density, hurricanes pose a risk along the Gulf Coast and entire East Coast of the United States, from Texas to Maine. The most at-risk region is the coastline from Texas to North Carolina, which includes the cities of Houston and Galveston, Texas; New Orleans, Louisiana; Tampa, Miami, and Fort Lauderdale, Florida; and Wilmington, North Carolina.

According to the National Hurricane Center, nearly 40% of Category 3 and higher hurricanes that have made landfall in the United States since 1900 have done so in Florida. Of those that made landfall as a Category 4 or higher, 83% have reached either Texas or Florida. The exposure in these areas continues to grow; over the last 50 years, about 25 million people have relocated to these coastal areas, with 15 million moving to the Florida coast.

In Florida, close to 80% of the total insured value is located in coastal counties. In comparison, 38% of the total exposure across the entire Gulf and East Coast states is located in coastal counties, which accounts for 16% of the total value of properties in the United States.

The Northeast is also at considerable risk. AIR estimates that the insured value of properties in the coastal counties of New York alone exceeds USD 2.3 trillion, accounting for 62% of the total insured value statewide. Another USD 770 billion of insured value is located in coastal counties of Massachusetts. Furthermore, it is not only coastal counties that are at risk. Hurricanes at these more northern latitudes tend to be both larger and faster moving, bringing damaging winds far inland.

Since 1900, eleven hurricanes have struck the northeastern United States (New Jersey and coastal states farther north). Scientists studying prehistoric tropical cyclone activity have estimated that the New England coast can expect a Category 3 or higher hurricane to make landfall approximately once every 100 years. Exacerbating the risk in this region is an older building inventory and the lack of stringent building codes for wind resistance, such as those found in Florida.

AIR estimates that property values in coastal areas of the United States have roughly doubled over the last decade, driven primarily by population growth and an increased standard of living. These demographic trends will continue to contribute to rising hurricane losses for insurers.

2.3 Significant Historical United States Hurricanes

Highlighted in this section are ten historical hurricanes that would produce the largest losses of all historical storms since 1900 were they to recur today. These ten are among the historical hurricanes that supplement the model's stochastic catalog. They are: the Galveston, Texas, Hurricane (1900); the Miami, Florida, Hurricane (1926); the Great Okeechobee, Florida, Hurricane (1928); the Great New England Hurricane (1938); the Fort Lauderdale, Florida, Hurricane (1947); Hurricane Donna (1960); Hurricane Betsy (1965); Hurricane Hugo (1989); Hurricane Andrew (1992); Hurricane Katrina (2005); Hurricane Gustav (2008); and Hurricane Ike (2008). Details about each of these storms are provided below.

Galveston Hurricane (1900)

The hurricane that made landfall in Galveston, Texas, on September8, 1900, is the deadliest natural disaster in the history of the United States, with an estimated 8,000 to 12,000 fatalities. The hurricane made landfall with an intensity equivalent to a Category 4 event, with 135 mph winds. The highest wind speed recorded was 150 mph and the lowest central pressure was 936 mb.

The greatest damage stemmed from the 15-foot storm surge that washed over the low-lying harbor , which destroyed over 3,600 homes and wiped out bridges and telegraph lines. On September 12 the storm tracked to New York City, where 65 mph winds were recorded. Before dissipating into the Atlantic, the storm caused over USD 20 million (1900 USD) in damage throughout the United States. AIR estimates that the hurricane in Galveston would cause approximately USD 38.8 billion in insured losses today.

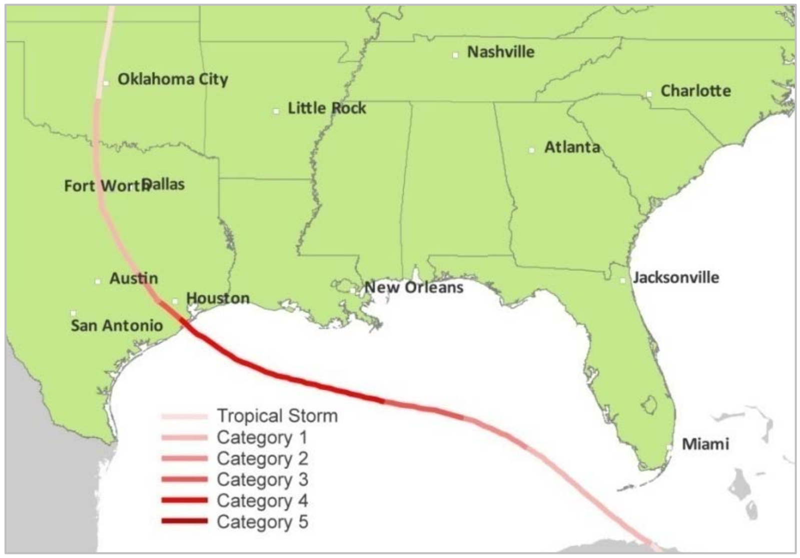


Figure 14. Track of the Galveston Hurricane (1900)

Miami Hurricane (1926)

On September 18, 1926, a hurricane made landfall south of Miami with an intensity equivalent to a Category 4, with winds of 125 mph. The storm generated a storm surge of 15 feet. It devastated Miami and caused extensive damage in the Florida Panhandle, Alabama, and the Bahamas.

The storm had developed near Cape Verde on September 6 and traveled towards St. Kitts and the Bahamas. After making landfall, it crossed Florida, entered the Gulf of Mexico, and made another landfall near Mobile, Alabama, on September 20, as a Category 3. The storm traveled westward over Alabama and Mississippi, eventually dissipating over Louisiana.

Heavy damage from wind, rain, and storm surge were reported along the Florida coast, but the greatest devastation was in Miami. It is estimated that between 25,000 and 50,000 people were left homeless, and nearly 370 people were killed. If this storm were to occur today, AIR estimates that it would cause nearly USD 125.8 billion in insured losses.

Figure 15. Track of the Miami Hurricane (1926)

Great Okeechobee Hurricane (1928)

The Great Okeechobee hurricane remains on record as the second deadliest disaster in U.S. history. It is the first known Atlantic hurricane with an intensity equivalent to a Category 5 and is one of the ten most intense storms known to make landfall in the United States. It is also the only Category 5 storm on record to make landfall in Puerto Rico.

The hurricane was first observed east of Guadalupe on September 10. Two days later it passed over the Leeward Islands causing heavy crop and property damage. The next day it struck Puerto Rico as a Category 5, with winds up to 160 mph. After leaving the Caribbean, the storm moved across the Bahamas as a Category 4 and, on September 16, made landfall in southern Florida with maximum sustained winds near 150 mph and a recorded atmospheric pressure of 929 mb.

Coastal damage in Florida was catastrophic; however, the most extreme destruction occurred inland at Lake Okeechobee. Strong winds generated storm surges that breached the seawall surrounding the lake, and the resulting flood was 20 feet deep in some places and covered hundreds of square miles. The Great Okeechobee Hurricane left thousands homeless and over 4,000 dead. Today, AIR estimates that this hurricane would result in insured losses exceeding USD 58.2 billion.

Figure 16. Track of the Great Okeechobee Hurricane (1928)

The Great New England Hurricane (1938)

Otherwise known as the Long Island Express, this was the first major cyclone to strike the region since 1869. The storm formed off the coast of Africa and developed into what is now known as a Category 5. Navigating through the Atlantic at 70 mph, the storm was able to travel far to the north before weakening over cooler waters. The hurricane made landfall on Long Island, New York, as a Category 3 on September 21. Heavy winds and storm surges resulted in approximately 680 deaths, 700 injuries, and the damage or destruction of 57,000 homes throughout New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, and Vermont.

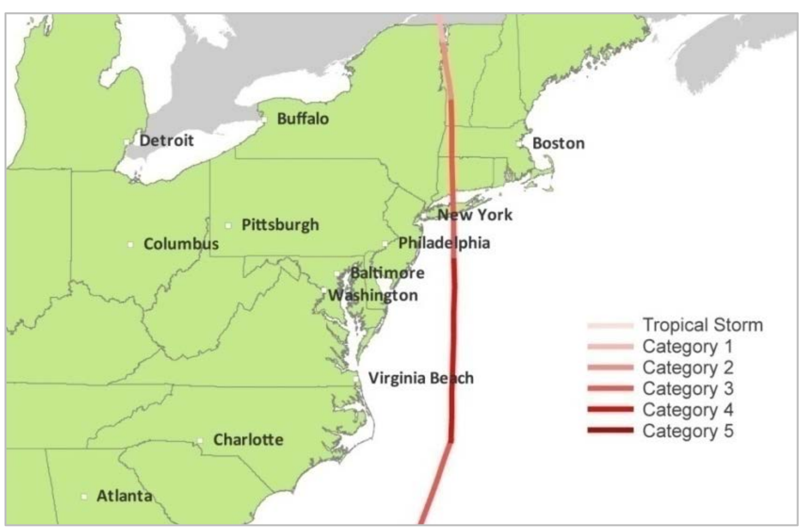


Figure 17. Track of the Great New England Hurricane (1938)

The hurricane destroyed power lines, automobiles, boats, and trees, killed thousands of cattle and chickens, and wiped out half of the region's apple crop. Rainfall and surges submerged communities along the coast in floodwaters that were measured at up to 13 feet high. AIR estimates that were it to strike today, this storm would likely result in insured losses in excess of USD 33.3 billion.

Fort Lauderdale Hurricane (1947)

This intense storm, also known as the Pompano Beach Hurricane, affected the Bahamas, Florida, Louisiana, and Mississippi. It developed east of Cape Verde on September 4, and reached peak winds of 160 mph as it passed over the Bahamas.

Figure 18. Track of the Fort Lauderdale Hurricane (1947)

On September 19, it made landfall near Fort Lauderdale as what would later be rated a Category 4, with wind speeds the highest ever recorded in the state of Florida until Hurricane Andrew in 1992. Eleven-foot storm surges along the coast caused extreme flooding, and records for single-month rainfall were set in some areas.

The hurricane traveled in a northwesterly direction into Louisiana and Mississippi, where storm surges and heavy rains caused extensive crop and property damage. In total, 51 people lost their lives and there was over USD 110 million in damage reported. AIR estimates that the Fort Lauderdale Hurricane would result in insured losses around USD 52.7 billion today.

Hurricane Donna (1960)

Hurricane Donna holds the record for the longest lasting major hurricane in the Atlantic, where it roamed for a total of 17 days. For nine of those days, Donna consistently had sustained wind speeds of at least 115 mph.

Donna formed off the coast of Africa, crossed the Bahamas, and made landfall in Key Marathon, Florida, as a Category 4 on September 10. Gusts up to 180 mph were recorded and 13-foot storm surges destroyed many properties. On September 11, the storm made landfall in southwestern Florida, where 30% of the grapefruit, 10% of the orange and tangerine, and nearly all of the avocado crops were lost.

Figure 19. Track of Hurricane Donna (1960)

The storm continued up the East Coast, landing in North Carolina and then Long Island, New York, on September 12. Hurricane-force winds from Donna affected every state from South Carolina to Maine, and heavy rains caused billions of dollars of damage. A total of 364 people lost their lives during the storm. AIR estimates that insured losses from Hurricane Donna would amount to nearly USD 34.5 billion today.

Hurricane Betsy (1965)

Hurricane Betsy formed east of the Windward Islands and moved northwestward across the Atlantic, at one point making a complete loop. The storm looked to be heading towards the Carolinas, but instead it made a second loop and passed over the Bahamas. Betsy made landfall in Key Largo, Florida, on September 8 as a Category 3 storm. Winds up to 155 mph were recorded as the storm gained intensity while crossing the Gulf of Mexico. On September 9 the storm made landfall in Grand Isle, Louisiana, just west of the mouth of the Mississippi River.

Betsy, which killed approximately 76 people, destroyed nearly every building in Grand Isle and caused extensive flooding of the Mississippi River and nearby lakes. It was the first hurricane to cause over a billion dollars (1965 USD) in damages, thus earning it the nickname "Billion Dollar Betsy." Devastation from the storm included 164,000 flooded homes and the destruction of eight offshore oil platforms. At the time, Betsy was the costliest hurricane to make landfall in the United States. AIR estimates that today this hurricane would cause over USD 44.9 billion in estimated insured losses.

Figure 20. Track of Hurricane Betsy (1965)

Hurricane Hugo (1989)

Hurricane Hugo was a destructive storm that killed between 80 and 100 people and left nearly 56,000 homeless. At the time, Hugo was the costliest hurricane to ever make landfall in the United States. Storm surges from Hugo remain the highest ever recorded on the East Coast.

The hurricane developed off the coast of Africa on September 9 and intensified as it tracked west. The storm reached Category 5 status east of Puerto Rico, where heavy rains washed away roads and nearly completely wiped out banana and coffee crops. Hugo tracked north and made landfall as a Category 4 on September 22 on Isle of Palms, South Carolina. Storm surges nearly 20 feet high piled boats on top of one another and washed out bridges, and intense localized winds damaged homes, forestland, and cotton crops.

Hugo damaged beaches and vegetation as it moved through North Carolina. Although the storm weakened as it progressed through the eastern United States and Canada, high winds in New York State toppled a tree onto a passing motorist. Were Hugo to strike today, AIR estimates that it would cause approximately USD 11.6 billion in insured losses.

Figure 21. Track of Hurricane Hugo (1989)

Hurricane Andrew (1992)

Hurricane Andrew began as a tropical storm off the coast of Africa on August 14. The storm reached peak winds of 170 mph off the Bahamas, but it weakened after striking the islands on August 23. Andrew regained strength as it moved through the warm waters of the Gulf Stream in the Florida Straits, and by the time it hit Homestead, Florida, it was a Category 5 with the fourth lowest central pressure in U.S. landfall records (922 mb).

Winds of 150 mph at landfall and a 17-foot storm surge created massive damage in the region, including agricultural losses of approximately USD 1.04 billion. On August 26, Hurricane Andrew moved into Louisiana, where storm tides, tornadoes, and winds up to 105 mph damaged crops and property. The storm resulted in 23 deaths in the United States and three in the Bahamas.

Figure 22. Track of Hurricane Andrew (1992)

Insurance claims from the storm contributed to the bankruptcy and closure of 11 companies and drained excessive equity from some 30 more. AIR estimates that Hurricane Andrew would result in losses over USD 56.7 billion were it to strike today.

Hurricane Katrina (2005)

Hurricane Katrina formed as a tropical depression over the Bahamas on August 23. It reached the intensity of a Category 1 hurricane only two hours before it made landfall in southern Florida on August 25. The storm weakened over land but quickly regained strength and nearly doubled in size as it crossed the Gulf of Mexico.

On August 29 the storm made landfall in southeastern Louisiana, where it caused massive property damage and severe loss of life. A storm surge led to 53 different levee breaches in greater New Orleans, leaving approximately 80% of the city submerged. A third U.S. landfall occurred at the Louisiana/Mississippi border at Category 3 intensity. Storm surges, high winds, and heavy rains caused billions of dollars of damage (2005 USD); officials estimate that 90% of structures within a half-mile of the affected coastline were destroyed.

The effects of Katrina were widespread as well as devastating. As the hurricane circulated towards the northeast, its outer bands spawned some 62 tornadoes, causing damage in eight states. Wind gusts of tropical storm strength were recorded as far north as Kentucky, and high winds damaged trees in New York State. Significant rainfall occurred in 20 states and in regions of Ontario, Canada. An estimated 1,800 Americans lost their lives from the hurricane.

Hurricane Katrina is currently the costliest and one of the deadliest natural disasters in the history of the United States. It is also one of the strongest hurricanes ever recorded in the Atlantic basin. Katrina remains the worst natural disaster the insurance industry has ever handled; were it to occur today, AIR estimates that the storm would cause USD 45.0 billion in estimated insured losses.

Figure 23. Track of Hurricane Katrina (2005)

Hurricane Ike (2008)

When Hurricane Ike struck the Gulf coast in 2008, it was the third costliest hurricane to ever make landfall in the United States. This event began as a tropical storm, which formed west of the Cape Verde islands on September 1. By September 4, Hurricane Ike was an intense Category 4 storm with 145 mph winds and a central pressure of 935 mbar, the most intense storm of 2008. The hurricane tracked over Turks and Caicos, and Cuba, and made landfall in Galveston, Texas on September 13 as a Category 2 event. At landfall, Hurricane Ike had wind speeds measuring 110 mph and a central pressure of 950 mbar. The storm then tracked to the north-northeast, and on September 14, it interacted with an extratropical system and became a transitioning storm. During this period, Ike underwent a period of re-intensification, and hurricane-force gusts were reported in Ohio and Pennsylvania.

Hurricane Ike left approximately 195 people dead, and caused massive destruction from Louisiana to Texas. Heavy flooding was reported in Louisiana, and high winds knocked over trees and power lines throughout Texas. Widespread flooding resulting from 17- foot-tall storm surge was reported in Galveston, Texas, and some residents in Houston were without power for nearly one month after the storm. Hurricane Ike resulted in the largest evacuation in Texas history, and left millions without power in Louisiana, Texas, Arkansas, Indiana, Ohio, Pennsylvania, and New York. Were it to occur today, AIR estimates that Hurricane Ike would cause nearly USD 12.2 billion in estimated insured losses.

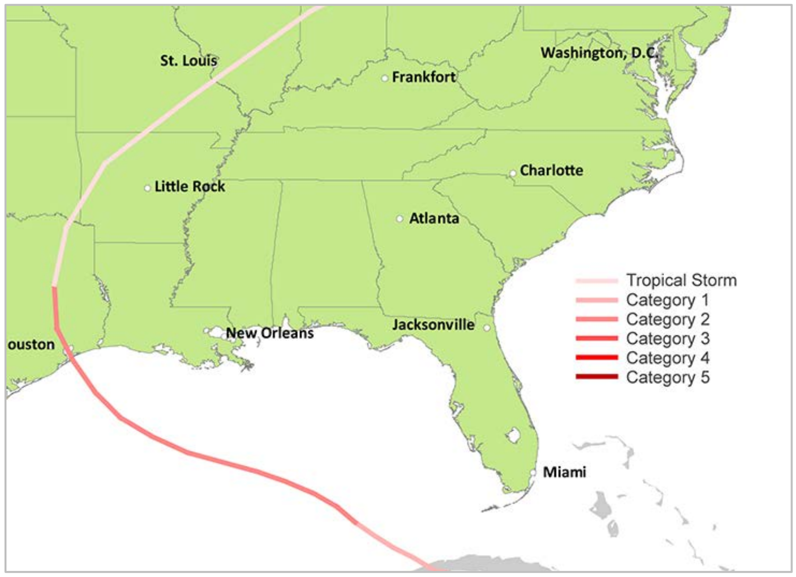


Figure 24. Track of Hurricane Ike (2008)

3 Event Generation

The AIR Hurricane Model for the United States captures the effects of wind and storm surge from landfalling and bypassing hurricanes on properties in Alabama, Arkansas, Connecticut, Delaware, Washington D.C., Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Mississippi, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Virginia, and West Virginia.[6]

AIR develops the model's stochastic catalog from data collected on more than 1,000 tropical cyclones that have formed in the North Atlantic basin since 1900. This information comes in the form of barograph traces from land stations and ships, actual wind records from National Weather Service stations, HURDAT data, aircraft reconnaissance flight data, radar data, and other pressure and wind reports.

The primary sources of data are the North Atlantic Basin Hurricane Database (HURDAT), the National Oceanic and Atmospheric Administration (NOAA), the National Hurricane Center (NHC), Purdue University, the U.S. Army Corps of Engineers, the U.S. Department of Commerce, the National Weather Service (NWS), and the National Climatic Data Center (NCDC). The most important technical documents include:

- NOAA Technical Report NWS 23
- NOAA Technical Report NWS 38
- The National Hurricane Center's Tropical Cyclone Reports
- The American Meteorological Society's Monthly Weather Review

When assessing tropical cyclone risk, the main environmental parameters are wind speed and storm surge. Wind speed intensity is logged as the number of hours with winds above a certain threshold. It is computed based on a storm's intensity, size, location, forward speed, and direction, as well as the underlying terrain and land use in the region. In the AIR Hurricane Model for the United States, storm surge is based upon the hurricane's meteorological parameters, coastal elevation and geometry, tide heights, and bathymetry.

Additional model parameters describing a simulated event are the landfall location, the date and hour of landfall, the radius of maximum winds, the landfall

[6] For details about the AIR Tropical Cyclone Model for Hawaii, please refer to the *AIR Tropical Cyclone Model for Hawaii* document available on www.air-worldwide.com (login required).

intensity (based on central pressure), the storm's track angle at landfall, the storm's forward speed, the gradient wind reduction factor, and the storm's duration.

The AIR Hurricane Model for the United States shares a storm catalog with the AIR Tropical Cyclone Model for the Caribbean, the AIR Tropical Cyclone Model for Mexico, and the AIR U.S. Hurricane Model for Offshore Assets. Please refer to AIR's technical documentation available on the Client Access site for more information about these models (http://www.air-worldwide.com).

3.1 Annual Frequency and Location

The modeled frequency, meteorological, and track data are analyzed in the geographical domain depicted in Figure 25. This basinwide model domain includes the Caribbean, United States, U.S offshore regions, and Mexico.

Figure 25. Domain of the AIR Hurricane Model for the United States

Annual Storm Frequency

As discussed in Section 2.2, approximately eleven hurricanes form in an average year in the North Atlantic. The average number of historical U.S. landfalls per year is 1.88, including multiple landfalls by a single hurricane. The average number of hurricanes making at least one landfall per year in the U.S. is 1.65.

AIR scientists develop probability distributions that govern the annual frequency of occurrence for simulated landfalling U.S. hurricanes based on the historical data. Statistical goodness-of-fit tests reveal that the annual landfall frequency of U.S hurricanes is well represented by a negative binomial distribution. The parameters of this distribution are estimated using historical data for the period between 1900 and 2010.

Note that the modeled variable is the number of hurricane landfalls, not the number of landfalling hurricanes. This is an important distinction since some hurricanes can have more than one landfall as, for example, Hurricane Andrew, which made a first landfall in Florida and a second landfall in Louisiana.

Figure 26 shows the modeled distribution of the annual frequency of hurricane landfalls in the United States.

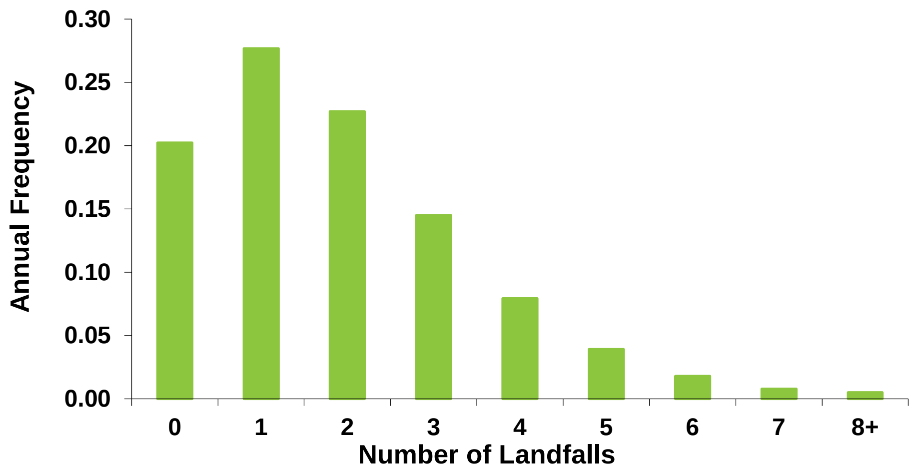


Figure 26. Modeled annual frequency of hurricane landfalls

Please see Section 1.4 for additional information regarding the seasonal and intensity distributions.

Storm Genesis Location and Initial Characteristics

The basinwide catalog is generated by first determining the frequency of storms that appear in each simulated year. For each simulated storm, a corresponding historical event is drawn at random from a record of all Atlantic storms since 1950. All initial storm characteristics such as starting (genesis) location, track angle, forward speed, and initial pressure are determined by stochastically perturbing the corresponding variables for the historical storm drawn. The perturbation is achieved by adding a random deviate drawn from a normal distribution. This process helps ensure that the simulated event characteristics reflect the historical distributions (Figure 27). Future evolution of the stochastic storm is then determined using autoregressive time-series models, as detailed below.

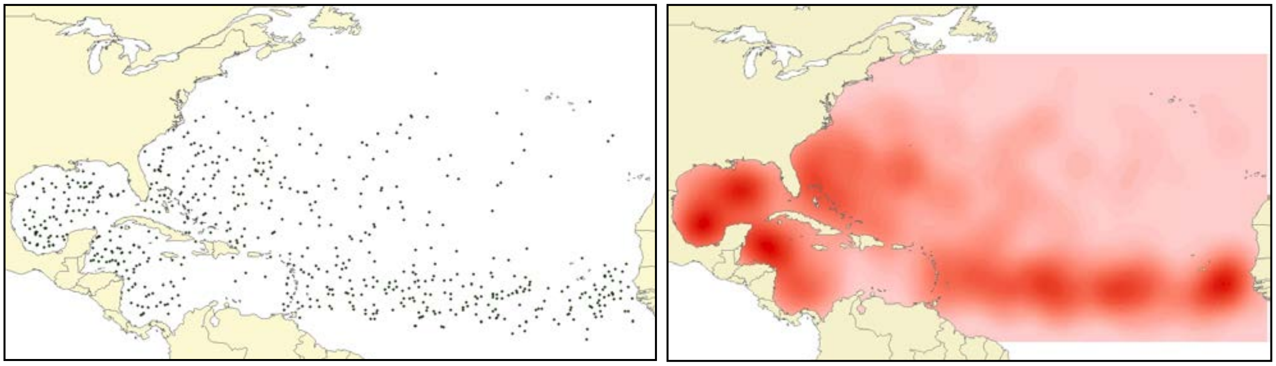


Figure 27. Historical storm genesis locations (left panel) and their smoothed spatial distribution (right panel)

3.2 Storm Tracks

The methodology used to generate basinwide storm tracks is developed using the HURDAT database from 1950-2007. The historical data, reported at successive six-hour time intervals, is used to develop time-series models that describe the track direction, forward speed, and central pressure as the storm moves across the basin. The analysis of the HURDAT data shows that first-order Markov models are appropriate for track direction and forward speed. Autocorrelation that is present in central pressure along the track is represented using a second-order autoregressive time-series model.

Additional information is needed as the storm approaches the U.S. coastline. HURDAT data is available only at six-hour time intervals, and the reported track information rarely corresponds to an exact landfall point. In addition, storm characteristics begin to change once the storm moves over land, so that a report four hours after landfall provides only partial information about circumstances at landfall. A strict linear interpolation is not appropriate. Thus AIR uses the more detailed landfall information available since 1900 in NOAA Technical Reports NWS 23 and NWS 38, and NOAA Technical Memorandum TPC 3 to generate landfall data.

Landfall information, including track angle and forward speed, is also used to generate post-landfall hurricane tracks. The basinwide tracks are integrated with the post-landfall hurricane tracks using a spline smoothing technique that ensures consistency in intensity, radius of maximum winds, and track angle across the tracks. This methodology produces realistic tracks that resemble the historically observed storm tracks across both the Atlantic and the U.S. mainland. However, tracks are fully probabilistic, so any possible storm track is generated, not merely those seen historically.

The model utilizes a 16 x 16 transition matrix for storm motion, which allows storms to move in any direction, including southward, over land. This is explained in some detail in Section 3.2. The model also accurately captures faster storm movement after landfall and extends storm tracks until the storm no longer causes damage.

Again, note that the AIR Hurricane Model for the United States shares a stochastic storm catalog with the AIR Tropical Cyclone Model for the Caribbean, the AIR Tropical Cyclone Model for Mexico, and the AIR U.S. Hurricane Model for Offshore Assets. Please refer to technical documentation available on AIR's website for more information about these models (http://www.air-worldwide.com) (login required).

Landfall Location

In the AIR Hurricane Model for the United States, there are 62 potential landfall segments each representing 50 nautical miles of smoothed shoreline along the Gulf and East Coasts[7], including the Florida Keys. A cumulative distribution of landfall locations within each coastal boundary segment is used to estimate the probability of a hurricane landfall occurring at a point along a segment. Once a segment is chosen, the landfall location is picked from a uniform distribution along that segment; that is, a storm can make landfall anywhere on that segment with equal probability.

The coastline is smoothed for inlets, bays, or other irregularities. The actual number of historical landfalls since 1900 is listed for each of the segments (Figure 28), and that distribution is then smoothed. The smoothing technique maintains areas of high and low risk while accounting for the possibility of future landfalls in segments of the coastline where there have been none historically.

[7] Note that the first three landfall segments are in northern Mexico, and half of the last segment is located in Canada.

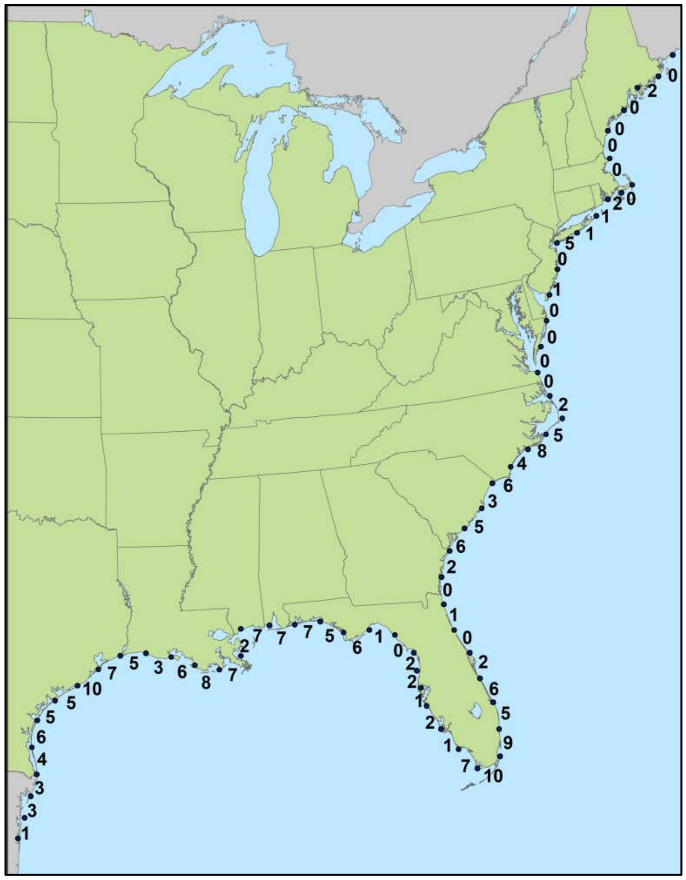


Figure 28. Historical hurricane landfall frequencies by 50-nautical-mile coastal segment, through 2010

The historical distribution is smoothed by setting the number of actual occurrences in each segment equal to the weighted average of seven successive data points centered on that segment. The following averaging formula is employed:

$$F_i = \frac{\sum_{n=-3}^{3} W_n \cdot C_{i+n}}{\sum_{n=-3}^{3} W_n}$$

where

C_i = the number of historical hurricane landfall occurrences for the i^{th} segment

F_i = the smoothed frequency value for the i^{th} segment

W_n = 0.30, 0.22, 0.12, and 0.01, for n = 0, ± 1, ± 2, and ± 3, respectively, as illustrated in Figure 29 below.

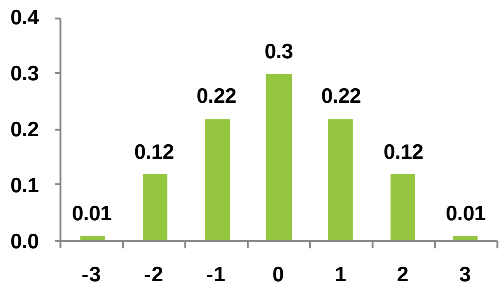


Figure 29. Illustration of W_n

Smoothing is necessary because the relative scarcity of historical data can result in discontinuities between two adjacent 50-nautical-mile segments. For some segments, however, there may be geographic or climatological reasons for the lack of historical storms, and some modification of the smoothing algorithm is therefore necessary. AIR's technique for determining landfall locations ensures consistency with the historical distribution while disallowing a zero relative frequency for any coastline segment.

Storm Track Angle at Landfall

Track angle at landfall is measured clockwise (+) or counterclockwise (–) with "zero" representing due north. Separate distributions are used for different 50-nautical-mile coastal segments to allow for variation in the coastal orientation of each segment. In the historical record, certain coastal segments seem to be characterized by bimodal track angles. To preserve consistency with the historical distribution, the track angle at landfall is modeled using a mixture of two normal distributions. That is, the track angle at landfall is drawn from the first normal distribution with probability p, or it is drawn from the second normal distribution with probability $1-p$. The final distributions are bounded based on the historical record, the coastline orientation, geographical constraints, and meteorological expertise.

Storm Track Propagation

Simulated storm tracks are generated with time series models, which describe the autocorrelation in parameters such as central pressure, Rmax, and forward speed along the storm track, as observed in historical data. Once landfall location and track angle at landfall are identified, the overland storm track is generated using conditional probability distributions. Historical data on more than 1,000 Atlantic storms was collected and analyzed, and this data was used to create conditional probability matrices with 16 directional probabilities. There is a uniform, continuous probability distribution within each of these 16 directional probabilities, each of which is represented by a slice of the pie charts shown in Figure 30, *a, b, c, d*, etc.

The conditional probability matrices determine the probability that a storm heading to location X (lon, lat) in a direction *a* will next be heading in one of the directions *a, b, c, d*, etc. Storm tracks generated in this manner will closely resemble the curving and recurving hurricane tracks actually observed (Figure 30).

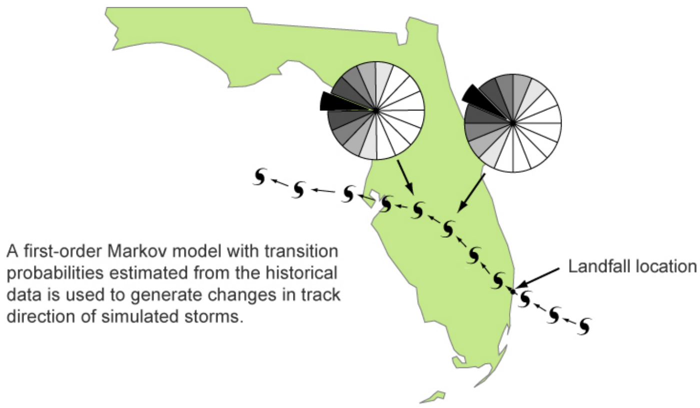


Figure 30. Generation of the model's storm track

Bypassing and Multiple-Landfalling Storms

A single hurricane may produce multiple landfalls or bypasses. Because the AIR Hurricane Model for the United States follows each simulated hurricane from inception until dissipation, multiple landfalls and bypassing hurricanes are included in the simulation. Bypassing hurricanes are defined as those that pass close enough to land to cause damaging winds (≥ 40 mph) onshore, although the center of their eye does not actually cross the coastline. The simulated frequency of these events is consistent with their historical frequency by coastal region.

3.3 Forward Speed

Forward or translational speed is the rate at which a hurricane moves from point to point along its track. In the AIR Hurricane Model for the United States, forward speed at landfall is generated from a lognormal distribution with parameters estimated for each coastal segment. The lower bound on forward speed is three nautical miles per hour, while the upper bound is dependent on latitude. In the AIR model, the wind speeds of fast-moving storms are computed over the course of an hour, rather than the top of the hour, to provide an efficient, accurate wind footprint.

In general, the higher the latitude of a tropical cyclone, the faster the forward speed. There have been observations in the northeastern United States of hurricanes moving at 60 mph. Fast storms result in higher losses further inland, yet they subject buildings to high wind speeds for a shorter duration. The AIR model captures the observed tendency for storms to increase in forward speed as they move inland and reach higher latitudes.

3.4 Central Pressure

The AIR Hurricane Model for the United States utilizes latitude-dependent central pressure as the primary intensity variable. All else being equal, wind speed increases as central pressure decreases. More precisely, wind speed is an increasing function of the difference between the central and peripheral pressures.

The historical data on central pressure are modeled using Weibull distributions where the parameters are estimated for each 100-nautical-mile coastal segment, as well as for larger regional segments. The final distribution is a mixture of the two Weibulls.

The Weibull form was selected based on goodness-of-fit tests with actual historical data, and its appropriateness is documented in the scientific literature. When the Weibull generates a storm that is more intense than what has been observed historically, the central pressure is reset to be no lower than 884 mb[8].

The procedure developed by AIR for modeling central pressure has a number of advantages over other techniques. First, a probability distribution can be derived even if a segment has only a few data points. Second, the modeled distributions can be constrained to change in meteorologically correct ways when moving along the coastline. For example, the probability of an intense storm should decrease when moving north. Upper and lower bounds on the distribution are based on historical experience and meteorological expertise.

Filling Effect

A storm's intensity dissipates as it moves inland. Central pressure rises and the eye of the hurricane begins to "fill" as it moves away from its energy source, the warm ocean water. AIR treats the decay of storms after landfall by applying an exponential filling function to the evolution of the central pressure deficit after landfall. Filling functions are derived based on HURDAT data since 1980.

AIR's modeled overland weakening rates, or filling rates, are a function of time—in particular, of the time elapsed since landfall—as faster moving storms will

[8] 884 mb was the central pressure measured for Hurricane Gilbert in 1988.

cause more damage inland than slower moving storms with the same initial intensity. The filling rates also vary by region, as in general, storms making landfall in Florida are more likely to fill slowly than in other regions, and intensity, as strong storms fill more rapidly than weak storms.

Storm decay in the AIR model is based on a reanalysis of the data in Kaplan and Demaria (1995), Vickery (2005), NWS-38 (1987), and observational data. The model combines 50-nautical-mile segments along the Gulf and East Coasts into four regions: the Gulf of Mexico, the Florida Peninsula, the Southeast, and the Northeast, and two intensity bins, Category 1 and 2 and Category 3, 4, and 5. Smoothing algorithms are used for the transition between adjacent regions.

The functional form of the pressure deficit decay function is:

$\Delta P_t = P_p - P_{eye\text{-}lf}(1 + LF_{offset} * T^{c1} * \exp(-C_2 * T))$

Where

ΔP_t = Pressure deficit at a given time after landfall

P_p = Atmospheric pressure at periphery of storm

$P_{eye\text{-}lf}$ = Central pressure of storm at landfall

LF_{offset} = Initial reduction of pressure deficit at landfall

T = time after landfall (hours)

c_1 = time shaping constant

C_2 = exponential decay rate constant

Reintensification after Landfall

Storms can reintensify after landfall. The remnants of Hurricane Ike (2008), for example, combined with an existing extratropical cyclone and reintensified over the Midwest, producing heavy rainfall and high winds. In addition, approximately 5-10% of all storms experience reintensification after extratropical transition. Typically, reintensification observed in HURDAT occurs 12-16 hours after landfall in the mid-latitude regions.

Simulated storms in the AIR model are also allowed to reintensify; the representation of such storms in the stochastic catalog is in proportion to their numbers in the historical catalog. Note that the central pressure of a storm that has reintensified over land cannot be less than the central pressure measured at landfall (Arndt et al., 2009, Bosart et al., 1995, and Hart et al., 2001).

3.5 Radius of Maximum Winds

The radius of maximum winds, Rmax, is the radial distance from the storm's center, or eye, to the radius where the highest cyclonic wind speeds occur. Rmax tends to be larger at latitudes farther from the equator and smaller for more intense storms.

The methodology used to estimate Rmax incorporates the correlation between Rmax, central pressure, and latitude. The procedure uses a regression model that relates the mean value of Rmax to the central pressure and latitude:

$Rmax = f(Cp, latitude) + \varepsilon$

where

f(Cp, latitude) is the mean Rmax for given values of central pressure and latitude and ε is a normally distributed error term. The parameters in this regression model are estimated based on historical data from NOAA Technical Report NWS-38 and the DeMaria Extended Best Track Dataset (EBTRK). The final distribution is truncated using limits that depend on central pressure and are consistent with the range of historically observed values. Note that Rmax is allowed to vary after landfall.

Note, too, that the modeled Rmax varies with height. This reflects research findings that show that hurricanes' eye walls are funnel-shaped (Figure 31). The more slanted the eyewall is, the greater the difference will be between the location of the maximum wind aloft and the location of the maximum winds at the surface. In some cases, this difference can be as much as 10-15 miles, which can make a significant difference in terms of damage and loss estimation. Further details about the transfer of winds aloft to the surface are provided in Section 4.1.

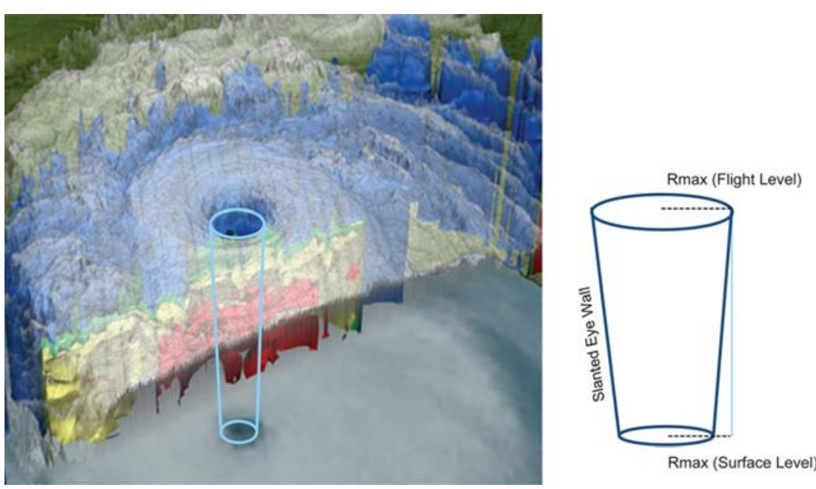


Figure 31. Variation of Rmax with height

3.6 Peak Storm Surge Height

The storm surge module is a fully probabilistic component of the AIR Hurricane Model for the United States. Storm surge is the rise in sea level that accompanies a low-pressure weather system, such as a hurricane. Virtually every hurricane is accompanied by storm surge of some magnitude, and extreme storm surges are capable of causing catastrophic property damage. They are also deadly; according to the Federal Emergency Management Agency (FEMA), nine out of ten hurricane fatalities in the United States can be attributed to the effects of storm surge.

In the AIR model, the peak surge height along the coastline is a function of storm intensity (central pressure), storm size (Rmax), and location along the coast relative to the storm's center and Rmax. The greater the difference between central and peripheral pressure, the higher are hurricane-force winds, which act to force water onshore. In addition, low barometric pressure relative to standard sea-level barometric pressure raises the sea-surface level. This increase in sea-surface level forms as a dome beneath the hurricane and travels with the hurricane.

Figure 32 shows an example of the peak surge height and exponential decay profile associated with a simulated storm having a central pressure of 953 mb and an Rmax of 30 miles. Note the asymmetry around the storm center, which reflects the asymmetric nature of hurricane wind fields, as explained below.

The along-coast surge height profile, as illustrated in Figure 32, is an exponential function, peaking at the coastal location that experiences the maximum wind speed and, from there, tailing to zero beyond a multiple of Rmax. The storm surge profile implemented in the AIR model has been validated with observations from several historical storms. The storm surge profile is then modified to account for forward speed, track angle at landfall, bathymetry, astronomical tide and bay amplification.

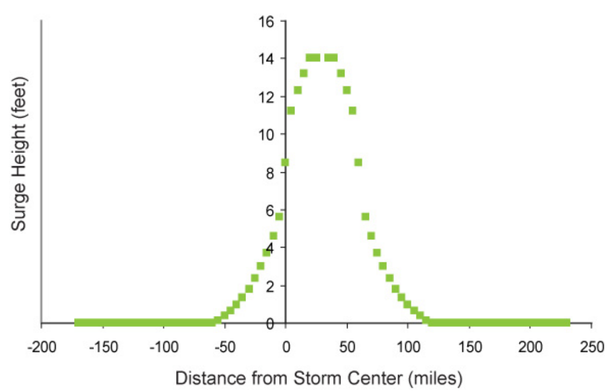


Figure 32. Surge profile for sample storm with central pressure of 953 mb and Rmax of 30 miles

Forward Speed and Storm Surge

Storm surge is not only caused by low barometric pressure in the eye, but also by winds pushing the ocean's surface ahead of the storm. In the Northern Hemisphere, hurricane winds rotate in a counterclockwise direction. The combined effects of hurricane winds and forward motion will produce higher wind speeds and thus higher storm surge on the right side of the storm. The faster the forward speed of the storm, the more pronounced this effect will be.

Track Angle at Landfall and Storm Surge

Hurricanes that make landfall perpendicular to the coastline, sometimes termed "coast-normal," cause greater levels of surge inland than hurricanes that make landfall at more oblique angles or skirt along the coast. Again, following the asymmetry of the hurricane wind field, storm surge is higher on the right of the storm track. A coast-normal track brings this enormous volume of water onshore. The East-Coast-parallel track exposes the coast to the weaker side of the storm system and the effects of storm surge are thus substantially diminished.

Bathymetry

Another factor that significantly affects the potential for destructive storm surge is the depth of the ocean at any particular location along the coast. In general, shallow water enhances surge height, a phenomenon sometimes referred to as the shoaling effect. Thus regions that have a broad, shallow continental shelf offshore have higher shoaling factors in the AIR model.

Water depth is obtained from high-resolution bathymetric maps, such as that shown in Figure 33.

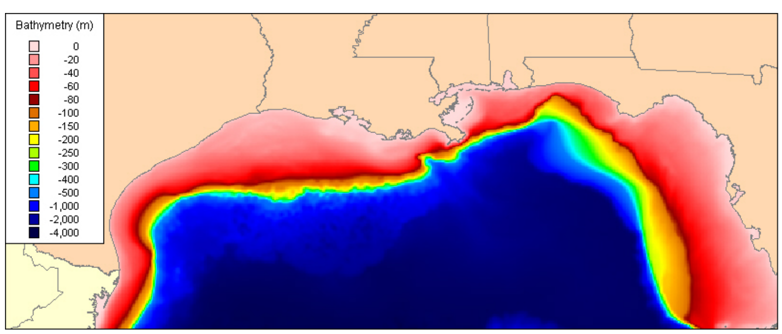


Figure 33. Bathymetry of the Gulf of Mexico

Tide Height

The total sea-surface elevation is an additive function of the surge generated by the hurricane and the height of the astronomical tide. The higher the tide, the greater is the sea-level elevation. This is one reason why some relatively minor hurricanes have nevertheless been accompanied by high storm surge. Tide height is determined probabilistically in the AIR model.

Bay Amplification Factor

The orientation (relative to hurricane track angle) and bathymetry of bays and estuaries can amplify the impact of storm surge. Specifically, the wave heights may be amplified because a larger volume of water is forced into a smaller area, as illustrated in Figure 34.

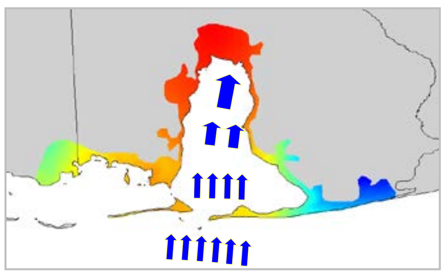


Figure 34. Amplification of surge heights in bays and estuaries

The amplification factor is a function of the bathymetry of the bay, its orientation relative to the dominant hurricane track angle, and its location relative to the track. That is, following the asymmetry of the hurricane wind field, the amplification factor is larger when the bay lies to the right of the storm track and smaller when it is to the left.

The bay amplification factors were derived from an analysis of output from NOAA's SLOSH (Sea, Lake, and Overland Surges from Hurricanes) model for various bays along the U.S. coastline. Ultimately, amplification factors were introduced in the eight bays that were observed to experience the most significant increases in storm surge: Corpus Christi Bay, Texas; Galveston Bay, Texas; Mobile Bay, Alabama; Tampa Bay, Florida; Delaware Bay; New York Bay; Narragansett Bay, Rhode Island; and Buzzards Bay, Massachusetts.

The bay factors have been implemented in the model by positioning the maximum amplification factor for a given bay at the coastal location that has been observed to experience the maximum storm surge height in numerous SLOSH simulations. In the implementation, this location is treated as the center point of a circle. From this maximum amplification at the center of the circle, the bay factor experiences linear decay in all radial directions towards the outer circumference of the circle.

Figure 35 illustrates the bay amplification factor implementation for Galveston Bay, where the maximum amplification factor is 1.6 as seen at the center point, which then decays to a value of 1.0 at the edge of the amplification area.

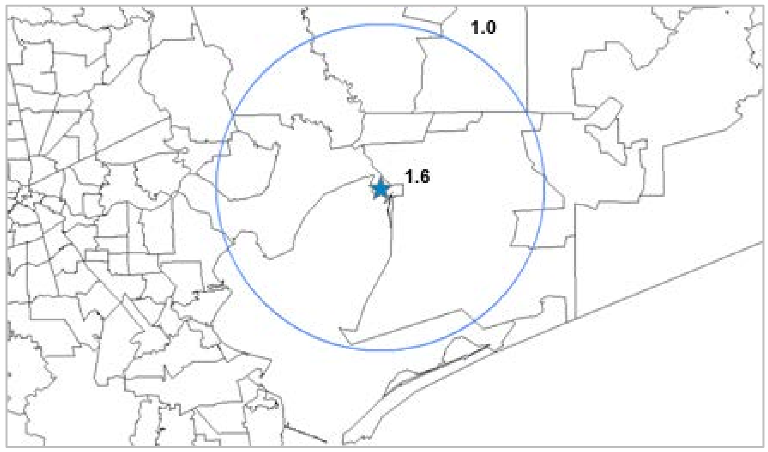


Figure 35. Amplification factor and extent for Galveston Bay

3.7 Stochastic Catalog Summary Statistics

The AIR 10,000-year standard catalog contains 50,011 simulated tropical cyclones, 19,067 of which impact the United States. Of the storms that affect the U.S., 17,084 make landfall while 1,983 bypass the mainland but cause damage to onshore properties. The maximum number of landfalls in a single simulated year is thirteen, including multiple landfalls by a single storm.

3.8 Validating Stochastic Event Generation

AIR catastrophe models are extensively validated. Every component of the model is carefully verified against data obtained from historical events. This section provides a few exhibits illustrating the results of this validation as it pertains to generating the simulated hurricanes that comprise the stochastic catalog.

Validating Frequency

The annual frequency of hurricane landfalls is represented by a negative binomial distribution. Figure 36 shows the historical data from 1900-2010, along with the modeled distribution.

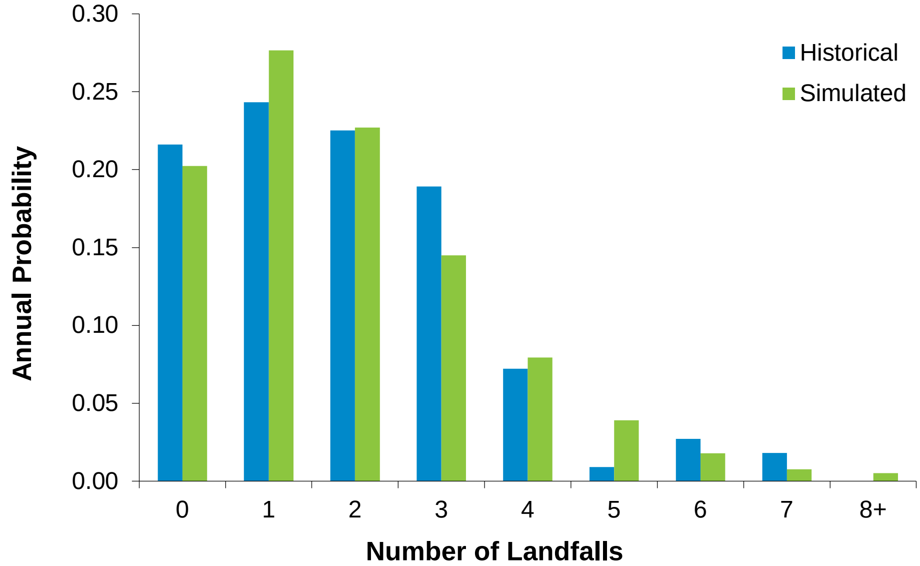


Figure 36. Historical (1900 – 2010) and simulated annual landfall frequency

To determine whether the stochastic catalog's simulated events exhibit appropriate seasonality, the frequency of events in the standard stochastic catalog is compared to the frequency of historical events (obtained from the HURDAT database, 1900-2008), by month, as shown in Figure 37. Note the good agreement between the historical and simulated frequencies.

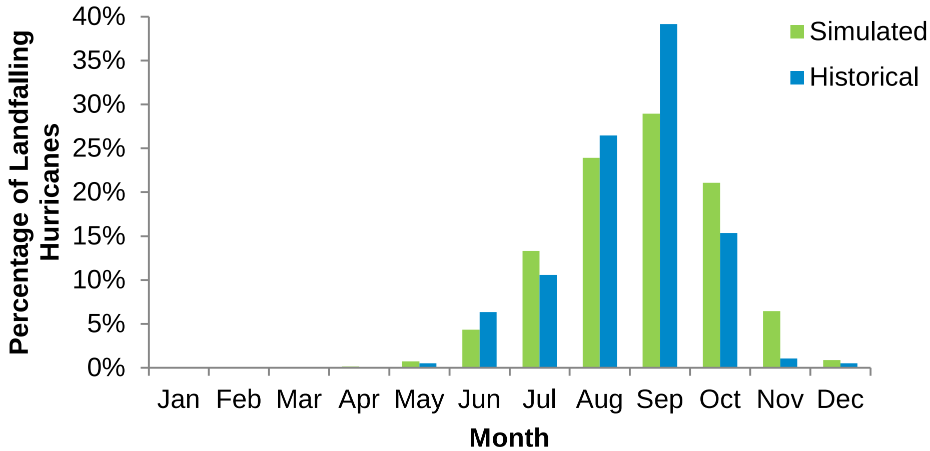


Figure 37. Historical and simulated tropical cyclone frequencies by month, HURDAT 1900-2008

To verify that the model is distributing tropical cyclone risk along the coastline appropriately, comparisons are made between historical and simulated frequencies by 100-nautical-mile coastal segment, which are illustrated for reference in Figure 38.

Figure 38. Modeled 100-Nautical-Mile Coastal Segments

Figure 39 shows the comparison, for each of the segments shown in Figure 38, between modeled and historical landfall frequency.

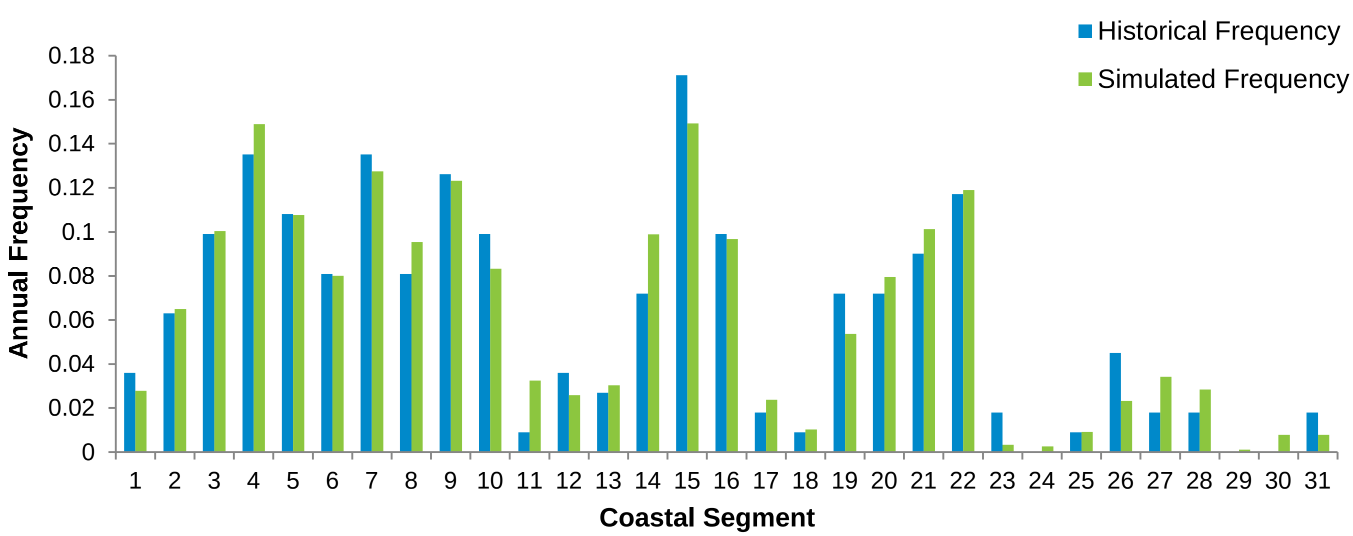


Figure 39. Historical and simulated tropical cyclone landfalls by 100-nautical-mile coastal segment

Validating Storm Tracks

Figure 40 shows both simulated and historical storm tracks in the Atlantic basin for a sample 25-year period. The simulated tracks appropriately capture the tendency for actual storms to move first to the west and then to the north-northeast.

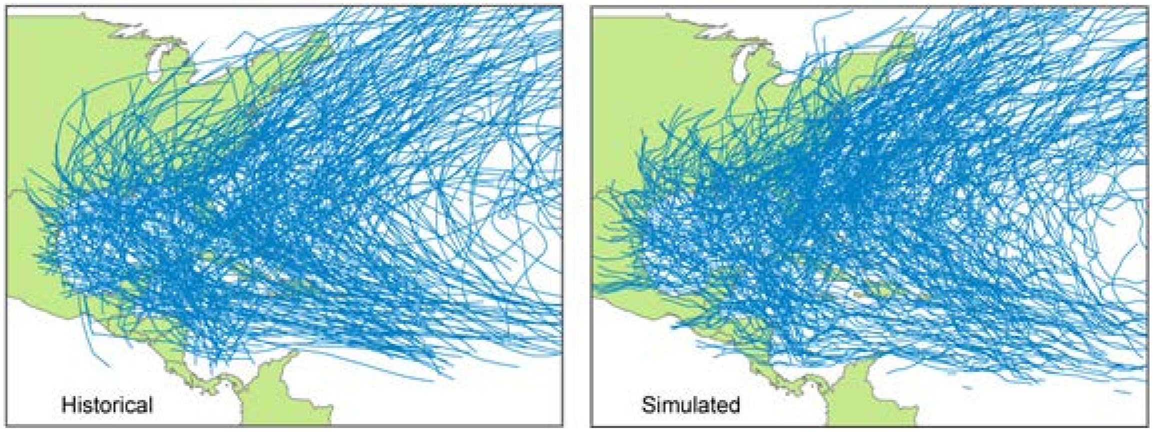


Figure 40. Historical and simulated storm tracks for a sample 25-year period

Validating Meteorological Parameters at Landfall

Figure 41 shows a comparison of historical and simulated storm intensities at landfall, with intensity based on central pressure. The two distributions are reasonably consistent, with the sparsity of the historical catalog accounting for possible discrepancies.

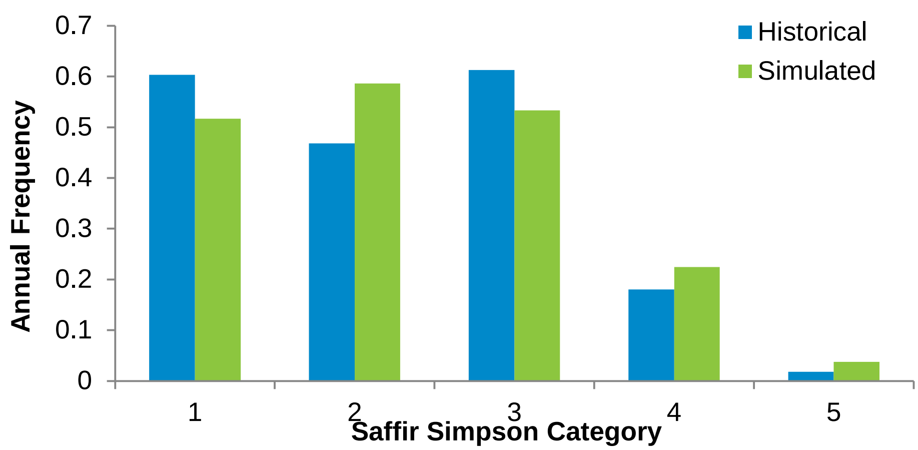


Figure 41. Historical and simulated intensities at landfall

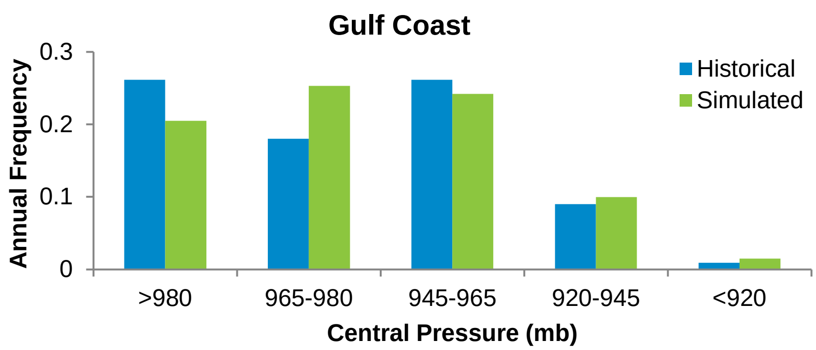
A comparison between the observed and modeled average landfall values of central pressure, radius of maximum winds, and forward speed is provided in Table 4. The agreement between historical and simulated values is quite good.

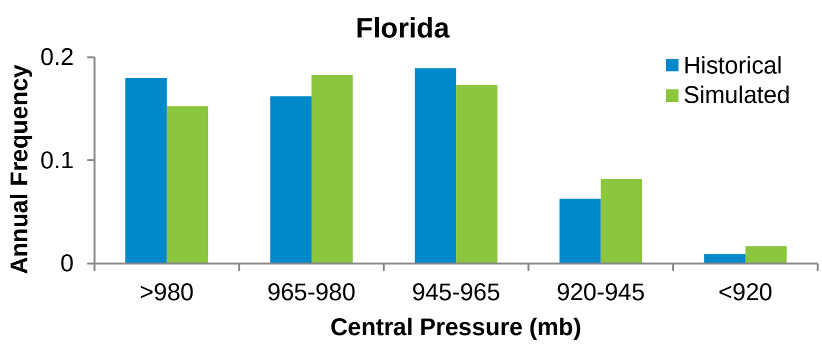
Table 4. Historical vs. Simulated Values at Landfall

Model Variable	Average of Historical Hurricanes, 1900-2008	Average of 10,000 Model Simulations
Central Pressure	967	966
Radius of Maximum Winds	28	27
Forward Speed	15	15

Validating Frequency by Intensity

AIR researchers also validate the distribution of simulated events by intensity. Figure 42 compares the observed and modeled relative annualized frequencies of hurricanes with different central pressures at landfall for four regions of the U.S. coastline[9].





[9] The Gulf Coast includes segments 1-17, Florida includes segments 18-36, the Southeast includes segments 37-49, and the northeast includes segments 50-62.

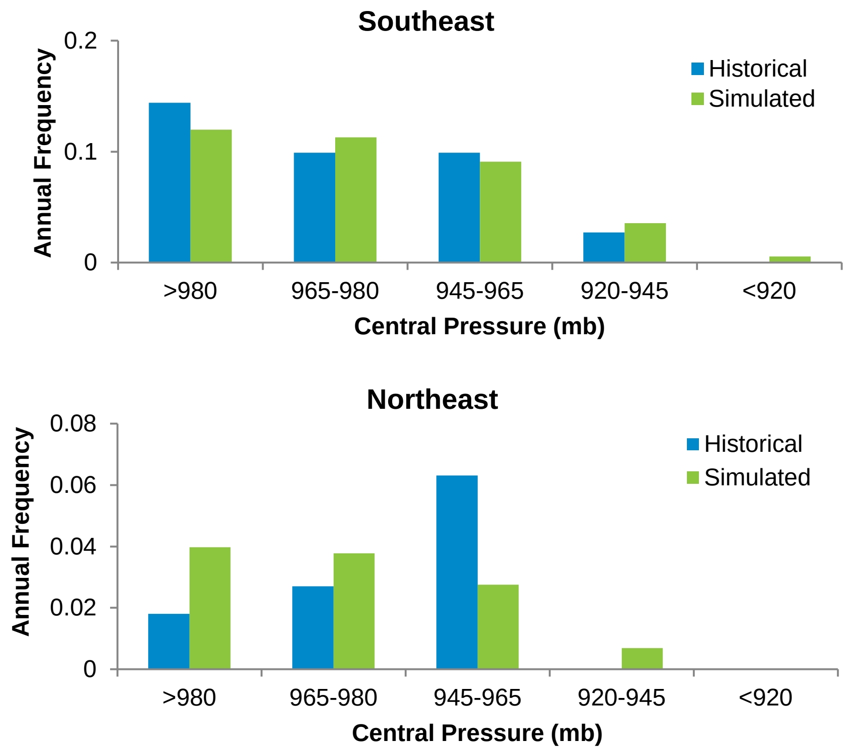


Figure 42. Actual and simulated relative annualized frequencies of central pressures at landfall for four different regions of the U.S. coastline

A critical part of the model development process is to ensure that the model appropriately captures the entire spectrum of potential catastrophe experience, including the most extreme—but still plausible—events that may not be represented in the historical record. Where historical data do not exist, AIR scientists validate the probability of occurrence of the most extreme events by relying on the reasonability and robustness of the science.

For example, modelers must determine the appropriate representation in the stochastic catalog of Saffir-Simpson Category 5 hurricanes in the northeastern United States. Since 1900, the lowest observed central pressure for hurricanes making landfall north of New Jersey was 946 mb, which was the Great New England Hurricane of 1938. Recorded wind speeds at landfall were 120 mph, making the 1938 storm a Category 3. As measured by central pressure, the storm was a borderline Category 3-4. (However, it should be noted that there is limited wind data for this event, most of which consists of wind-gust estimates. This event is likely to be recategorized when HURDAT data is reanalyzed.)

However, the reliable historical record is short; in extending it through stochastic simulation, the question arises whether to include Category 5 hurricanes in the

Northeast. AIR meteorologists used a physics-based intensity model to investigate the upper limits of hurricane strength in the Northeast. The model was used to generate "what if" scenarios by perturbing characteristics of historical storms. For example, historical storms were modified to spend more time over warmer water further south, thereby allowing them to further intensify, but then made to speed up so that they would spend less time before landfall over the colder waters off the Northeast coast. Other "what if" scenarios involved warming the waters off the Northeast coast to the warmest ever observed. The net result of these experiments showed that the probability of a Category 5 hurricane was sufficiently close to zero to warrant their exclusion from the catalog for this region.

Validating Filling Rates

Figure 43 shows observed filling rates for 10 historical hurricanes from the 2004 and 2005 seasons (indicated by the colored dotted lines), including Hurricane Katrina's two landfalls in Florida and Louisiana. On the vertical axis of the graph in Figure 43 is the ratio of the observed central pressure as the storms moved inland and the observed central pressure at landfall. The observations consist of intensity information from HURDAT, supplemented with landfall data from the NOAA Technical Memorandum NWS TPC-5.

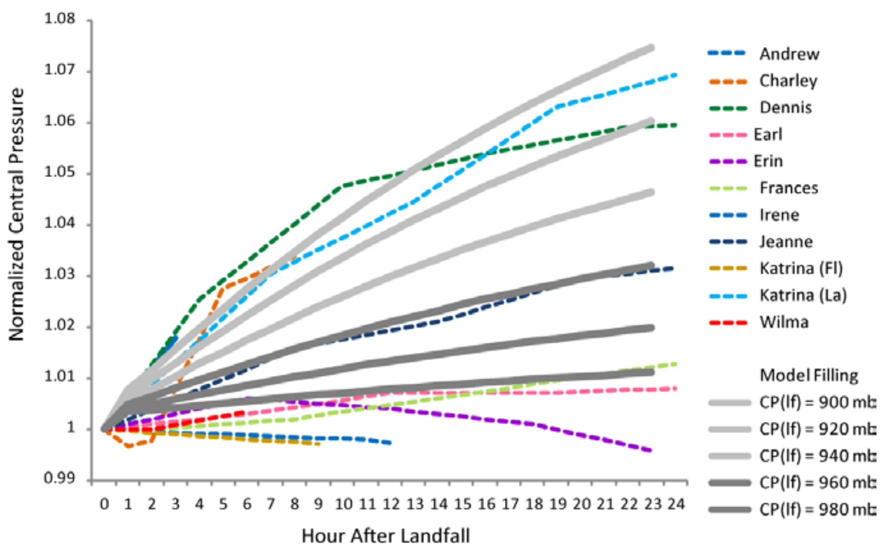


Figure 43. Modeled and historical filling as a function of hour after landfall for several hurricanes

Also shown are the filling equations implemented in the AIR model for the Florida region for a range of storm intensities at landfall. As described in the section on filling above, for each of four regions the model employs two functional forms, one for weaker storms (Categories 1 and 2, as shown in dark gray) and one for major hurricanes (Categories 3, 4, and 5 as shown in light gray).

The inland decay of model-generated winds is consistent with that of observed winds.

4 Local Intensity Calculation

Damage to onshore properties is caused by wind and storm surge. Specifically, the measures of intensity used in the AIR Hurricane Model for the United States are:

- 1-minute sustained winds at 10 meters above the ground
- Water height (from storm surge) in feet

Their derivation and implementation in the model are described in the sections below.

4.1 Local Wind Intensity

Wind speed describes a storm's intensity and indicates how damaging a storm is likely to be. The measure of wind intensity used in the model is the 1-minute sustained wind at 10 meters above ground level. The model first computes the maximum winds at upper levels and then translates these winds to the surface (defined as 10 meters above the ground) via a conversion factor called the gradient wind reduction factor (GWRF).

The wind intensity used in the AIR Hurricane Model for the United States is as follows:

$V_{1min,10m}$ = [Vmax * GF * GWRF * Radial Decay + FwdAdj] *FF

where

Vmax = the upper-level wind at Rmax expressed as a function of central pressure (P_o), peripheral pressure as a function of latitude (P_w), radius of maximum winds (Rmax), and latitude.

GF = the gust factor expressed as a function of the effective roughness length (Z_0) and the averaging time, which translates a 10-minute average wind speed to a 1-minute average wind speed.

GWRF = the gradient wind reduction factor, which translates upper-level wind speeds to surface wind speeds. This is a function of the distance from the eye (r) and the peak weighting factor.

FwdAdj = the forward speed adjustment, which is a function of forward speed and the angle between the direction the storm is moving in and the direction of the wind.

FF = the friction factor expressed as a function of the effective roughness length (Z_0), which takes into account the frictional effects of the surface over which the storm is moving.

The GWRF is a stochastic variable, with an adjustment applied to account for observed differences in the factor as a function of radius from the eye. In general, the dense convection surrounding the eye enables the efficient transfer of winds aloft to the surface. Further from the eye, this efficiency is reduced, and thus so is the GWRF.

The mean GWRF value, the distribution about the mean, and the radial profile are based on dropsonde data from 2002-2005 and the work of Powell et al. (2009) and Franklin et al. (2003). For comparison, Figure 44 below shows the mean GWRF as calculated by AIR, along with data from Powell et al. (2009).

The GWRF is not only variable within a storm; it also differs from storm to storm, is independent of storm intensity, and is dependent on the distance from the eye and the Peak Weighting Factor (PWF) associated with the storm. The PWF, a parameter used to reflect the vertical slant in a hurricane eye as discussed in Section 3.5, was derived from Powell et al. (2009). The GWRF and the PWF are generated jointly from a bounded bivariate normal distribution.

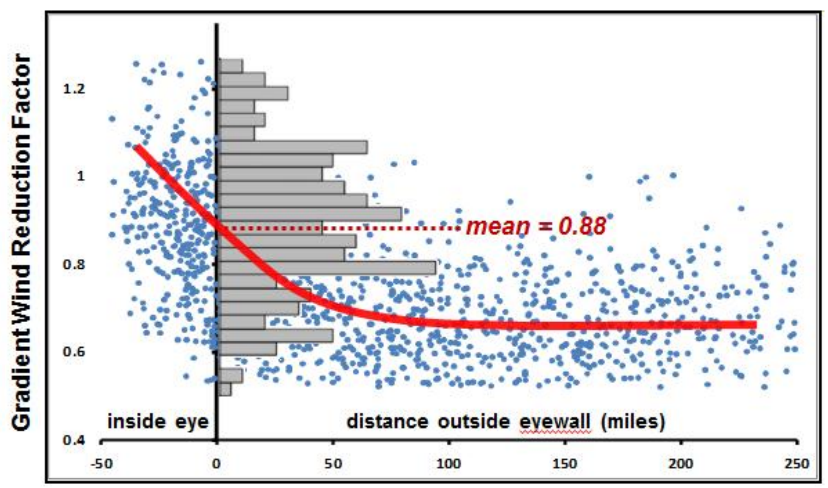


Figure 44. Mean gradient wind reduction factor calculated by AIR (red line) and corresponding GWRF from Powell et al. 2009 (gray bars)

To determine the wind speed at a specific location on the Earth's surface, the maximum wind speed for a storm must first be evaluated at the eyewall, and then a radial profile is used to evaluate how much the wind speed decreases depending on the location with respect to the eyewall. The model's local wind field radial profile is based on the formulation introduced by Willoughby et al. (2006) and depends on Rmax, Vmax, latitude, and distance from the eye. Wind speed increases as a power of the radius inside the eye and decays exponentially with increasing radius outside the eye, following a smooth transition between the two regions (Figure 45). The wind direction at a given location away from the storm's center is included in the asymmetry term, which is proportional to the forward speed of the storm and the cosine of the angle between the wind direction and the storm's forward direction.

Generation of the local wind field involves modulating the gradient wind for frictional and gustiness effects. It also accounts for how these effects are altered by wind direction and fetch (the distance over which a wind of nearly constant direction has blown). For example, wind blowing across a rough surface will behave differently if it has arrived from over water than it will if it has arrived from over an equally rough surface.

Note that after landfall, storm intensity diminishes, and the eye of the storm fills as the barometric pressure increases. Storm filling will be discussed in greater detail below.

As mentioned previously, conversion of 10-minute averaged wind speeds to one-minute sustained winds is based on accepted engineering relationships, including Simiu and Scanlan (1996) and Cook (1985). The conversion factor varies from 1.12 to 1.26, depending on land use/land cover data.

Aspects of the model's wind-field generation process are discussed in greater detail in the subsections below.

Relative Wind Speeds

The wind speed at any particular location is dependent on Rmax, the distance between the eye of the storm and the location of interest, and the Gradient Wind Reduction Factor and Peak Weighting Factor. The AIR model's wind speed profile was developed based on the radial variation of wind speed described in Willoughby et al. (2006).

The radial wind profile is based on historical observations, using reconnaissance data from 493 hurricanes in the Atlantic and eastern Pacific basins from 1977 to 2000. The profile is defined by three equations: one for the area inside the eyewall, one for the eyewall region, and one for the area outside of the eyewall. Figure 45 illustrates the wind profile for an "average" storm.

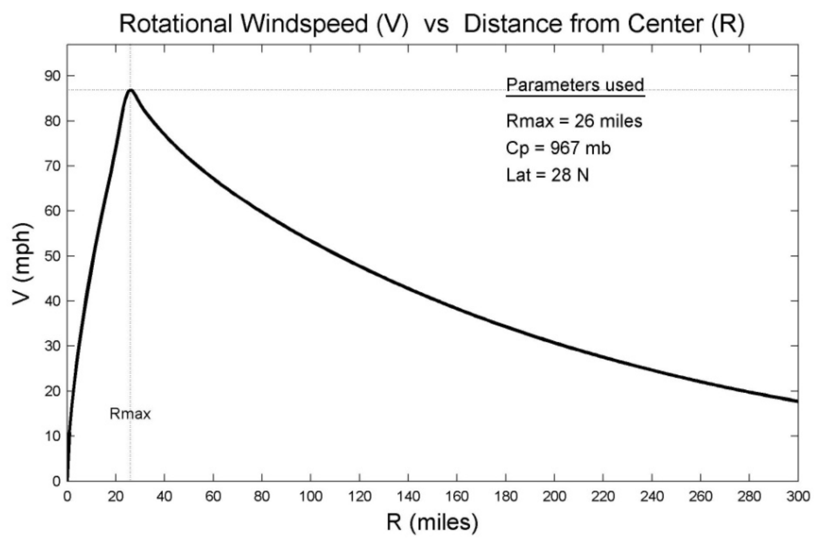


Figure 45. Symmetric gradient wind profile

Asymmetry Effect

In the Northern Hemisphere, hurricane winds rotate in a counterclockwise direction. The combined effects of hurricane winds and forward motion produce higher wind speeds (and higher storm surge) on the right side of the storm, as viewed facing the storm's forward direction. The model accounts for the dynamic interaction of forward (translational) and rotational speeds, as well as the inflow angle.

Surface Friction Effects on Wind Speeds

Differences in surface terrain also affect wind speeds on a smaller scale. Wind velocity profiles (Figure 46) typically show higher wind speeds at higher elevations. At ground level, horizontal drag forces induced by surface roughness are exerted on the wind flow, causing retardation of the wind near the ground. The addition of obstacles such as buildings further reduces wind speed.

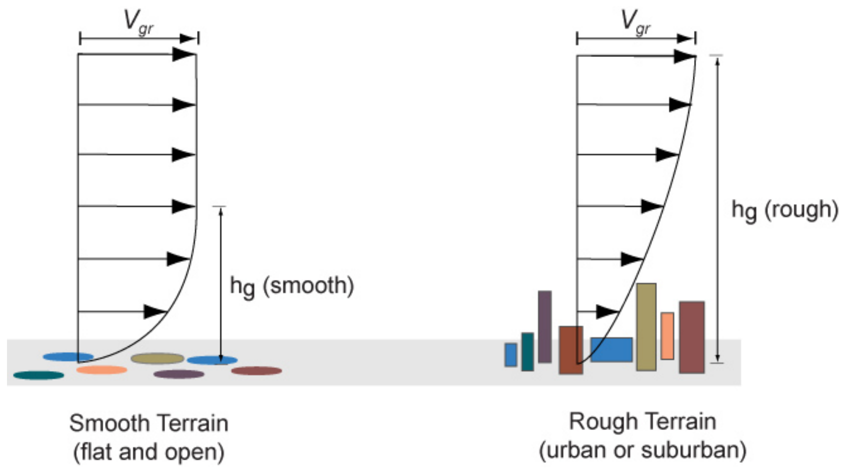


Figure 46. Terrain effects on wind-velocity profiles (adapted from Cook, 1985)

AIR applies a friction coefficient at each location of interest to reflect estimates of surface roughness derived from digital land use/land cover (LULC) data available from the U.S. Geological Survey (USGS). The model uses the 2001 USGS National Land Cover Dataset (NLCD), a digital, satellite-derived database dating from 1999 to 2001 (Homer et al., 2004; Homer et al., 2007). The LULC classifications are provided at 30-meter resolution, which AIR then resampled at 220-meter (0.002°) resolution and aggregated to ZIP Code level.

Each LULC terrain type has a different roughness value that will lead to different frictional effects on wind speeds. In general, the rougher the terrain, the more quickly wind speeds will dissipate.

Figure 47 illustrates the LULC data for South Florida as used in the model. Note that additional quality control was undertaken at AIR to identify and correct the erroneous categorization of land use that would have impacted the hurricane wind speed estimates.

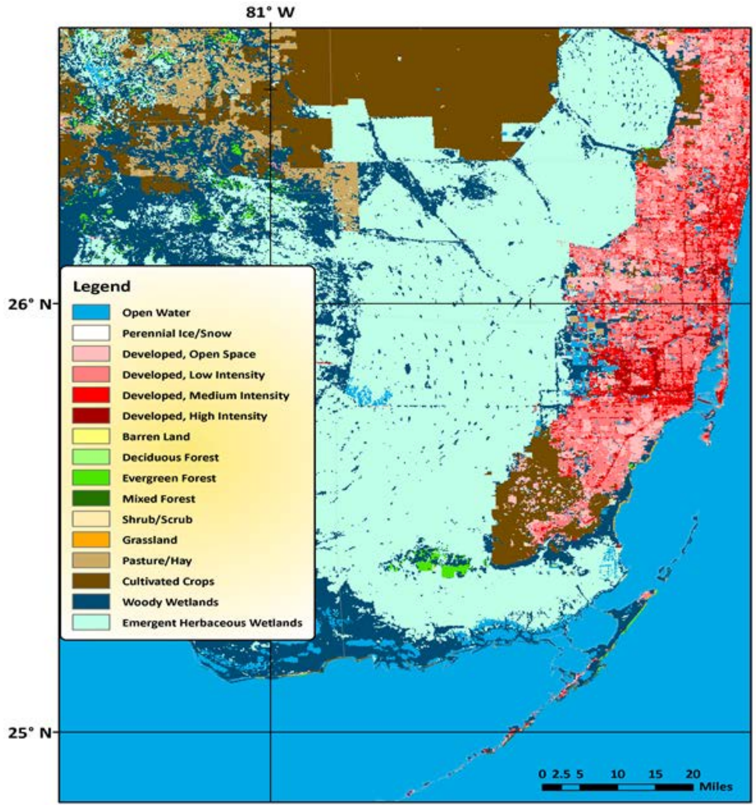


Figure 47. Land use/land cover data used in the AIR model

As a hurricane travels inland and encounters different types of terrain, the hurricane wind speeds do not adjust immediately upon experiencing a new terrain type. In practice, the wind has to blow over a certain distance before the planetary boundary layer (PBL)[10] is in equilibrium with the underlying surface. Downwind of a change in terrain roughness, such as the edge of an urban area, a new boundary layer begins to grow. Within this new layer the flow is not in equilibrium, and the wind profile adjusts.

The boundary layer adjustment is accounted for by adjusting the friction factor according to an "effective" roughness, which is defined in the model as the average surface roughness for an area out to a radius of 10 km (6.2 miles) for the time averaging (gust) factor and 15 km (9.2 miles) for friction from a given location—and is representative of the *mean* land surface acting on the wind field at that location.

[10] The lower layer of the atmosphere—extending vertically from the surface to between 1,000 and 2,000 feet—within which surface roughness has an effect on wind speeds. This height, beyond which surface roughness no longer affects wind speeds, is referred to as the gradient height.

In addition, the direction of the wind at a given time and location is computed along with the wind speed, and the land characteristics upwind of the location are used in making the local wind adjustments.

Wind Field Directionality

The model explicitly includes directional effects of surface friction on locally estimated wind speeds. Rather than using a single friction adjustment that takes into account the average land surface surrounding a location, the wind-field model uses updated LULC data to estimate the roughness in eight wind directions: north, northeast, east, southeast, south, southwest, west, and northwest.

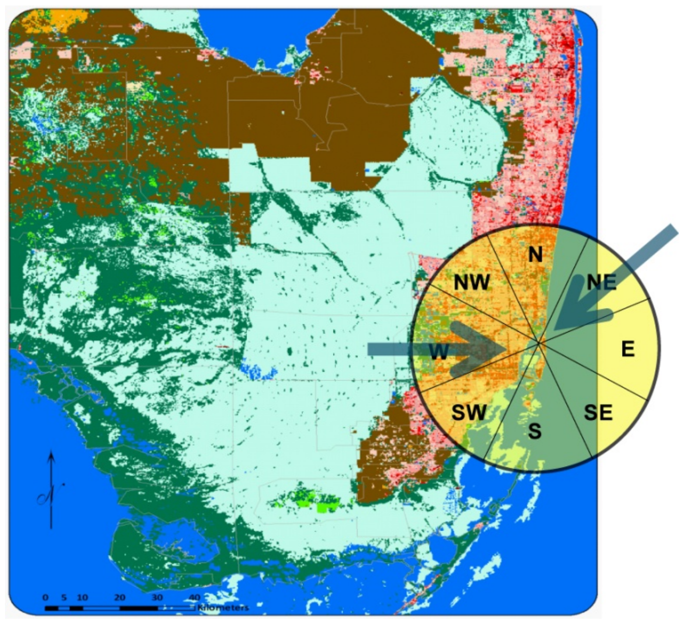


Figure 48. Directional dependence of surface friction is explicitly modeled

In the area of southern Florida shown in Figure 48, for example, a northeast wind coming from the Atlantic Ocean will be relatively unobstructed. On the other hand, a wind from the west will be crossing the city of Miami and undergoing wind-reducing adjustments representative of a built-up urban environment. In the AIR model, the influence of the maritime environment on the wind transition is explicitly quantified, which yields a realistic wind field at a local level for the duration of the event.

Figure 49 demonstrates schematically the impact of directionality on wind speeds. When a hurricane approaches the coastline, winds coming from the water are strong because the hurricane is just beginning to make landfall and has not yet begun to fill. When a hurricane passes a coastal location, winds switch direction and subsequently come from off the land. These winds are weaker than those coming off the water because the hurricane is already dissipating and the rougher land surface is having its effects.

The top panel of Figure 49 shows "unidirectional" friction effects. In this example, half of the surrounding area is land and half water, so the average effect of friction is the average of the water effect (a 5% reduction in wind speeds) and the land effect (a 25% reduction in winds). Thus, for winds entering a location X on the immediate coast from either onshore (100 mph) or offshore (80 mph), the average friction effect would reduce winds by 15% (computed as the average of 5% and 25%). Assuming winds come from the east and the west at the same frequency, the average wind speed would be 76.5 mph (50% from the onshore contribution, and 50% from the offshore contribution).

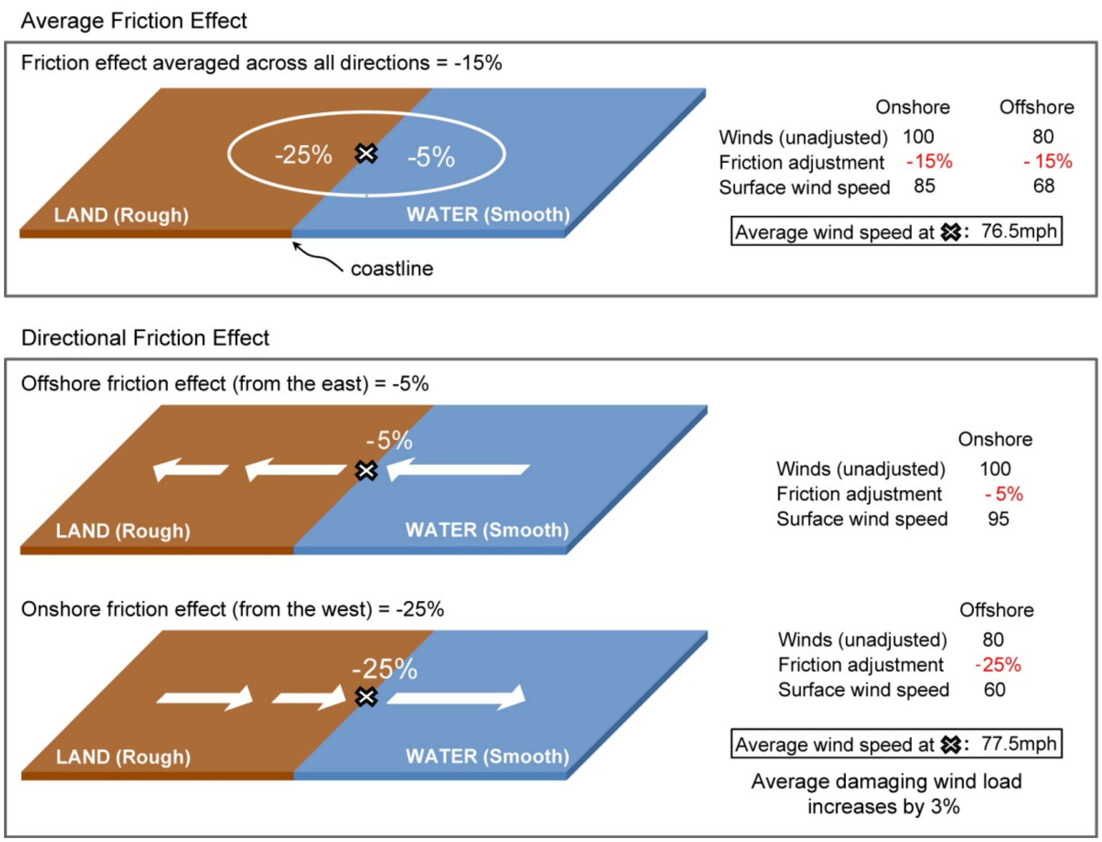


Figure 49. Schematic of the effect of directionality on friction

The lower panel in Figure 49 demonstrates directional friction effects. The different friction effects for winds arriving from water and land are modeled explicitly. Winds coming from the ocean will be reduced by only 5%, resulting in 95 mph winds, as compared to the 85 mph that is calculated when direction is not considered. Similarly, winds passing over land before reaching location X will be reduced by 25%, resulting in weaker winds than would be computed not considering direction. The average for the storm (both onshore and offshore winds) in the simplified example is 77.5 mph—1 mph higher than before.

While 1 mph may seem insignificant, there is a nonlinear relationship between wind speed and damage. That is, increasing wind speeds slightly by some amount increases damage more than reducing wind speeds by the same amount reduces damage. Furthermore, the frequency of strong winds from water directions is higher than the frequency of weak winds from land directions.

Gustiness Effects on Surface Winds

Just as surface roughness exerts a frictional drag on winds, so too can surface roughness enhance gustiness. Gustiness is a measure of how wind speed near the surface varies as a function of time. Winds near the surface—even those in a hurricane that is neither intensifying nor weakening—generally undergo oscillations in time resulting from different sized eddies. These eddies are generated from different types of land use and land cover, and can cause temporary changes in wind speed.

The many different-sized whirls that typically exist at any given time result in different strengths and durations of gusts. These gusts range from the very extreme, which last only several seconds, to weaker ones which may last several minutes. Typically, very rough surfaces can increase gustiness, while smooth surfaces are associated with low levels of gustiness. Scientists at AIR have accounted for the gustiness effects on tropical-cyclone winds not only across different types of surfaces, but also from different directions across those surfaces.

Wind Speed and Wave Height

When a storm is located over open water, high wind speeds result in large ocean waves. In return, larger waves impart more friction on surface wind flow than do smaller waves. In the model, an adjustment is made to modeled wind speeds near the coast to account for this interaction between wind speed and wave height. The adjustment is based both on the modeled wind speed and the percentage of water exposure within the wind octant of interest, and the magnitude of the adjustment is consistent with historical observations as noted by Powell et al. (2003)[11].

[11] The wind octant refers to the way in which directionality is treated in the model. The wind direction spectrum is broken into the eight compass directions: north, northeast, east, southeast, south, southwest, west, and northwest. Local wind adjustment factors are calculated for each of these octants.

Modeled Wind Risk

Figure 50 shows the final modeled 100-year return period hurricane wind speeds in the United States.

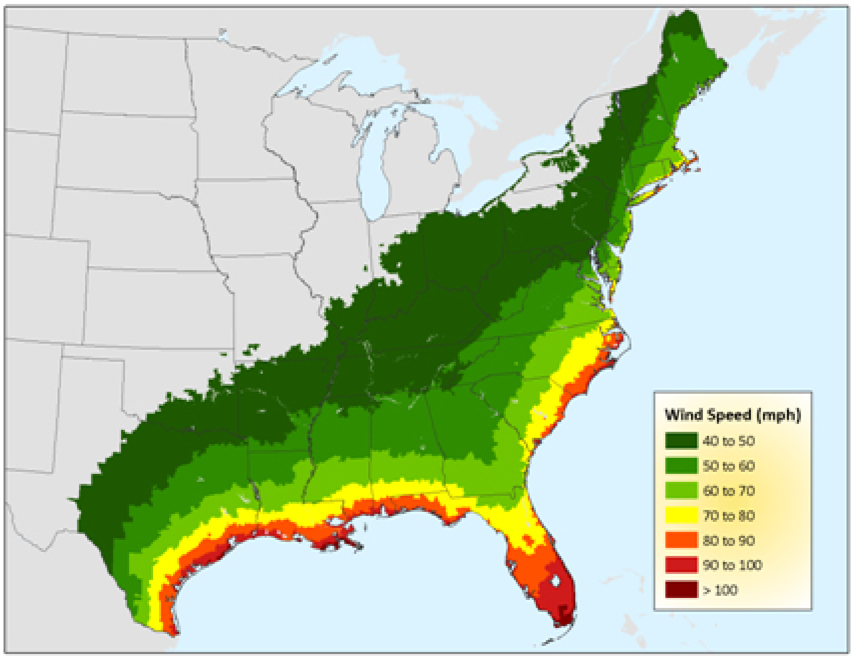


Figure 50. Modeled 100-year return period wind speeds

4.2 Local Storm Surge Intensity

The local intensity parameter used in the storm surge component of the AIR model is water depth in feet. High-resolution elevation data is critical to the calculation; the native horizontal resolution of the USGS elevation data used to model distances within 5 miles from the coast is 30 meters and is aggregated to 220 meters.

As discussed in the previous section, peak storm surge height at the coast is a function of central pressure, storm size and location relative to the storm center, and Rmax. It is then modified to account for track angle at landfall, bathymetry, astronomical tide, and bay amplification.

In order to estimate water depth at each affected location onshore, storm surge is propagated inland using attenuation relationships.

Storm Surge Attenuation

After the storm surge reaches the coastline, its forward travel is impeded by the friction it experiences from the local terrain. This loss of momentum is referred to as attenuation. Steeper slopes and rougher terrain lead to more rapid attenuation;

gradual slopes and smoother terrain lead to slower attenuation. In the regions illustrated in Figure 51, for example, coastal Louisiana has a gentle slope compared to Long Island, New York. The difference is reflected in the attenuation functions through regional modifiers that characterize the coastal terrain as smooth, medium, and rough.

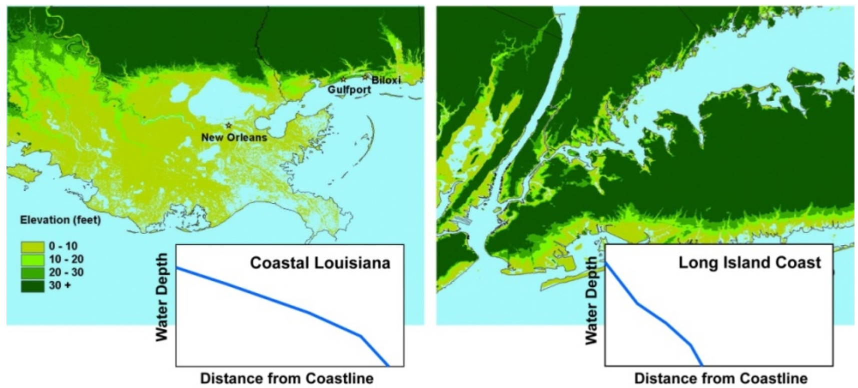


Figure 51. Elevation and surge attenuation relationships capture coastal characteristics at high resolution

Also, while the effect is relatively minor, there is evidence that a slow forward speed reduces the rate of attenuation, as slower storms generally push larger quantities of water onto the coast over longer periods of time. This effect is accounted for in the model.

4.3 Validating Local Intensity

Among the 37 stringent standards set by the Florida Commission on Hurricane Loss Projection Methodology (Florida Commission) are six meteorological standards. To meet these, AIR must demonstrate that the modeled wind field is consistent with the distribution of observed winds for historical storms. The AIR model has consistently met this standard since the Florida Commission was established. Below, we provide sample exhibits demonstrating wind speed validation and wind footprint validation for the AIR model.

Wind Speed Validation

and provide a comparison between observed and modeled wind speeds for Hurricane Katrina (2005) and Hurricane Wilma (2005), respectively.

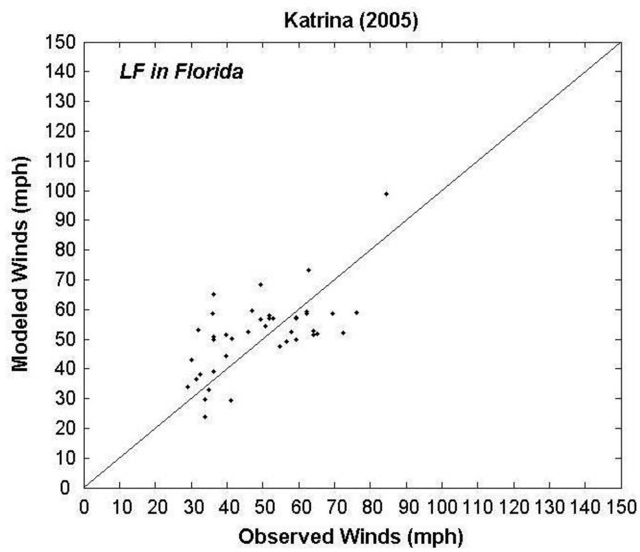


Figure 52. Observed and modeled wind speeds (mph) for Hurricane Katrina

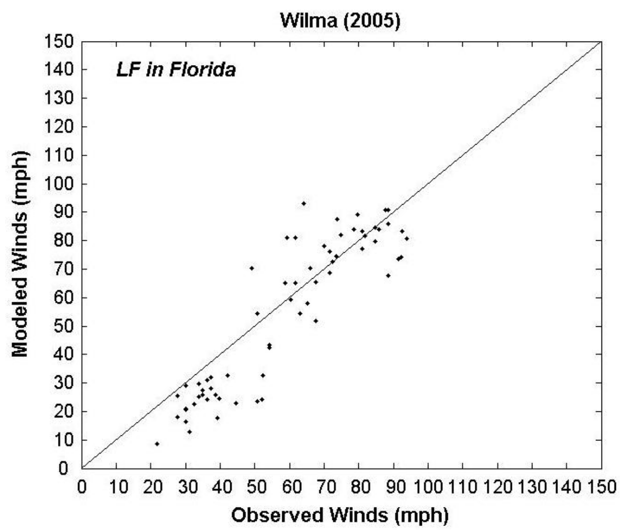


Figure 53. Observed and modeled wind speeds (mph) for Hurricane Wilma

Validation of Wind Footprint

A comparison between observed and modeled wind speeds for Hurricanes Charley (2004) and Dennis (2005) is provided in Figure 54. Note that the colored regions in the figure represent modeled wind footprints, while the colored circles capture the location and intensity of observed wind speeds.

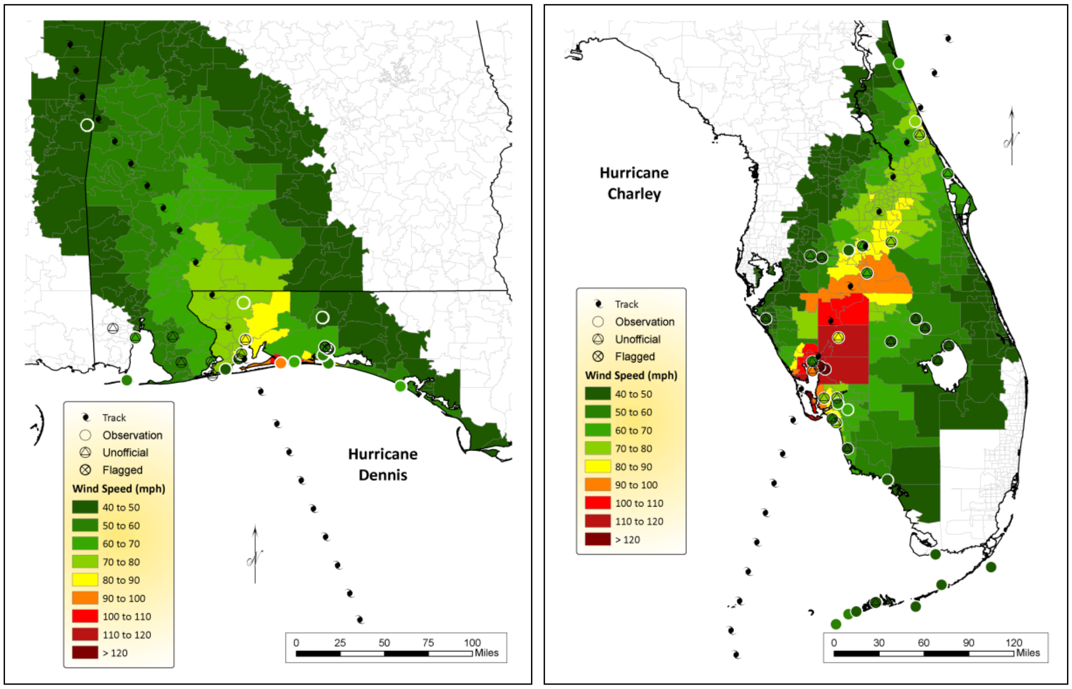


Figure 54. Observed and modeled wind speeds (mph) for Hurricanes Dennis (left) and Charley (right)

AIR modeled hurricane risk extends well inland from the immediate coast, and even to interior states such as Oklahoma, Kentucky, and Ohio. Figure 55 shows claims data from the 2004 and 2005 seasons, illustrating inland loss potential. The AIR modeled wind footprints for the 2004 and 2005 storms are also shown in the figure; the model's wind field appropriately captures inland risk.

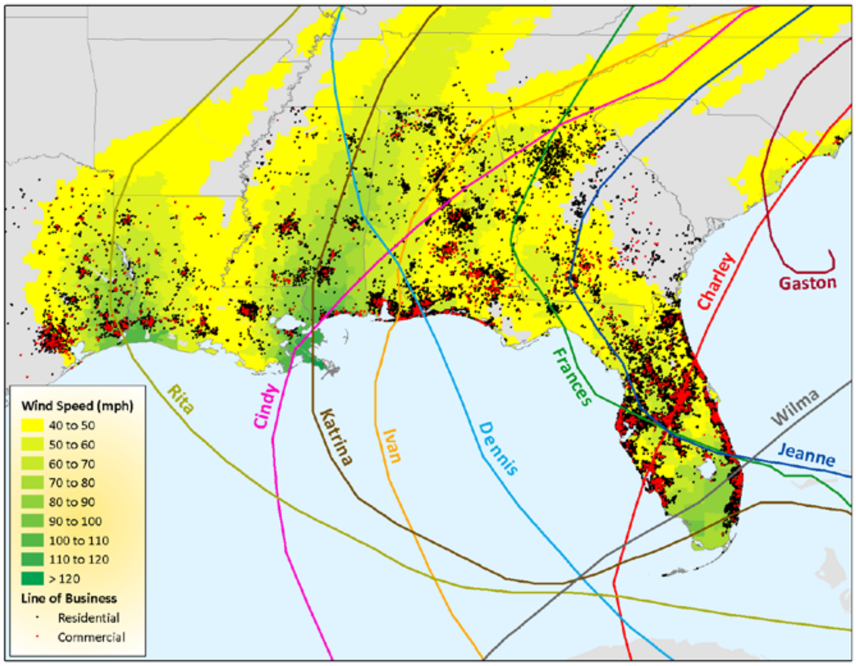


Figure 55. Claims data from the 2004 and 2005 hurricanes on AIR modeled wind fields

Figure 56 compares observed and modeled wind speeds for 36 historical hurricanes, including Gloria, Hugo, Bob, Andrew, Erin, Opal, Bertha, Fran, Danny, Bonnie, Earl, Georges, Bret, Dennis, Floyd, Irene, Lili, Claudette, Isabel, Alex, Charley, Frances, Gaston, Ivan, Jeanne, Cindy, Dennis, Emily, Katrina, Ophelia, Rita, Wilma, Humberto, Dolly, Gustav, and Ike.

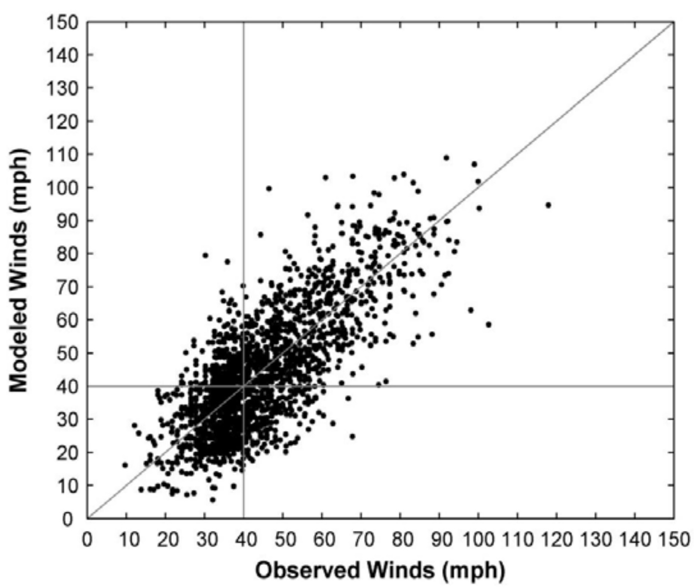


Figure 56. Modeled and observed winds for 36 events, 1982-2008

Figure 57 compares observed and modeled storm surge heights for 2005's Hurricane Rita.

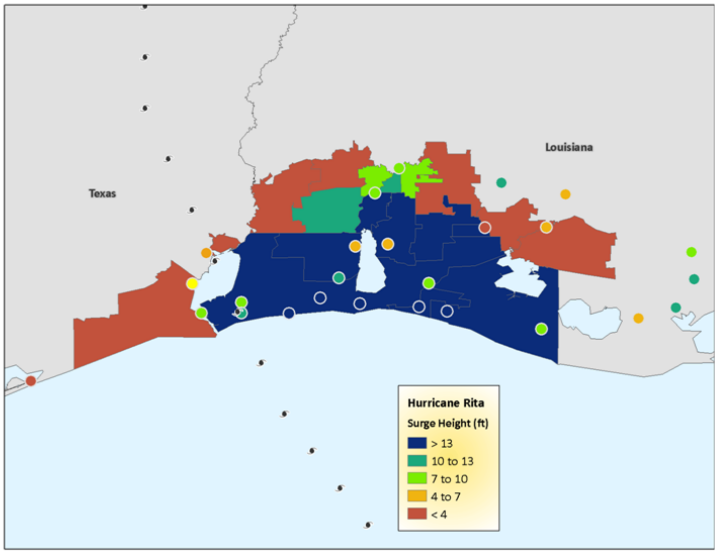


Figure 57. Comparison between observed (colored circles) and modeled (colored zip codes) storm surge heights for Hurricane Rita

5 Damage Estimation

In this component of the model, the local intensities of each simulated event are superimposed onto a database of exposed properties (see Section 5.1 for a discussion of building inventory in the United States, and Section 7.3 for summary statistics), and the resulting monetary damage is then calculated. This is accomplished by way of damage functions, which have been developed for various types of structures. Damage functions translate the intensity of the hazard affecting a structure or portfolio of structures into monetary loss before any risk sharing arrangements (e.g. insurance contracts) are taken into account.

For the hurricane model, hazard is defined in terms of wind speed (one-minute sustained winds at 10-meter height) or water depth (in feet). Note that damage functions for a structure not only account for the physical response of the structure to a hazard, but also encapsulate the effects of many other macro-level effects such as claims adjustment practices, building codes and their enforcement, the preparedness and response of individuals and communities to hurricane risk, and the representation of the hazard in the model.[12]

The AIR Hurricane Model for the United States provides separate wind and storm surge damage functions by coverage, construction, occupancy, and height. The major occupancy classes are homeowners, apartments/condos, commercial, industrial, and automobiles. These are further broken down into distinct construction classes, including wood frame, unreinforced masonry, reinforced masonry, masonry veneer, reinforced concrete, steel frame, light metal, mobile homes, and pleasure boats and yachts. Details regarding the main construction classes are outlined further in Table 5. AIR's *Unicede® /px Data Exchange Format Preparer's Guide* lists all the occupancies and constructions supported for the AIR Hurricane Model for the United States.

Table 5. Descriptions of selected construction classes

Construction Class	Description
Wood Frame	Mostly structures of 1 to 3 stories. Stud walls constructed of 2" x 4" or 2" x 6" wood members vertically set 16" or 24 "apart. Walls are braced by plywood or by wood or steel diagonals.
Masonry Veneer	Wood frame structures with one width of non-load-bearing concrete, stone, or clay brick attached to the stud wall.
Unreinforced Masonry	No steel reinforcing within a load-bearing masonry wall. Floors, roofs, and internal partitions in bearing wall. Usually wood buildings.

[12] See the AIR Current "Anatomy of a Damage Function," published in March 2010.

Reinforced Masonry	Consists of load-bearing walls of reinforced brick or concrete-block masonry. Floor and roof joists constructed with wood framing common.
Reinforced Concrete	Consists of reinforced concrete columns and beams.
Steel	Consists of steel columns and beams.
Light Metal	Made of light-gauge steel frame and usually clad with lightweight metal or asbestos siding and roof, often corrugated. Typically are low-rise structures.
Unknown	Represents a weighted average of all of the above construction types
Mobile Homes	A weighted average of tie-down types, including no tie-downs, used for mobile homes when tie-down information is unknown.
Pleasure Boats and Yachts, Power Boats	A pleasure boat that is powered only by a motor (no sails).
Pleasure Boats and Yachts, Sail Boats	A pleasure boat that is capable of being powered by wind through the use of sails. Note that boats with both sails and a motor should be modeled under this code.

5.1 Building Classification

Residential

In the AIR Hurricane Model for the United States, residential buildings include single- and multi-family homes, as well as condominiums/apartment buildings. Note that the residential building stock varies regionally across the United States.

The prevalent construction method for United States single-family homes are wood or masonry systems. The relative proportions of these two construction materials changes regionally. For example, single-family homes in Gulf of Mexico states employ a greater percentage of masonry than similar houses in East Coast states[13].

In general, masonry houses are better able to withstand high winds than those made of wood. When masonry is used as the exterior wall material, the walls are normally constructed to full height. Then wood floors and the roof are framed into the masonry, resulting in continuous exterior walls and an overall strong structural frame. Such a structure is more resistant to hurricane winds and the impact of windborne debris as compared to wood frame buildings.

Apartment buildings tend to have a more diversified construction mix than single family homes. In addition to wood and masonry, apartments may comprise steel and concrete. Buildings of concrete and steel construction are generally better able to withstand high winds than masonry structures. From a structural viewpoint,

[13] Gulf Coast states include Texas, Mississippi, Louisiana, Alabama, and Florida, and East Coast states include Connecticut, Delaware, Georgia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Rhode Island, South Carolina, and Virginia.

apartments and condominiums have exterior building components that make them susceptible to wind-related damage. These may include balconies, awnings, and double-sliding glass doors. These exterior features are less engineered at the design and construction stages and are hence more vulnerable than the main building structure.

Typically, Gulf of Mexico states employ greater levels of concrete and masonry, and East Coast states use more wood and steel in apartment buildings.

Commercial

In the United States, the phrase "commercial buildings" is an umbrella term that includes many categories of structures, such as hotels, offices, and restaurants. Overall, the county's commercial building stock is quite heterogeneous. Low-rise commercial structures are generally similar to single-family homes, involving wood and masonry construction. Mid- and high- rise commercial buildings are engineered structures typically made of reinforced masonry, concrete, or steel. Moreover, building codes are generally stricter for engineered commercial buildings than residential structures.

As with residential buildings, commercial building construction material percentages vary by region. Around the Gulf of Mexico, greater levels of concrete, masonry, and light metal are used. Along the East Coast, higher levels of steel and wood are used.

Industrial

The AIR Hurricane Model for the United States features the capability to assess potential property and business interruption (BI) losses in CLASIC/2 and Touchstone to small industrial plants and large industrial facilities. Small industrial plants are assumed to consist of multiple sets of buildings with different construction types. Most of the equipment is located within the buildings of small industrial plants. Large industrial facilities are plants featuring a diverse suite of structures, including stacks, cooling towers, pipes, and tanks located in a widespread open area.

Small industrial plants should be coded with the AIR occupancy codes 321 to 330. When these occupancy codes are used, the Unknown construction class (code 100) must be used. If the user knows the construction of each building in the small industrial facility, they should use the AIR *commercial* occupancy codes with known construction type in CLASIC/2 and Touchstone. For large industrial facilities, AIR's 400 series of occupancy codes should be used. See Section 5.13 for detailed information about AIR's modeling of large industrial facilities.

Pleasure Boats and Yachts

In the United States, pleasure boats and yachts have historically suffered significant damage during hurricanes. While some boat owners take precautionary measures before a storm, such as moving boats out of the water or into sheltered inland waterways, a number of boats remain in coastal marinas and can be subjected to intense winds and storm surge during a storm.

As boats vary in type and size, so do their risk of damage. In general, smaller marine vehicles are at greater risk of damage than larger boats. Additionally, sail-powered boats are at larger risk of damage than motor-powered boats. For more details on the vulnerability of pleasure boats and yachts, refer to Section 5.10.

Buildings Under Construction

In the United States, a significant portion of buildings are under construction. The buildings in this class include residential and commercial buildings, and account for all height ranges. Buildings under construction are built in phases, and these phases are constant across regions. The first phase includes the substructure, such as the foundation. The second phase involves the construction of a building's superstructure, such as columns, beams, and slabs. The third phase includes the completion of exterior building features (i.e., walls, windows, and doors). Finally, the fourth phase involves the completion of interior finish, electrical, plumbing, and mechanical systems; this phase is similar in vulnerability to completed buildings. A more comprehensive review of buildings under construction vulnerability is provided in Section 5.11.

5.2 Wind Damage Functions

The AIR model's wind damage functions represent the relationship between wind speed and the mean damage ratio (MDR). The MDR is the average ratio between the repair cost of the property and its replacement value for properties subjected to a given wind speed. These damage functions vary by primary building characteristics such as occupancy, construction, and height, as well as year built and region. Also, individual risk features such as roof type can be used to further modify the wind damage functions (see Section 8.7 for more details.) Total damage is calculated by applying the appropriate damage function to the replacement value of the insured property.

AIR's wind damage functions, developed by experts in wind and structural engineering, are based upon published engineering research and analyses of findings from post-disaster surveys. The resulting functions have been validated by external experts from leading wind-engineering institutions, as well as through extensive analysis of detailed insurance claims data.

Actual damage and loss data is generally not available for all types of structures with various characteristics, and so claims data alone cannot be used to develop damage functions for all structures. For example, loss data is often aggregated at a policy level for various commercial buildings, and location-level loss information of such structures must be investigated. Specifically, details regarding roof-cover or roof-type are commonly not available in claims data. Engineering expertise is thus needed to develop damage functions, along with actual claims and damage data.

There are three key elements in the vulnerability module of the AIR Hurricane Model for the United States:

- The damage functions for basic structural characteristics, such as construction, occupancy, and height.
- The modeling of the regional and temporal variation in the vulnerability of building inventory, due to the evolution of building codes and their enforcement, building construction practices and materials, structural aging, and building upgrades over time. AIR's Individual Risk Module is employed to estimate the regional and temporal variation in vulnerability in the model.
- AIR's Individual Risk Module can be used to modify the default damage functions by using detailed building characteristics, such as glass percentage and roof type, available to the user for input into the model.

In the following sections, these elements are discussed in detail. Note that the second and third elements in the list of key elements interact with each other in the AIR model to avoid double counting these effects, as discussed below.

Historically, users of a catastrophe model did not have detailed information about building characteristics, and catastrophe models used damage functions based only on primary building characteristics, such as construction, occupancy, and height. Over time, temporal and regional modifiers and information accounting for detailed building features have been introduced in catastrophe models. Generally, these modifiers are applied to damage functions independently, on top of one another, without accounting for potential overlap between different modifiers.

The AIR vulnerability module properly accounts for the effects of different vulnerability modifiers and their interactions, and avoids double accounting of their effects. The AIR Individual Risk Module, which is discussed in Sections 5.4 and 8.7, is fully integrated within the vulnerability module. Typical, or "model", buildings have been defined in terms of individual risk features – such as roof covering type, roof-to-wall connection, and glass type – for all locations and years-built. For example, while homes built in Miami after the 2001 implementation of the Florida Building Code are likely to have building features such as shutters and high-wind rated shingles, homes built in inland Alabama before 1995 are not likely to have such features. If users have information about individual risk features, it can be input in the model to override the model's default features. Note that the marginal impact of the individual risk features selected by the user will depend on the model building assumptions. For example, the impact of the user-input of engineered shutters on building vulnerability will vary by region and year built.

The development of the damage functions for primary structural characteristics, such as construction, occupancy, and height, are discussed in the following sections.

Residential Damage Functions

A building's response to wind loads depends upon its construction and occupancy classes. Non-engineered buildings are typically more vulnerable than engineered buildings. In general, most residential dwellings are categorized as non-engineered. Post-disaster surveys indicate that low-rise commercial wood frame and masonry buildings have vulnerabilities similar to those of their residential counterparts. Multi-family homes, which are generally 2 to 4 stories tall, are closer to single-family structures than are apartments and condominiums in terms of their vulnerability.

Recent survey findings also indicate that in states with an evolved building code, year built is an important indicator of the vulnerability of residential construction. In Florida, for example, newer homes have been observed to consistently outperform older ones.

Wind damage primarily affects the nonstructural elements of residential properties, such as different components of the building envelope. Failure of houses with wood-framed roofs often occurs first at the roof, and often because of improper fastening between the roof sheathing and building frame. For example, a common failure initiation point on roof systems occurs where the roof membranes are attached to edges and corners; failure is often attributable to the lifting and peeling of metal edge flashings.

Uplift of the roof edges allows the wind to penetrate underneath the roof membrane, resulting in pressure rise beneath the membrane and subsequent removal of the roof covering. At high wind speeds, the integrity of the entire structure can be compromised, particularly in cases where the roof provides the lateral stability by supporting the tops of the building's walls.

Thus, three damage regimes can be identified for residential buildings: (a) a low-damage regime corresponding to wind speeds of less than about 90 mph, where damage is limited to roof covering and cladding; (b) a medium-damage regime where damage propagates to roof sheathing, connections and openings, and; (c) a catastrophic-damage regime corresponding to wind speeds in excess of 130 mph, where the roof framing is severely damaged, resulting in lateral instability of walls, possibly causing their collapse and ultimately the complete destruction of the building. A significant amount of detailed, quality claims data has been used to calibrate and validate the damage functions for single family homes.

Apartments and condominiums frequently receive a degree of engineering attention similar to that given to commercial construction. From a structural viewpoint, therefore, commercial and apartments/condominiums construction is similar. Nevertheless, apartments and condominiums have some building components that make them more susceptible to windstorms than commercial construction. These may include balconies, awnings, and double sliding-glass doors. Because these components are less engineered at the design and construction stages and are hence more vulnerable, AIR engineers have developed separate damage functions for apartments and condominiums.

The vulnerability of mobile (manufactured) homes is much greater than that of other construction types. The AIR model includes four damage functions for mobile homes, as follows: mobile home with no tie-downs, mobile home with partial tie-downs, mobile home with full tie-downs, and mobile homes with unknown tie-down information. This last classification would be used when the tie-down information is unknown and represents a weighted average of tie-down types, including no tie-downs.

Commercial Damage Functions

The development of damage functions for commercial structures is more challenging than for residential structures because of the relative scarcity of detailed loss data. Because commercial structures are generally less vulnerable to wind damage, the absolute amount of industry loss data is smaller. Furthermore, for multi-location policies, losses paid centrally to corporate headquarters often do not include information about the actual damaged property.

Damage to engineered buildings typically occurs to nonstructural components like mechanical equipment, roofing, cladding, and windows; complete structural collapse is extremely rare. Figure 58 is a schematic of AIR's component-based engineering approach for the development of commercial damage functions.

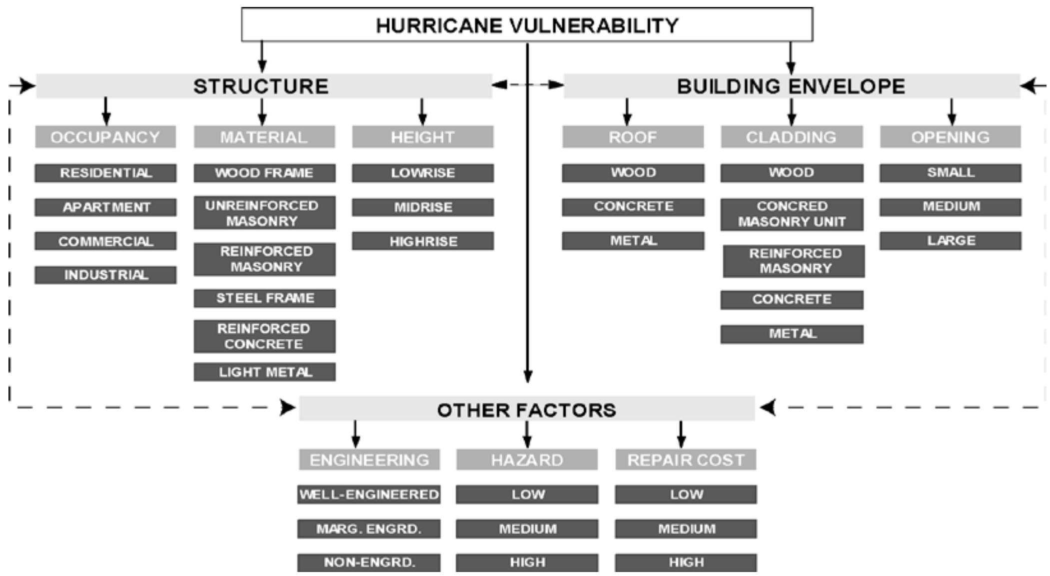


Figure 58. Component-based vulnerability model for commercial structures

Several building components and attributes that affect vulnerability to hurricane winds are considered. These can be divided into three broad categories: (a) the primary attributes regarding the occupancy, material, and height of the building; (b) secondary attributes that define the building envelope, such as the roof, cladding material, and size of openings, and; (c) other attributes, including the amount of engineering attention, wind hazard and repair cost, that indirectly affect building vulnerability. Information on the relative impact each component has on vulnerability is obtained from a variety of sources, including experience gained from post-disaster surveys and input from wind-engineering experts.

AIR wind damage functions for commercial and apartment/condominium buildings explicitly account for building height. Table 6 shows the height bands supported for various occupancy and construction types.

Table 6. Supported height bands for construction and occupancy classes

Occupancy Codes	Construction Class	Construction Codes	Building Height			
			Low	Mid	High	Unknown
301-302	All	All	Same vulnerability for all height bands			
303-373 Excluding 321-330	Wood frame	101-104	1	>1	-	0
	Masonry	111-119	1	2-3	>3	0
	Concrete	131-137	1-3	4-7	>7	0
	Steel	151,153-155	1-3	4-7	>7	0
	Mobile Homes	191-194	Same vulnerability for all height bands			
	Wind Resistive	181-183	1-3	4-7	>7	0
	200 Series	201-261	Same vulnerability for all height bands			
	Unknown	100	1-3	4-7	>7	0
321-330*	Unknown	100	1-3	4-7	>7	0
400-482	All	All	Same vulnerability for all height bands			
300	Wood Frame	101-104	Same vulnerability for all height bands			
	Masonry	111-119	1	2-3	>3	0
	Concrete	131-137	1-3	4-7	>7	0
	Steel	151,153-155	1-3	4-7	>7	0
	Mobile Homes	191-194	Same vulnerability for all height bands			
	Wind Resistive	181-183	1-3	4-7	>7	0
	200 Series[14]	201-261	Same vulnerability for all height bands			
	Unknown	100	1-3	4-7	>7	0

* For the 321-330 series occupancy codes, only the Unknown construction class (100) should be used.

Wind profiles show that wind speeds increase with height; for any given storm, a low-rise building may experience Category 1 wind speeds, while the upper floors of a 20-story building at the same location may experience Category 3 wind speeds. However, while the wind hazard increases with height, vulnerability typically decreases. High-rise buildings are less vulnerable because they are generally well-engineered, built to strict building-code requirements, and have wind-resistant flat-slab roofs. See Section 8.5 for more information about the height bands supported in this model.

Figure 59 shows AIR wind damage functions for several construction types in the United States.

[14] The 200 series of construction classes includes bridges, storage tanks, pipelines, chimneys, towers, equipment, cranes, compressor stations, and waterfront and offshore structures. Please see Section 9 for a complete list of these classes.

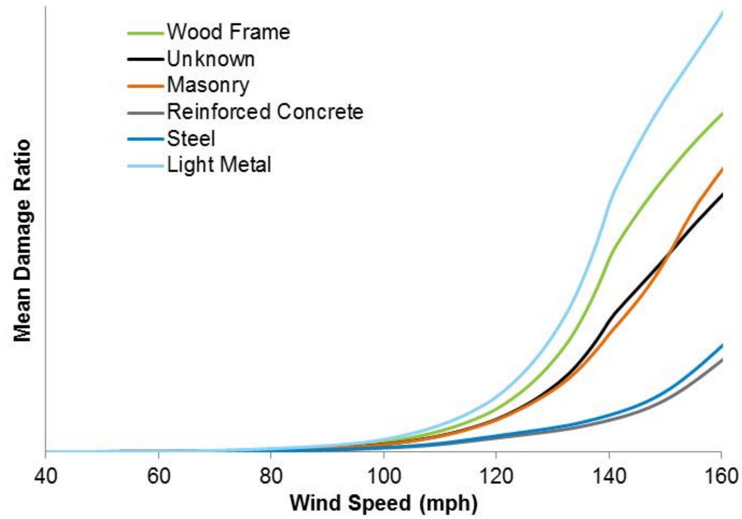


Figure 59. Wind damage functions for selected construction classes

Modeling the Effects of Wind Duration on Damage[15]

The damage estimation module develops a complete time profile of wind speeds for each location affected, thus capturing the effects wind duration and peak wind speed have on structures. Design loads are routinely exceeded in tropical cyclones of even moderate intensity. With no reserve strength, a fastener or connector that has been pulled out from an uplift load can compromise the integrity of the building envelope. Wind damage is manifested at the weak links in a structural system. As each connector is overwhelmed, loads are transferred to the next point of vulnerability. The longer the duration of high winds, the longer this process continues and the greater the resulting damage.

Figure 60(a) shows a sample time profile of wind speeds at a particular location. Note that wind speed peaks at 95 mph and then diminishes as the storm recedes. Figure 60(b) shows the corresponding damage function for the given wind-speed profile. The building damage ratios (δ_1 through δ_5), corresponding to each wind speed as measured in the wind-speed profile, appear on the vertical axis.

[15] See the AIR research paper "Statistical Analysis of 2004 and 2005 Hurricane Claims Data," *Proceedings of the 11th Americas Conference on Wind Engineering*, San Juan, Puerto Rico, June 22-26, 2009. Available at: http://www.iawe.org/Proceedings/11ACWE/11ACWE-Jain.Vineet2.pdf

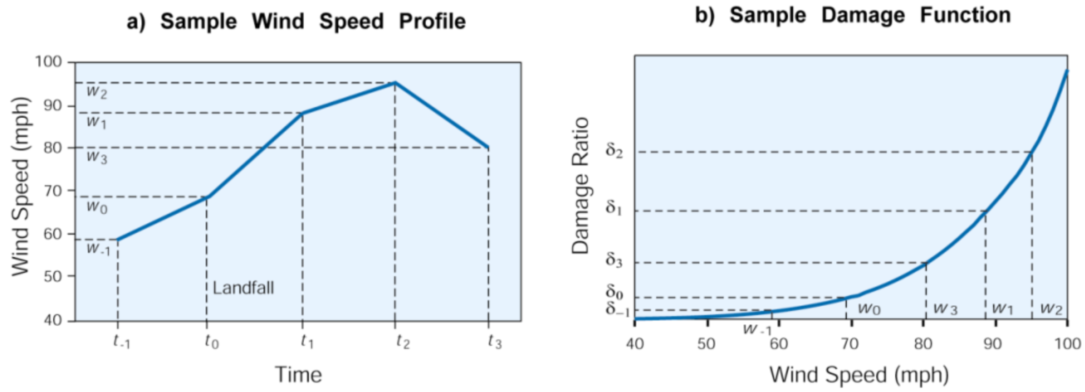


Figure 60. (a) Sample wind speed profile and (b) corresponding damage ratios

Figure 61 highlights the impact of wind duration on the mean building damage ratio. To create the figure, detailed location-level claims data are used to quantify the effect of wind speed duration on building damage. Regression models fit to the data (gray points) capture the mean building damage ratio when a location is subjected to high winds (>40 mph) for more than 10 hours (orange curve) or for less than 10 hours (red curve). Note that at slower wind speeds such as 45 mph, the effect of wind duration on building damage is notable (45-mph winds experienced for > 10 hours produce much more damage than 45-mph winds experienced for < 10 hours). At higher wind speeds such as 90 mph, the effect of wind duration is less noticeable.

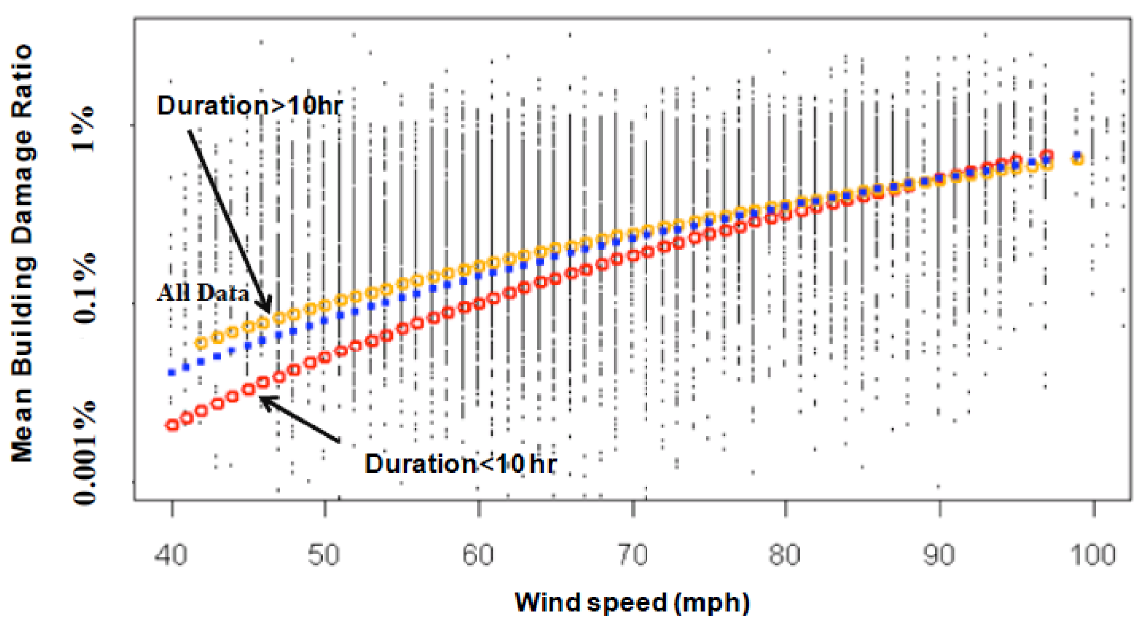


Figure 61. The effect of wind duration on the mean damage ratio (Source: Jain et al. 2009)

The cumulative effects of winds can be examined using a dynamic approach. In order to estimate damage to a property at any point in time, it is important to take into account the extent of the damage that has occurred in the preceding period. Each damage ratio is applied in succession to the remaining undamaged portion of the exposure from the preceding period. Figure 62 illustrates this process.

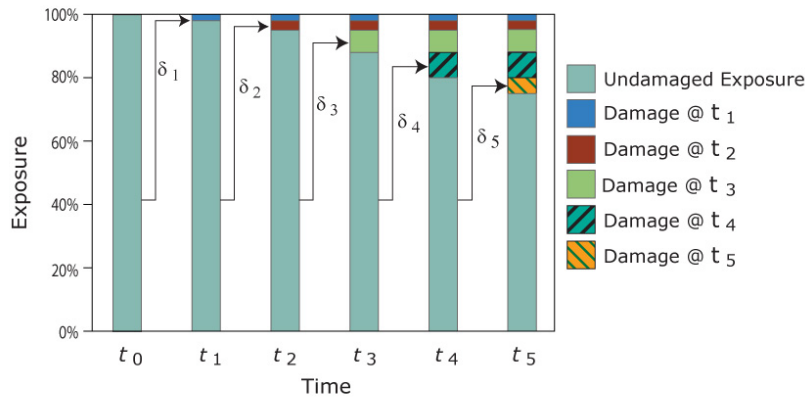


Figure 62. Measuring the cumulative effects of winds

At t_0, before tropical-storm winds have reached the site, there is zero or negligible damage. At time t_1, with wind speeds near 70 mph, the damage ratio δ_1 is calculated as a percentage of the full replacement value. At t_2, the damage ratio δ_2 is applied to the percentage of the property that was left undamaged in the previous period. This process continues until wind speeds once again fall below tropical-storm strength.

Calculating damage only when winds are at their maximum, at t_4, and applying a single damage ratio, δ_4, to the full replacement value would completely miss the cumulative effects of prolonged winds. Therefore the damage estimation module of the AIR Hurricane Model for the United States considers the complete time profile of wind speeds at each location.

5.3 AIR's Comprehensive Methodology for Estimating Regional and Temporal Vulnerability Variation

Engineering studies, claims data, and damage surveys indicate that there can be significant variation in building vulnerability by region and time-period. This variation is due to changes in building codes, construction practices, structural aging, and upgrading.

Reliable loss estimation depends on accurately capturing significant differences in vulnerability between time-periods and regions. AIR undertook a comprehensive, peer-reviewed study to enhance the understanding of the evolution of wind load standards, building codes, and building construction practices for all hurricane-prone regions in the United States. Detailed findings of this study have been incorporated in the model to capture regional and temporal variations in wind vulnerability. For a given occupancy, construction, and height combination, the model features different damage functions for each region and time-period, where a time-period can be as short as a year and regions can be highly localized. *To take full advantage of the new capabilities, it is therefore important that CLASIC/2 and Touchstone users geocode their exposures and avoid bulk-coding Year Built.*

The AIR model takes a comprehensive approach to developing damage functions for each region and year built in the United States, while drawing on many years of experience and research conducted at AIR. The model utilizes a detailed methodology based on engineering analysis and the vulnerability of individual building features. Detailed claims data from recent storms are used to calibrate and validate the damage estimation module and model performance in general.

There are many sets of building codes released in the United States, with varying levels of adoption and enforcement. This, coupled with a lack of historical data, makes it somewhat challenging to assess the regional impact of building codes. AIR takes a top-down approach to incorporate information about building codes at a local level for all regions (Figure 63). First, the evolution over time of the national wind load standards (ASCE 7-98 and ASTM) and their impact was analyzed. Next, the wind design provisions of the model building codes (National Building Code (NBC), Standard Building Code (SBC), and International Council of Codes (ICC)) were evaluated. As state and local authorities may significantly amend codes, their adoption and amendment as related to wind design provisions was then examined. For example, in North Carolina, the wind-debris zone is limited to 1,500 feet within the shoreline, while according to the International Residential Code (IRC), the wind debris zone is all locations where the design wind speed is higher than 120 mph. Mississippi has recently adopted the ICC codes, but in other coastal counties of the United States, these codes are mandatory only if they are adopted by a particular jurisdiction.

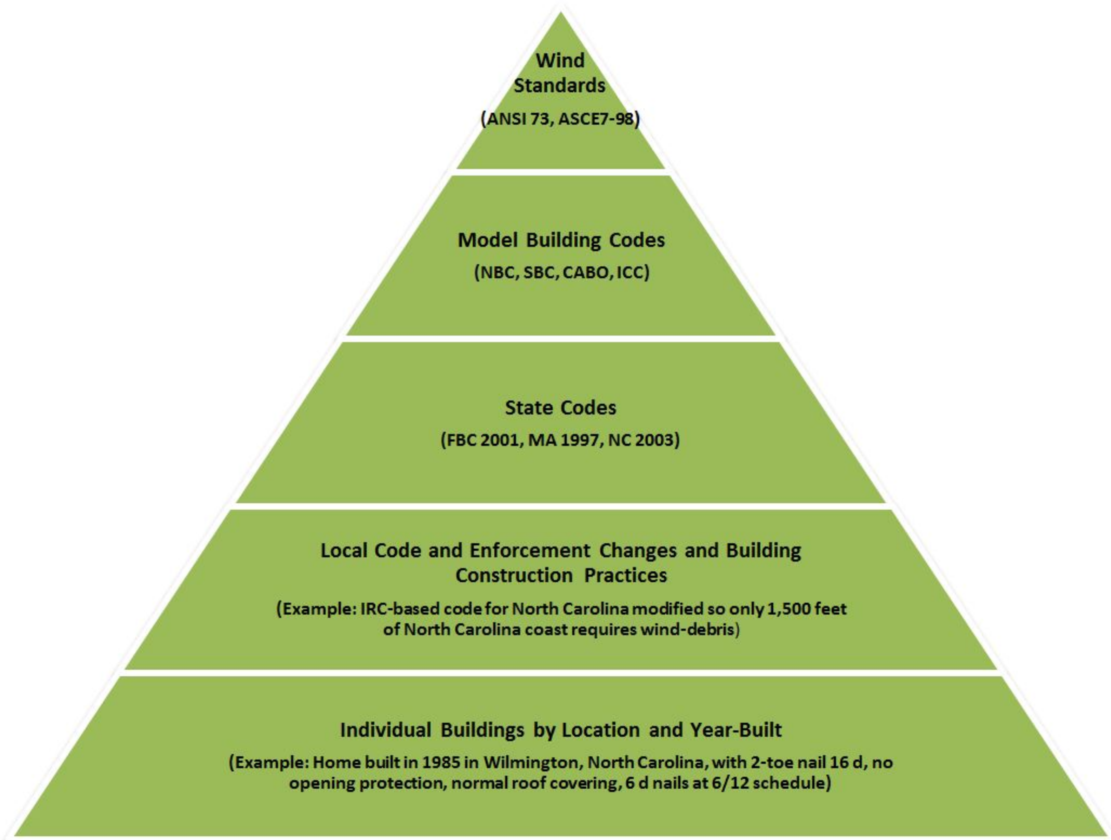


Figure 63. AIR's comprehensive methodology for estimating relative vulnerability by region and time period

A "model" building—in terms of individual risk features such as roof covering, roof sheathing, roof-to-wall connection, and opening protection—that meets the building code requirements for that region and time-period is defined and the degree of code enforcement in the region is analyzed. In some localities, enforcement of building codes is mandatory and changes to instituted codes are not allowed. In other localities, changes may be made to the building codes only if the modifications are more restrictive than the original codes. In some states, a state authority can declare certain codes to be mandatory state-wide. Nonetheless, a locality can determine whether or not to adopt the "mandatory" code, and therefore a mandatory code is only practiced in those localities that choose to adopt it.

The relative vulnerability of different model buildings is assessed based on the AIR Individual Risk Module, which estimates the impact of detailed secondary building features on the overall building vulnerability. By repeating this process for all hurricane-prone regions in the United States, model buildings have been defined for all locations and time-periods.

For example, Table 7 and Table 8 show the key structural characteristics of a typical single-family wood frame home and a typical commercial reinforced concrete building, respectively. These structures have been built according to the code requirements in place in 1998 and in 2005 in Wilmington, North Carolina.

Table 7. Key structural characteristics of non-engineered building built according to building codes in Wilmington, North Carolina, in 1998 and 2005

Location	Year Built	Roof Covering	Roof Sheathing Nailing	Roof to Wall Connection	Window Protection Required	Gable-end Bracing Requirement
Wilmington, NC	1998	Asphalt Shingles or Equivalent	8d @ 6/12	Clips	None	Yes
	2005	Hurricane wind-rated covering	8d @ 6/6	Hurricane Ties	None	Yes

Table 8. Key structural characteristics of engineered buildings built according to code requirements in Wilmington, North Carolina, in 1998 and 2005

Location	Year Built	Roof Covering	Wall Siding	Secondary Water Protection	Window Protection Required
Wilmington, NC	1998	Single Ply or Equivalent	Siding with poor resistance to wind	No	None
	2005	Hurricane wind-rated covering	Siding with strong resistance to wind	Yes	None

Figure 64 shows three regions of vulnerability in North Carolina for buildings built between 1995 and 2002, based on the building code requirements in place during that period. The figure also shows the damage function for structures built in 1998 for these three regions. Vulnerability is higher for inland regions as compared to coastal regions, as building code requirements are typically less stringent inland.

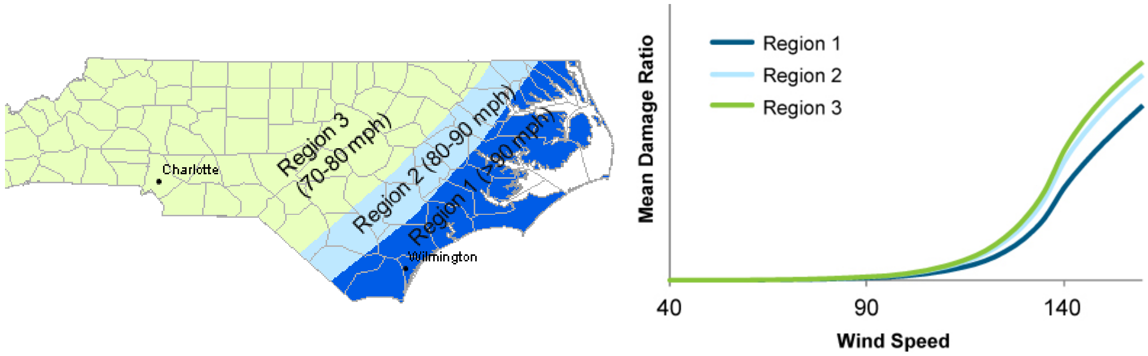


Figure 64. Vulnerability regions for structures built in 1995-2002 in North Carolina and corresponding damage functions

Note that while building code changes occur at discrete points in time as revisions are released, there are generally continual changes in building construction materials and practices, code enforcement, engineering attention regarding the design of a structure, structural aging, and building maintenance. These forces lead to *continual* changes in vulnerability over time. In the AIR model, the impact of individual risk features is explicitly combined with the impact of macro-level changes to estimate the total variation of vulnerability by year built. Figure 65 shows the breakdown of temporal changes in the vulnerability at a location explained by the individual risk features and other macro-level changes. In the current model, the effect of macro-level changes on vulnerability has been applied up to the year 2005.

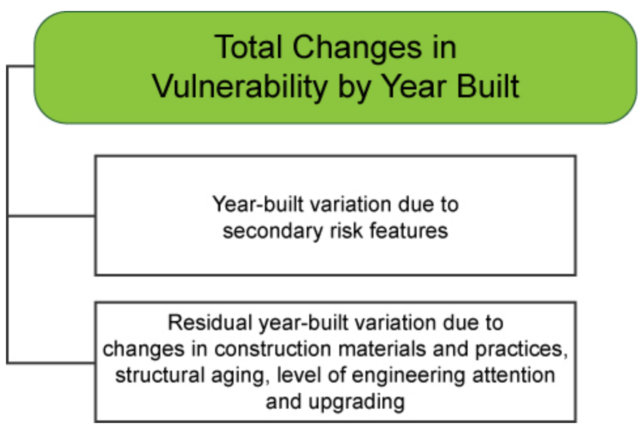


Figure 65. Total temporal changes in vulnerability are explained by key secondary risk features and macro-level changes

Figure 66 and Figure 67 illustrate the vulnerability of non-engineered and engineered structures, respectively, in Wilmington, North Carolina, by year built. Between 1995 and 2002, yearly changes in vulnerability are attributable to adjustments in building materials and practices, structural aging, and upgrading. There is reduction in vulnerability in 2003 due to the implementation of the North Carolina Building Code (2002). Gradual changes in vulnerability are noted until 2005, after which no further change is apparent.

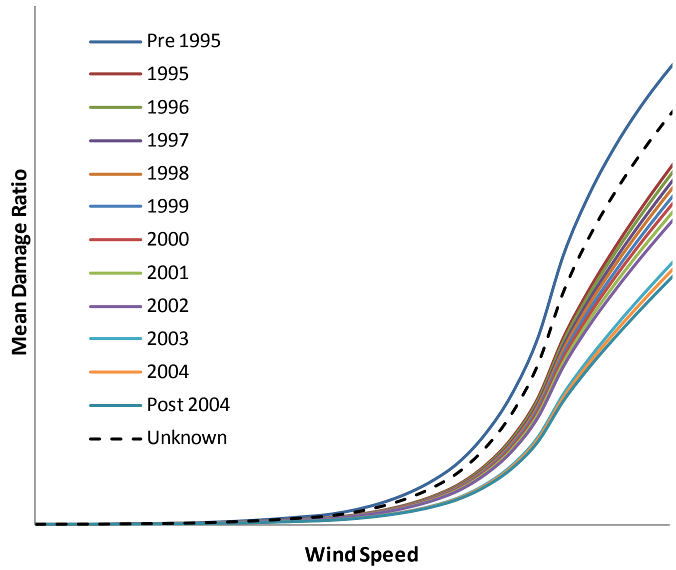


Figure 66. Year built damage functions for a single-family wood-frame structure in Wilmington, North Carolina

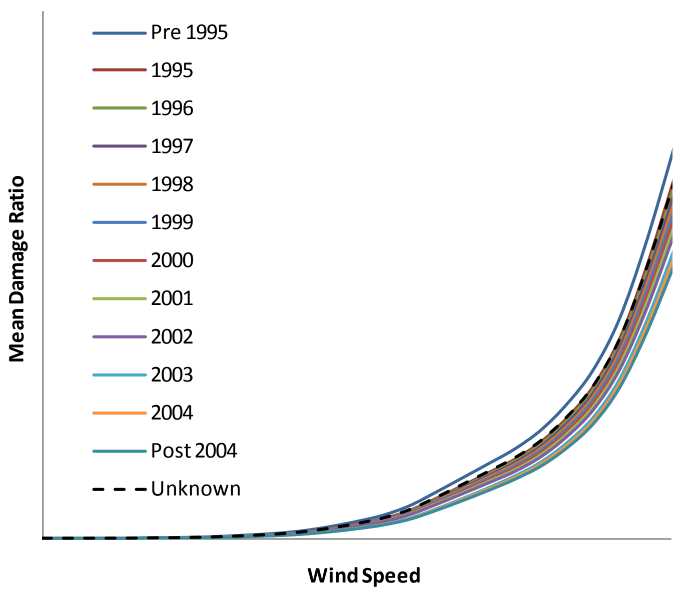


Figure 67. Year built damage functions for a commercial reinforced-concrete structure in Wilmington, North Carolina

Building codes include design wind speed specifications, which may vary by location. For example, wind-debris zone requirements are defined either based on design wind speed (i.e., >110 mph) or distance to coast (i.e., one mile from the coast). To account for this, vulnerability can vary by latitude and longitude in the AIR model; that is, vulnerability may be different for locations within a ZIP Code.

Prior to Hurricanes Hugo (1989) and Andrew (1992), building codes mainly focused on the wind design of the Main Wind Force Resistant System (MWFRS) of a structure. Damage from these events brought attention to the importance of the building envelope, including the roof covering. In the mid-1990s, changes such as roof-shingle testing and roof-sheathing connection testing were introduced. Glazing standards were also updated, but these standards were only used in the South Florida Building Codes until the ICC codes were released in 2000. Prior to 1995, building codes were mandatory in only a few states. Currently, most states have enacted statewide, mandated building codes. However, there is significant variation in the model code adoption over time in different states. To account for this, vulnerability varies by year built and construction for a region in the model (Table 9).

Table 9. Temporal vulnerability changes by region and construction type

		Vulnerability Changes for Non-Engineered Structures			Vulnerability Changes for Engineered Structures		
State	**Counties**	**None***	**Changes Annually**	**None**	**None**	**Changes Annually**	**None**
Florida	All	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered		
Texas	All	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered		
Louisiana	St. Tammany, Cameron, Vermilion, Iberia, St. Mary, Terrebonne, Lafourche, Jefferson, Plaquemines, St. Bernard, Orleans Counties	≤ 1994	1995 - 2004	2005 - 2006, ≥ 2007	≤ 1994	1995 - 2004	2005 - 2007, ≥ 2008
	Rest of the State	≤ 1994	1995 - 2004	2005 - 2007, ≥ 2008	Same as Non-Engineered		
Mississippi	Jackson, Harrison, Hancock, Stone and Perl River counties	≤ 1994	1995 - 2004	2005 - 2006, ≥ 2007	Same as Non-Engineered		
	Rest of the State	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered		
Alabama	Mobile	≤ 1994	1995 - 2004	≥ 2005	≤ 1994	1995 - 2004	2005 - 2007, ≥ 2008
	Baldwin	≤ 1994	1995 - 2004	2005 - 2007, ≥ 2008	Same as Non-Engineered		
	Rest of the State	≤ 1994	1995 - 2004	≥ 2005	≤ 1994	1995 - 2004	2005 - 2007, ≥ 2008
Delaware	Sussex County, DE	≤ 1994	1995 - 2005	≥ 2006	Same as Non-Engineered		

	Kent County and New Castle County, DE	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered
Georgia	All	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered
South Carolina	All	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered
North Carolina	All	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered
Virginia	All	≤ 1994	1995 - 2005	≥ 2006	Same as Non-Engineered
Maryland	All	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered
New Jersey	All	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered
Connecticut	All	≤ 1994	1995 - 2005	≥ 2006	Same as Non-Engineered
Rhode Island	All	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered
Massachusetts	All	≤ 1994	1995 - 2004	2005 - 2008, ≥ 2009	Same as Non-Engineered
New Hampshire	All	≤ 1994	1995 - 2004	2005 - 2006, ≥ 2007	Same as Non-Engineered
Maine	All	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered
New York	All	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered
Illinois	All	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered
Indiana	All	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered
Missouri	All	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered
Arkansas	All	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered
Kentucky	All	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered
Ohio	All	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered
Oklahoma	All	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered
Pennsylvania	All	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered
Tennessee	All	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered
Vermont	All	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered
West Virginia	All	≤ 1994	1995 - 2004	≥ 2005	Same as Non-Engineered

*None indicates no changes, or no variation in vulnerability for structures built on or before the year indicated.

Non-Engineered and Engineered Structures

Building code requirements depend on the occupancy, construction, and height of a structure. Furthermore, key building features may vary with construction, occupancy, and height class. For example, the roof-to-wall connection is an important feature in a low-rise structure, whereas for a high-rise structure, the roof-to-wall connection is not as important as other features, such as glass type and percentage.

Two types of building classes are used in the model to capture the difference in building code requirements: non-engineered and engineered structures. Engineered structures are typically high-rise commercial and apartment buildings constructed with reinforced concrete and steel. These structures have typically been designed with a high level of engineering attention. Non-engineered structures are typically low-rise residential and commercial structures that have been designed with a lower level of engineering attention. Table 10 summarizes how non-engineered and engineered structures are defined in the model, based on occupancy, construction, and building height.

Table 10. Definition of non-engineered and engineered construction

<table>
<tr><th>Occupancy Codes</th><th>Construction Codes</th><th>Height Class</th><th>Temporal-Spatial Vulnerability</th><th>Building Class</th></tr>
<tr><td rowspan="6">300, 301-319, 331-346</td><td>101-120</td><td>Any Height</td><td>Yes</td><td>Non-Engineered</td></tr>
<tr><td>131-140, 151, 153-183</td><td>Any Height</td><td>Yes</td><td>Engineered</td></tr>
<tr><td>152, > 184, 261</td><td>Any Height</td><td>No</td><td>-</td></tr>
<tr><td rowspan="3">100</td><td>1 – 3 Stories</td><td>Yes</td><td>Non-Engineered</td></tr>
<tr><td>> 3 Stories</td><td>Yes</td><td>Engineered</td></tr>
<tr><td>Unknown Height</td><td>Yes</td><td>Non-Engineered</td></tr>
<tr><td>321-330*, > 351</td><td>Any Construction Class</td><td>Any Height</td><td>No</td><td>-</td></tr>
<tr><td>All Occupancies</td><td>200 Series</td><td>Any Height</td><td>No</td><td>-</td></tr>
<tr><td>400 Series</td><td>Any Construction Class</td><td>Any Height</td><td>No</td><td>-</td></tr>
</table>

* For the 321-330 series occupancy codes, only the Unknown construction class (100) should be used

5.4 The Individual Risk Module

The AIR Hurricane Model for the United States contains an Individual Risk Module, which identifies key building features or characteristics that may significantly exacerbate or mitigate losses. This module was developed based on structural engineering expertise and building damage observations made in the aftermath of actual hurricanes.

The IRM follows a structured, logical approach that groups building characteristics according to their function to reflect the contribution of each to overall building performance. The AIR model first estimates secondary risk modifiers corresponding to the secondary risk characteristics, and these modifiers are then applied to the base damage functions to reflect the effects that a wide variety of building characteristics have on a building's performance during a hurricane. Weighting factors are used to combine the effects of features whose interaction is complex and not necessarily additive.

Examples of individual risk modifiers in the model include roof pitch, roof anchorage, and roof age. The geometry of a roof affects the wind pressure intensity it is subjected to and its ability to resist uplift; the steeper the slope, the lower the uplift load. Roof anchorage systems, such as hurricane straps, establish a path by which wind loads can be transferred from the roof to the walls. A building that has hurricane straps is likely to experience less damage than a building with no hurricane straps. An older roof would be more prone to damage than a newer one, as older roofs lose their ability to resist wind loads because of weakened attachments between their various components and the presence of older materials that may have deteriorated over time.

Another secondary risk characteristic is the Seal of Approval, which accounts for the level of professional engineering attention given to the construction of a structure. This characteristic accounts for the differing impact the same class of mitigation features may have on the vulnerability of a structure. For example, the impact of a roof-to-wall connection may be much higher for a home where a high level of engineering attention was paid during construction than for a home where there was minimal engineering attention paid during construction. Note that while this feature distinguishes the impact of a mitigation feature, it will not change the vulnerability of a structure with poor building features. Even when building codes are mandatory, the level of engineering participation during the design and construction of a structure can vary by region.

Please refer to the document titled *The AIR U.S. Hurricane Model: Accounting for Secondary Risk Characteristics*, which is available on the AIR website, and Section 8.7 of this document for more information regarding these secondary modifiers.

Note that the AIR model's builders risk line of business is treated similarly to individual risks in the software. Details about the development of the builders risk line of business are provided in Section 5.11; information about the implementation of this line of business in the software is reviewed in Section 8.7.

5.5 Storm Surge Damage Functions

Damage from storm surge can account for a significant portion of total hurricane losses. The AIR Hurricane Model for the United States simulates the abnormal sea-level rise accompanying hurricane activity and estimates the maximum surge depth experienced at each coastal location using high resolution digital elevation data.

While the intensity parameter used in the storm surge component of the AIR model is water depth, the nature of damage from storm surge is quite different from the damage caused by standing water. Therefore, the model's damage functions take into account damage due to the momentum of the water, as well as damage due to the water itself. This is accomplished by calibrating the damage functions to the dynamic forces of the moving water, which is proportional to water velocity squared, while water velocity is proportional to the square root of water height. Observation data available from FEMA and the Army Corps of Engineers was used in the development of the model's surge damage functions. The damage functions have been validated through findings from AIR's post-disaster surveys and loss experience data.

Building damage from storm surge is modeled as a function of construction type, height, and occupancy. Building height is a significant variable in surge damage estimation as lower stories are more vulnerable. AIR's storm surge damage functions explicitly account for building height.

Table 11 shows the height bands supported for selected construction and occupancy types. Both contents and time element damage are functions of construction, height, and occupancy. For time element, the model estimates the effective downtime (days of loss of use) before the facility is restored or usable.

Table 11. Height bands supported for selected construction and occupancy classes

<table>
<tr><th rowspan="2">Occupancy Codes</th><th rowspan="2">Construction Class</th><th rowspan="2">Construction Codes</th><th colspan="4">Building Height</th></tr>
<tr><th>Low</th><th>Mid</th><th>High</th><th>Unknown</th></tr>
<tr><td rowspan="8">300-373 (excluding 321-330)</td><td>Wood Frame</td><td>101-104</td><td colspan="4">Same vulnerability for all height bands</td></tr>
<tr><td>Masonry</td><td>111-119</td><td>1-3</td><td>4-7</td><td>>7</td><td>0</td></tr>
<tr><td>Concrete</td><td>131-135, 137</td><td>1-3</td><td>4-7</td><td>>7</td><td>0</td></tr>
<tr><td>Steel</td><td>151,153-155</td><td>1-3</td><td>4-7</td><td>>7</td><td>0</td></tr>
<tr><td>Mobile Homes</td><td>191-194</td><td colspan="4">Same vulnerability for all height bands</td></tr>
<tr><td>Wind Resistive</td><td>181-183</td><td>1-3</td><td>4-7</td><td>>7</td><td>0</td></tr>
<tr><td>200 Series</td><td>201-261</td><td colspan="4">Same vulnerability for all height bands</td></tr>
<tr><td>Unknown</td><td>100</td><td>1-3</td><td>4-7</td><td>>7</td><td>0</td></tr>
<tr><td>321-330*</td><td>All</td><td>All</td><td>1-3</td><td>4-7</td><td>>7</td><td>0</td></tr>
<tr><td>400-482</td><td>All</td><td>All</td><td colspan="4">Same vulnerability for all height bands</td></tr>
</table>

* For the 321-330 series occupancy codes, only the Unknown construction class (100) should be used

Figure 68 shows relativities for AIR storm surge damage functions for the General Commercial occupancy for different height categories and construction types. Note that the damage functions for wood frame structures do not vary by height.

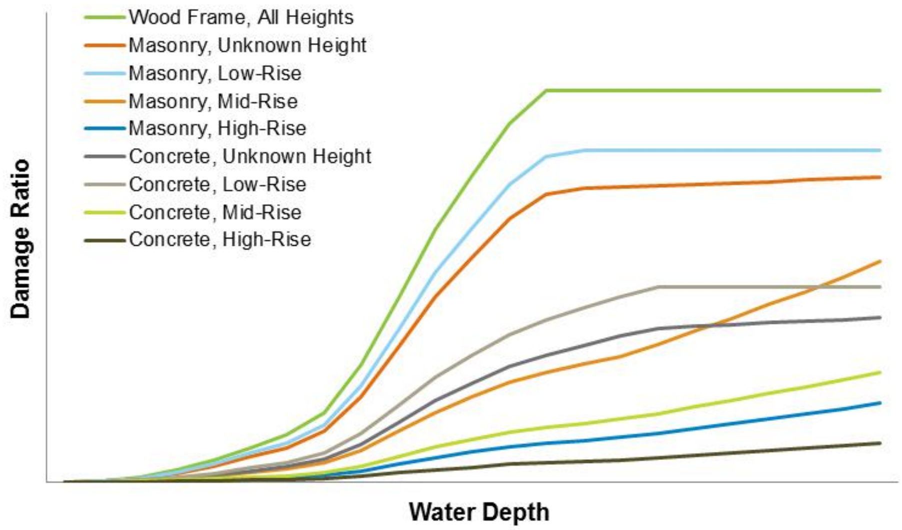


Figure 68. Storm surge damage functions for different height and construction categories, general commercial occupancy

Please note that storm surge damage functions do not vary by region or year built. There are no secondary risk features supported for the storm surge model.

5.6 Damage Functions for Unknown Construction/Occupancy/Height Classes

The AIR model supports buildings of unknown occupancy, construction, and height, and accounts for regional variation in vulnerability when these risk characteristics are unknown. Wind and storm surge damage functions for all combinations of unknown construction, occupancy, and height classes were developed as weighted averages of the damage functions for buildings for which these characteristics are known, with a building-inventory weight derived from the industry exposure database. Different damage functions are used depending on how many variables, and which ones, are unknown.

For example, the damage function for a particular exposure of known construction and occupancy, but unknown height, would be a weighted average of the damage functions, for the same construction and occupancy classes, corresponding to all the different height classes. The damage function for a particular exposure of known occupancy, but unknown construction and height, would be a weighted average of the damage functions for the same occupancy class corresponding to all combinations of construction and height classes.

As discussed earlier, building inventory distribution changes by region; for example, masonry construction dominates the building inventory in Florida, whereas Louisiana has mostly wood frame construction. In developing these damage functions, states with similar building inventory in the industry exposure database were combined, resulting in six regions with distinct inventory breakdowns. These regions are illustrated in Figure 69 and listed in Table 12. These regional building inventory distributions were then utilized to derive region-specific damage functions for buildings of unknown construction, occupancy, or height classes.

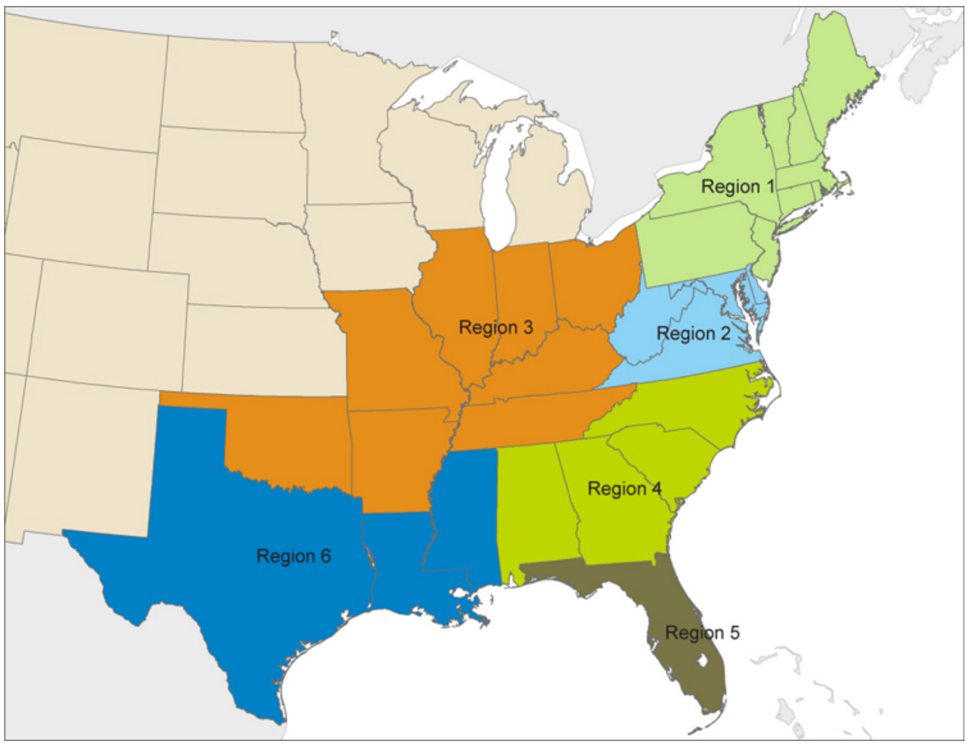


Figure 69. Hurricane-prone regions of similar building inventory in the United States

Table 12. Building Inventory Regions in the United States

Region	States
Region 1	Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New Jersey, New York, and Pennsylvania
Region 2	Delaware, Maryland, Washington D.C., Virginia, and West Virginia
Region 3	Ohio, Kentucky, Tennessee, Arkansas, Oklahoma, Illinois, Indiana, and Missouri

Region 4	North Carolina, South Carolina, Georgia, and Alabama
Region 5	Florida
Region 6	Louisiana, Mississippi, and Texas

The total regional inventory distribution was used to develop these damage functions for each state in a particular region, so all states in that region will have the same damage functions for buildings of unknown construction, occupancy, or height classes. Similarly, these damage functions will differ for two states if they are located in different regions. For the building inventory shown in Figure 70, the unknown construction damage function for the state of Florida is closer to the damage function for masonry construction, whereas for Louisiana, it is closer to the damage function for wood frame construction. For both the wind and storm surge perils, damage functions for any combination of unknown construction/occupancy/height are supported for all states listed in Table 12.

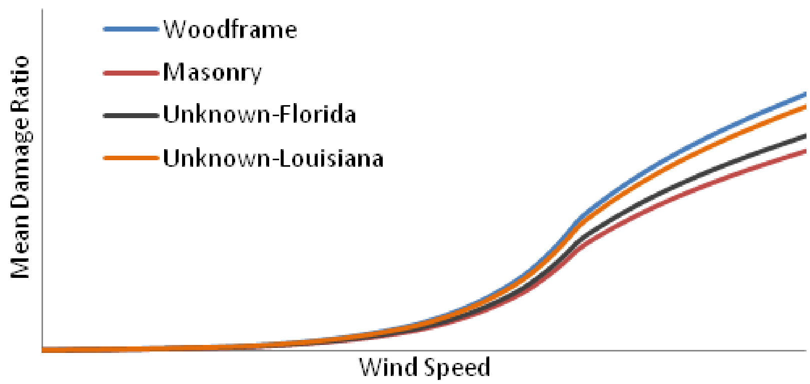


Figure 70. Unknown construction damage function for Florida and Louisiana

When the year built of the structure is not known, the model calculates an unknown year built damage function by applying an exposure-weighted distribution to the corresponding damage functions for each year built. Note that when year built is unknown, data for all states is used and not merely the states listed in Table 12. The exposure distribution varies by state to take into account regional variability in the building stock. For example, construction in the Northeast is typically older than construction in the Southeast. Damage functions for unknown year built are calculated at the ZIP Code centroid and do not vary within a given ZIP Code.

5.7 Contents Damage Functions

The contents damage ratio is the dollar loss to the contents divided by the replacement value of the contents. The AIR model calculates contents damage separately from building damage, since some policies cover contents only and some building policies provide no contents coverage.

The main cause of contents damage is wind-driven rain after the building envelope is breached. Thus significant damage to contents is not likely to occur unless there is significant damage to the roof covering, loss of roof decking panels, or window failure. For most of the wind-speeds observed during hurricanes, the modeled contents damage ratio for single-family homes is lower than the modeled building damage ratio. This is borne out in claims data.

Claims data from the 2004 and 2005 hurricane seasons indicated that contents vulnerability for homeowners has decreased significantly in recent years. There are several possible reasons for the decrease in contents damage, including:

- Advances in hurricane forecasting are giving homeowners more time to secure valuables and take mitigating actions, such as boarding up windows
- Improved claims adjustment practices are reducing hurricane losses
- Post-event mitigation programs, such as the Army Corps of Engineers' "Operation Blue Roof," are helping to prevent further damage to contents after the building envelope has been breached
- Although contents value is typically estimated as a percentage of building value, the value of contents is not increasing at the same rate as building values are increasing

While claims data indicates lower contents vulnerability for homeowners, data and research indicate higher contents vulnerability in apartments and commercial properties. Even if building damage is minimal, water may enter unsealed openings and gaps around windows and doors to damage contents in apartment and commercial properties. Recent damage reports indicate that even relatively small holes in a damaged roof may cause significant damage to contents in commercial properties.

5.8 Time Element (Business Interruption) Damage Functions

In the case of time element, the damage ratio represents per-diem expenses or business interruption losses associated with the expected number of days that the building is uninhabitable (for residential structures) or unusable (for commercial).

Time element damageability for residential construction is a function of the mean building damage and the time it takes to repair or reconstruct the damaged building. Implicit in the time to make repairs is damage to the infrastructure. Published building construction/restoration data and expert engineering judgment have been used to establish the functional relationship between building damage and loss of use.

For major events, business interruption (BI) losses can account for a significant proportion of total commercial losses. Analyses of claims data from clients and ISO confirmed that building damage alone cannot explain total BI losses. Thus the approach implemented in the AIR Hurricane Model for the United States accounts not only for building damage, but also for building characteristics such as size, contents, and complexity of the building system, and business characteristics such as the potential for relocation or for continued operations while repairs are underway (Figure 71). The model also captures complex BI policy features, including extra expense, civil authority, dependent building damage, and extended period coverage.

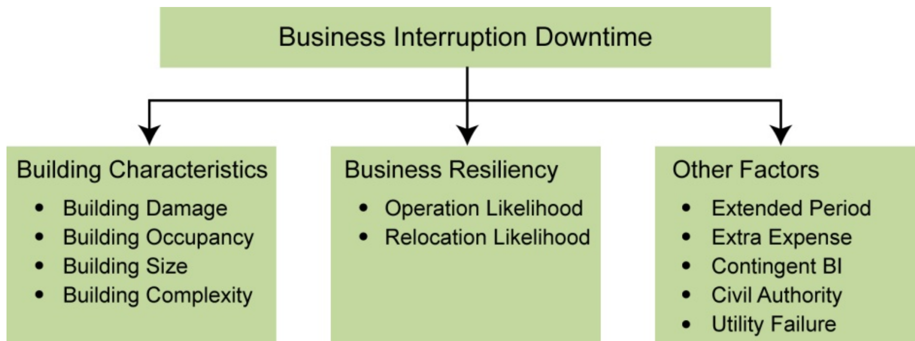


Figure 71. Modeled factors determining business interruption downtime

The methodology does not require any additional input from the user, but instead uses existing input variables such as occupancy and characteristics of typical BI policies to model total BI losses for any given occupancy and the variation in BI losses across different occupancies.

Understanding Business Interruption Coverage and Inputs to the AIR Model

BI coverage is more complex than property coverage from an underwriting perspective. Different ISO policy forms exist for small and large businesses. BI coverage is included in the Business Owner Policy form, which is used by small to mid-sized businesses. For other businesses, the separate business income form CP 00 30 is used. Individual insurance companies may depart to some extent from the standard ISO forms, but fundamentally all of the forms are similar.

Business income has two primary components: (a) net income that a business will lose due to disruption and (b) normal expenses that must be paid even if the business is not operating. Underwriting guidelines recommend the use of business interruption worksheets (e.g. ISO CP 15 15 06 95 or its equivalent) to determine the business income exposure for each covered location in the event of a disaster.

Business interruption at a location can occur for a variety of reasons, and how much is recoverable from insurance depends upon the policy conditions. Direct BI occurs if there is physical damage to the insured building for the covered peril. In fact, these policies require that physical damage must cause the suspension of the business and there must be a loss due to the suspension.

However, business interruption can occur even when there is no physical damage to the insured building. The building may be inaccessible due to curfew, for example, or there may be business interruption at a dependent building such as a supplier of a necessary input, or electrical or water outages may prevent the resumption of operations. Indirect BI (which for purposes of the discussion herein includes BI due to damage to dependent buildings, and civil authority and utility failure) is not automatically covered under all BI polices; these optional coverages are available by endorsement for an extra premium.

Since BI losses can be triggered in a variety of ways and there are complex policy conditions to establish a BI loss, claims settlements can be quite complex. As a result, modeling BI losses is similarly challenging. Certain logical assumptions based on the limited available data are made to model the impact of typical BI coverage features. These assumptions were derived from Applied Technology Council (ATC) documents, construction reports from the U.S. Census Bureau, building size data from the U.S. Department of Energy, insurance and social sciences literature, damage reports, and claims data. Additional references are provided at the end of this document.

Estimating Business Interruption Downtime[16]

Downtime, or the number of days before the business can return to full operation, is the primary parameter in estimating business interruption losses. Figure 72 illustrates the "event tree" approach the model uses to estimate mean business-interruption downtime. For comparison purposes, Figure 72 also highlights hypothetical event paths for an office and hotel. The event tree shows the sequence of events that can occur in a system. For example, an office building is likely to take a different path to recovery than a hotel, and hence it will have a different downtime in the event of interruption hurricane.

[16] See the AIR research paper "Modeling Business Interruption Losses for Insurance Portfolios," *Proceedings of the 11th Americas Conference on Wind Engineering*, San Juan, Puerto Rico, June 22-26, 2009. Available at: http://www.iawe.org/Proceedings/11ACWE/11ACWE-Jain.Vineet1.pdf

The model calculates downtime for each stage of the damage assessment and recovery process. The first stage, pre-repair, is the time before repairs can get underway. The damage must be assessed, the repair cost negotiated with the contractors, and the building permit obtained. The next stage is the repair period. Some businesses choose to relocate rather than wait for repairs, but relocation takes time as well. Once repairs are completed, revenues may not immediately resume at the pre-disaster level; it may take some time to regain market share, or to rebuild a labor force that may have found employment elsewhere.

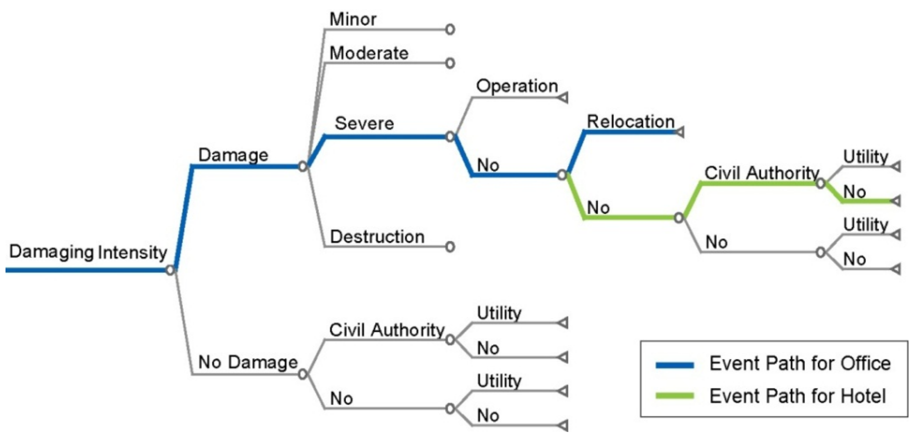


Figure 72. Hypothetical event tree for office building and hotel

The estimated number of days needed to restore the business to full operation depends on a number of key factors, including the level of damage sustained, the size of the building (square footage) and its architectural complexity.

For a given damage ratio, a 25,000-square-foot hotel will take significantly longer to repair than a 5,000-square-foot professional office. For a given square footage, buildings with significant architectural complexity will also take more time to repair. Warehouses can be quite large, but repairs are likely to take place quickly because of their architectural simplicity. Interior finishes must also be taken into account. Hotels are not only typically larger than office buildings, but can take more time to repair due to the higher quality of interior finishing.

Some types of businesses, such as hospitals, are more resilient than others and may be able to restart operations before repairs are complete, or they may have had disaster management plans in place that allow them to relocate quickly. For other businesses, such as hotels, location is critical and relocation is not an option. Since many parameters (e.g., building size, complexity, and business resiliency) that play an important role in determining business interruption are generally not available for input into the model, occupancy class is used as a proxy to determine these parameters.

Occupancy is also used to estimate the probability that there may be business interruption at a dependent building within the storm footprint—such as the supplier of a necessary manufacturing input—that will exacerbate BI losses at the principal building. Estimation of the impact of the dependent building's damage on the principal building requires the knowledge of the location and the degree of interdependence between the dependent and principal buildings. Since this level of detailed information is generally not available, logical assumptions are made to estimate the impact of the dependent building on the principal building's downtime.

Once the damage state of the dependent building is estimated as a function of the principal building's damage state, BI losses are calculated based on the maximum of BI downtime associated with the damage states of the principal and dependent buildings. This assumption implies that the impact of the dependent building damage is more significant at lower principal-building damage states than at higher damage levels of the principal building. A similar logic-based approach is used to estimate the impact of civil authority and utility failure on the downtime of the principal building. Downtime is also adjusted to account for BI policy conditions such as limited ordinary payroll, extra expense, and the extended business income coverages.

Figure 73 shows sample mean BI curves for three occupancies, hotels, offices, and hospitals. Not only is the mean BI downtime different for different occupancies for a given mean building damage ratio, the relativity between occupancies varies as a function of building damage ratio. That is, repair time, which is a function of building size and complexity, determines the shape of the BI curve for all levels of building damage.

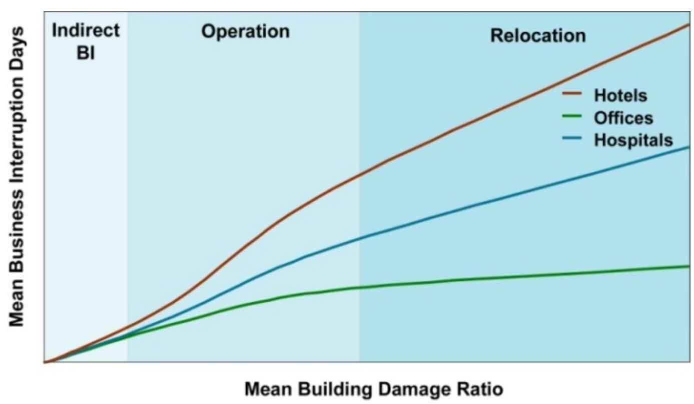


Figure 73. Impact of factors determining business interruption downtime varies with occupancy and severity of building damage

However, the impact of the many determining factors varies with the degree of building damage. For example, the impact of indirect BI and other factors such as extra expense on the shape of the BI curve is particularly important at low levels of damage. At moderate levels of building damage, the likelihood of continued operation while repairs are underway determines the shape of the BI curve. As building damage increases and continued operation becomes less likely, the impact of relocation on the BI curve increases. Office buildings are likely to be relocated at a certain level of building damage, so the BI curve does not change with increasing damage beyond that point. However, as it is unlikely that a hotel or hospital will be relocated, the BI curve increases with increasing levels of building damage for these occupancies. Thus at higher levels of building damage, relocation becomes the determining factor in estimation of the BI curve.

Figure 74 shows, for different mean damage ratios, the modeled BI damageability of selected occupancies relative to the general commercial occupancy.

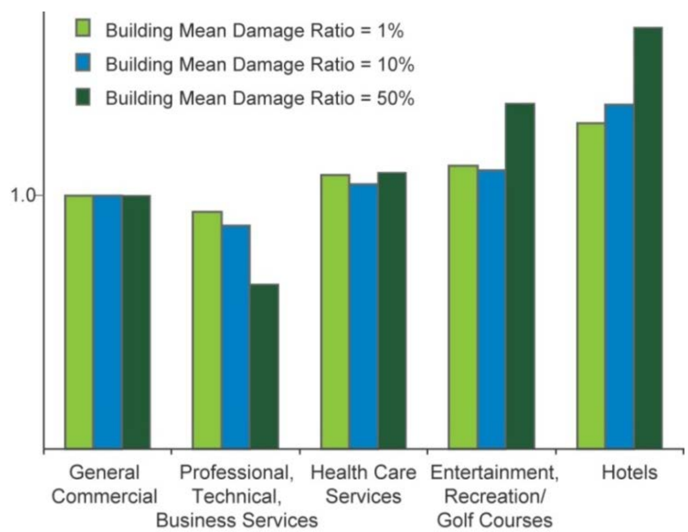


Figure 74. Relativity of business interruption damageability across commercial occupancies

The methodology for calculating BI losses relies in part on expert judgment in the face of limited available exposure data, but it has been rigorously calibrated using detailed claims data from recent hurricane experience.

Note on the Importance of Business Interruption Exposure Data Quality

Two key user inputs are needed to model direct BI losses: BI exposure value and the number of days associated with the exposure. That is, business income exposure is generally defined in terms of dollars per unit of time. For example, a business may generate USD 1 million in business income exposure per year, or 1/365 million USD per day. If USD 1 million is entered as the business income exposure, 365 must be entered for the number of days. If a user enters 1/365 million for business income exposure, 1 day must be entered as the number of days. The per-diem exposure, together with the modeled estimated number of days of downtime, provides an estimate of BI loss.

The model estimates the number of days of downtime as a function of building and contents damage, occupancy, size and complexity, business resiliency and other factors discussed above. Ground-up losses are calculated by multiplying BI exposure per day by the number of downtime days. Note that when calculating BI losses, the occupancy field, and not the gross area, is used as a proxy for building size.

As is the case with building replacement values, high quality BI exposure data is essential for generating reliable loss estimates. In the course of AIR's continuing audits of client exposure data, it has become apparent that large numbers of locations have very low BI/day values. In most cases, business interruption limits have been entered as annual BI exposure. Exacerbating the problem, AIR also found evidence of the use of loose "rules of thumb" to determine the BI limit, rather than the use of BI worksheets for each location in multi-location policies. Finally, AIR found evidence of a general underestimation of the number of locations that may sustain damage in a catastrophe. AIR cautions that these problems with BI exposure data quality will result in significant underestimation of BI losses.

5.9 Automobile Damage Functions

The AIR damage function for automobiles is developed based on actual loss data and expert judgment. The estimation of hurricane losses for the automobile line is challenging due to the nonstationary nature of the exposure and the uncertainty with respect to the public response in advance of hurricane landfall, which can vary by region and over time.

Automobile damage functions take into account peril-specific damage mechanisms, such as the impact of windborne debris. Water damage from storm surge is calculated separately. To the extent that the damage functions have been calibrated to aggregate losses for historical events, the model implicitly captures the evacuation of automobiles prior to a storm's arrival.

5.10 Pleasure Boat and Yacht Damage Functions

The AIR Hurricane Model for the United States explicitly accounts for the effects of tropical cyclone-induced storm surge and winds on pleasure boats and yachts.

Damage to pleasure boats is a function of both wind and storm surge (flood is not included). Damage from high winds can affect components on a boat or force it to break loose from its moorings. Airborne debris can also damage boats. Storm surge can cause water levels to rise to a point where boats float free, sometimes allowing them to be impaled by submerged pilings. Boats that become undocked and are blown further by the wind can collide with anything in their erratic path, including other marine craft, docks, pilings, or the ground. This can damage many components of the boat including the hull, which increases the possibility of sinking. The uncertainty in damage is accounted for by using a hybrid of distributions of the probabilities of given percentages of damage.

Wind and storm surge are highly correlated making it difficult to separate the damage due to each. To account for this, a weighted combination of the wind and surge mean damage ratios is used for boat damage functions, depending on the location. For some locations, no surge is included. In general, as the modeled surge level increases, the surge function attains more weight since it is a more damaging peril than wind.

Boat Characteristics

The size, type, and age of a boat all affect its vulnerability. In terms of boat type, the model includes damage functions for sail and motor-powered pleasure boats and yachts, as well as for those whose source of power is unknown. Different style boats contain distinct components that are vulnerable to damage. For example, sailboats have additional components (i.e. sails, masts, and riggings) as compared to power boats. The addition of these extra components means not only do sailboats have more components at risk of tropical cyclone damage, but also these components increase the force of intense winds on the overall boat structure, further increasing the boats vulnerability compared to power boats.

Boat length is accounted for using four different size, or length, categories included in the damage functions: small (up to 26 feet), medium (26-50 feet), large (over 50 feet), and unknown. While smaller boats are easier to trailer and remove from the water before a storm strikes, they tend to suffer more damage than larger boats when left in place. This is primarily due to the fact that larger boats are more likely to be under the care of a dedicated crew with a reliable procedure for securing the craft.

The year built is factored into the damage functions with different factors for the pre-1991 period, and then for every year from 1991 until 2010. The amount of wear and tear on a boat increases with age, due to exposure to the elements as well as prolonged use. Boat owners also tend to invest more towards protecting newer boats.

Figure 75 illustrates the relative vulnerability for different types, sizes, and ages of boats based on data from pleasure boat and yacht damage in the United States following historical hurricanes.

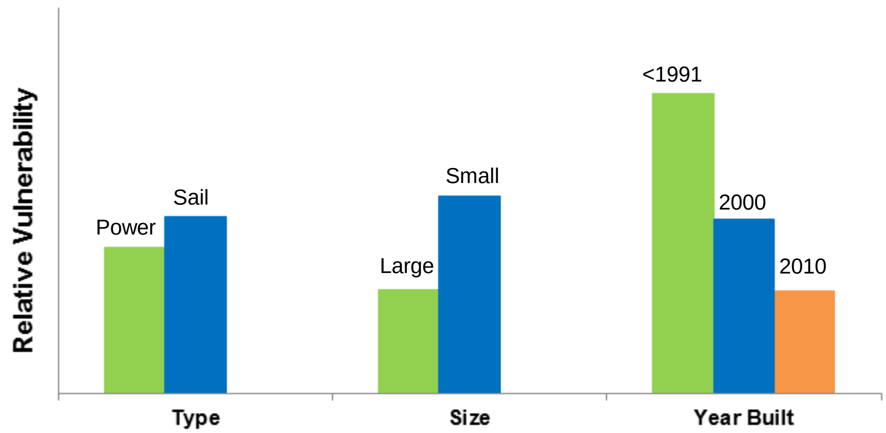


Figure 75. Relative vulnerability for different boat characteristics

Mitigation Factors

Boat damage can be mitigated by transporting the vehicles out of the water and into dry stack storage, or moving them to inland water areas such as canals. Another mitigation technique is to moor boats to a floating dock, as floating docks change height in high waves along with the boat, decreasing the likelihood of boats being torn from their moorings. The effects of mitigation are implicitly captured in the model to the extent that such practices are represented in the actual reported losses used for validation purposes.

5.11 Builders Risk

The builders risk line of business determines potential losses resulting from tropical cyclone wind and storm surge damage to buildings while they are still under construction. Modeling builders risk is supported for the majority of the 100-series construction classes and 300-series occupancy classes included in the model, for all height and age bands. Note that contractor equipment is not modeled under builders risk; it is modeled using existing construction and occupancy classes.

In the AIR Hurricane Model for the United States, builders risk can be modeled as a secondary risk modifier. Users are required to input policy start and end dates to estimate losses for different construction phases, average annualized project loss, and worst-case loss. For more information about user requirements and loss calculation, see Section 9.7.

To develop damage functions for buildings whose replacement value and vulnerability vary during construction, AIR engineers conducted extensive structural analyses of buildings, for each occupancy and construction class, during the four phases of construction (see Table 13). These functions were developed for two classes of construction type: engineered and non-engineered. For these analyses, AIR used statistical data from RS Means 2011 (Reed Business Information), United States Construction 2010 Census, and the National Building Construction Manual for 2009.

Table 13. Building phases during construction

Building Phases	
I Foundation and Substructure	III Walls and Roofing
II Superstructure	IV Finishing, Mechanical and Electrical Installation

Duration of Building Phases

The building phases overlap one another, with the timeline of each dependent on the type of building. For commercial buildings, phase IV will be much longer than it would be for residential ones. To determine the phase duration, AIR engineers used engineering cost estimation data, project duration data, and input from construction management engineers. Figure 76 shows an example of the phase timeline for a mid-rise (four to seven stories) commercial building. The duration for each phase is presented as a percentage of the total amount of time to complete a building.

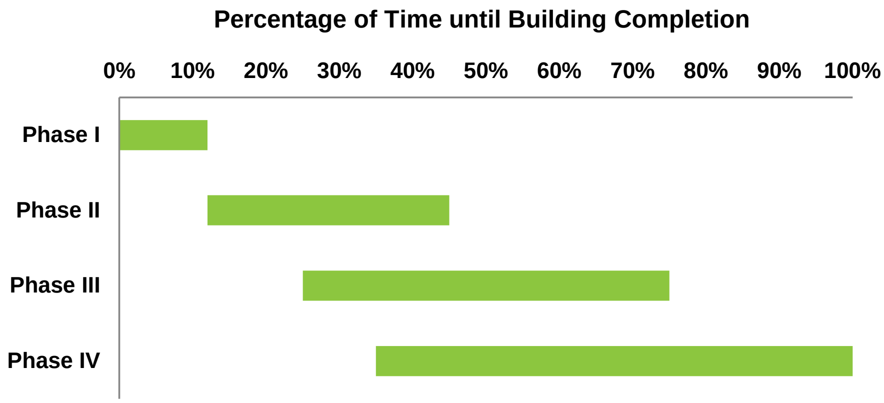


Figure 76. Duration of phases for a mid-rise commercial building

AIR engineers also took into consideration the subcomponents at each phase. For example, to determine the vulnerability curves for phase III, the vulnerability of the roofing, windows, and exterior walls were all considered. Figure 77 illustrates the duration of some of the subphases for a mid-rise commercial building. The figure includes the duration and overlap of the main four phases, illustrating how the many subphases are included in more than one main phase.

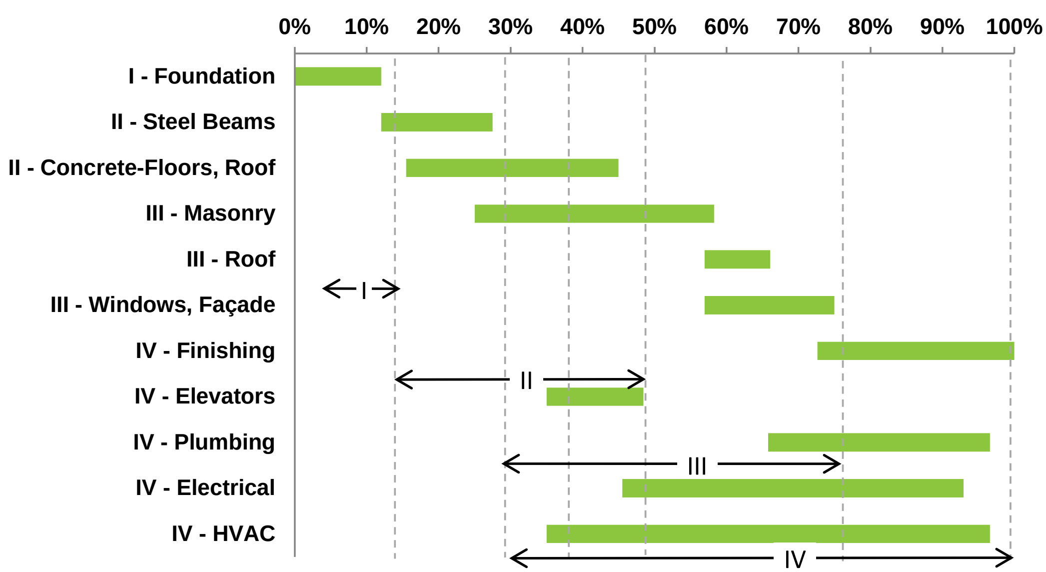


Figure 77. Duration of some sub-phases for a mid-rise commercial building

Variations in the Replacement Value during Construction

The relationship between the building cost, or replacement value, and project duration is captured in a cost ramp-up curve, which shows the evolution of a total project cost over time. The slope of this cost ramp-up curve is largely affected by building height and occupancy class[17] (the effect of construction class is negligible). Note that cost ramp-up curves remain constant across perils.

For example, the effects of height on building costs can be illustrated by examining the percentages of the total cost at each construction phase, for buildings of the same occupancy type at different heights. Table 14 compares the percentage of the total cost at each construction phase between apartment buildings of different heights. For each height band, the cost of each phase is presented as a percentage of the total cost; therefore, a change in the costs at particular phase causes the costs of other phases to be adjusted.

For low-rise buildings, the foundation and substructure account for a larger percentage of the entire building (and its cost) than they would for a mid-rise building. This is because the absolute cost of phase II in mid-rise buildings has a higher increase over phase I than it does for low-rise buildings, making the percentage of the phase I cost lower. The cost percentage for high-rise buildings is greater since these buildings require a more elaborate foundation than shorter buildings.

The cost percentages at phase II increase steadily with height, with a larger increase from phase I for taller buildings. This is to be expected since the columns and other elements of the superstructure are more elaborate for taller buildings than lower ones. It is also the reason for the decrease in the percentage of cost with height at phases III and IV. Due to the large increase in the costs of phase II for mid-rise and high-rise buildings, the percentages of the total cost at phases III and IV are diminished.

Table 14. Percentage of the total cost at each construction phase for apartment buildings of different heights

Construction Phase	Low-Rise (1-3 Stories)	Mid-Rise (4-7 Stories)	High-Rise (8+ Stories)
I Foundation and Substructure	6%	5%	7%
II Superstructure	9%	12%	13%
III Walls and Roofing	14%	12%	10%
IV Finishing, Mechanical and Electrical Installation	71%	71%	70%
All Phases	**100%**	**100%**	**100%**

[17] Only a subset of the model occupancies is supported in builders risk. The main occupancies modeled with unique phase durations are residential and commercial buildings; they do not include industrial facilities.

The cost ramp-up curve in Figure 78 shows the changes in the replacement value for commercial buildings of different heights. The sharp bend in the curves indicate the beginning of phase IV when the interior work occurs, mechanical and electrical systems are installed, and the finishing touches are applied. The replacement value then levels off slightly once the finishing touches begin since the costliest parts of this phase are complete at that time.

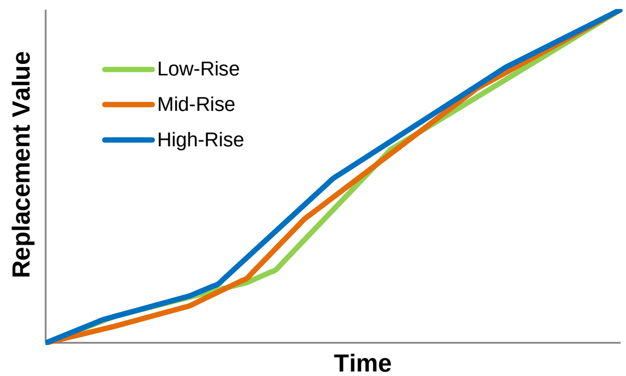


Figure 78. Changes in replacement value during construction of a commercial building, for different heights

Figure 79 compares the cost ramp-up curves for low-rise buildings of different occupancy classes. After phase IV, the curve ramps up more sharply for apartment buildings. Apartment buildings have a larger amount of interior work and finishing, which have to be done in each unit. In addition, the materials used for kitchens and bathrooms are of a higher quality than in commercial and industrial buildings. While commercial and industrial buildings have more wall partitions, facilities, and fixtures, the materials are not as costly as those in apartment buildings.

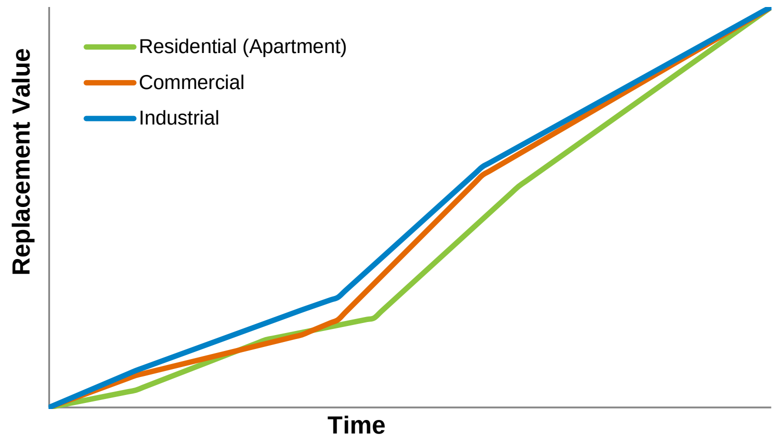


Figure 79. Changes in replacement value during construction of low-rise buildings with different occupancy classes

The various occupancy types within each class can have a significant effect on the variations in replacement value during construction, as shown in Figure 80. For example, phase IV of a hospital can take up a significant percentage of the total cost compared to other buildings, due to the extensive electrical and mechanical fittings that are required for a hospital. For other large structures, such as a wholesale trade centers, costs are more concentrated in phases II and III due to the extensive walls, roofing, and other elements of the superstructure. Phase IV is less important in these cases since the interior walls and fixtures are not as costly as in other buildings.

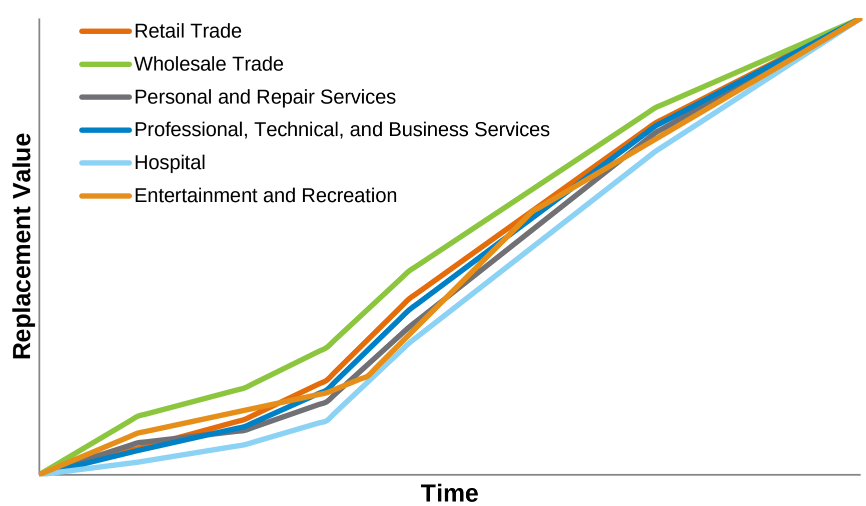


Figure 80. Changes in replacement value during construction of mid-rise commercial buildings with different occupancy types

Variations in Vulnerability during Construction

As building progresses, the changes in vulnerability must be considered along with the replacement value. The specific wind and storm surge effects on the building at the different building phases are detailed below.

Vulnerability to Wind

For each building phase, a structure's vulnerability to intense winds can vary significantly. At phase I, the building foundation is susceptible to wind-stress damage to the structure's columns and walls from high lateral loads. Wind-driven rain can also cause water pooling, debris accumulation, and improper drainage issues within the foundation, as well as subsidence of soil around the building area. At phase II, the building skeleton, from the roof to the flood deck, is at risk of wind damage from up-lift, as well as damage from air-borne debris. At this stage, non-engineered buildings can sustain major damage. It is important to note that a major jump in vulnerability occurs between phase I and phase II, since the most dramatic increase in construction occurs between these initial phases.

Wind damage to external building features such as cladding and windows is common during phase III. The wind damage observed during phase IV is similar to that of a completed building. Additional damage experienced in phase IV, in contrast to a completed building, may occur if exterior work such as installing roof top equipment, including exhaust hoods, is incomplete. Figure 81 shows the damage function for a mid-rise engineered commercial building.

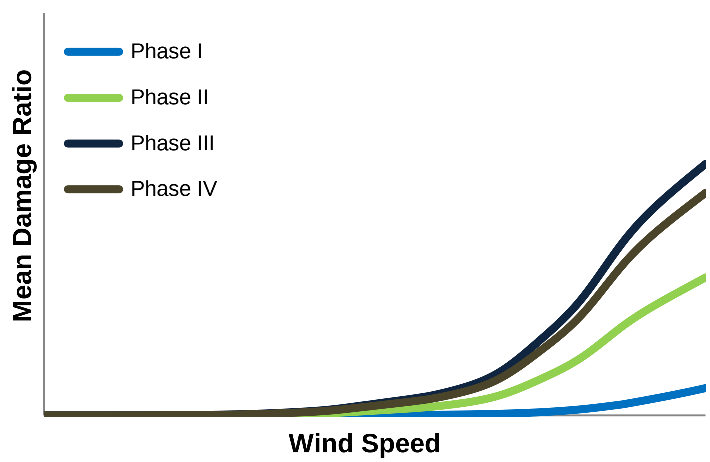


Figure 81. Wind damage functions by building phase for an engineered mid-rise commerical building

Vulnerability to Storm Surge

Similar to wind, the vulnerability of a building under construction to storm surge depth generally increases with building phase. At phase I, storm surge may erode and scour a building foundation, where a shallow foundation is more susceptible to damage. Storm surge can also stress building columns and walls, lead to water pooling, debris accumulation, and soil subsidence. The level of damage experienced at phase II is lower than that of phase I. At this point, storm surge waves are pounding into a building skeleton rather than a more vulnerable incomplete building foundation; phase II damage is largely debris-related. Types of surge damage observed in phase III are similar to that in phase II; one key difference includes damage to completed walls and the building interiors. At phase IV, potential building surge damage is similar to that of a completed building. Figure 82 shows a surge damage function by building phase for an engineered mid-rise commercial building.

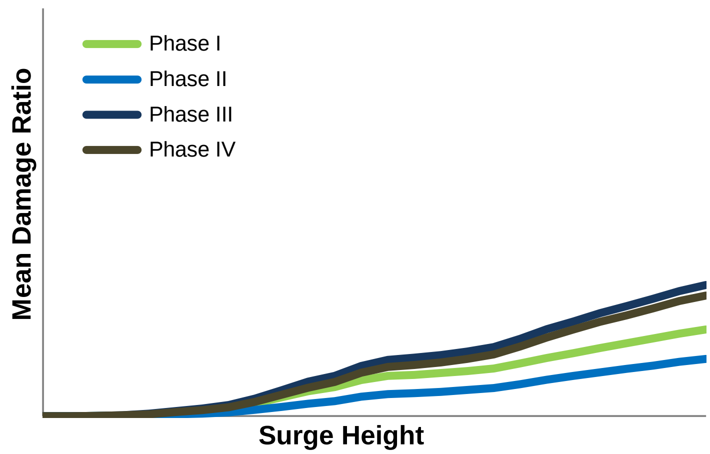


Figure 82. Surge damage functions by building phase for an engineered mid-rise commercial building

Modeling the Effects of Seasonality

To ensure accurate damage calculations for buildings under construction, the AIR Hurricane Model for the United States explicitly accounts for seasonality. In the model, each month in the hurricane season, June to November, has been assigned a hurricane frequency value. Note that all non-hurricane season months have been attributed a frequency of zero.

Using user input policy start and end dates, the model determines which construction phases overlap with the hurricane season for each project and then only calculates losses for those phases. During the loss calculation process, frequency is considered along with building phase, replacement value, and peril vulnerability.

5.12 Validating Damage Functions

The model's damage functions report the mean damage ratio for each level of intensity. Validating the damage-estimation component of the model is closely related to the validation of modeled losses. A discussion of modeled-loss validation can be found in Section 6.3.

Nevertheless, validating the relative vulnerability of different construction types and occupancy classes is a critical component in damage-function development. The AIR Hurricane Model for the United States leverages more than 20 years of experience in developing wind damage functions. The damage functions incorporate findings from published engineering research and analyses, and are validated through the analysis of billions of dollars of detailed claims data.

The analysis of post-disaster surveys conducted in the aftermath of hurricanes provides additional validation. AIR engineers have performed such surveys for every hurricane to make landfall in the United States since Hugo in 1989, and for several major storms in the Caribbean and Asia-Pacific regions. The relative vulnerabilities of different construction/occupancy/height combinations in the AIR damage functions are borne out by survey findings.

Figure 83, Figure 84, and Figure 85 illustrate one type of validation undertaken by AIR wind engineers. The figures compare simulated and actual damage ratios for single-family homes for damage functions for different coverages. The actual and simulated data compare well.

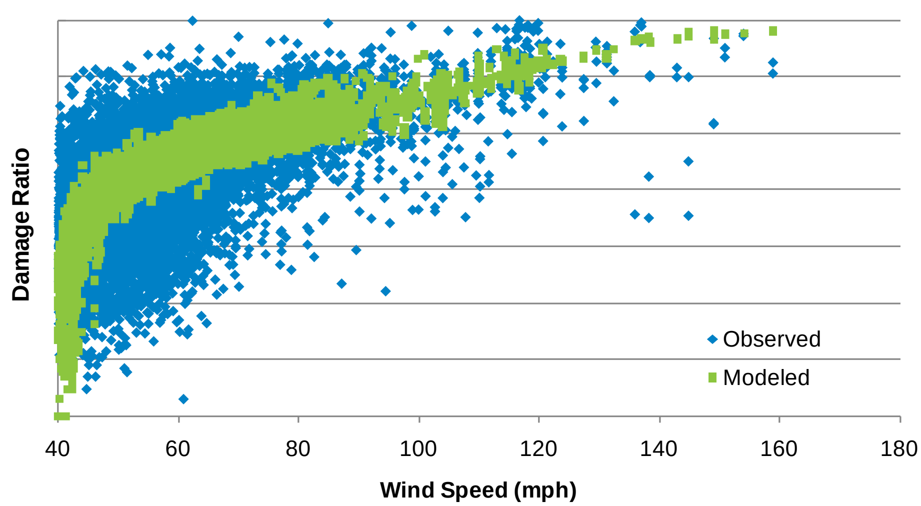


Figure 83. Observed and modeled damage ratios with wind speeds, Coverage A

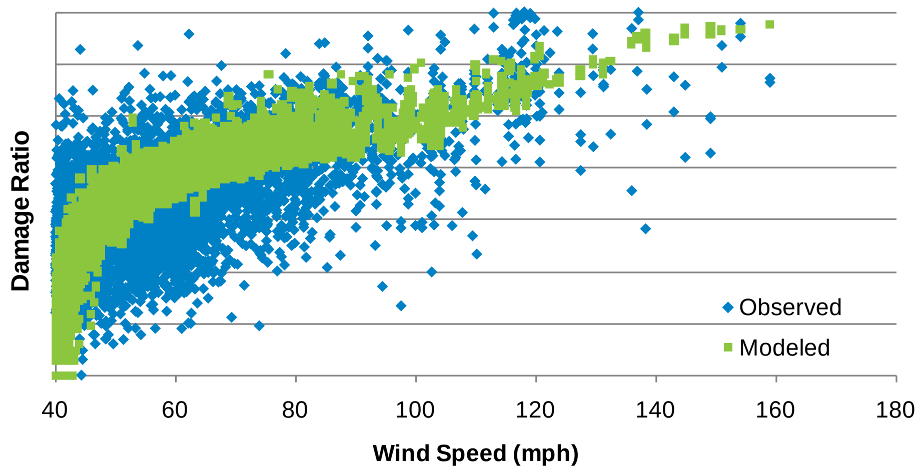


Figure 84. Observed and modeled damage ratios at different wind speeds, Coverage C

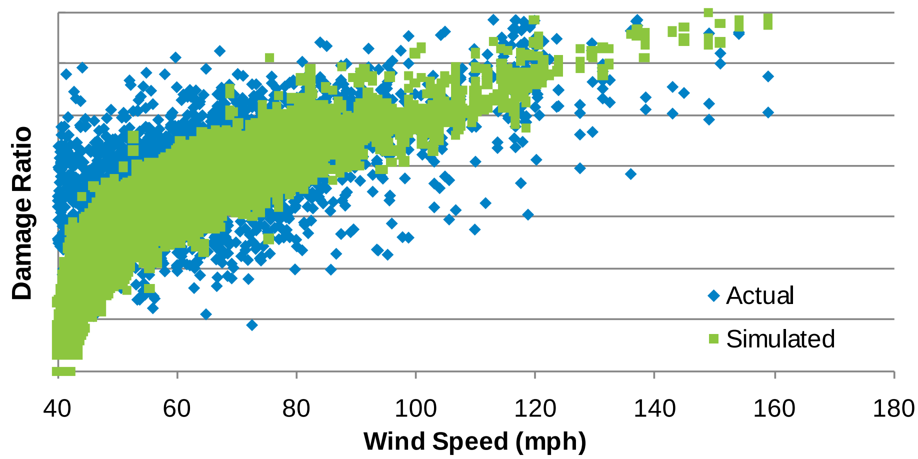


Figure 85. Observed and modeled damage ratios at different wind speeds, Coverage D

Figure 86 and Figure 87 compare the observed and modeled damage distribution around modeled mean damage ratios of 3% and 10%, respectively. The observed and modeled uncertainty around the mean damage ratio is quite similar.

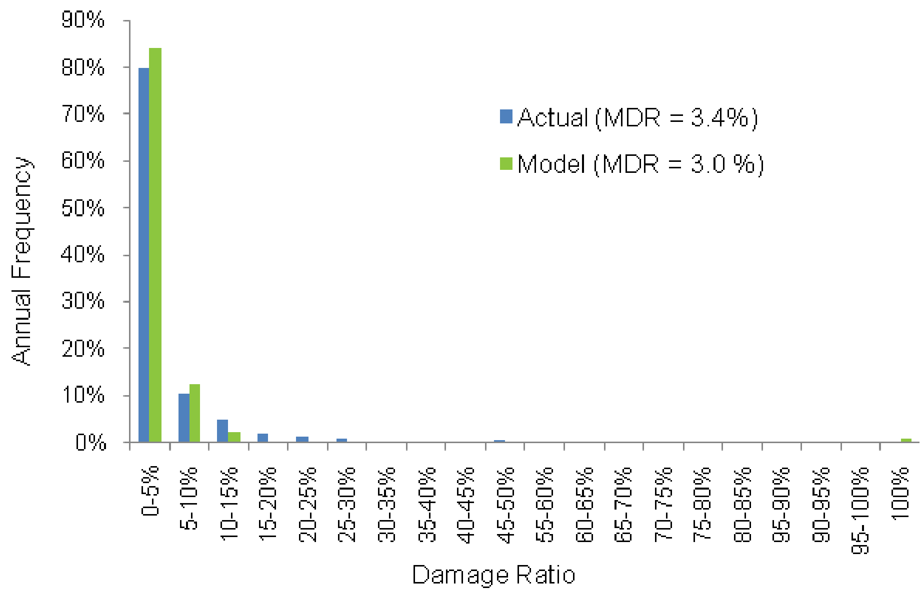


Figure 86. Observed and modeled uncertainty around the mean damage ratio

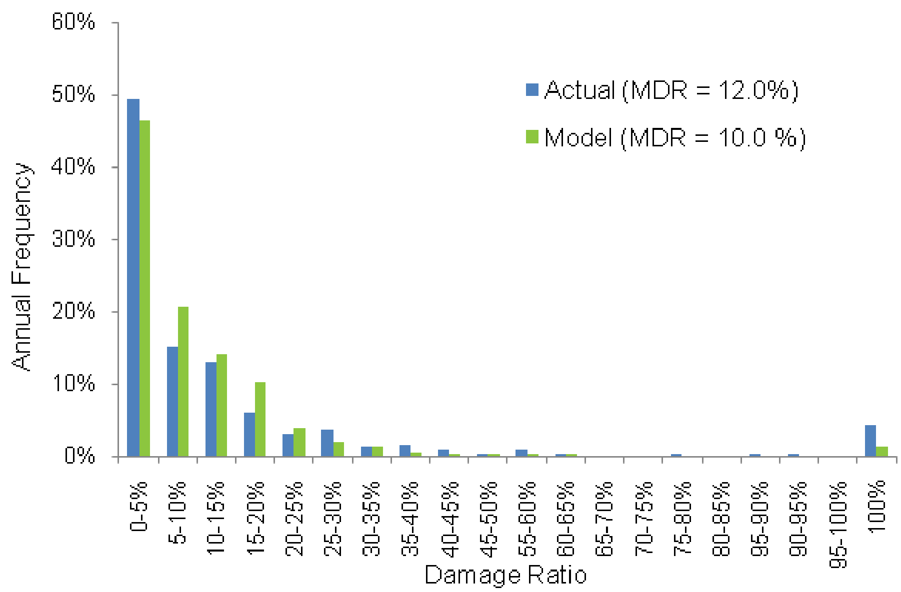


Figure 87. Observed and modeled uncertainty around the mean damage ratio

5.13 Estimating Damage to Industrial Facilities

The AIR Hurricane Model for the United States features the ability to assess potential property and business interruption (BI) losses to industrial facilities from wind or storm surge. More than 400 damage functions were developed for roughly 550 distinct industrial components and subcomponents. Their development was based on findings from detailed, site-specific, engineering-based risk assessments conducted by AIR through AIR's Catastrophe Risk Engineering (CRE) services—assessments that encompassed engineering studies, structural calculations, materials tests and post-disaster field surveys. By developing component-level damage functions based on engineering analysis and hard data, AIR has thus developed a defensible, transparent and reproducible methodology, and damage functions that are realistic and robust.

AIR employs a component-based approach to evaluate the damage and loss to an entire industrial facility, which allows the damage functions to account for the primary components intrinsic to an industrial facility and the interconnectivity between these components. The primary components are categorized into classes and sub-classes to account for variations in vulnerability within each component class.

To develop damage functions for an industrial facility, some assumptions regarding the characteristics of individual components are made. Aggregated functions based on the component and subcomponent damage functions were developed for each industrial facility. Each component and subcomponent damage function was assigned a weighting factor, based on its replacement value relative to the replacement value of the industrial facility, in order to determine the damage function for the industrial facility as a whole.

This approach provides damage estimates that are transparent, realistic, and consistent for a variety of facilities. Furthermore, the component-based approach is also essential for a reliable assessment of business interruption (BI) losses, which depend on the numerous interactions between the various components and lifelines at an industrial facility.

Figure 88 and Figure 89 show examples of industrial facilities and industrial facility components, respectively. Major components are also listed in Table 15.

Figure 88. Examples of industrial facilities

Figure 89. Examples of industrial facility components

Component and industrial facility level damage functions are validated with observational damage data collected during damage after historical hurricanes.

Developing Component-Level Damage Functions for an Industrial Facility

More than 550 industrial components are included in the model, which each have associated subcomponents. Major industrial facility components are listed in Table 15.

Table 15. Industrial facility components in the AIR Hurricane Model for the United States

Components of Industrial Facilities		
Air Handling Units	Distribution Panels	Motor-Driven Pumps
Baffles	Electric Power Backup	Open-Frame Structures
Basins	Electric Transmission Towers	Paddles
Battery Chargers	Elevated Pipes	Pipe Racks
Battery Racks	Engine Generators	Pipes and Pipelines
Boiler/Pressure Vessels	Equipment	Potential Transformers
Boilers	Fans	Pressurized Reactors
Buildings	Filter Gallery	Process Towers
Chillers	Flares	Pumps
Chlorination Equipment	Generators	Scrapers
Circuit Breakers	Equipment	Sediment Flocculation Equipment
Commercial Backup Power	Highways/Runways/Railroads	Silos
Compressors	Large Horizontal Vessels	Stacks/Chimneys
Control Panels	Large Motor-Operated Valves	Switch Gears
Cooling Towers	Large Vertical Vessels with Formed Head	Tanks
Coupling Capacitors	Lightning Arrestors	Transformers
Current Transformers	Loading Structures (Cranes/Cargo Handling/Conveyor Systems)	Tunnels
Dams	Motor Control Centers	Wells
Disconnect Switches	Large Motor-Operated Valves	Valves

A detailed discussion of some major components follows.

Tanks

Storage tanks are probably the most common components found in industrial facilities. Not all tanks are the same, however. They can have different aspect ratios (the ratio of height to diameter), different levels to which they are filled, different methods to anchor them, and so on, all of which affect their vulnerability. Large-diameter storage tanks (which have a relatively low aspect ratio), for example, tend to buckle at lower wind speeds than tanks with higher aspect ratios. Tanks with very high aspect ratios, however, also can fail—by being overturned or caused to slide before their walls ever begin to buckle; however, such tanks are typically anchored at the foundation.

The presence of a foundation anchorage system affects a storage tank's vulnerability to storm surge more so than to the wind peril. Absent a foundation anchorage system, even very large tanks are susceptible to floating at flood depths just greater than the liquid level within the tank.

Reports of wind damage to steel storage tanks during Hurricanes Celia (1970), Alicia (1983), and Georges (1998) indicate that most tanks experience minor damage during Category 3 events. More extensive damage has been reported following Category 4 events, such as Hurricane Hugo in 1989. The primary damage reported was buckling of the tank wall, generally initiated near the top of the tank, perforation of the tank wall by flying debris, and damage to tank insulation.

Figure 90 shows observed tank damage following strong hurricane winds.

Figure 90. Observed Wind Damage to Storage Tanks

AIR engineers undertook a variety of engineering studies in developing damage functions for storage tanks. In one set of tests, structural analytical models of storage tanks were developed using the computer engineering software SAP.

Wind pressure distributions (based on the published results of wind tunnel studies) were applied to the models incrementally, thus simulating increasing wind loads (Figure 91). The loading-factor was raised until elastic buckling developed, indicating a local failure of the tank wall (Figure 92). These tests were repeated with the storage tanks modeled to hold three different levels of liquid (empty, half-full, and full).

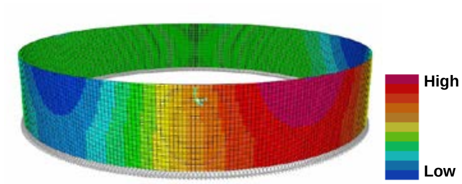


Figure 91. Distribution of Wind Pressure around a Tank Wall

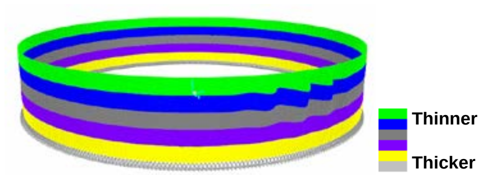


Figure 92. Deflection of Tank Wall at Onset of Elastic Buckling (Colored Bands Represent Different Levels of Tank Shell Thicknesses)

Mean wind damage functions for each aspect ratio and liquid level considered in the analyses were developed, assuming a damage ratio of 100% when buckling of the tank wall occurs. The damage function reflects minimal damage until the onset of wall buckling, and covers such incidental damage as minor deflections, damage associated with flying debris, and damage to the insulation.

Buoyancy calculations over a range of tank dimensions were analyzed, assuming an equal probability of liquid level within the tank for each possible set of tank dimensions. This analysis was performed for tanks with and without anchorage to the foundation. The damage states considered in the analysis are as follows:

- If buoyant forces of floodwaters were less than the resisting force of the tank, including anchor yield capacity: no damage to tanks
- If buoyant forces are greater than the resisting force of the tank, including anchor yield capacity, and flood depth was less than levee height: damage ratio is 50% for unanchored tanks and 75% for anchored tanks
- If buoyant forces are greater than the resisting force of the tank and flood depth is greater than levee height: damage ratio is equal to 100%

A damage ratio of 50% was assigned to unanchored tanks because it's likely that most floating tanks would experience minimal displacement during a hurricane, and can be reused with minimal repair costs. The damage ratio is 75% for anchored tanks, as anchor failure would likely result in additional repair costs for both the anchor and the tanks. A damage ratio of 100% was assigned to floating tanks to reflect the fact that displacement and impact with floating debris during storm surge could result in extensive damage. Anchored tanks are less susceptible to damage from storm surge than unanchored tanks.

Open-Frame Structures

Open-frame structures are another common component of industrial facilities. These structures support plant equipment and product-loading mechanisms for both rail and marine transport. These steel structures are often assembled using a combination of welded and bolted connections forming open space frames, with little or no exterior cladding. Open-frame structures vary in height, size, bracing details, and in terms of the equipment and processes that they support. Examples of open-frame structures are in Figure 93.

Figure 93. Examples of Open-Frame Structures

Damage reports following Category 3 and 4 hurricanes indicate that open-frame structures have relatively low vulnerability. Damage is generally limited to tall, slender structures such as elevator towers, water towers, and cranes. Wind damage reports in Corpus Christi, Texas, following the Category 3 Hurricane Celia in 1970 and the Category 4 Hurricane Andrew in 1992 indicate that larger construction types fared best, and open-frame structures performed well.

The wind vulnerability of open-frame structures was evaluated using an analytical model developed with the computer program SAP. Wind pressure distributions, based on ASCE-7 guidelines, were utilized to apply incrementally increasing wind loads to the structure. Loading was increased until the onset of elastic buckling at a brace member, at which point the structure's lateral load resistance decreased and partial or complete collapse of the structure occurred.

The results of the analysis indicate that open-frame structures perform well when subjected to hurricane-force winds.

Due to their substantial steel structural members, open-frame structures exhibit low vulnerability to storm surge flooding over a large range of depths. Damage to the open-structure's bare frame is negligible at all flood depths, whereas substantial damage to the embedded equipment is expected.

Cooling Towers

Cooling towers transfer heat produced by industrial processes to the atmosphere. Figure 94 shows typical cooling towers inside of industrial facilities.

Figure 94. Examples of Cooling Towers (Top Left: 9-Cell Wooden Tower; Top Right: 2-Cell Wooden Tower; Bottom Left: 2-Cell Concrete Tower; Bottom Right: 2-Cell Fiber-Reinforced Plastic Tower)

Of all the industrial facility components for which damage data was available following Hurricanes Katrina and Rita in 2004, cooling towers sustained the most damage. According to the Louisiana Chemical Association, 29 cooling towers sustained some damage during these events, including 1 complete collapse, 12 reports of heavy damage, and 12 reports of moderate damage. Observational data suggests that damage to fan shrouds and structural damage occur at wind speeds associated with Category 1 and Category 2 hurricanes. More extensive structural damage to cooling towers, including collapse, was reported following Hurricane Celia in 1970. Figure 95 shows examples of damage to cooling towers following hurricanes.

Figure 95. Observed Hurricane Damage to Cooling Towers

A study of approximately 40 cooling towers in the Galveston Bay area indicates that damage to a cooling tower associated with winds from a Category 1 or 2 hurricane tends to be in the form of damaged fans and fan cylinders or siding and louver loss. Partial or complete collapse of the structural frame and loss of motors and gearboxes is likely during stronger hurricanes.

Cooling towers are likely to sustain minor to moderate amounts of damage at wind speeds corresponding to a Category 2 hurricane. Loss of exterior cladding and fan cylinders, and possible collapse of the tower frame, will likely occur at each end of a tower, before damage progresses inward toward the center of the tower. Hence, some of the interior cells may remain operational even after an extreme wind event. Smaller portable cooling towers typically sustain less damage than larger ones, assuming the base of the tower is securely anchored to its supporting foundation.

Damage from wind speeds associated with Category 2 hurricanes is likely to include minor to moderate damage to louvers, sidewall cladding, fans and fan cylinders, and shrouds. There may be limited instances of partial or complete collapse of cell frame structures, and tower functionality may be lost. Equipment inspection, cleanup, and repair are usually required following a Category 2 event for which the damage ratio in the model is approximately 10-20%.

Wind damage from Category 3 events typically includes moderate to major damage to louvers, sidewall cladding, fans and fan cylinders, motors and gearboxes, and shrouds. Partial or complete collapse of cell-frame structures and the loss of tower functionality may also occur. Equipment inspection, cleanup, and repair are usually required following a Category 3 event. The mean damage ratio in the model is about 20-50%.

Wind damage from Category 4 events includes lost louvers and sidewall cladding, fans and fan cylinders, motors and gearboxes, and shrouds. Partial or complete collapse of cell frame structures and the complete loss of tower functionality are also likely. Demolition and major repairs are typically required. The mean damage ratio in the model is approximately 50%.

Process Towers

Figure 96 shows an example of a process tower, which are typically walled steel cylinders bolted to a concrete foundation and insulated for temperature control. Piping and access decks are often attached at various levels of the process towers, imparting additional wind loading to the structures.

Figure 96. Example of a Process Tower

Historical reports of damage to process towers at wind speeds corresponding to Category 3 and 4 hurricanes indicate that damage is typically limited to the insulation. Isolated accounts of towers leaning due to anchor bolt elongation as well as one overturned tower were reported in Corpus Christi, Texas, following Category 3 Hurricane Celia in 1970.

Figure 97 shows damage to process towers that occurred during historical hurricanes.

Figure 97. Observed Hurricane Damage to Process Towers

Based on a review of historical wind damage reports, structural damage to process towers is usually associated with anchor-bolt yielding or rupture. Wind pressure, as defined by ASCE-7, was computed for three typical process towers with heights ranging from 80-140 feet. Wind pressure was increased incrementally until a wind speed associated with yielding of the first anchor bolt was obtained. Yielding of the bolts corresponds to the onset of anchor-bolt elongation and leaning of the process tower. Wind pressure was further increased until a wind speed associated with rupture of the first anchor bolt was obtained, which corresponds to loss of lateral capacity and subsequent collapse of the process tower. Computed wind speeds associated with anchor-bolt yield and rupture are presented in Table 16 for the three towers.

Table 16. Threshold Wind Speeds for Process Towers

Process Tower Height (ft)	Sustained One-Minute Wind Speed at First Anchor Bolt Yield (mph)	Sustained One-Minute Wind Speed at First Anchor-Bolt Rupture (mph)
86	162	193
129	147	155
138	122	152

The mean damage functions in the model were developed under the assumptions that no damage will occur until the first anchor bolt yields and complete damage will occur when the first anchor bolt ruptures. A low-vulnerability damage function which increases with wind speed was used to represent damage associated with flying debris and damage to process tower insulation.

Process towers exhibit low vulnerability to flooding over a wide range of flood depths, primarily due to their substantial cross sections and sound footing. Process towers subject to storm surge flooding are typically damaged by floating debris.

Flare Towers

Three types of flare towers were modeled and analyzed: freestanding, guyed flare, and derrick-supported, as shown in Figure 98.

Figure 98. Examples of flare towers (left: freestanding flare, middle: guyed flare, and right: derrick-supported flare)

Historical damage reports indicate that flare towers are significantly damaged at wind speeds corresponding to weak hurricanes. During Hurricane Rita in 2005, a guyed flare collapsed in Category 1 wind speeds. At a petrochemical facility in Corpus Christi, Texas, all flare towers at one plant collapsed in Category 3 winds during Hurricane Celia in 1970. Figure 99 illustrates a collapsed flare tower.

Figure 99. Damage to a flare tower

In 1981, a large petrochemical plant operator in Galveston Bay, Texas, performed an engineering assessment of five flare stacks at three different plant sites. The estimated threshold for collapse of these flare stacks, which were all designed prior to 1980, was a sustained one-minute wind speed of approximately 107 mph, equivalent to a Category 2 hurricane. More recently, the same operator performed an analysis of a guyed flare stack that was upgraded to comply with ASCE 7-98 codes. The analysis indicated that its ultimate load capacity would be reached at an estimated sustained one-minute wind speed of approximately 135 mph, or Category 4 hurricane winds. These studies are consistent with observed damage following Hurricane Celia in 1970.

An analytical structural model of a derrick-supported flare tower was developed using the computer program SAP. Wind pressure distributions based on ASCE-7 guidelines were used to apply incrementally increasing wind loads to the structure while deflections were recorded. Loading was increased until the onset of buckling at a tower leg located approximately in the middle of the structure. After this buckling, the capacity of the structure decreases significantly, representing collapse. Figure 100 represents the deflected shape of the derrick-supported flare tower, just prior to collapse.

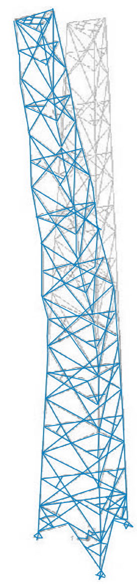


Figure 100. Deflected shape of a derrick-supported flare tower prior to collapse (analytical model)

The wind speeds associated with structure failure correspond to a strong Category 4 or weak Category 5 hurricane. AIR's mean wind damage functions for flare towers demonstrate a steep increase in the damage potential beginning with Category 2 hurricane wind speeds, approaching almost complete damage at Category 3 hurricane wind speeds.

Flare towers exhibit low vulnerability to flooding over a wide range of flood depths, primarily due to their substantial cross sections and sound footing. Flood damage is generally limited to that associated with floating debris.

Developing Damage Functions for an Industrial Facility

For each industrial facility, aggregated damage functions were developed based on the damage functions for the associated component and subcomponent classes. The damage functions for each component and subcomponent were assigned a weighting factor equal to the ratio between the replacement value of the class and the total replacement value of the industrial facility. The weights for different industrial facilities are based on scientific research, the Applied Technology Council report ATC-13 1995, and HAZUS data.

Figure 101 and Figure 102 show damage functions for sample industrial facilities for the wind and storm surge perils, respectively. The figures show the weighting factors for each component and subcomponent class. The facility-level damage function is a weighted average of the damage functions of the individual components.

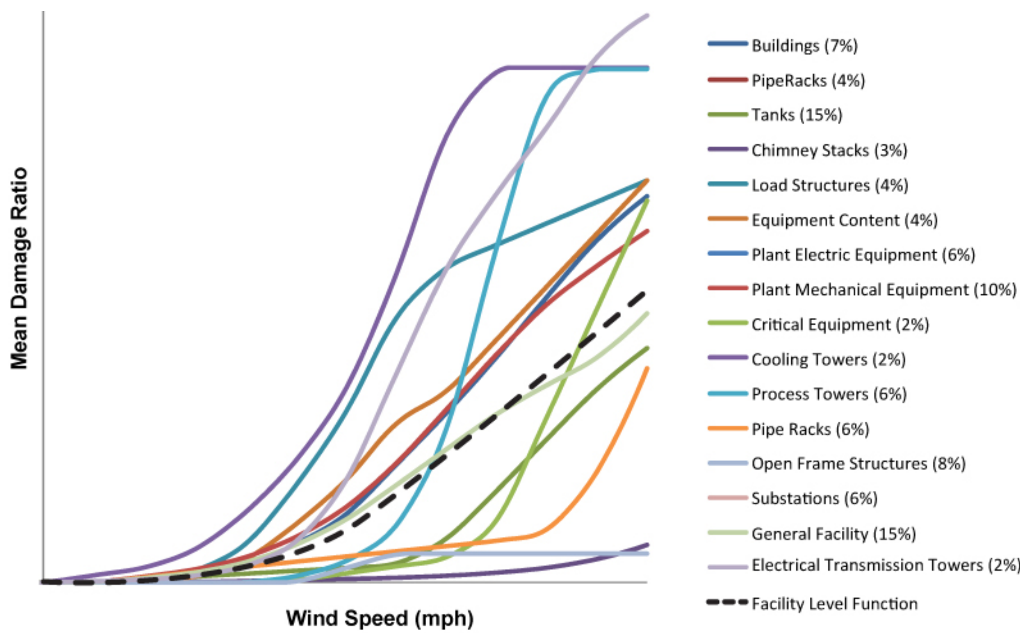


Figure 101. Wind damage functions for a sample industrial facility

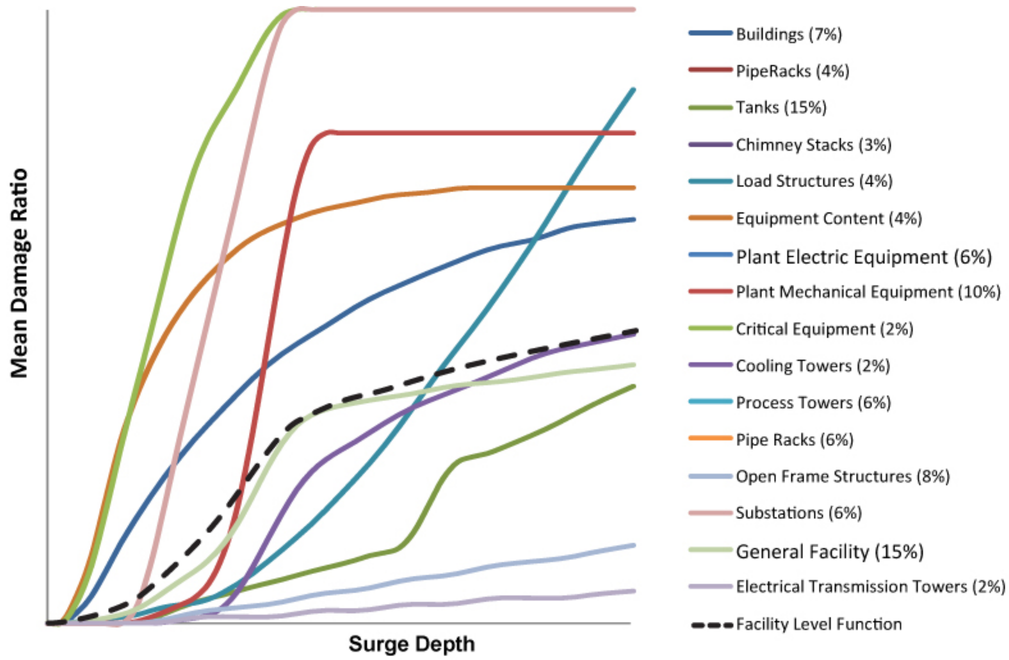


Figure 102. Storm surge damage functions for a sample industrial facility

Damage Functions for Industrial Facility Components

In order to develop damage functions for various components, some reasonable assumptions are made about the typical characteristics of individual subcomponents in an industrial facility. For example, AIR assumes different percentages of anchored and unanchored tanks, and different filling levels and aspect ratios for tanks within a facility.

Figure 103 and Figure 104 show damage functions for selected industrial facility components for the wind and storm surge perils, respectively.

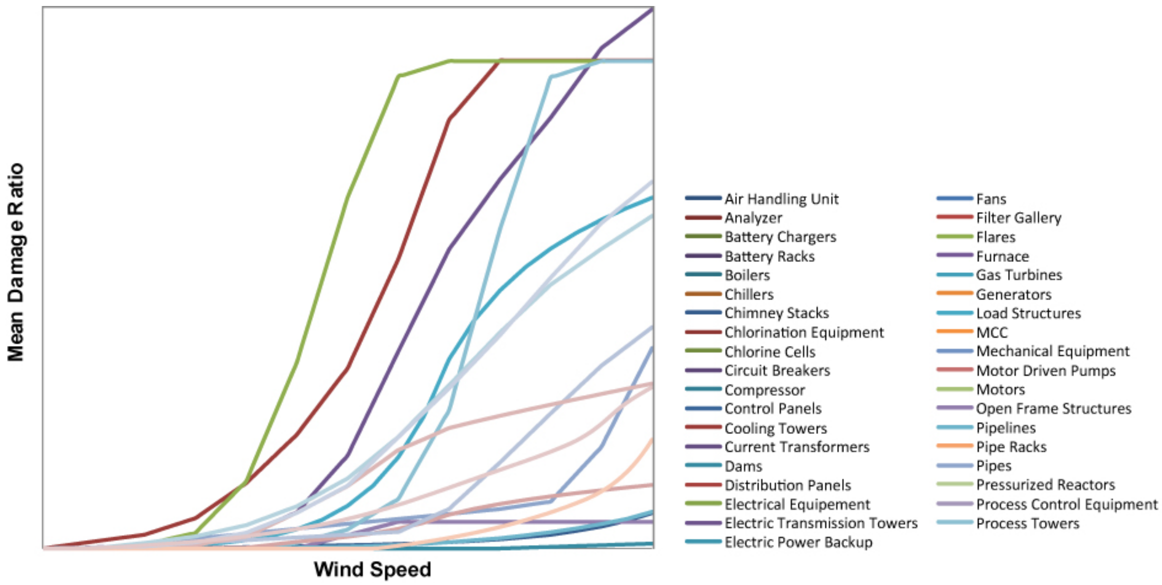


Figure 103. Wind Damage functions for industrial facility components

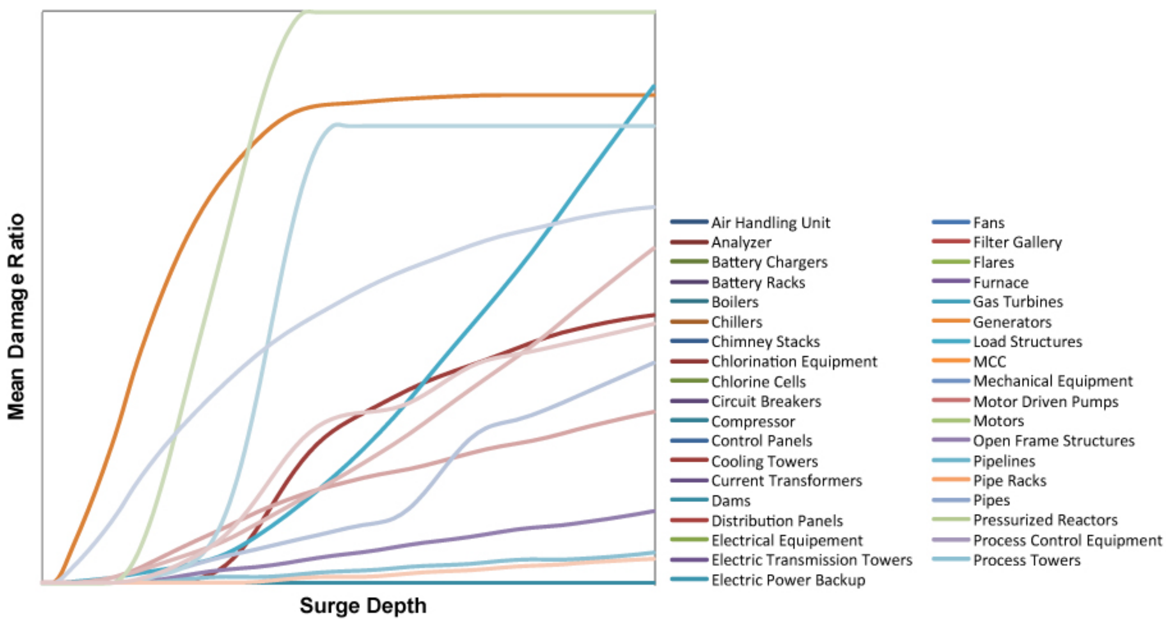


Figure 104. Storm surge damage functions for industrial facility components

For many industrial facility components, there is insufficient damage data or available research to derive accurate damage functions. In such cases, information from many sources, including historical hurricane damage data, scientific literature, site-specific measurements, and structural analyses was incorporated to assign mean damage ratios over a range of wind speeds and storm surge depths. All analysis took into account the complexity of each component and its characteristic response to wind speeds and storm surge levels.

Note that the damage functions for industrial facilities are not applicable to any individual asset at a particular location (e.g., a specific pump or cooling tower). The damage functions have been developed considering a range of characteristics and behaviors within any particular asset class or subclass and are intended to represent the average damage ratio for a group of many individual assets. At any given wind speed or storm surge depth, the actual damage sustained by some assets within a class may be higher or lower than the mean damage ratio specified by the corresponding damage function.

At any given hazard level, the damage ratio for a particular asset may be found within a range of damage ratios corresponding to the hazard level and asset class. This reflects the fact that seemingly identical assets may experience different levels of damage during a particular event. That is, one cooling tower may experience total collapse while another similar cooling tower may experience moderate damage during the same hurricane. Such variation exists due to differences in material properties, wind field patterns, construction quality, building maintenance, and the presence or absence of flying debris.

Information regarding damage to industrial facilities during historical hurricanes and other events was used to develop the industrial facility component of AIR's models. Table 17 lists some of the historical events used as well as the locations of affected industrial facilities.

Table 17. Historical events and locations of affected industrial facilities

Event Name (Year)	Location of Affected Industrial Facilities
Hurricane Celia (1970)	Corpus Christi, Texas
Hurricane Alicia (1983)	Baytown, Texas
Hurricane Hugo (1989)	St. Croix
Hurricane Andrew (1992)	South of Miami, Florida
Hurricane Georges (1998)	Pascagoula, Mississippi, and the Dominican Republic
Hurricane Katrina (2005)	Pascagoula, Mississippi; St. Charles Bay, Texas; St. Louis, Mississippi; Meraux, Louisiana; and Biloxi, Mississippi
Hurricane Rita (2005)	Port Arthur, Louisiana; Orange, Texas; Port Neeches, Texas; and Bridge City, Texas

Customized Composite Damage Functions for a Particular Industrial Facility

The previous sections described the development of plant-level damage functions using generic information for each industrial facility type, such as the type of equipment found in the plant, and the replacement value and secondary characteristics of the associated components. In reality, each industrial facility is unique and complex. For example, not all of the equipment in one plant may be anchored to withstand ground shaking, while in another plant the equipment might all be secured.

Recognizing that each facility is unique, AIR's CLASIC/2 and Touchstone software allows users who have access to facility-specific information to specify the various actual constituent components and subcomponents present, their characteristics (such as whether a particular component is anchored or unanchored, the aspect ratios for tanks, etc.), and their percentage of the total site replacement value. The ability to specify the composition of each facility, when known, will result in better loss estimates when the user has data about the component make-up of a particular facility.

Developing Damage Functions for Unknown Industrial Facility Types

Damage functions for the general or unknown facility type are based on the weighted average of the damage functions for different industrial facility types.

Figure 105 and Figure 106 show industrial facility-level wind and storm surge damage functions, respectively, for selected industrial facilities in the United States. The unknown industrial facility type is represented by the black line labeled "General".

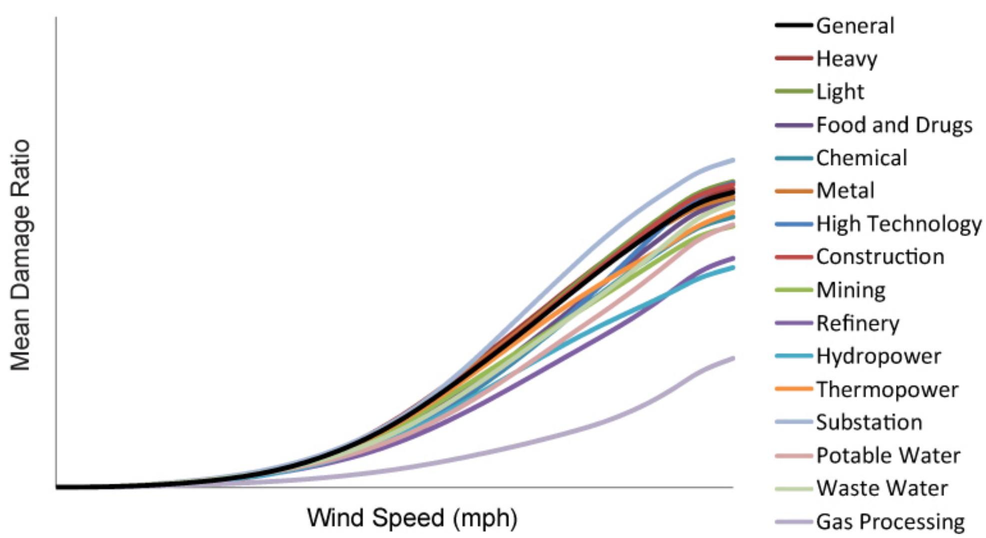


Figure 105. Industrial facility-level wind damage functions

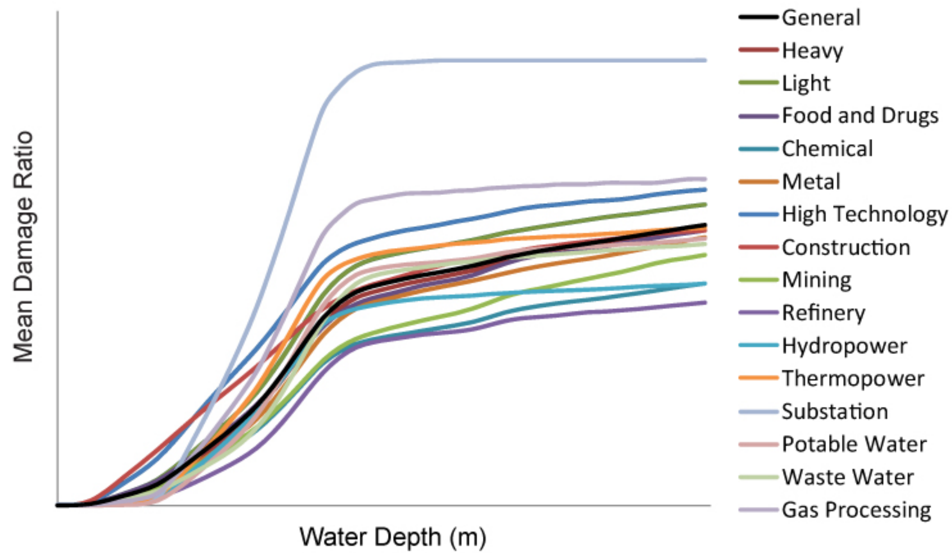


Figure 106. Industrial facility-level storm surge damage functions

Business Interruption Losses for Industrial Facilities

Assessing business interruption (BI) losses for industrial facilities is complex, particularly in the case of highly integrated facilities. The major contribution to BI losses is the loss of revenues incurred when product chains are rendered completely or partially non-functional. Loss of functionality can occur as a result of physical damage to the components, the interconnectivity between components, or lifelines such as electricity and water systems.

Downtime is the primary parameter for assessing BI losses. To assess these losses for an entire industrial facility, time element damage functions are determined for each component for each stage of the damage assessment and repair process. As in any other business interruption assessment, the time before repairs can get underway, or pre-repair, is determined and combined with the time required for the actual repair. Once the time element functions are determined for all of the components, the model aggregates the functions by determining a weighted average of the component functions. Figure 107 illustrates time element damage functions for selected industrial facilities components.

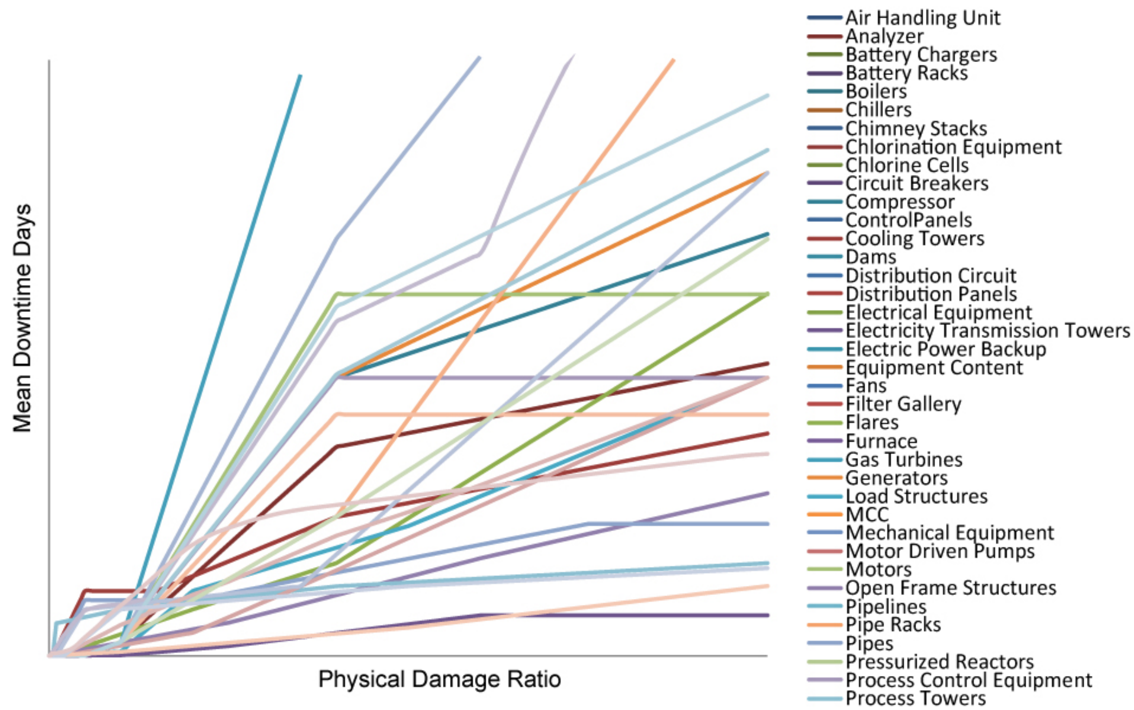


Figure 107. Time element functions for industrial facility components

As described above, time element functions at the facility level are derived from component distribution information and the individual component and subcomponent downtime functions.

Figure 108 and Figure 109 show the time element functions for selected industrial facilities in the Unites States for the wind and storm surge perils, respectively.

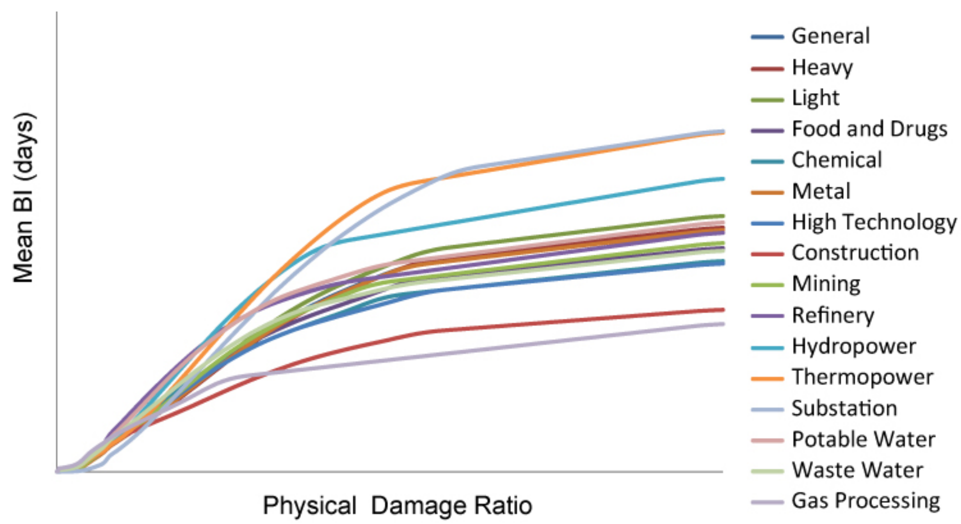


Figure 108. Time element functions for wind damage to industrial facilities

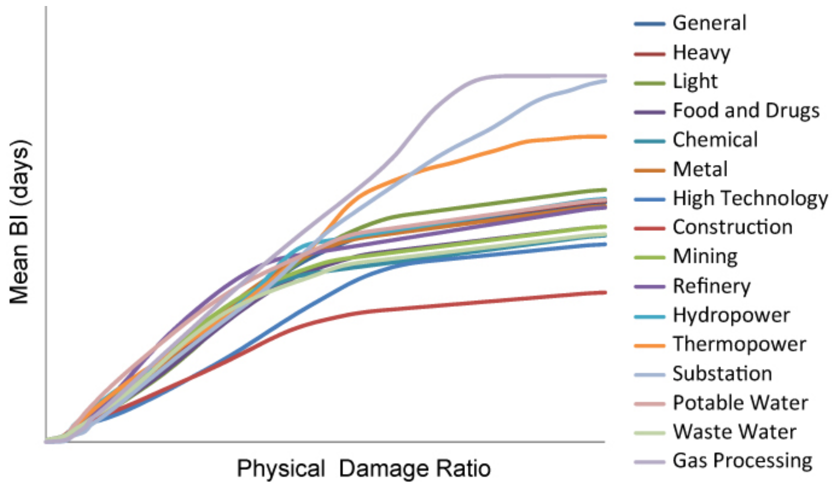


Figure 109. Time element functions for storm surge damage to industrial facilities

A partial correlation between components is utilized to assess modeled BI losses to industrial facilities. The analysis implicitly incorporates the numerous connections between components, lifelines, and product chains. The high degree of site-specific connectivity and the complexity of the product chains that exist at most plants make the estimation of downtime for industrial facilities a challenge. It is a many-faceted calculation involving numerous operations, including evaluations of onsite process interactions, bottlenecks and redundancies, offsite interdependencies, and revenue generators. Downtime estimation is accomplished by building a "network model" that constructs a simulation of the many interconnections between components, processes, lifelines, and product chains, and accounts for components to be idle even if undamaged or already fixed in the event that other components or lifelines remain down.

6 Insured Loss Calculation

The AIR Hurricane Model for the United States uses a comprehensive cost model to estimate the repair cost of each damaged component in order to translate ground-up damage into monetary losses. Insured losses are calculated by applying policy conditions to the damage estimates. A wide variety of policy conditions are supported in this model, including franchise deductibles, coverage limits, loss triggers, and risk-specific reinsurance terms.

6.1 Aggregating Losses Probabilistically

Post-disaster surveys and actual claims data reveal an inherent variability in the damage that results from a given wind speed and storm surge depth. Loss estimates generated by the AIR Hurricane Model for the United States capture this variability by accounting for both primary and secondary uncertainty. Primary uncertainty derives from the uncertainty associated with the stochastic event generation process, while secondary uncertainty describes the uncertainty in damage resulting from a given event. This secondary uncertainty captures the uncertainty in damage and in the local intensity estimation. The uncertainty in building damage arises due to a degree of inherent randomness in the response of buildings of similar construction to a given event intensity, resulting from variability in building characteristics, construction materials, workmanship, etc. The uncertainty in local intensity of the hazard can be attributed to unmodeled phenomena and local site factors.

As was discussed in Section 5, damage is calculated by damage functions that provide, for a given event intensity, a mean damage ratio (MDR) and a probability distribution around the mean that captures the variability in damage. For the AIR Hurricane Model for the United States, a truncated gamma distribution combined with empirically derived probabilities of 0% and 100% damage levels is used to model the uncertainty around the mean damage.

The damage functions are used to produce, for each event, a distribution of ground-up loss by location and coverage. Limits, deductibles, and reinsurance are applied in the financial module to the ground-up loss distribution to produce gross and net loss estimates. Note that insured losses can accumulate even if the mean damage ratio is below the deductible, because some structures are damaged above the mean damage ratio and the deductible. The distributions are applicable to the analysis of a single exposure and in this case usually have a high degree of uncertainty. The individual distributions are combined to obtain the portfolio distribution, where the uncertainty is lower.

In the financial module, there clearly is a need for aggregating losses probabilistically, at various levels. Specifically, computational techniques have been developed for statistically aggregating nonparametric distributions. That is, even though the ground-up, coverage-level damage distributions typically use parametric distributions, after the application of location and policy terms the distributions cannot be represented in a parametric way. Further aggregations of such loss distributions are achieved using numerical algorithms.

Convolution is the statistically correct way of deriving the probability distribution of the sum of multiple loss distributions. The probability density function of the convolution of two random variables F and G with density functions f(x) and g(x), respectively, is represented by the equation,

$$(f * g)(x) = \int_{-\infty}^{\infty} f(x-t)g(t)dt$$

where t is a dummy variable.

The AIR models employ an efficient and accurate numerical algorithm for "convolving" any number of nonparametric loss distributions. Extreme care has to be taken when combining distributions with differing size of loss. The technique used allows the correct representation of the shape of the loss distributions throughout the financial loss estimation process. Preserving the right shape is particularly important when insurance terms apply to the tails of the distributions.

The financial module within AIR's software applications allows for the application of a wide variety of location, policy, and reinsurance conditions. Location terms may be specified to include limits and deductibles by site or by coverage. Supported policy terms include blanket and excess layers, minimum and maximum deductibles, and sublimits. Reinsurance terms include facultative certificates and various types of risk-specific and aggregate treaties with occurrence and aggregate limits. Please see product-specific documentation available from the client support section of AIR's website (http://www.air-worldwide.com) as well as details on the industry standard UNICEDE data format (http://www.unicede.com) for additional information.

6.2 Demand Surge

Market forces generally ensure that the availability of materials and labor in any particular geographical area is sufficient to accommodate a normal level of demand without affecting price. However, demand can increase sharply and unexpectedly after a catastrophe, such as a significant hurricane or earthquake.

The resulting widespread property damage can cause a sharp increase in the need for building materials and labor, which in turn can cause prices to inflate temporarily. Demand for related services and resources, such as transportation, equipment, and storage, might also escalate in the affected area.

Scarce resources can also result in an increase in the time required to repair and rebuild damaged property, which may cause greater business interruption losses and additional living expenses. Infrastructure damage, delayed building-permit processes, and a shortage of available building inspectors also increase time-element loss. These factors can lead to insured losses exceeding expectations for a particular event and portfolio, a phenomenon known as demand surge. The greater and more widespread the damage from an event, the greater the resulting demand surge and insured losses will be.

AIR engineers and statisticians have developed a mathematical function that relates the amount of demand surge to the amount of modeled industry insurable losses from a particular event. This function was developed based on historical data, statistical analysis, economic time-series reviews, and analysis of construction-material and labor-cost data.

The demand surge function currently implemented in the AIR software systems is the result of over 15 years of research and refinement. AIR will continue to make improvements as new data becomes available. For details on the methodology used to develop the AIR demand surge function and its validation, please see the client-confidential technical document *AIR U.S. Demand Surge Function*, which is available on the AIR website.

6.3 Validating Modeled Losses

Perhaps the most distinguishing feature of the AIR Hurricane Model for the United States is the extent to which it has been validated using actual loss data. The model has a long and impressive record of providing reliable, credible loss estimates. The AIR model was estimating that losses from hurricanes in Florida had the potential to exceed USD 40 billion well before Hurricane Andrew; no other source was providing this type of information to the industry at that time. Just four hours after landfall, AIR issued an estimate that industry losses resulting from Andrew could reach USD 13 billion.

AIR has compiled an extensive database of over 20 years of claims data for historical U.S. hurricanes from several major client companies. Experts at AIR have collected and analyzed over USD 6 billion of detailed data in order to validate modeled losses. Further validation is undertaken after each damage survey, which AIR has conducted for every U.S. landfalling hurricane since Hurricane Hugo in 1989.

Comparison of Observed (PCS) and Modeled Losses

Figure 110 and Figure 111 compare the observed (PCS) and modeled losses for selected events. The modeled loss estimates compare well with the PCS losses. Note that in the following figures, the modeled losses are based on 2009 exposure data and the historical losses are normalized to 2009 values for inflation and exposure growth since the time of the actual event.

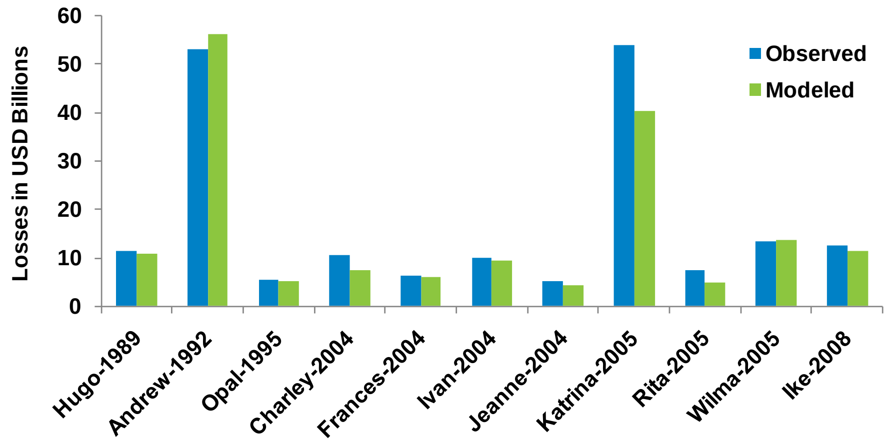


Figure 110. Observed (PCS) and modeled losses for selected events

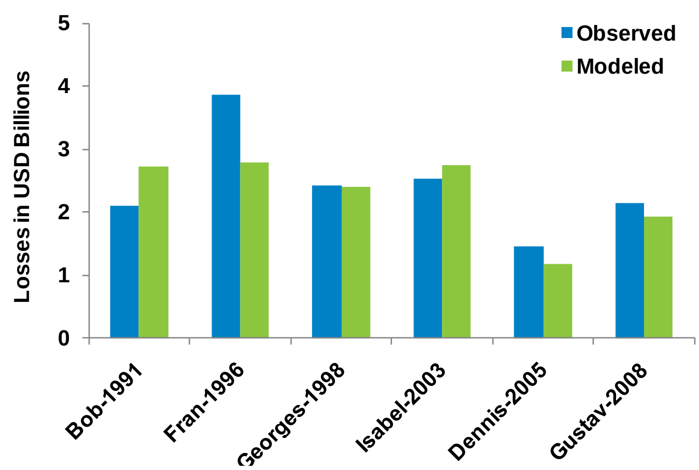


Figure 111. Observed (PCS) and modeled losses for selected events

Figure 112 compares actual loss data from clients and modeled losses for selected events. All losses are multiplied by a constant factor to disguise the identity of the companies whose data was used.

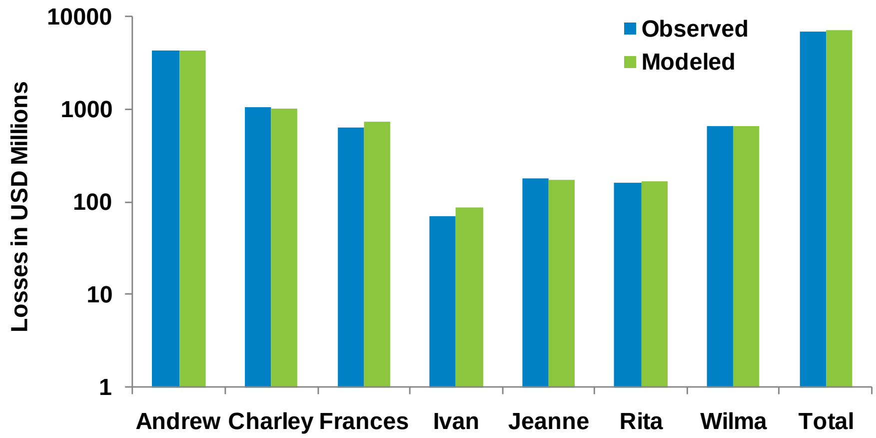


Figure 112. Observed and modeled losses for selected events

Figure 113 through Figure 116 compare actual and modeled insured loss data, obtained from three different insurance companies (A, B, and C) for four hurricanes (Charley, Francis, Ivan, and Jean) for various residential coverages. All losses are multiplied by a constant factor and are provided in event-year currency. Again, actual and simulated losses compare well.

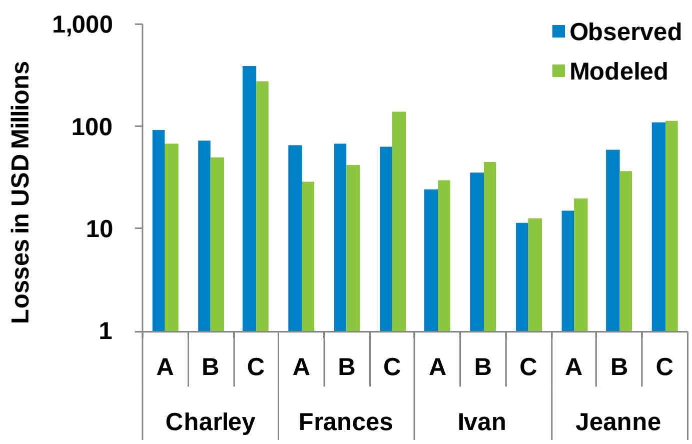


Figure 113. Observed and modeled losses from four hurricanes based on data from three companies, total residential coverage

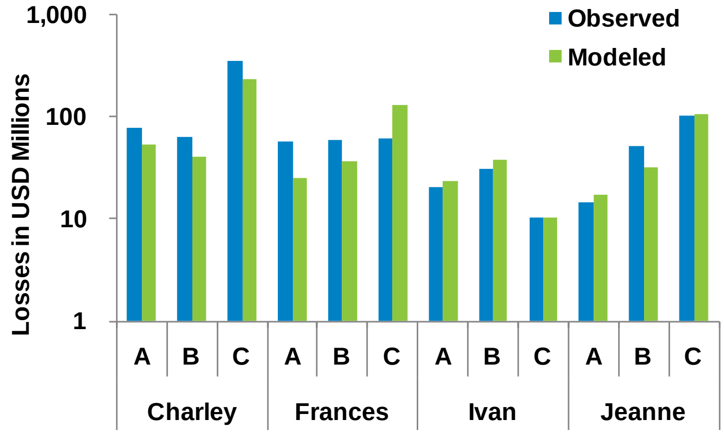


Figure 114. Observed and modeled losses from four hurricanes based on data from three companies, residential building coverage

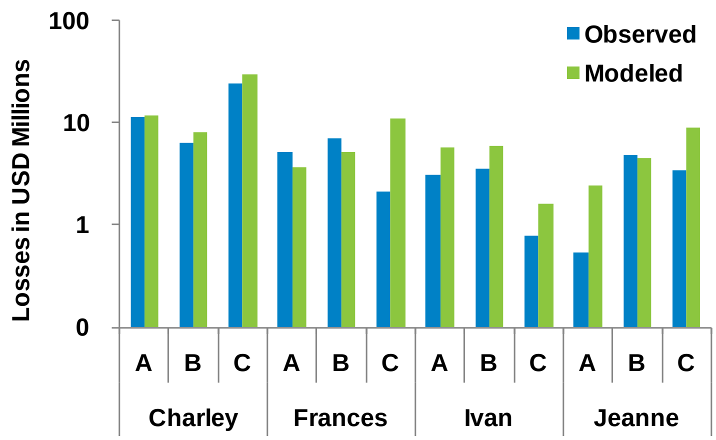


Figure 115. Observed and modeled losses from four hurricanes based on data from three companies, residential contents coverage

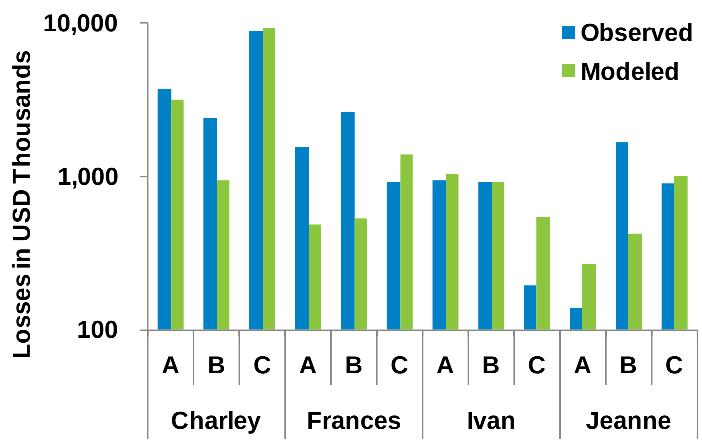


Figure 116. Observed and modeled losses from four hurricanes based on data from three companies, residential additional living expenses (ALE) coverage

Figure 117 compares actual and modeled commercial loss data, obtained from three different insurance companies (X, Y, and Z). All losses were multiplied by a constant factor and are presented in event-year currency.

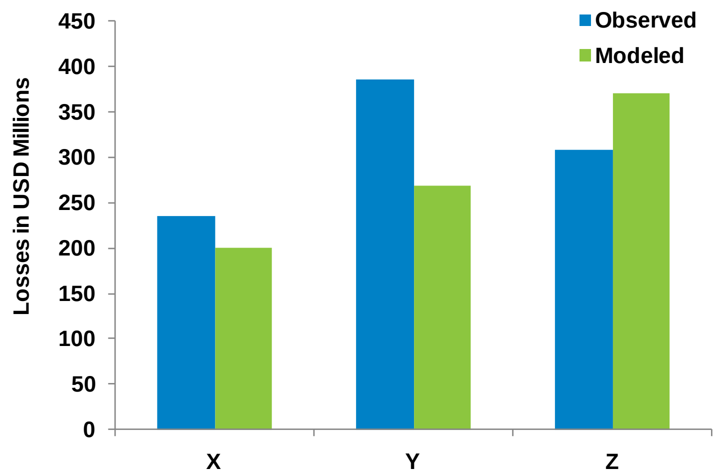


Figure 117. Observed and modeled losses based on data from three companies, total commercial coverage

Figure 118 compares actual and modeled losses for the commercial line of business, by coverage. The modeled losses compare well to the actual loss data.

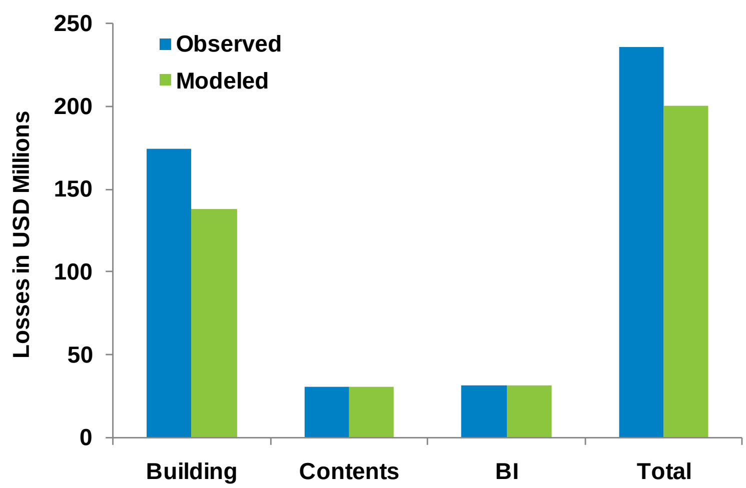


Figure 118. Observed and modeled commercial losses by coverage

Figure 119 compares actual and modeled commercial losses for selected historical events.

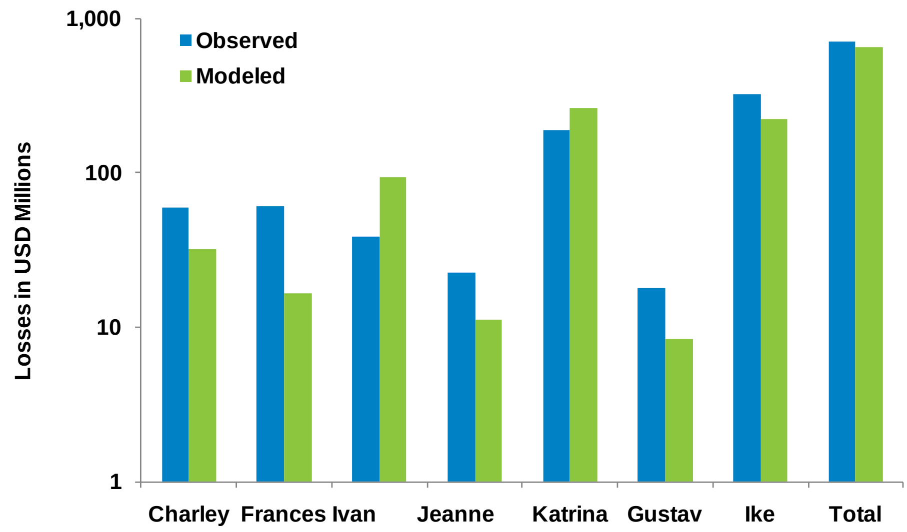


Figure 119. Observed and modeled commercial losses for selected events

Figure 120 compares actual and modeled losses for Hurricane Ike by line of business. Again, AIR's modeled loss estimates compare well to historical losses.

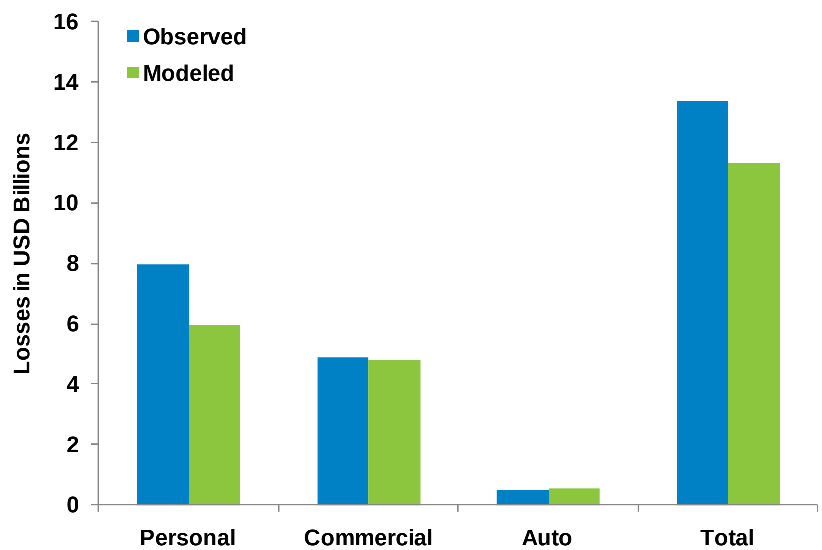


Figure 120. Observed (PCS) and modeled losses for Hurricane Ike (2008) by line of business

Figure 121 compares actual and modeled losses for Hurricane Ike for selected states. AIR's modeled loss estimates compare well to historical losses.

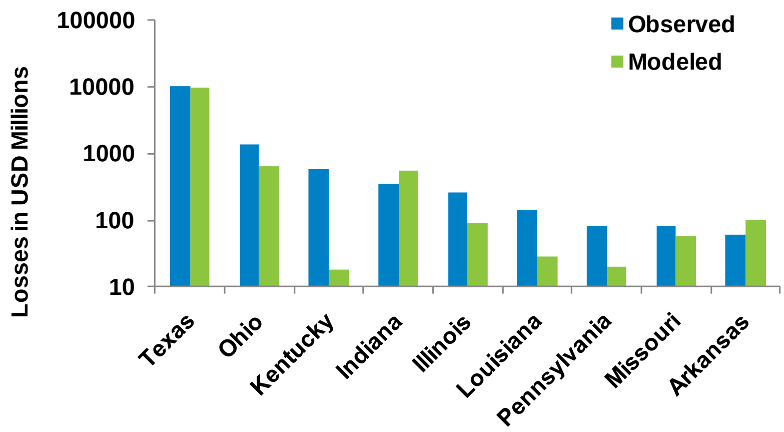


Figure 121. Observed (PCS) and modeled losses for Hurricane Ike (2008) by State

Figure 122 compares AIR modeled losses to trended observed (PCS) losses for a range of historical events, on a log-log scale. Note that the modeled losses compare well to the trended observed losses; most data points fall close to the $y=x$ line (shown in the figure) that indicates complete agreement between the modeled and observed values. Note, however, that for some historical events, reported losses include losses not covered by the AIR model, such as losses associated with levee failure and clean-up costs. For this reason, some variation in reported losses compared to modeled losses is expected.

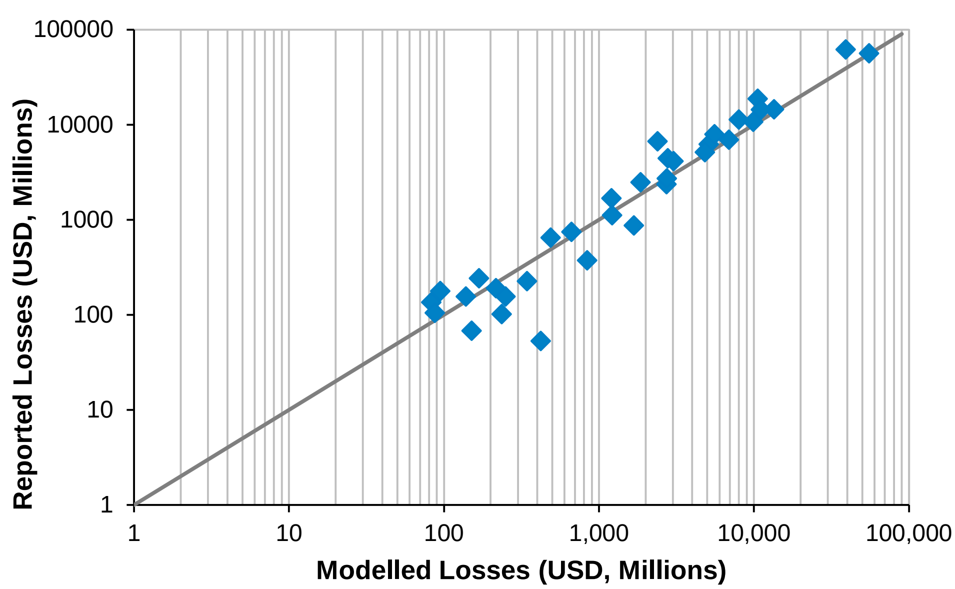


Figure 122. Observed losses (PCS; trended to 2011) and AIR modeled losses for selected historical events, 1989-2009 (log-log plot)

Figure 123 compares AIR modeled losses to trended observed (PCS) losses for a range of historical events, by line of business. Note the good agreement between the modeled losses and the trended observed losses. However, as noted above, the reported losses obtained from PCS included losses that are not modeled by AIR; therefore, reported losses may plot above the *y*=*x* line in Figure 120.

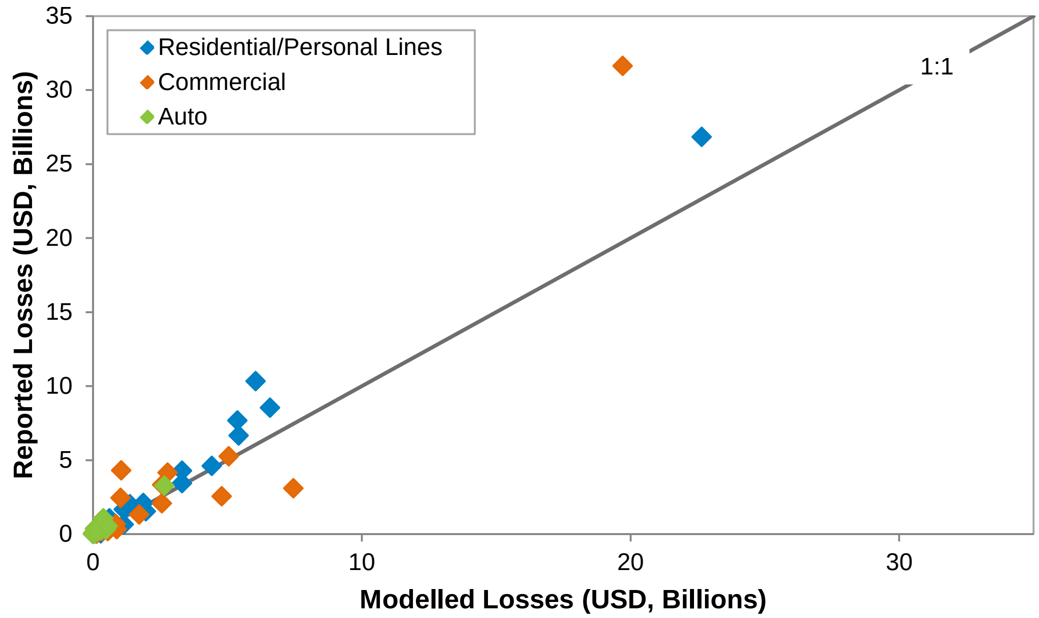


Figure 123. Observed (PCS; trended to 2011) losses and AIR modeled losses, by line of business, for selected historical events, 1998-2008.

Comparison of Estimated Historical Losses and the Stochastic Exceedance Probability Curve

Figure 124 shows the historical loss distribution for hurricanes in the United States and the AIR exceedance probability curve. Note the good agreement between the historical losses and the EP curve.

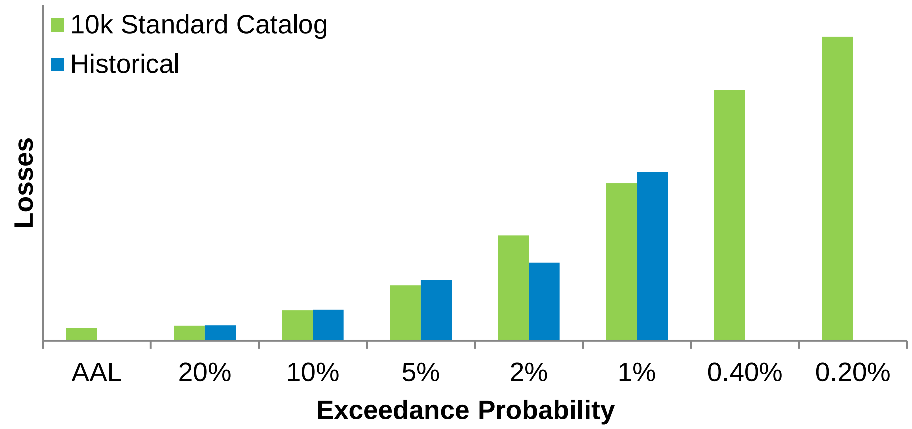


Figure 124. Historical loss distribution for U.S. hurricanes (blue) and the AIR exceedance probability curve (green)

Comparison of Estimated Historical AAL and Stochastic AAL

Figure 125 shows the industry average annual loss (AAL) generated by the AIR Hurricane Model for the United States, as well as the estimated (modeled) AAL for historical events. While the estimated AAL for historical events shows notable variation from year to year (blue solid line), examining these losses over a longer time period, such 1900-2009, yields a more stable AAL estimate (dashed blue line). The estimated AAL of historical events (1900-2009) of approximately USD 9 billion compares well to the AAL of USD 11.3 billion and USD 12.8 billion yielded by the AIR standard 10,000-year stochastic catalog, and the AIR WSST catalog, respectively.

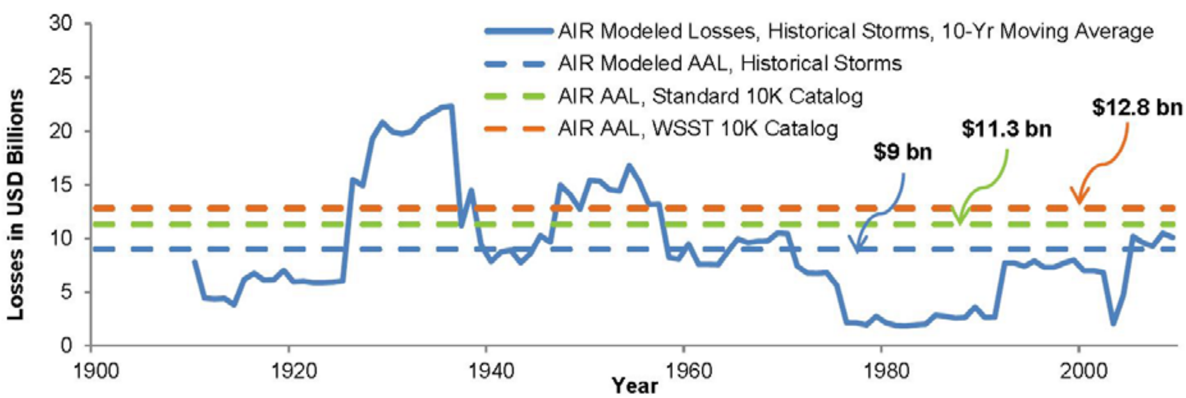


Figure 125. Estimated AAL for historical storms occurring between 1900 and 2009 and the modeled AAL from the standard and WSST catalogs

Comparison of Observed (PCS) and Modeled (AIR ALERT) Losses for Events in Real Time

Figure 126 compares modeled loss estimates produced by AIR in real time (ALERT losses) to the actual losses reported by PCS, for selected historical events. The ALERT losses compare well to the observed (PCS) losses. In addition, note that the AIR loss estimates do not appear biased; for some events, losses were overestimated, while for others, losses were underestimated.

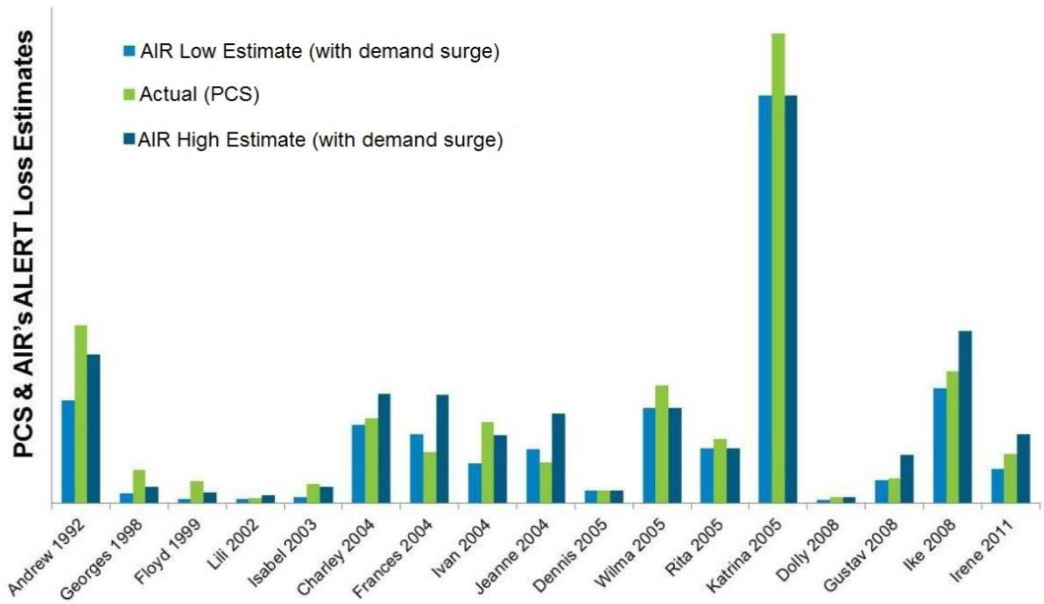


Figure 126. Observed (PCS) losses and AIR ALERT losses (low and high) for selected historical hurricanes (1992-2011)

7 AIR Hurricane Model for the United States in CATRADER

7.1 Available Catalogs

CATRADER incorporates a 10,000-year stochastic catalog.[18] A historical event set is also available, which contains the historical events shown in Table 18.

Table 18. Historical events available in CATRADER

Year	Storm Name	Year	Storm Name
1900	Galveston, Texas	1989	Hugo
1903	No-Name 3	1991	Bob
1906	No-Name 6	1992	Andrew
1915	No-Name 2	1993	Emily
1915	No-Name 6	1994	Gordon
1916	No-Name 2	1995	Erin
1916	No-Name 6	1995	Opal
1919	No-Name 2	1996	Fran
1921	No-Name 6	1996	Bertha
1926	Miami, Florida	1997	Danny
1928	Great Okeechobee, Florida	1998	Bonnie
1932	No-Name 2	1998	Earl
1935	No-Name 2	1998	Georges
1935	No-Name 6	1999	Floyd
1938	Great New England	1999	Bret
1941	No-Name 2	1999	Dennis
1942	No-Name 2	1999	Irene
1944	No-Name 7	2004	Charley
1944	No-Name 11	2000	Gordon
1945	Homestead, Florida	2002	Lili
1947	Fort Lauderdale, Florida	2003	Claudette
1949	No-Name 2	2003	Isabel
1950	Easy	2004	Alex
1954	Carol	2004	Gaston
1954	Hazel	2004	Frances
1960	Donna	2004	Ivan
1961	Carla	2004	Jeanne
1965	Betsy	2005	Dennis

[18] Note that a 50,000-year catalog is also available.

1969	Camille
1969	Gerda
1979	Bob
1979	David
1979	Frederic
1983	Alicia
1985	Juan
1985	Elena
1985	Gloria
1989	Chantal
2005	Katrina
2005	Rita
2005	Wilma
2005	Cindy
2005	Ophelia
2007	Humberto
2008	Gustav
2008	Dolly
2008	Ike

Table 19. Lloyd's realistic disaster scenario (RDS) events available in CATRADER

Description	Modeled Insured Losses (USD Millions)*		
	All Areas**	Gulf of Mexico	U.S.
RDS Northeast Windstorm Event	78,638	-	78,638
RDS Carolinas Windstorm Event	48,066	-	48,066
RDS Gulf of Mexico Windstorm Event	128,514	7,791	120,723
RDS Florida Miami-Dade Windstorm Event	120,970	-	120,970
RDS Florida Pinellas Windstorm Event	143,079	-	143,079

7.2 Resolution of Analysis Results

Modeled loss estimates are reported at county and state level.

7.3 AIR Industry Exposure Database

The Industry Exposure Database (IED) is an integral and highly valuable component of CATRADER. This database contains estimates of insured and insurable property exposures at a high degree of resolution, including the number of risks, their replacement values broken down by line of business (LOB), by coverage, by occupancy, and by construction type, building attributes, and information regarding standard policy terms and conditions. AIR uses a variety of public and private sources to estimate industry exposures, including government data, commercially available demographic information, and other industry data. AIR's industry exposure database is extensively validated via comparison against values obtained from various insurance industry and governmental sources.

The industry exposure database implemented in the AIR Hurricane Model for the United States is current through the end of 2011. For more details about the IED for this model, see the document *AIR Industry Exposure Databases for the United States* (available from the client access portion of the AIR website), which provides further details about the IED for this region and peril, including:

- Details regarding how the IED was developed
- The data sources used to develop the IED
- Maps detailing the total exposure for the modeled region
- Share of Industry Exposure by LOB
- Construction Splits by LOB
- Coverage Splits by LOB
- Height Band Splits by LOB
- Assumed Take-up Rates
- Policy Condition Assumptions

7.4 Supported Lines of Business for Reporting Modeled Losses

CATRADER supports the following lines of business for reporting modeled losses (the components of each line of business are also indicated below):

- Residential – Building, Contents, and Time Element
- Mobile Home – Building, Contents, and Time Element
- Commercial/Industrial – Building, Contents, and Time Element
-
- Automobile

8 AIR Hurricane Model for the United States in CLASIC/2 and Touchstone

8.1 Available Catalogs

CLASIC/2 and Touchstone incorporate a 10,000-year stochastic catalog.[19] A historical event set is also available, which contains the events shown in Table 20.

Table 20. Historical events available in CLASIC/2 and Touchstone

Year	Storm Name	Year	Storm Name
1900	Galveston, Texas	1989	Hugo
1903	No-Name 3	1991	Bob
1906	No-Name 6	1992	Andrew
1915	No-Name 2	1993	Emily
1915	No-Name 6	1994	Gordon
1916	No-Name 2	1995	Erin
1916	No-Name 6	1995	Opal
1919	No-Name 2	1996	Fran
1921	No-Name 6	1996	Bertha
1926	Miami, Florida	1997	Danny
1928	Great Okeechobee, Florida	1998	Bonnie
1932	No-Name 2	1998	Earl
1935	No-Name 2	1998	Georges
1935	No-Name 6	1999	Floyd
1938	Great New England	1999	Bret
1941	No-Name 2	1999	Dennis
1942	No-Name 2	1999	Irene
1944	No-Name 7	2004	Charley
1944	No-Name 11	2000	Gordon
1945	Homestead, Florida	2002	Lili
1947	Fort Lauderdale, Florida	2003	Claudette
1949	No-Name 2	2003	Isabel
1950	Easy	2004	Alex
1954	Carol	2004	Gaston
1954	Hazel	2004	Frances
1960	Donna	2004	Ivan

[19] Note that catalogs of 50,000 and 100,000 years are also available.

1961	Carla		2004	Jeanne
1965	Betsy		2005	Dennis
1969	Camille		2005	Katrina
1969	Gerda		2005	Rita
1979	Bob		2005	Wilma
1979	David		2005	Cindy
1979	Frederic		2005	Ophelia
1983	Alicia		2007	Humberto
1985	Juan		2008	Gustav
1985	Elena		2008	Dolly
1985	Gloria		2008	Ike
1989	Chantal			

Table 21. Lloyd's realistic disaster scenario (RDS) events available in CLASIC/2 and Touchstone

RDS ID	Description	Modeled Insured Losses (USD Millions)*		
		All Areas	Gulf of Mexico	U.S.
1	RDS Northeast Windstorm Event	78,638	-	78,638
2	RDS Carolinas Windstorm Event	48,065	-	48,065
3	RDS Gulf of Mexico Windstorm Event	120,723	7,791	128,514
4	RDS Florida Miami-Dade Windstorm Event	120,970	-	120,970
5	RDS Florida Pinellas Windstorm Event	143,079	-	143,079

*Includes Demand Surge

8.2 Supported Geographic Resolutions

The following geographic resolutions are supported for the AIR Hurricane Model for the United States in CLASIC/2 and Touchstone:

- County
- ZIP Code
- Complete Address (including street, city, and state)
- Address with just city and state, which will geocode at the city-centroid resolution
- User specified latitude/longitude

8.3 Modeling Aggregate Data

There is no disaggregation for the AIR Hurricane Model for the United States in CLASIC/2 and Touchstone. Note that average properties are supported in this model.

8.4 Supported Construction and Occupancy Classes

CLASIC/2 and Touchstone support 68 construction classes and 111 occupancy classes, of which 63 are occupancy classes for large (400-series) industrial facilities.

For detailed descriptions of supported construction classes, please refer to Appendix M of the UNICEDE/px Preparer's Guide on http://www.unicede.com.

Table 22. Supported construction classes

Construction classes		
AIR code	**Category**	**Construction class**
100	None	Unknown
101	Wood	Wood frame
102	Wood	Light wood frame
103	Wood	Masonry veneer
104	Wood	Heavy timber
111	Masonry	Masonry
112	Masonry	Adobe
113	Masonry	Rubble stone masonry
114	Masonry	Unreinforced masonry–bearing wall
115	Masonry	Unreinforced masonry–bearing frame
116	Masonry	Reinforced masonry
117	Masonry	Reinforced masonry shear wall–with mrf
118	Masonry	Reinforced masonry shear wall–without mrf
119	Masonry	Joisted masonry
131	Concrete	Reinforced concrete
132	Concrete	Reinforced concrete shear wall–with mrf
133	Concrete	Reinforced concrete shear wall–without mrf
134	Concrete	Reinforced concrete mrf–ductile
135	Concrete	Reinforced concrete mrf–non-ductile
136	Concrete	Tilt-up
137	Concrete	Precast concrete
151	Steel	Steel
152	Steel	Light metal
153	Steel	Braced steel frame
154	Steel	Steel mrf–perimeter
155	Steel	Steel mrf–distributed

181	Special	Long-span
182	Special	Semi-wind resistive
183	Special	Wind resistive
185	Special	Unknown glass
186	Special	Safety glass
187	Special	Impact resistant glass
191	Mobile homes	Mobile homes
192	Mobile homes	Mobile homes–no tie down
193	Mobile homes	Mobile homes–part tie down
194	Mobile homes	Mobile homes–full tie down
201	Bridges	Conventional–multiple span bridges
202	Bridges	Conventional–continuous bridges
203	Bridges	Major bridges
223	Storage tanks	On ground liquid tanks
224	Storage tanks	On ground solid tanks
225	Storage tanks	Elevated liquid tanks
226	Storage tanks	Elevated solid tanks
228	Pipelines	At grade pipelines
231	Chimneys	Masonry chimneys
232	Chimneys	Concrete chimneys
233	Chimneys	Steel chimneys
234	Towers	Electrical transmission–conventional
235	Towers	Electrical transmission–major
236	Towers	Broadcast towers
237	Towers	Observation towers
238	Towers	Offshore towers
241	Equipment	Residential equipment
242	Equipment	Office equipment
243	Equipment	Electrical equipment
244	Equipment	Mechanical equipment
245	Equipment	High technology equipment
246	Equipment	Trains, trucks airplanes etc.
251	Miscellaneous	Pumping stations
252	Miscellaneous	Compressor stations
253	Miscellaneous	Cranes
254	Miscellaneous	Conveyor systems
257	Miscellaneous	Waterfront structures
258	Miscellaneous	Offshore structures
261	Automobiles	Automobiles
265	Marine craft	Pleasure boats and yachts
266	Marine craft	Pleasure boats and yachts – power boats
267	Marine craft	Pleasure boats and yachts – sailboats

Table 23. Supported occupancy classes

Occupancy classes		
AIR code	**Category**	**Occupancy class**
300	Unknown	Unknown
301	Residential	General residential
302	Residential	Permanent dwelling–single family
303	Residential	Permanent dwelling–multi family
304	Residential	Temporary lodging
305	Residential	Group institutional housing
306	Residential	Apartments/condos
311	Commercial	General commercial
312	Commercial	Retail trade
313	Commercial	Wholesale trade
314	Commercial	Personal and repair services
315	Commercial	Professional, technical and business services
316	Commercial	Health care services
317	Commercial	Entertainment and recreation
318	Commercial	Parking
319	Commercial	Golf courses
321	Industrial	General industrial
322	Industrial	Heavy fabrication and assembly
323	Industrial	Light fabrication and assembly
324	Industrial	Food and drug processing
325	Industrial	Chemical processing
326	Industrial	Metal and minerals processing
327	Industrial	High technology
328	Industrial	Construction
329	Industrial	Petroleum
330	Industrial	Mining
331	Restaurants	Restaurants
335	Mercantile	Gasoline stations
336	Mercantile	Automotive repair services and carwashes
341	Public	Religion and nonprofit

342	Public	Churches
343	Government	General services
344	Government	Emergency services
345	Education	Universities, colleges, technical schools
346	Education	Primary and secondary schools
351	Transportation	Highway
352	Transportation	Railroad
353	Transportation	Air
354	Transportation	Sea and inland waterways
355	Transportation	Aircraft hangars
361	Utilities	Electrical
362	Utilities	Water
363	Utilities	Sanitary sewer
364	Utilities	Natural gas
365	Utilities	Telephone and telegraph
371	Miscellaneous	Communication
372	Miscellaneous	Flood control
373	Miscellaneous	Agriculture

Table 24 shows supported occupancy classes for ***large industrial facilities***, which refers to industrial facilities with replacement values of USD 5 million or more.

While the threshold value of USD 5 million to distinguish between small and large industrial facilities is somewhat arbitrary, it is clear that large industrial sites comprise structures that are very different than those in small industrial facilities. Small industrial facilities typically include one or more buildings with equipment inside. Large industrial sites, however, are much more complex and include a wide range of components in addition to buildings. These may include tanks process towers, flares, cooling towers, utility poles, to name just a few. These components do not behave like buildings when subjected to ground shaking and, therefore, large industrial sites require a different modeling approach.

Small facilities (those with replacement values of USD 5 million or less) consist of mostly buildings and some machinery, and their damage functions were developed using a combination of the building types generally found within these industries. These occupancies, which are included in the 300-series of CLASIC/2 and Touchstone, are listed above.

Table 24. Supported occupancy classes for industrial facilities

Occupancy classes – industrial facilities category	
AIR Code	**Occupancy class**
400	Unknown
401	Heavy fabrication and assembly–general
402	Automotive manufacturer
403	Fabricated metal products
404	Industrial and commercial machinery and equipment
405	Transportation equipment assembly
406	Pulp/paper and allied products manufacturing
407	Textile mill products
408	Lumber and wood products (except furniture)
409	Stone/clay/glass/ceramics products
414	Light fabrication and assembly–general
415	Furniture and fixtures
416	Apparel and finished products from fabrics
417	Printing/ publishing, and allied industries
418	Rubber and miscellaneous plastics products
419	Leather and leather products
420	Electronic and other electrical equipment (except computer equipment)
421	Measuring, analyzing, and controlling instruments
422	Photographic, medical and optical goods
423	Watches and clocks
424	Miscellaneous manufacturing industries
425	Tire manufacturers
429	Food and drug processing –general
430	Food and kindred products
431	Tobacco products
432	Pharmaceutical plants
433	Biological products (except diagnostic) medicinals/botanicals/biomedical
434	Wineries
438	Chemical processing–general
439	Chlorine plants
440	Vinyl plants

441	Light hydrocarbon or aromatics plants
442	Plastics plants
443	Chlorhydrin plants
444	Fertilizer plants
445	Cement plants/ cement mills
446	Other chemical and allied products
449	Metal and minerals processing –general
450	Primary metal industry
451	Steel mills
452	Smelters
455	High technology–general
456	Semi-conductor and related devices
457	Electronic computer devices
458	Computer storage devices
459	Electron tubes
460	Printed circuit boards
463	General building/ construction contractors
464	Heavy construction
465	Special trade contractors
470	Mining –general
471	Mining operations
472	Metal mining
473	Coal mining
474	Mining / quarrying–non-metallic mineral (except fuels)
475	Oil refinery systems–general
476	Hydro-electric power systems–general
477	Thermo-electric power systems–general
478	Nuclear power systems all–general
479	Electric substations
480	Potable water systems–general
481	Waste water treatment systems–general
482	Gas processing systems–general

Supported Construction/Occupancy Class Combinations

Table 25 lists the combinations of construction and occupancy classes that are supported in the model. Note that this applies to Coverage A (Buildings).

Table 25. Supported construction/occupancy class combinations

	Supported Combinations	
	300-Series Occupancy Classes	**400-Series Occupancy Classes (Industrial Facilities)***
Construction Classes 100–183 and 191–267	All combinations	Construction classes 100-183
Construction Classes 185–187	Occupancy classes 306 and 311	

*Although the 400-series of occupancies supports different construction types, damage is not a function of construction type.

8.5 Supported Height Bands

Wind Peril

In the AIR Hurricane Model for the United States, there is no variation in vulnerability by building height for single-family homes. For apartments, commercial buildings, vulnerability varies by height, which varies by construction class:

- Wood Frame: 1 story and >1 story
- Masonry: 1 story, 2–3 stories, and > 3 stories
- Reinforced Concrete and Steel: 1–3 stories, 4–7 stories, and 8+ stories
- Light Metal: there is no variation by height for this construction class

For pleasure boats and yachts, vulnerability varies by length for the three different boat types. The marine craft length bands are small (<26 feet), medium (26–50 feet), and large (>50 feet).

For small (300-series) industrial buildings, construction should be coded as Unknown, and the height bands are 1–3 stories, 4–7 stories, and 8+ stories. For large (400-series) industrial facilities, there is no variation in vulnerability by height.

Storm Surge Peril

The height bands are as follows for all building construction classes:

- Unknown
- Low-rise: 1–3 stories

- Mid-rise: 4–7 stories
- High-rise: 8+ stories

As with wind, pleasure boats and yachts vulnerability varies by length for the three different boat types. The marine craft length bands are small (<26 feet), medium (26-50 feet), and large (>50 feet).

Relative Height/Length Vulnerability Tables

Table 26 through Table 28 show the relative wind vulnerability by height, for mid- and high-rise structures, relative to low-rise structures, for different construction and occupancy class combinations.

Table 26. Relative height vulnerability for wind damage, apartments/condos occupancy class (relative to low-rise structures)

Construction Code	306 – Apartments/Condos	
	Mid-Rise	High-Rise
101	1.000	1.000
102	1.000	1.000
103	1.000	1.000
104	1.000	1.000
111	0.949	0.845
112	0.949	0.848
113	0.949	0.848
114	0.949	0.848
115	0.949	0.848
116	0.903	0.803
117	0.903	0.803
118	0.903	0.803
119	0.949	0.847
131	0.729	0.593
132	0.729	0.593
133	0.729	0.593
134	0.729	0.593
135	0.729	0.593
136	0.729	0.593
137	0.729	0.593
151	0.704	0.586

152	1.002	1.002
153	0.704	0.586
154	0.704	0.586
155	0.704	0.586
181	0.707	0.589
182	0.903	0.803
183	0.729	0.593
185	1.021	1.070
186	1.023	1.074

Table 27. Relative height vulnerability for wind damage, general commercial occupancy class (relative to low-rise structures)

Construction Class	311- General Commercial	
	Mid-Rise	High-Rise
101	1.000	1.000
102	1.000	1.000
103	1.000	1.000
104	1.000	1.000
111	0.936	0.738
112	0.937	0.744
113	0.937	0.744
114	0.937	0.744
115	0.937	0.744
116	0.889	0.774
117	0.889	0.774
118	0.889	0.774
119	0.937	0.744
131	0.680	0.519
132	0.680	0.519
133	0.680	0.519
134	0.680	0.519
135	0.680	0.519
136	0.680	0.519
137	0.680	0.519
151	0.607	0.463

152	1.000	1.000
153	0.607	0.463
154	0.607	0.463
155	0.607	0.463
181	0.610	0.466
182	0.889	0.774
183	0.680	0.519
185	1.145	1.585
186	1.152	1.611

Table 28. Relative height vulnerability for wind damage, general industrial occupancy class (relative to low-rise structures)

Construction Class	321- General Industrial	
	Mid-Rise	High-Rise
100	0.529	0.287

Table 29 shows the relative vulnerability, by length, for medium and large boats relative to small boats, for occupancy class 354.

Table 29. Relative vulnerability to wind damage, sea and inland waterways occupancy class (relative to small boats)

Construction Class	354- Sea and Inland Waterways	
	Medium	Large
265	1.000	0.523
266	1.000	0.455
267	1.000	0.523

8.6 Vulnerability by Year Built

As described in Section 5.3, the model accounts for regional and temporal variations in building vulnerability. AIR undertook a comprehensive, peer-reviewed study to further understand the evolution of wind load standards, building codes, and building construction practices for all hurricane-prone regions in the United States. Detailed findings of this study were incorporated in the model to capture regional and temporal variations in building vulnerability. *Note that to take full advantage of the new capabilities of differentiating risks by age, it is important that CLASIC/2 and Touchstone users geocode their exposures and avoid bulk-coding Year Built.*

Table 30 lists the vulnerability by age for engineered and non-engineered structures, relative to unknown year built, in select ZIP Codes throughout the modeled region.

Table 30. Relative vulnerability by age and construction type for wind damage

Location (City, State)	Zip Code	Non-Engineered Construction					Engineered Construction				
		Unknown Year	1994	1995	2004	2009	Unknown Year	1994	1995	2004	2009
Birmingham, AL	35203	1.00	1.08	1.05	0.84	0.82	1.00	1.07	0.97	0.77	0.69
Gulf Shores, AL	36542	1.00	1.07	1.05	0.86	0.32	1.00	1.10	0.88	0.71	0.47
Mobile, AL	36602	1.00	1.15	1.12	0.33	0.32	1.00	1.11	0.86	0.69	0.45
Little Rock, AR	72204	1.00	1.08	1.05	0.84	0.82	1.00	1.05	1.02	0.82	0.79
Hartford, CT	6105	1.00	1.06	0.96	0.77	0.51	1.00	1.02	1.00	0.80	0.72
New Haven, CT	6510	1.00	1.07	0.94	0.75	0.41	1.00	1.03	1.01	0.81	0.57
Washington, D.C.	20001	1.00	1.04	0.87	0.70	0.68	1.00	1.01	0.98	0.72	0.70
Dover, DE	19901	1.00	1.14	1.03	0.71	0.69	1.00	1.11	1.00	0.74	0.72
Wilmington, DE	19801	1.00	1.14	1.03	0.72	0.70	1.00	1.11	1.00	0.74	0.72
Fort Lauderdale, FL	33304	1.00	1.42	0.59	0.29	0.28	1.00	1.36	0.76	0.41	0.40
Jacksonville, FL	32202	1.00	1.29	0.86	0.57	0.55	1.00	1.25	0.93	0.64	0.62
Key West, FL	33040	1.00	1.26	0.93	0.46	0.45	1.00	1.24	1.03	0.57	0.56
Miami, FL	33133	1.00	1.46	0.57	0.28	0.27	1.00	1.37	0.75	0.40	0.39
Orlando, FL	32801	1.00	1.27	1.04	0.55	0.54	1.00	1.26	0.93	0.63	0.61
Orlando, FL	32806	1.00	1.27	1.04	0.55	0.54	1.00	1.26	0.93	0.63	0.61
Pensacola, FL	32502	1.00	1.28	0.89	0.53	0.52	1.00	1.22	0.96	0.67	0.65
Tallahassee, FL	32399	1.00	1.27	1.04	0.56	0.54	1.00	1.26	0.93	0.63	0.61
Tampa, FL	33607	1.00	1.28	0.87	0.56	0.54	1.00	1.23	0.96	0.66	0.64
Atlanta, GA	30303	1.00	1.14	1.12	0.77	0.75	1.00	1.11	1.08	0.80	0.77
Atlanta, GA	30314	1.00	1.14	1.12	0.77	0.75	1.00	1.11	1.08	0.80	0.77
Savannah, GA	31401	1.00	1.34	1.01	0.44	0.43	1.00	1.27	0.99	0.55	0.53
Chicago, IL	60608	1.00	1.07	1.04	0.83	0.81	1.00	1.04	1.01	0.81	0.78
Indianapolis, IN	46204	1.00	1.08	1.05	0.84	0.81	1.00	1.05	1.02	0.81	0.79
Louisville, KY	40217	1.00	1.08	1.05	0.84	0.82	1.00	1.05	1.02	0.82	0.79

New Orleans, LA	70121	1.00	1.08	1.04	0.84	0.30	1.00	1.10	0.82	0.66	0.44
Boston, MA	2111	1.00	1.05	1.00	0.80	0.54	1.00	1.02	1.00	0.80	0.73
Hyannis, MA	2601	1.00	1.08	0.77	0.62	0.45	1.00	1.05	0.85	0.68	0.61
Baltimore, MD	21202	1.00	1.10	0.92	0.74	0.72	1.00	1.05	1.03	0.76	0.74
Ocean City, MD	21842	1.00	1.12	0.99	0.41	0.40	1.00	1.07	1.05	0.47	0.46
Augusta, ME	4330	1.00	1.08	1.05	0.84	0.69	1.00	1.06	1.03	0.82	0.69
Portland, ME	4101	1.00	1.08	1.05	0.84	0.69	1.00	1.06	1.03	0.82	0.69
Kansas City, MO	64120	1.00	1.08	1.05	0.84	0.82	1.00	1.04	1.01	0.81	0.79
Saint Louis, MO	63108	1.00	1.08	1.04	0.84	0.81	1.00	1.04	1.01	0.81	0.79
Biloxi, MS	39530	1.00	1.08	1.05	0.87	0.32	1.00	1.07	1.01	0.82	0.43
Jackson, MS	39201	1.00	1.07	1.04	0.84	0.81	1.00	1.04	1.02	0.81	0.79
Charlotte, NC	28202	1.00	1.12	1.09	0.76	0.74	1.00	1.08	1.06	0.78	0.76
Raleigh, NC	27609	1.00	1.12	1.09	0.75	0.73	1.00	1.08	1.06	0.79	0.76
Wilmington, NC	28401	1.00	1.24	0.94	0.54	0.52	1.00	1.18	0.92	0.65	0.64
Concord, NH	3301	1.00	1.09	1.06	0.85	0.62	1.00	1.06	1.03	0.82	0.65
Portsmouth, NH	3801	1.00	1.09	1.06	0.85	0.49	1.00	1.06	1.03	0.82	0.65
Atlantic City, NJ	8401	1.00	1.08	0.95	0.77	0.44	1.00	1.05	0.95	0.77	0.56
Albany, NY	12207	1.00	1.05	1.03	0.71	0.69	1.00	1.02	1.00	0.74	0.72
Long Beach (Long Island), NY	11561	1.00	1.05	1.03	0.45	0.44	1.00	1.03	1.01	0.61	0.60
New York City, NY	10007	1.00	1.06	1.03	0.56	0.55	1.00	1.02	1.00	0.74	0.72
Cleveland, OH	44113	1.00	1.07	1.04	0.83	0.81	1.00	1.03	1.01	0.80	0.78
Oklahoma City, OK	73102	1.00	1.07	1.04	0.83	0.81	1.00	1.04	1.01	0.81	0.78
Philadelphia, PA	19107	1.00	1.05	1.02	0.82	0.80	1.00	1.03	1.00	0.80	0.78
Newport, RI	2840	1.00	1.05	0.99	0.80	0.44	1.00	1.04	0.94	0.75	0.56
Providence, RI	2903	1.00	1.06	1.01	0.81	0.45	1.00	1.04	0.94	0.75	0.52
Charleston, SC	29401	1.00	1.24	0.92	0.41	0.39	1.00	1.16	1.06	0.51	0.49
Columbia, SC	29223	1.00	1.11	1.08	0.75	0.73	1.00	1.08	1.05	0.78	0.76
Myrtle Beach, SC	29577	1.00	1.23	0.90	0.41	0.40	1.00	1.15	1.06	0.53	0.51
Nashville, TN	37219	1.00	1.09	1.06	0.85	0.82	1.00	1.05	1.02	0.82	0.80
Corpus Christi, TX	78419	1.00	1.27	0.76	0.41	0.40	1.00	1.28	0.67	0.55	0.53
Dallas, TX	75246	1.00	1.13	1.10	0.74	0.72	1.00	1.10	1.07	0.74	0.71
Galveston, TX	77550	1.00	1.26	0.78	0.42	0.41	1.00	1.27	0.69	0.56	0.55
Houston, TX	77002	1.00	1.13	1.10	0.70	0.68	1.00	1.10	1.07	0.74	0.72
Norfolk, VA	23510	1.00	1.11	1.06	0.85	0.58	1.00	1.06	1.04	0.83	0.75
Richmond, VA	23298	1.00	1.09	1.07	0.86	0.72	1.00	1.06	1.04	0.83	0.75
Virginia Beach, VA	23451	1.00	1.17	0.89	0.71	0.50	1.00	1.13	0.88	0.71	0.63
Montpelier, VT	5602	1.00	1.07	1.04	0.83	0.81	1.00	1.04	1.01	0.81	0.78
Charleston, WV	25301	1.00	1.06	1.03	0.83	0.80	1.00	1.03	1.00	0.80	0.78

8.7 Individual Risk Module (Secondary Modifiers)

As described in Section 5.4, the AIR Hurricane Model for the United States contains an Individual Risk Module (IRM), which identifies key building features that may significantly exacerbate or mitigate losses. This module was developed based on structural engineering expertise and building damage observations made in the aftermath of historical hurricanes.

Table 31 lists the individual risk characteristics, or secondary modifiers, that are supported in the model. The table provides a description of each modifier and an estimate of its relative importance with regard to other modifiers for specific locations and year built. Please note that the effects of a building feature on vulnerability are sensitive to factors such as wind speed; therefore, the relativity may change according to wind speed. The relative importance of each modifier listed in Table 31 is an average over a variety of wind speeds. There is no definitive way to determine which secondary risk modifiers have the greatest impact on building vulnerability. The values provided in Table 31 are only estimates of each modifier's relative importance.

Table 31. Secondary risk modifiers supported in CLASIC/2 and Touchstone and their relative importance

		Miami, FL	Raleigh, NC	Boston, MA
Secondary Risk Modifier	**Description**	**Year Built 2010**	**Year Built 1995**	**Year Built 1994**
Appurtenant Structures	Non-integral components of a property that are not connected to the main building, such as pool enclosures, sheds, and boundary walls surrounding a house.	22%	14%	17%
Building Condition	A building's overall general condition of the external cladding and maintenance, based on a visual inspection.	9%	6%	6%
Building-Foundation Connection	Connection between the structure and foundation. This connection transfers the vertical and lateral wind loads on the building to the foundation.	5%	0%	1%
Exterior Doors	Exterior door construction. Doors and frames can weaken under heavy winds.	29%	4%	6%
Glass Type	Type of glass used for windows, walls, and doors, which can determine resistance to wind loads and debris impact.	2%	5%	6%
Glass Percent	The percentage of the wall that is glass. Generally, a higher percentage of glass means higher vulnerability.	4%	5%	7%

Large Missile Source	Indicates if materials within a 100-foot radius of the property may, during high winds, become large missiles capable of damaging the property. Examples are garden furniture, or wood planks that dislodge from nearby buildings.	11%	4%	5%
Small Debris Source	Indicates if any small debris within a 200-foot radius of the property may, during high winds, become small missiles capable of breaking window glass. Small debris can be carried to all heights of the building. Examples are roof gravel, trash bins, and tree branches.	11%	5%	6%
Tree Exposure	The tree hazard around the building. Trees may snap in strong winds and damage nearby buildings.	3%	1%	1%
Roof Anchorage	Connections that secure the roof support system to the walls. Roof anchorage transfers wind loads from roof to walls.	43%	4%	6%
Roof-Attached Structures	Any equipment attached to the roof, mechanical or otherwise. Attached structures are often more vulnerable than the main building.	21%	4%	6%
Roof Cover Attachment	Connections that secure the roof covering to the underlying roof deck. An improper attachment can increase the vulnerability of the roof.	27%	8%	7%
Roof Cover	Material used to cover the roof. Damage to the roof covering can allow water damage to the building's interior.	53%	23%	21%
Roof Deck	Material and construction type of the roof deck. Roof decks transfer the roof loads to the underlying joists and purlins. Damage to the roof deck allows breaching of the building envelope, which can lead to significant damage.	29%	5%	6%
Roof Geometry	Shape of the roof, which affects the wind pressure intensity and the uplift resistance.	38%	19%	21%
Roof Pitch	The roof slope. Low pitch roofs experience greater uplift forces during high winds as compared to high pitch roofs.	15%	9%	10%
Seal of Approval	The level of professional engineering attention given to the design of a structure.	17%	0%	0%
Wall-Attached Structures	Nonintegral components of a property that are physically attached to the main building. Attached structures are often more vulnerable than the main building.	11%	6%	7%
Window Protection	Window protection can reduce the potential damage to a building.	54%	11%	13%

Wall Siding	Materials to protect walls from weathering, which affects the resistance to wind damage. A breach in the wall siding can expose walls to wind and rain, resulting in damage and the buildup of internal pressure.	58%	19%	19%
Wall Type	External wall materials affect resistance to wind-induced lateral loads. Breaches in the wall can result in damage and the buildup of internal pressure.	2%	5%	6%
Year Roof Built	The year the roof was built or had a major renovation. With age, roofs lose their ability to resist wind loads.	17%	10%	11%

Please refer to the document titled *AIR U.S. Hurricane Model: Accounting for Secondary Risk Characteristics*, which is available on the AIR website (login required), for more information regarding these secondary modifiers.

Builders Risk

In CLASIC/2 and Touchstone, the builders risk line of business is modeled within the individual risk module using the same style as any other secondary risk modifier. However, it is not a true secondary risk modifier and hence, it is not included in Table 29 and has no relative importance with respect to the other secondary risk characteristics.

The builders risk line of business is used to provide loss estimates for buildings under construction. By integrating vulnerability, cost, and seasonality functions for buildings of all construction and occupancy classes (except complex industrial facilities), the model accurately estimates the tropical cyclone wind and storm surge risk to buildings at each construction phase, from foundation and substructure to finish, and for the construction project as a whole. For more information on builders risk, see Section 5.11.

8.8 Relative Vulnerability of Selected Construction/Occupancy Class Combinations

Table 32 displays the relative building vulnerability for the wind peril for selected construction/occupancy class combinations, and Table 33 shows these vulnerabilities for the storm surge peril. Relative vulnerabilities for the 300 series, 301-371 in the table, are computed by taking the average annual loss for a particular construction/occupancy combination and dividing by the average annual loss for the wood frame construction/general residential combination. Relative vulnerabilities for the 400 series, 400-449 in the table, are computed by taking the average annual loss for a particular construction/occupancy combination and dividing by the average annual loss for the wood frame construction/general industrial combination (400).

Table 32. Relative wind vulnerability of selected construction/occupancy combinations

	Occupancy Class													
Construction Class	**301**	**311**	**321**	**331**	**341**	**351**	**361**	**371**	**400**	**401**	**414**	**429**	**438**	**449**
101	1.000	0.907	0.703	0.987	0.907	0.907	0.826	0.907	1.000	1.035	1.024	0.920	0.860	1.006
102	1.000	0.987	0.703	1.065	0.987	0.987	0.907	0.987	1.000	1.035	1.024	0.920	0.860	1.006
103	0.955	0.867	0.703	0.947	0.867	0.867	0.785	0.867	1.000	1.035	1.024	0.920	0.860	1.006
104	0.910	0.826	0.703	0.907	0.826	0.826	0.743	0.826	1.000	1.035	1.024	0.920	0.860	1.006
111	0.825	0.668	0.703	0.740	0.668	0.668	0.596	0.668	1.000	1.035	1.024	0.920	0.860	1.006
112	0.899	0.775	0.703	0.845	0.775	0.775	0.704	0.775	1.000	1.035	1.024	0.920	0.860	1.006
113	0.825	0.775	0.703	0.845	0.775	0.775	0.704	0.775	1.000	1.035	1.024	0.920	0.860	1.006
114	0.825	0.775	0.703	0.845	0.775	0.775	0.704	0.775	1.000	1.035	1.024	0.920	0.860	1.006
115	0.825	0.775	0.703	0.845	0.775	0.775	0.704	0.775	1.000	1.035	1.024	0.920	0.860	1.006
116	0.769	0.476	0.703	0.520	0.476	0.476	0.431	0.476	1.000	1.035	1.024	0.920	0.860	1.006
117	0.769	0.476	0.703	0.520	0.476	0.476	0.431	0.476	1.000	1.035	1.024	0.920	0.860	1.006
118	0.769	0.476	0.703	0.520	0.476	0.476	0.431	0.476	1.000	1.035	1.024	0.920	0.860	1.006
119	0.825	0.775	0.703	0.845	0.775	0.775	0.704	0.775	1.000	1.035	1.024	0.920	0.860	1.006
131	0.769	0.360	0.703	0.394	0.360	0.360	0.325	0.360	1.000	1.035	1.024	0.920	0.860	1.006
132	0.769	0.360	0.703	0.394	0.360	0.360	0.325	0.360	1.000	1.035	1.024	0.920	0.860	1.006
133	0.769	0.360	0.703	0.394	0.360	0.360	0.325	0.360	1.000	1.035	1.024	0.920	0.860	1.006
134	0.769	0.360	0.703	0.394	0.360	0.360	0.325	0.360	1.000	1.035	1.024	0.920	0.860	1.006
135	0.769	0.360	0.703	0.394	0.360	0.360	0.325	0.360	1.000	1.035	1.024	0.920	0.860	1.006
136	0.769	0.360	0.703	0.394	0.360	0.360	0.325	0.360	1.000	1.035	1.024	0.920	0.860	1.006
137	0.769	0.360	0.703	0.394	0.360	0.360	0.325	0.360	1.000	1.035	1.024	0.920	0.860	1.006
151	0.796	0.409	0.703	0.447	0.409	0.409	0.370	0.409	1.000	1.035	1.024	0.920	0.860	1.006
152	1.207	1.194	0.630	1.296	1.194	1.194	1.089	1.194	1.000	1.035	1.024	0.920	0.860	1.006
153	0.796	0.409	0.703	0.447	0.409	0.409	0.370	0.409	1.000	1.035	1.024	0.920	0.860	1.006
154	0.796	0.409	0.703	0.447	0.409	0.409	0.370	0.409	1.000	1.035	1.024	0.920	0.860	1.006
155	0.796	0.409	0.703	0.447	0.409	0.409	0.370	0.409	1.000	1.035	1.024	0.920	0.860	1.006
181	0.868	0.447	0.703	0.486	0.447	0.447	0.409	0.447	1.000	1.035	1.024	0.920	0.860	1.006
182	0.796	0.476	0.703	0.520	0.476	0.476	0.431	0.476	1.000	1.035	1.024	0.920	0.860	1.006
183	0.769	0.360	0.703	0.394	0.360	0.360	0.325	0.360	1.000	1.035	1.024	0.920	0.860	1.006
185	-	0.187	-	-	-	-	-	-	-	-	-	-	-	-
186	-	0.188	-	-	-	-	-	-	-	-	-	-	-	-
187	-	0.164	-	-	-	-	-	-	-	-	-	-	-	-
191	2.233	1.942	1.942	1.942	1.942	1.942	1.942	1.942	-	-	-	-	-	-

	Occupancy Class													
Construction Class	**301**	**311**	**321**	**331**	**341**	**351**	**361**	**371**	**400**	**401**	**414**	**429**	**438**	**449**
192	3.043	2.658	2.658	2.658	2.658	2.658	2.658	2.658	-	-	-	-	-	-
193	2.217	1.928	1.928	1.928	1.928	1.928	1.928	1.928	-	-	-	-	-	-
194	2.001	1.738	1.738	1.738	1.738	1.738	1.738	1.738	-	-	-	-	-	-
201	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	-	-	-	-	-	-
202	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	-	-	-	-	-	-
203	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	-	-	-	-	-	-
223	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	-	-	-	-	-	-
224	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	-	-	-	-	-	-
225	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	-	-	-	-	-	-
226	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	-	-	-	-	-	-
228	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	-	-	-	-	-	-
231	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	-	-	-	-	-	-
232	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	-	-	-	-	-	-
233	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	-	-	-	-	-	-
234	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	-	-	-	-	-	-
235	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	-	-	-	-	-	-
236	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	-	-	-	-	-	-
237	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	-	-	-	-	-	-
238	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	-	-	-	-	-	-
241	0.742	0.737	0.737	0.737	0.737	0.737	0.737	0.737	-	-	-	-	-	-
242	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	-	-	-	-	-	-
243	0.459	0.458	0.458	0.458	0.458	0.458	0.458	0.458	-	-	-	-	-	-
244	0.311	0.311	0.311	0.311	0.311	0.311	0.311	0.311	-	-	-	-	-	-
245	0.325	0.322	0.322	0.322	0.322	0.322	0.322	0.322	-	-	-	-	-	-
246	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	-	-	-	-	-	-
251	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	-	-	-	-	-	-
252	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	-	-	-	-	-	-
253	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	-	-	-	-	-	-
254	0.234	0.233	0.233	0.233	0.233	0.233	0.233	0.233	-	-	-	-	-	-
257	0.796	0.791	0.791	0.791	0.791	0.791	0.791	0.791	-	-	-	-	-	-
258	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	-	-	-	-	-	-
261	0.594	0.594	0.594	0.594	0.594	0.594	0.594	0.594	-	-	-	-	-	-
265	0.302	0.302	0.302	0.302	0.302	0.302	0.302	0.302	-	-	-	-	-	-
266	0.346	0.346	0.346	0.346	0.346	0.346	0.346	0.346	-	-	-	-	-	-
267	0.287	0.287	0.287	0.287	0.287	0.287	0.287	0.287	-	-	-	-	-	-

Table 33. Relative storm surge vulnerability of selected construction/occupancy combinations

Construction Class	Occupancy Class													
	301	311	321	331	341	351	361	371	400	401	414	429	438	449
101	1.000	0.936	0.748	0.932	0.936	0.936	0.940	0.936	1.000	0.980	1.100	0.980	0.784	0.931
102	1.000	0.932	0.748	0.929	0.932	0.932	0.936	0.932	1.000	0.980	1.100	0.980	0.784	0.931
103	0.856	0.814	0.748	0.811	0.814	0.814	0.817	0.814	1.000	0.980	1.100	0.980	0.784	0.931
104	0.827	0.940	0.748	0.936	0.940	0.940	0.944	0.940	1.000	0.980	1.100	0.980	0.784	0.931
111	0.890	0.838	0.748	0.836	0.838	0.838	0.839	0.838	1.000	0.980	1.100	0.980	0.784	0.931
112	0.956	0.835	0.748	0.833	0.835	0.835	0.837	0.835	1.000	0.980	1.100	0.980	0.784	0.931
113	0.890	0.835	0.748	0.833	0.835	0.835	0.837	0.835	1.000	0.980	1.100	0.980	0.784	0.931
114	0.890	0.794	0.748	0.793	0.794	0.794	0.796	0.794	1.000	0.980	1.100	0.980	0.784	0.931
115	0.890	0.794	0.748	0.793	0.794	0.794	0.796	0.794	1.000	0.980	1.100	0.980	0.784	0.931
116	0.891	0.757	0.748	0.757	0.757	0.757	0.758	0.757	1.000	0.980	1.100	0.980	0.784	0.931
117	0.891	0.757	0.748	0.757	0.757	0.757	0.758	0.757	1.000	0.980	1.100	0.980	0.784	0.931
118	0.891	0.757	0.748	0.757	0.757	0.757	0.758	0.757	1.000	0.980	1.100	0.980	0.784	0.931
119	0.890	0.752	0.748	0.751	0.752	0.752	0.753	0.752	1.000	0.980	1.100	0.980	0.784	0.931
131	0.480	0.482	0.748	0.482	0.482	0.482	0.482	0.482	1.000	0.980	1.100	0.980	0.784	0.931
132	0.480	0.482	0.748	0.482	0.482	0.482	0.482	0.482	1.000	0.980	1.100	0.980	0.784	0.931
133	0.480	0.482	0.748	0.482	0.482	0.482	0.482	0.482	1.000	0.980	1.100	0.980	0.784	0.931
134	0.480	0.482	0.748	0.482	0.482	0.482	0.482	0.482	1.000	0.980	1.100	0.980	0.784	0.931
135	0.480	0.482	0.748	0.482	0.482	0.482	0.482	0.482	1.000	0.980	1.100	0.980	0.784	0.931
136	0.480	0.482	0.748	0.482	0.482	0.482	0.482	0.482	1.000	0.980	1.100	0.980	0.784	0.931
137	0.480	0.482	0.748	0.482	0.482	0.482	0.482	0.482	1.000	0.980	1.100	0.980	0.784	0.931
151	0.678	0.662	0.748	0.662	0.662	0.662	0.662	0.662	1.000	0.980	1.100	0.980	0.784	0.931
152	0.672	0.652	0.749	0.650	0.652	0.652	0.653	0.652	1.000	0.980	1.100	0.980	0.784	0.931
153	0.678	0.662	0.748	0.662	0.662	0.662	0.662	0.662	1.000	0.980	1.100	0.980	0.784	0.931
154	0.678	0.662	0.748	0.662	0.662	0.662	0.662	0.662	1.000	0.980	1.100	0.980	0.784	0.931
155	0.678	0.662	0.748	0.662	0.662	0.662	0.662	0.662	1.000	0.980	1.100	0.980	0.784	0.931
181	0.677	0.655	0.748	0.654	0.655	0.655	0.655	0.655	1.000	0.980	1.100	0.980	0.784	0.931
182	0.678	0.655	0.748	0.654	0.655	0.655	0.655	0.655	1.000	0.980	1.100	0.980	0.784	0.931
183	0.678	0.656	0.748	0.655	0.656	0.656	0.656	0.656	1.000	0.980	1.100	0.980	0.784	0.931
191	1.156	0.967	1.169	0.967	0.967	1.169	0.967	0.967	-	-	-	-	-	-
192	1.123	0.942	1.138	0.942	0.942	1.138	0.942	0.942	-	-	-	-	-	-
193	1.157	0.968	1.170	0.968	0.968	1.170	0.968	0.968	-	-	-	-	-	-
194	1.166	0.975	1.178	0.975	0.975	1.178	0.975	0.975	-	-	-	-	-	-
201	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	-	-	-	-	-	-
202	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	-	-	-	-	-	-
203	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	-	-	-	-	-	-
223	0.287	0.286	0.286	0.286	0.286	0.286	0.286	0.286	-	-	-	-	-	-

	Occupancy Class													
Construction Class	**301**	**311**	**321**	**331**	**341**	**351**	**361**	**371**	**400**	**401**	**414**	**429**	**438**	**449**
224	0.287	0.286	0.286	0.286	0.286	0.286	0.286	0.286	-	-	-	-	-	-
225	0.287	0.286	0.286	0.286	0.286	0.286	0.286	0.286	-	-	-	-	-	-
226	0.287	0.286	0.286	0.286	0.286	0.286	0.286	0.286	-	-	-	-	-	-
228	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	-	-	-	-	-	-
231	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	-	-	-	-	-	-
232	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	-	-	-	-	-	-
233	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	-	-	-	-	-	-
234	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	-	-	-	-	-	-
235	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	-	-	-	-	-	-
236	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	-	-	-	-	-	-
237	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	-	-	-	-	-	-
238	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	-	-	-	-	-	-
241	1.863	1.730	1.730	1.730	1.730	1.730	1.730	1.730	-	-	-	-	-	-
242	1.880	1.744	1.744	1.744	1.744	1.744	1.744	1.744	-	-	-	-	-	-
243	1.875	1.740	1.740	1.740	1.740	1.740	1.740	1.740	-	-	-	-	-	-
244	1.881	1.744	1.744	1.744	1.744	1.744	1.744	1.744	-	-	-	-	-	-
245	1.873	1.738	1.738	1.738	1.738	1.738	1.738	1.738	-	-	-	-	-	-
246	1.887	1.750	1.750	1.750	1.750	1.750	1.750	1.750	-	-	-	-	-	-
251	1.353	1.248	1.248	1.248	1.248	1.248	1.248	1.248	-	-	-	-	-	-
252	1.353	1.248	1.248	1.248	1.248	1.248	1.248	1.248	-	-	-	-	-	-
253	0.573	0.550	0.550	0.550	0.550	0.550	0.550	0.550	-	-	-	-	-	-
254	0.564	0.541	0.541	0.541	0.541	0.541	0.541	0.541	-	-	-	-	-	-
257	0.160	0.160	0.160	0.160	0.160	0.160	0.160	0.160	-	-	-	-	-	-
258	0.161	0.161	0.161	0.161	0.161	0.161	0.161	0.161	-	-	-	-	-	-
261	0.384	0.384	0.384	0.384	0.384	0.384	0.384	0.384	-	-	-	-	-	-
265	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	-	-	-	-	-	-
266	0.093	0.093	0.093	0.093	0.093	0.093	0.093	0.093	-	-	-	-	-	-
267	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	-	-	-	-	-	-

8.9 Damage Functions for Unknown Characteristics

Many times a characteristic of a building, such as its construction or occupancy class, or height, is unknown. In these cases, CLASIC/2 and Touchstone use a composite damage function based on AIR's industry exposure database. For a given unknown characteristic, the unknown damage function represents a weighted average of the damage functions of the different classes that are in the

AIR industry exposure database, with weights determined by the relative share of total insurable value of each class. Detailed information on the damage functions is available in Section 5.

8.10 Supported Policy Terms

The financial module in CLASIC/2 and Touchstone allows for the application of a wide variety of location, policy, and reinsurance conditions. Location terms may be specified to include limits and deductibles by site or by coverage. Supported policy terms include blanket and excess layers, minimum and maximum deductibles, and sublimits. Reinsurance terms include facultative certificates and various types of risk-specific and aggregate treaties with occurrence and aggregate limits. For more information, please see product-specific documentation available on the client support section of AIR's website (http://www.air-worldwide.com/) or http://www.unicede.com for details on the industry standard UNICEDE data format.

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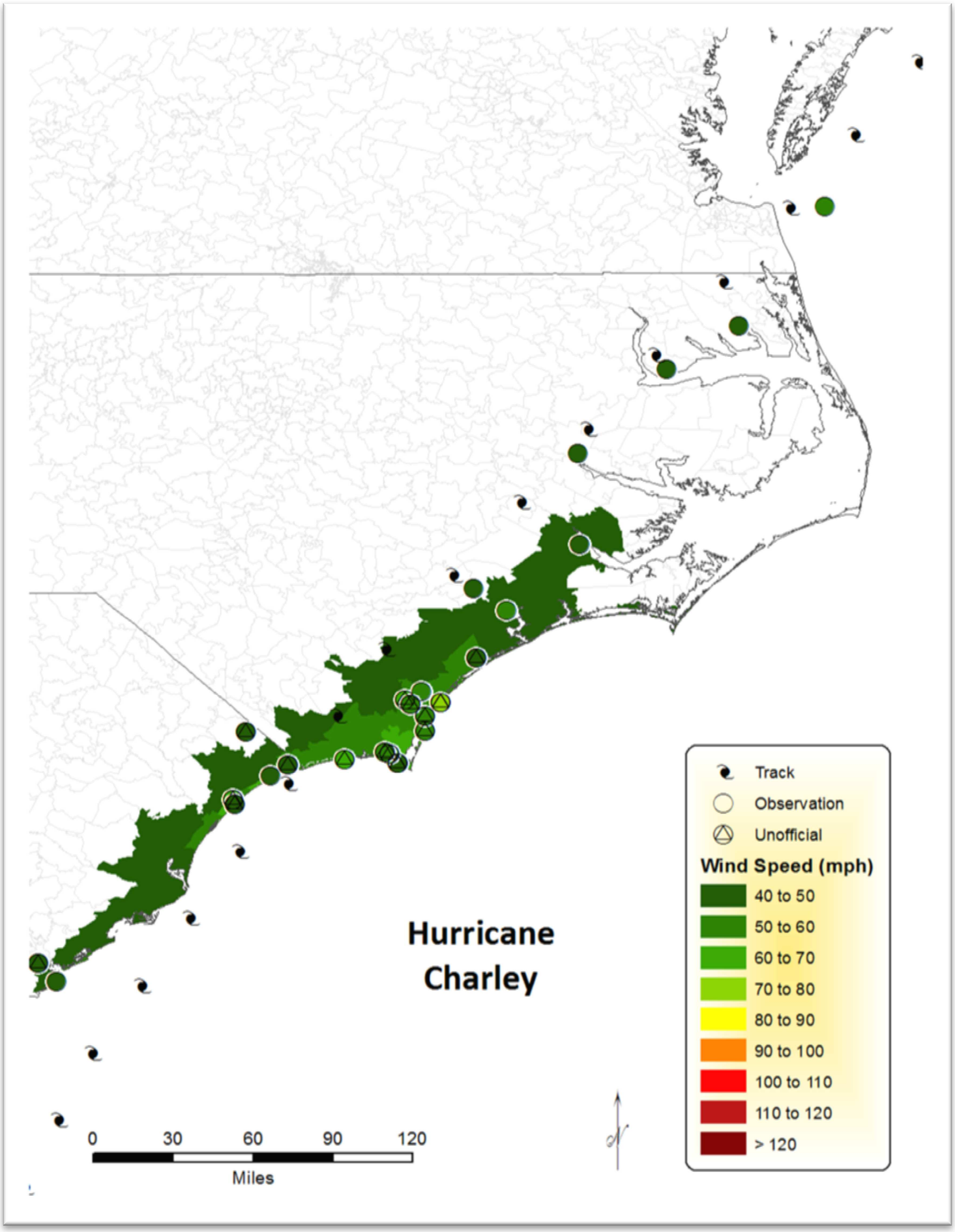
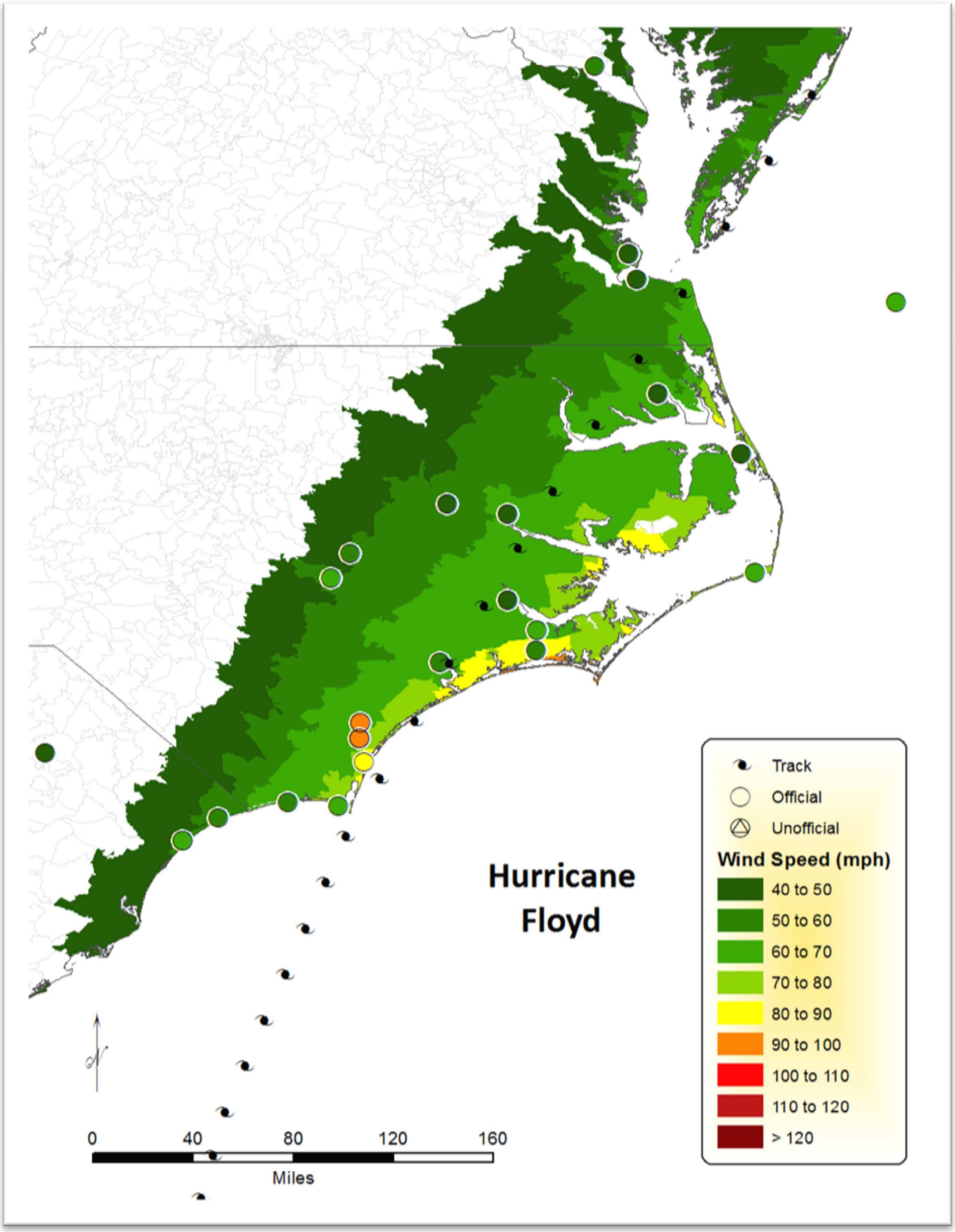
10 About AIR Worldwide

AIR Worldwide (AIR) is the scientific leader and most respected provider of risk modeling software and consulting services. AIR founded the catastrophe modeling industry in 1987 and today models the risk from natural catastrophes and terrorism in more than 90 countries. More than 400 insurance, reinsurance, financial, corporate, and government clients rely on AIR software and services for catastrophe risk management, insurance-linked securities, detailed site-specific wind and seismic engineering analyses, and agricultural risk management. AIR is a member of the Verisk Insurance Solutions group at Verisk Analytics (Nasdaq:VRSK) and is headquartered in Boston with additional offices in North America, Europe, and Asia. For more information, please visit www.air-worldwide.com.

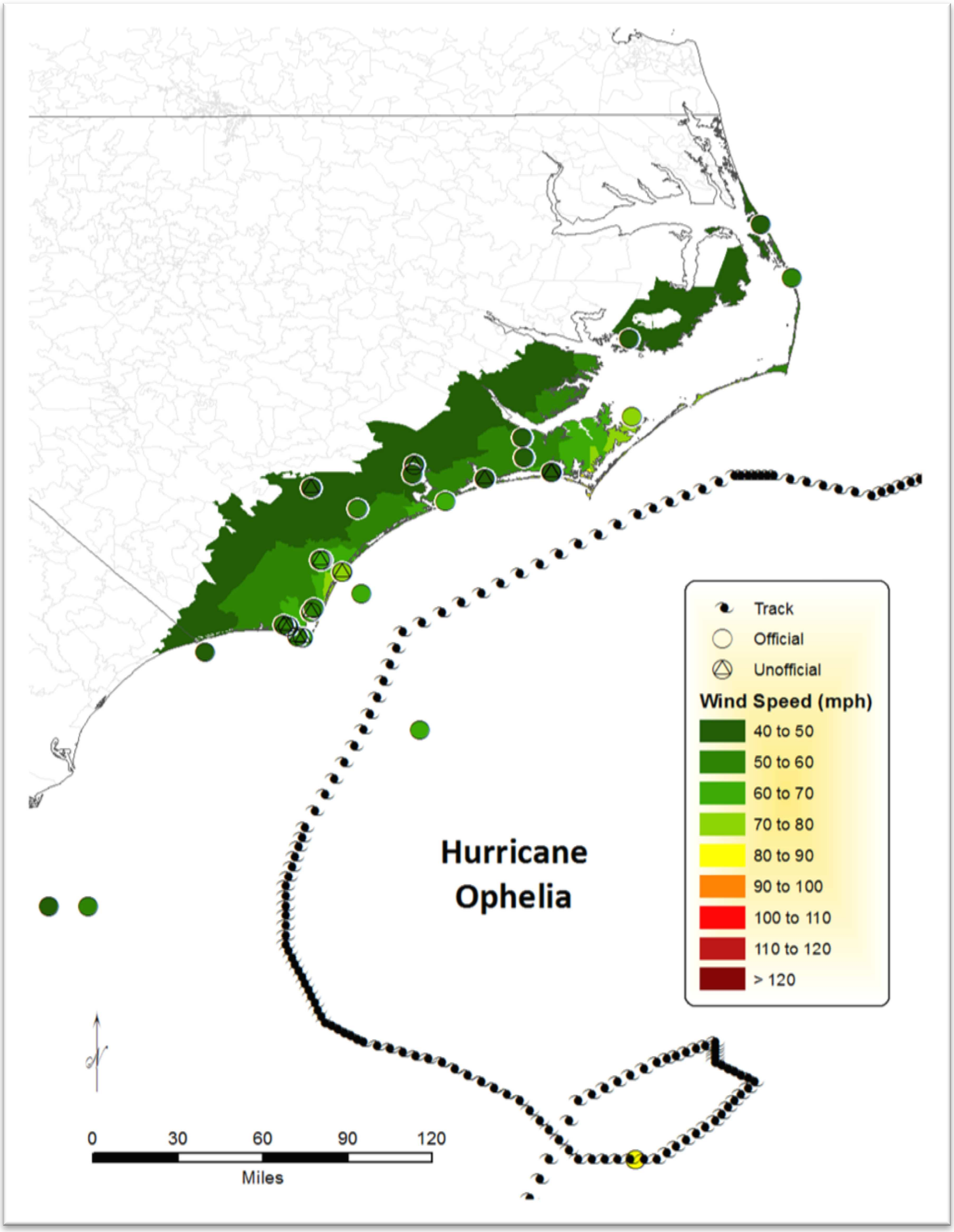
Exhibit RB-6D



Modeled and observed wind speeds from Hurricane Charley (2004)

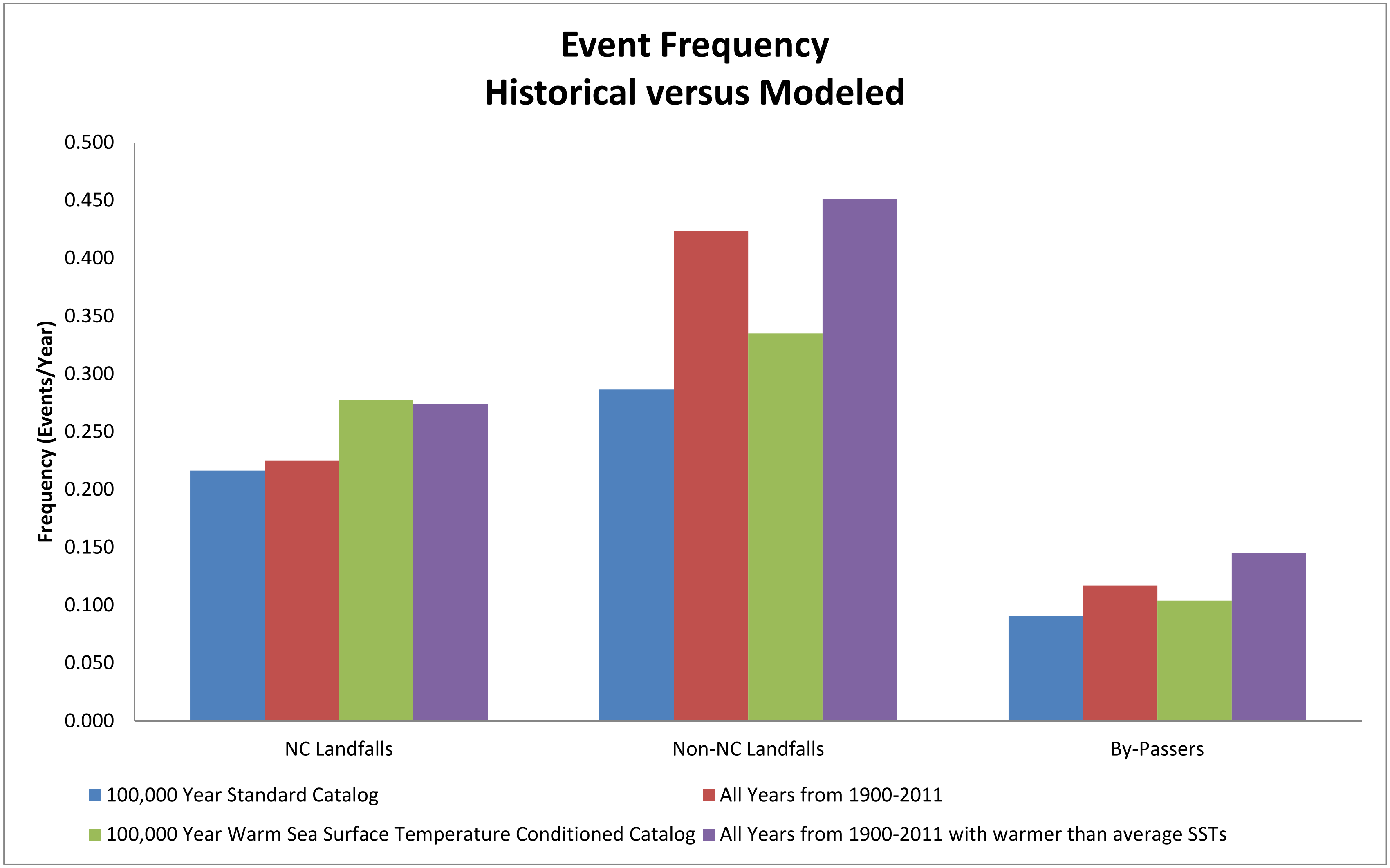


Modeled and observed wind speeds for Hurricane Floyd (1999)



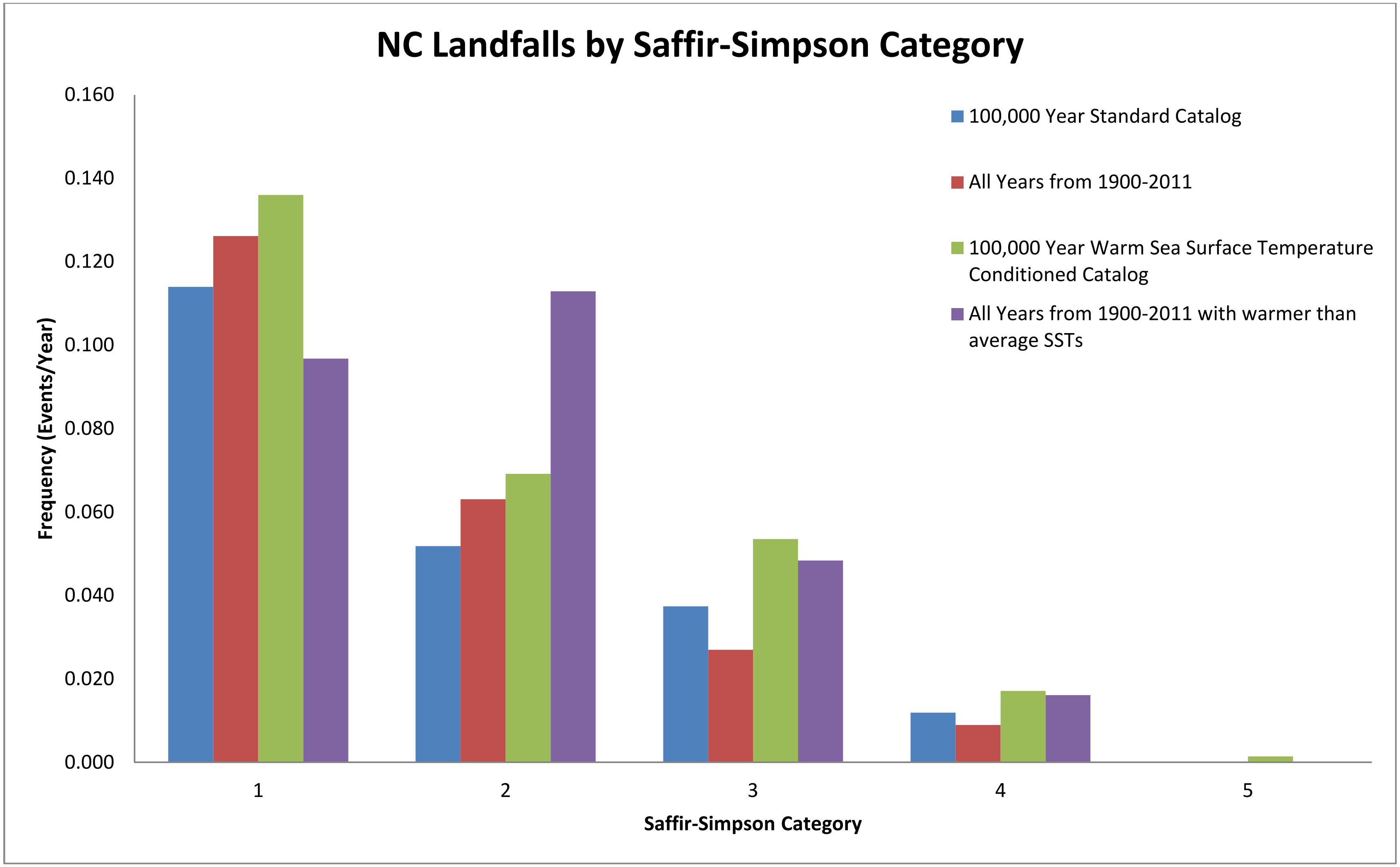
Modeled and observed wind speeds for Hurricane Ophelia (2005)

Exhibit RB-6E



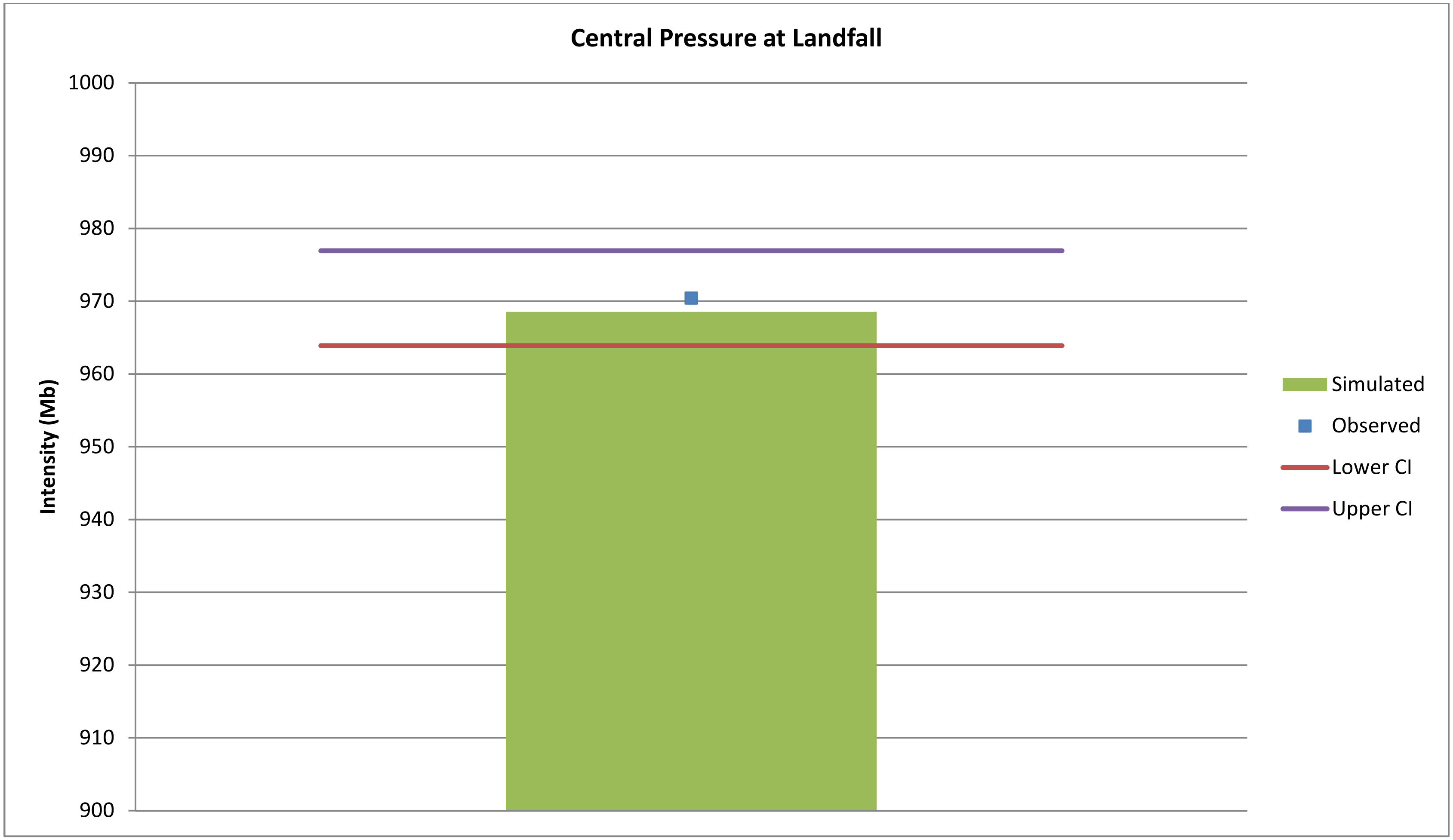
Comparison of the frequency of events of different types which impact North Carolina in AIR's stochastic catalogs and the historical record

Exhibit RB-6F



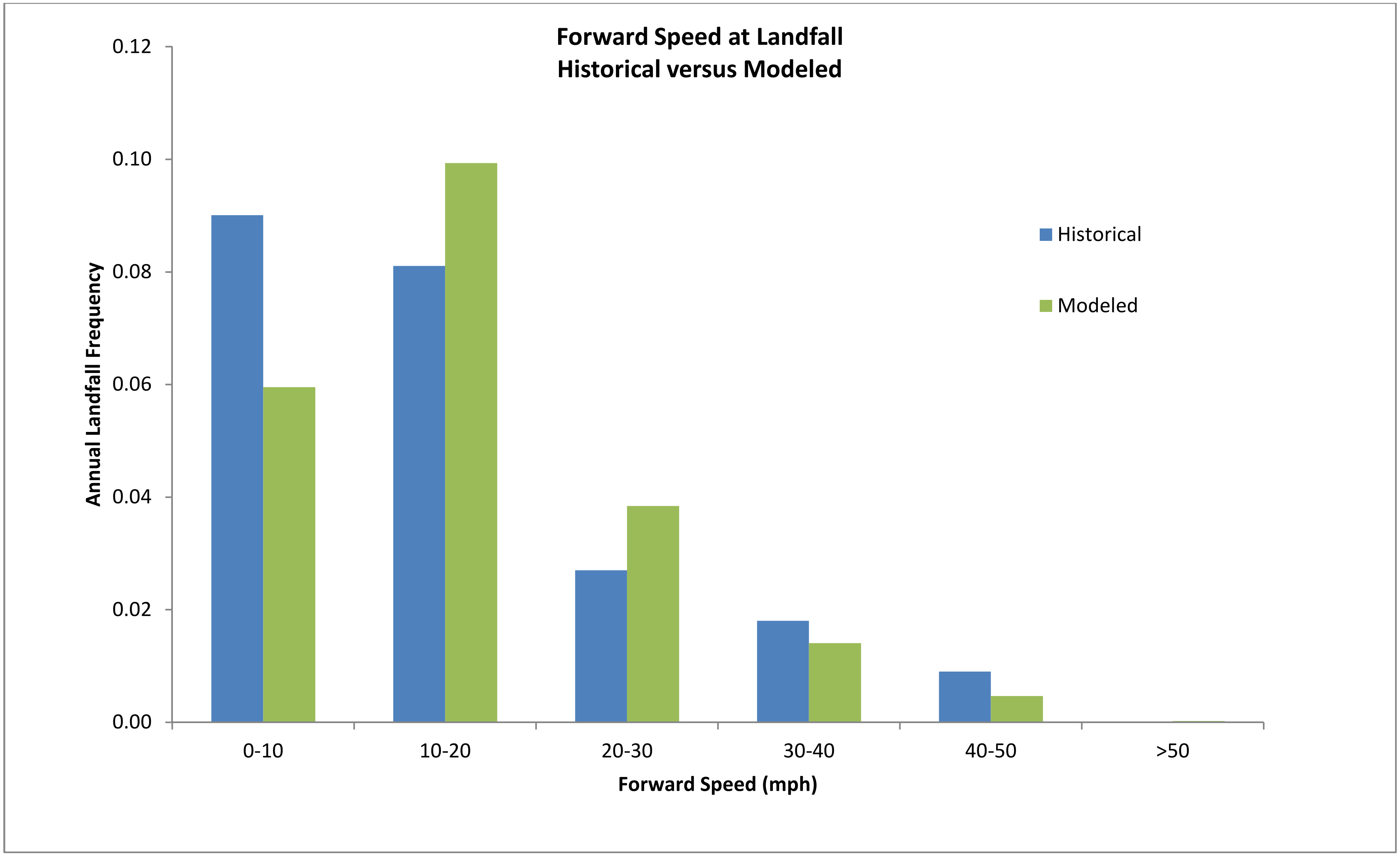
Comparison of the frequency of events of different Saffir-Simpson categories, which make landfall in North Carolina in AIR's stochastic catalogs and the historical record

Exhibit RB-6G



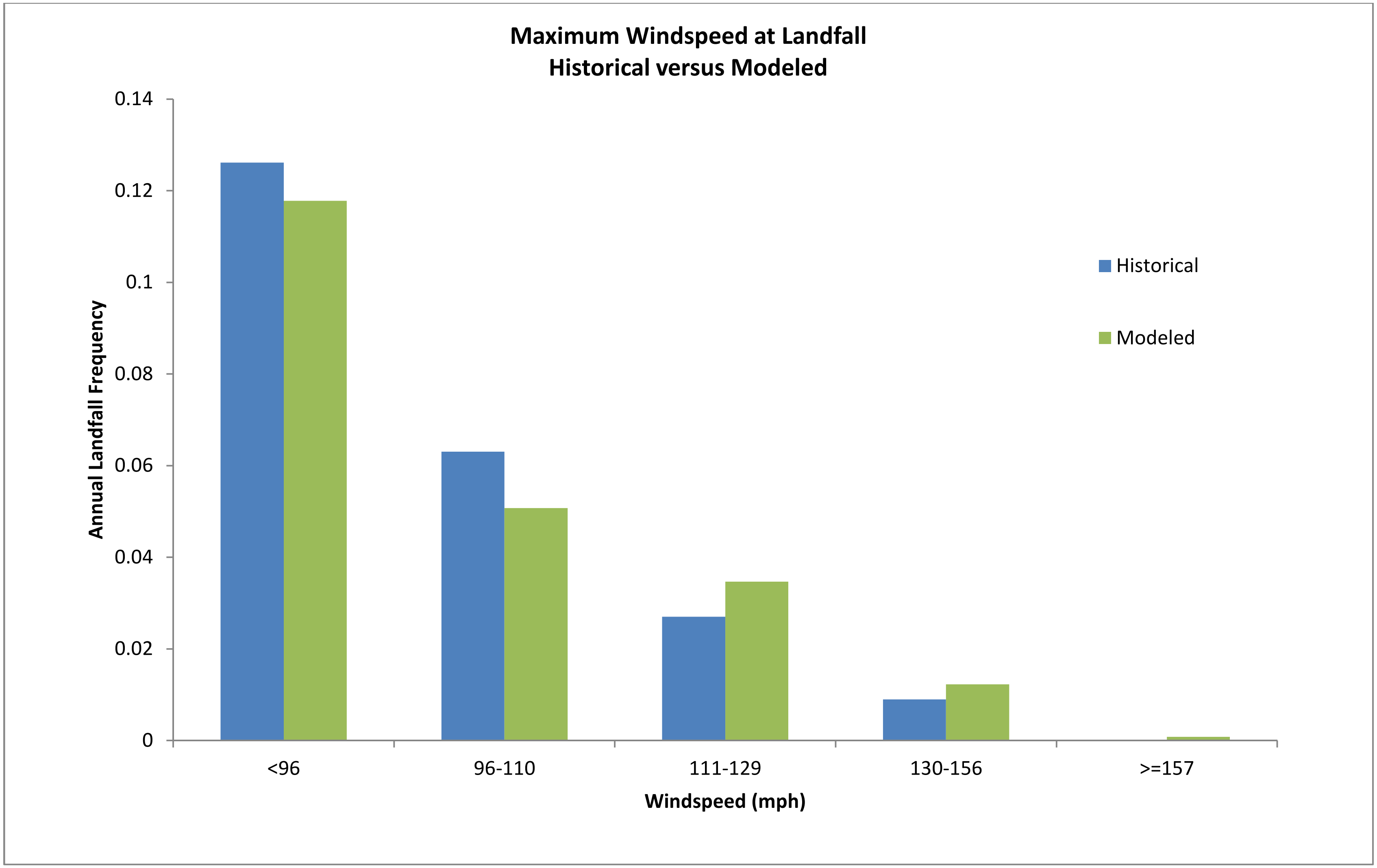
Comparison of historical and modeled central pressure for events which make landfall in North Carolina in AIR's standard stochastic catalog and the historical period from 1900-2011

Exhibit RB-6H



Comparison of historical and modeled forward speed bands for events which make landfall in North Carolina in AIR's standard stochastic catalog and the historical period from 1900-2011

Exhibit RB-6I



Comparison of maximum wind speed at landfall for events in AIR's Standard Modeled Stochastic Catalog and the historical record for all events which make landfall in North Carolina.

PREFILED TESTIMONY OF JAMES H. VANDER WEIDE

2014 MOBILE HOME INSURANCE RATE FILING BY THE NORTH CAROLINA RATE BUREAU

Q. WHAT IS YOUR NAME, OCCUPATION, AND BUSINESS ADDRESS?

A. My name is James H. Vander Weide. I am President of Financial Strategy Associates, a firm that provides strategic and financial consulting services to corporate clients. My business address is 3606 Stoneybrook Drive, Durham, North Carolina.

Q. PLEASE DESCRIBE YOUR EDUCATIONAL BACKGROUND AND PRIOR ACADEMIC EXPERIENCE.

A. I graduated from Cornell University with a Bachelor's Degree in Economics and then attended Northwestern University where I earned a Ph.D. in Finance. I joined the faculty of the School of Business at Duke University where I was subsequently named Assistant Professor, Associate Professor, Professor, and Research Professor. I have published research in the areas of finance and economics and taught courses in these fields at Duke for more than thirty-five years. I am now retired from my teaching duties at Duke.

I have taught courses in corporate finance, investment management, and management of financial institutions. I also taught a graduate seminar on the theory of public utility pricing and lectured in executive development seminars on the cost of capital, financial analysis, capital budgeting, mergers and acquisitions, cash management, short-run financial planning, and competitive strategy.

I have served as Program Director and taught in numerous executive education programs at Duke, including the Duke Advanced Management Program, the Duke Management Challenge, the Duke Executive Program in Telecommunications, Competitive Strategies in Telecommunications, and the Duke Program for Manager Development for managers from the former Soviet Union. I have also taught in tailored programs developed for corporations such as ABB, Accenture, Allstate, AT&T, Progress Energy, GlaxoSmithKline, Lafarge, MidAmerican Energy, Norfolk Southern, The Rank Group, Siemens, TRW, and Wolseley PLC.

In addition to my teaching and executive education activities, I have written research papers on such topics as portfolio management, the cost of capital, capital budgeting, the effect of regulation on the performance of public utilities, and cash management. My articles have been published in *American Economic Review, Financial Management, International Journal of Industrial Organization, Journal of Finance, Journal of Financial and Quantitative Analysis, Journal of Bank Research, Journal of Accounting Research, Journal of Cash Management, Management Science, The Journal of Portfolio Management, Atlantic Economic Journal, Journal of Economics and Business,* and *Computers and Operations Research.* I have written a book titled *Managing Corporate Liquidity: an Introduction to Working Capital Management*, a chapter for *The Handbook of Modern Finance*, "Financial Management in the Short Run," and a chapter for the book, *The Handbook of Portfolio Construction: Contemporary Applications of Markowitz Techniques,* "Principles for Lifetime Portfolio Selection: Lessons from Portfolio Theory."

Q. HAVE YOU PREVIOUSLY PRESENTED EVIDENCE ON THE COST OF CAPITAL AND OTHER REGULATORY ISSUES?

A. Yes. As an expert on financial and economic theory and practice, I have participated in more than four hundred regulatory and legal proceedings before the U.S. Congress, the Canadian Radio-Television and Telecommunications Commission, the Federal Communications Commission, the National Telecommunications and Information Administration, the Federal Energy Regulatory Commission, the National Energy Board (Canada), the public utility commissions of forty-five states and four Canadian provinces, the insurance commissions of five states, the Iowa State Board of Tax Review, the National Association of Securities Dealers, and the North Carolina Property Tax Commission. In addition, I have prepared expert testimony in proceedings before the U.S. Tax Court, the U.S. District Court for the District of Nebraska; the U.S. District Court for the District of New Hampshire; the U.S. District Court for the District of Northern Illinois; the U.S. District Court for the Eastern District of North Carolina; the Montana Second Judicial District Court, Silver Bow County; the U.S. District Court for the Northern District of California; the Superior Court, North Carolina; the U.S. Bankruptcy Court for the Southern District of West Virginia; the U. S. District Court for the Eastern District of Michigan; and the Supreme Court of the State of New York.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. I have been asked by the North Carolina Rate Bureau to make an independent appraisal of the aggregate cost of equity capital for the companies writing mobile home insurance in North Carolina and to recommend a rate of return on equity that is fair, that allows those companies in the aggregate to attract and retain capital on reasonable terms, that is commensurate with returns on investments of comparable risk, and that maintains the financial integrity of those companies in the aggregate.

Q. WHAT DO YOU MEAN BY THE PHRASE "COST OF EQUITY CAPITAL?"

A. A firm's cost of equity capital is the rate of return expectation that is required in the marketplace on equity investments of comparable risk. If an investor does not expect to earn a return on an equity investment in a firm that is at least as large as the return the investor could expect to earn on other investments of comparable risk, then the investor will not invest in that firm's shares. Thus, a firm's cost of equity capital is also the rate of return expectation that is required in the marketplace in order to induce equity investors to purchase shares in that firm.

Q. IS THE COST OF EQUITY CAPITAL THE SAME AS THE RETURN ON EQUITY?

A. No. The cost of equity capital is a market-based concept that reflects investors' future expectations, while the return on equity is an accounting concept that measures results of past performance. The return on equity is equal to income available for common equity divided by the book value of common equity.

Q. HAVE YOU FORMED AN OPINION REGARDING THE COST OF EQUITY CAPITAL FOR THE AVERAGE COMPANY WRITING MOBILE HOME INSURANCE IN NORTH CAROLINA?

A. Yes.

Q. WHAT IS YOUR OPINION IN THAT REGARD?

A. The cost of equity capital for such a company is in the range 9.0 percent to 12.7 percent.

Q. WHAT ECONOMIC PRINCIPLES DID YOU CONSIDER IN ARRIVING AT THAT OPINION?

A. There are two primary economic principles relevant to my appraisal of the cost of equity capital. The first, relating to the demand for capital, states that a firm should continue to invest in its business only so long as the return on its investment is greater than or equal to its cost of capital. In the context of a regulated firm, this principle suggests that the regulatory agency should establish revenue levels which will offer the firm an opportunity to earn a return on its investment that is at least equal to its cost of capital.

The second principle, relating to the supply of capital, states that rational investors are maximizing their total return on capital only if the returns they expect to receive on investments of comparable risk are equal. If these returns are not equal, rational investors will reduce or completely eliminate investments in those activities yielding lower expected returns for a given level of risk and will increase investments in those activities yielding higher expected returns. The second principle implies that regulated firms will be unable to obtain the capital required to expand service on reasonable terms unless they are able to provide investors returns equal to those expected on investments of comparable risk.

Q. DO THESE ECONOMIC PRINCIPLES APPLY TO THE SETTING OF INSURANCE RATES?

A. Yes. These are general economic principles that apply to investing in any business activity, including insurance.

Q. HOW DID YOU GO ABOUT DETERMINING THE COST OF EQUITY CAPITAL FOR THE AVERAGE COMPANY WRITING MOBILE HOME INSURANCE IN NORTH CAROLINA?

A. I used two generally accepted methods to estimate the cost of equity: (i) the Discounted Cash Flow (DCF) Model, and (ii) the Risk Premium Approach.

Q. PLEASE DESCRIBE THE DCF MODEL.

A. The DCF Model suggests that investors value an asset on the basis of the future cash flows they expect to receive from owning the asset. Thus, investors value an investment in a bond because they expect to receive a sequence of semi-annual coupon payments over the life of the bond and a terminal payment equal to the bond's face value at the time the bond matures. Likewise, investors value an investment in a firm's stock because they expect to receive a sequence of dividend payments and, perhaps, expect to sell the stock at a higher price sometime in the future.

A second fundamental principle of the DCF approach is that investors value a dollar received in the future less than a dollar received today. This is because, if they had the dollar today, they could invest it in an interest earning account and increase their wealth. This principle is called the time value of money.

Applying the two fundamental DCF principles noted above to an investment in a bond suggests that investors should value their investment in the bond on the basis of the present value of the bond's future cash flows. Thus, the price of the bond should be equal to:

Equation 1

$$P_B = \frac{C}{(1+i)} + \frac{C}{(1+i)^2} + \ldots + \frac{C+F}{(1+i)^n}$$

where:

P_B = Bond price;
C = Cash value of the coupon payment (assumed for notational convenience to occur annually rather than semi-annually);
F = Face value of the bond;
i = The rate of interest the investor could earn by investing his money in an alternative bond of equal risk; and
n = The number of periods before the bond matures.

Applying these same principles to an investment in a firm's stock suggests that the price of the stock should be equal to:

Equation 2

$$P_S = \frac{D_1}{(1+k)} + \frac{D_2}{(1+k)^2} + \ldots + \frac{D_n + P_n}{(1+k)^n}$$

where:

P_S = Current price of the firm's stock;
$D_1, D_2 \ldots D_n$ = Expected annual dividend per share on the firm's stock;
P_n = Price per share of stock at the time the investor expects to sell the stock; and
k = Return the investor expects to earn on alternative investments of the same risk, i.e., the investor's required rate of return.

Equation (2) is frequently called the Annual Discounted Cash Flow (DCF) Model of stock valuation.

Q. HOW DO YOU USE THE DCF MODEL TO DETERMINE THE COST OF EQUITY CAPITAL?

A. The "k" in the equation is the cost of equity capital. We make certain simplifying assumptions regarding the other factors in the equation and then mathematically solve for "k."

Q. WHAT ARE THE ASSUMPTIONS YOU MAKE?

A. Most analysts make three simplifying assumptions. First, they assume that dividends are expected to grow at the constant rate ("g") into the indefinite future. Second, they assume that the stock price at time "n" is simply the present value of all dividends expected in periods subsequent to "n." Third, they assume that the investors' required rate of return, "k," exceeds the expected dividend growth rate, "g."

Q. DOES THE ANNUAL DCF MODEL OF STOCK VALUATION PRODUCE APPROPRIATE ESTIMATES OF A FIRM'S COST OF EQUITY CAPITAL?

A. No. The Annual DCF Model of stock valuation produces appropriate estimates of a firm's cost of equity capital only if the firm pays dividends just once a year. Since most firms pay dividends quarterly, the Annual DCF Model produces downwardly biased estimates of the cost of equity. Investors can expect to earn a higher annual effective return on an investment in a firm that pays quarterly dividends than in one which pays the same amount of dollar dividends once at the end of each year. A complete analysis of the implications of the quarterly payment of dividends on the DCF Model is provided in Exhibit RB-10. For the reasons cited there, I employed the Quarterly DCF Model throughout my calculations.

Q. PLEASE DESCRIBE THE QUARTERLY DCF MODEL YOU USED.

A. The Quarterly DCF Model I used is described by Equation 10 on page 11 in Exhibit RB-10. This equation shows that the cost of equity is: the sum of the dividend yield and the growth rate, where the dividend in the dividend yield is the equivalent dividend at the end of the year, and the growth rate is the expected growth in dividends or earnings per share.

Q. HOW DO YOU APPLY THE DCF APPROACH TO OBTAIN THE COST OF EQUITY CAPITAL FOR THE COMPANIES WRITING MOBILE HOME INSURANCE IN NORTH CAROLINA?

A. I apply the DCF approach to two groups of companies: Value Line's group of property/casualty insurance companies and the S&P 500.

Q. WHY DO YOU APPLY THE DCF APPROACH TO THE S&P 500 AS WELL AS TO VALUE LINE'S PROPERTY/CASUALTY INSURANCE COMPANIES?

A. As I noted previously, the cost of equity is defined as the rate of return investors expect to earn on investments in other companies of comparable risk. I apply the DCF approach to the S&P 500 because they are a large group of companies that, on average, are typically viewed as being comparable in risk to the property/casualty insurance industry. The use of a larger set of comparable risk companies should provide an accurate estimate of the cost of equity for the companies writing mobile home insurance in North Carolina.

Q. DO YOU INCLUDE ALL THE VALUE LINE PROPERTY/CASUALTY INSURANCE COMPANIES?

A. No. Among the Value Line property/casualty insurance companies, I delete any firm which has recently lowered its dividend and which has fewer than three five-year earnings forecasts available from I/B/E/S (formerly known as the Institutional Brokers Estimate System, now part of Thomson

Reuters).[1] The Value Line property/casualty companies I use are shown in Exhibit RB-8.

Q. WHAT CRITERIA DO YOU USE TO SELECT COMPANIES IN THE S&P 500?

A. I include those firms which pay dividends and which have at least three five-year earnings forecasts available from I/B/E/S. I exclude the insurance companies in the S&P 500, as identified by I/B/E/S Thomson Reuters, because I have already calculated DCF results for the Value Line property/casualty insurance companies. The S&P 500 companies I use are shown in Exhibit RB-9.

Q. WHY DO YOU ELIMINATE ANY COMPANY WHICH HAD RECENTLY LOWERED ITS DIVIDEND OR WHICH FAILS TO PAY DIVIDENDS?

A. I eliminate those companies because it is difficult to make a reliable estimate of the future dividend growth rate for companies that have recently lowered their dividends or do not pay dividends. If a company has recently lowered its dividend, investors do not know whether the company will again lower its dividend in the future, or whether the company will attempt to increase its dividend back toward

[1] At this time, my selection criteria produce a group of only four Value Line property/casualty insurance companies. Therefore, I also report DCF results for three additional companies that have at least two I/B/E/S analysts' five-year earnings growth forecasts, including ACE Limited, CNA Financial, and RLI.

its previous level. If a company does not pay a dividend, one cannot mathematically apply the DCF approach.

Q. HOW DO YOU ESTIMATE THE GROWTH COMPONENT OF THE QUARTERLY DCF MODEL?

A. I use the average of analysts' estimates of future earnings per share (EPS) growth reported by I/B/E/S. As part of their research, financial analysts working at Wall Street firms periodically estimate EPS growth for each firm they follow. The EPS forecasts for each firm are then published. The forecasts are used by investors who are contemplating purchasing or selling shares in individual companies.

Q. WHAT IS I/B/E/S?

A. I/B/E/S is a collection of analysts' forecasts for a broad group of companies expressed in terms of a mean forecast and a standard deviation of forecast for each firm. The mean forecast is used by investors as an estimate of future firm performance.

Q. WHY DO YOU USE THE I/B/E/S GROWTH ESTIMATES?

A. The I/B/E/S growth rates (1) are widely circulated in the financial community, (2) include the projections of reputable financial analysts who develop estimates of future growth, (3) are reported on a timely basis to investors, and (4) are widely used by institutional and other investors. For these reasons, I believe these estimates represent unbiased estimates of investors' expectations of each firm's long-term growth prospects and, accordingly, are incorporated by investors into their return requirements. Consequently, in my opinion, they provide the best available estimate of investors' long-term growth expectations.

Q. WHY DO YOU RELY EXCLUSIVELY ON ANALYSTS' PROJECTIONS OF FUTURE EPS GROWTH IN ESTIMATING THE INVESTORS' EXPECTED GROWTH RATE RATHER THAN LOOKING AT PAST HISTORICAL GROWTH RATES?

A. There is considerable empirical evidence that analysts' forecasts are more highly correlated with stock prices than are firms' historical growth rates, and, thus, that investors actually use these forecasts.

Q. HAVE YOU PERFORMED ANY STUDIES CONCERNING THE USE OF ANALYSTS' FORECASTS AS THE BEST ESTIMATE OF INVESTORS' EXPECTED GROWTH RATE, G?

A. Yes, I prepared a study with Willard T. Carleton, Professor of Finance Emeritus at the University of Arizona, on why analysts' forecasts provide the best estimate of investors' expectations of future long-term growth. This study is described in a paper entitled "Investor Growth Expectations: Analysts vs. History," published in *The Journal of Portfolio Management*.

Q. PLEASE SUMMARIZE THE RESULTS OF YOUR STUDY.

A. First, we performed a correlation analysis to identify the historically-oriented growth rates which best described a firm's stock price. Then we did a regression study comparing the historical growth rates with the consensus analysts' forecasts. In every case, the regression equations containing the average of analysts' forecasts statistically outperformed the regression equations containing the historical growth estimates. These results are consistent with those found by Cragg and Malkiel, the early major research in this area. These results are also consistent with the hypothesis that investors use analysts' forecasts, rather than historically-oriented growth calculations, in making buy and sell decisions. They provide overwhelming evidence that the analysts' forecasts of future growth are superior to historically-oriented growth measures in predicting a firm's stock price.

Q. WHAT PRICE DO YOU USE IN YOUR DCF MODEL?

A. I use a simple average of the monthly high and low stock prices for each firm for the three-month period, May, June, and July 2014. These high and low stock prices are obtained from Thomson Reuters.

Q. WHY DO YOU USE THE THREE-MONTH AVERAGE STOCK PRICE, P_0, IN APPLYING THE DCF METHOD?

A. I use a three-month average stock price in applying the DCF method because stock prices fluctuate daily, while financial analysts' forecasts for a given company are generally changed less frequently, often on a quarterly basis. Thus, to match the stock price with an earnings forecast, it is appropriate to average stock prices over a three-month period.

Q. PLEASE EXPLAIN YOUR INCLUSION OF FLOTATION COSTS.

A. All firms that have sold securities in the capital markets have incurred some level of flotation costs, including underwriters' commissions, legal fees, printing expense, etc. These costs are paid from the proceeds of the stock sale and must be recovered over the life of the equity issue. Costs vary depending upon the size of the issue, the type of registration method used and other factors, but in general these costs range between four percent and five percent of the proceeds from the issue. In addition to these costs, for large equity issues there is likely to be a decline in price associated with the sale of shares to the public. On average, the decline due to market pressure has been estimated at two percent to three percent.

These cost ranges have been developed and confirmed in a number of generally accepted studies. I believe a combined five percent allowance for flotation costs and market pressure is a conservative estimate that can be used in applying the DCF Model in this proceeding.

Q. PLEASE SUMMARIZE THE RESULTS OF YOUR APPLICATION OF THE DCF METHOD TO THE PROPERTY/CASUALTY INSURANCE COMPANIES AND THE S&P 500.

A. As shown in Exhibits RB-8 and RB-9, the average DCF cost of equity capital for my group of Value Line property/casualty companies is 10.6 percent; and for the S&P 500 companies, 12.7 percent.

Q. WHAT CONCLUSION DO YOU REACH FROM YOUR DCF ANALYSIS ABOUT THE COST OF EQUITY CAPITAL FOR COMPANIES WRITING MOBILE HOME INSURANCE IN NORTH CAROLINA?

A. On the basis of my DCF analysis, I would conclude that for companies writing mobile home insurance in North Carolina the cost of equity is in the range 10.6 percent to 12.7 percent.

Q. YOU NOTE THAT THE SECOND METHOD YOU USE TO ESTIMATE THE COST OF EQUITY CAPITAL FOR COMPANIES WRITING MOBILE HOME INSURANCE IN NORTH CAROLINA IS A RISK PREMIUM APPROACH. PLEASE DESCRIBE THAT APPROACH.

A. I perform a study of the comparable returns received by bond and stock investors over the last eighty-eight years. I estimate the returns on stock and bond portfolios, using stock price and dividend yield data on the S&P 500 stock portfolio and bond yield data on Moody's A-rated utility bonds.

My study consists of analyzing the historically achieved returns on broadly based stock and bond portfolios going back to 1926. For stocks, I use the S&P 500 stock portfolio; and for bonds, I use Moody's A-rated utility bonds. The resulting annual returns on the stock and bond portfolios purchased in each year from 1926 through 2013 are shown on Exhibit RB-11. The difference between the stock return and the bond return over that period of time on an arithmetic average basis is 4.7 percentage points.

Q. WHAT CONCLUSIONS DO YOU DRAW FROM YOUR RISK PREMIUM ANALYSES?

A. My own studies, combined with my analysis of other studies, provide strong evidence for the belief that investors today require an equity return of at least 4.7 percentage points above the expected yield on A-rated long-term debt issues.

Interest rates on Moody's seasoned A-rated utility bonds during the three months May through July 2014 range from 4.2 percent to 4.3 percent. On the basis of this information and my knowledge of bond market conditions, I conclude that the long-term yield on A-rated utility bonds is approximately 4.3 percent. Adding a 4.7 percentage point risk premium to the 4.3 percent expected yield on A-rated utility bonds, I obtain an expected return on equity of 9.0 percent.

Q. ARE THERE REASONS TO BELIEVE THAT THE RESULT OF YOUR EX POST RISK PREMIUM ANALYSIS MAY UNDERESTIMATE THE COST OF EQUITY AT THIS TIME?

A. Yes. The ex post risk premium model may produce an unrealistically low result because the model result is highly sensitive to the estimate of the bond yield. At this time, bond yields are unusually low, reflecting policy decisions of the U.S. government and the U.S. Federal Reserve Bank to keep interest rates low in order to stimulate the economy. Since the ex post risk premium cost of equity result is the sum of the risk premium and the bond yield, the use of an unusually low bond yield in the model may cause the ex post risk premium model result to underestimate the cost of equity. Because the cost of equity is a forward-looking concept, it would be reasonable to apply the ex post risk premium model using a forecast of the expected bond yield, rather than a recent bond yield. Because bond yields are expected to increase over the next several years, the use of a forecasted bond yield would produce a significantly higher ex post risk premium estimate of the cost of equity. Thus, I consider my ex post risk premium model result to be conservative.

Q. BASED ON YOUR ANALYSES, WHAT IS YOUR OPINION AS TO THE COST OF CAPITAL FOR THE AVERAGE INSURANCE COMPANY WRITING MOBILE HOME INSURANCE IN NORTH CAROLINA?

A. Based on my review and studies, I believe that a conservative estimate of the cost of common equity capital for the average insurance company writing mobile home insurance in North Carolina is in the range 9.0 percent to 12.7 percent.

SUMMARY OF DISCOUNTED CASH FLOW ANALYSIS FOR PROPERTY/CASUALTY INSURANCE COMPANIES

LINE	COMPANY	MOST RECENT QUARTERLY DIVIDEND (D_0)	STOCK PRICE (P_0)	FORECAST OF FUTURE EARNINGS GROWTH	DCF MODEL RESULT
1	ACE Limited	0.630	104.488	10.00%	12.6%
2	Allstate Corp.	0.280	58.267	7.82%	10.0%
3	Chubb Corp.	0.500	92.442	6.35%	8.7%
4	CNA Fin'l	0.250	40.217	10.00%	12.6%
5	RLI Corp.	0.180	44.824	15.00%	17.0%
6	Travelers Cos.	0.550	93.260	6.60%	9.1%
7	XL Group plc	0.160	33.009	2.50%	4.5%
8	Average				10.6%
9	Average w/o highest, lowest				10.6%

Notes:

d_0 = Latest quarterly dividend.

d_1, d_2, d_3, d_4, = Expected next four quarterly dividends, calculated by multiplying the last four quarterly dividends per Value Line, by the factor (1 + g).

P_0 = Average of the monthly high and low stock prices during the three months ending July 2014 per Thomson Reuters.

FC = Flotation costs.

g = I/B/E/S forecast of future earnings growth July 2014.

k = Cost of equity using the quarterly version of the DCF Model and a five percent allowance for flotation costs and market pressure (selling costs) as shown by the formula below:

$$k = \frac{d_1(1+k)^{.75} + d_2(1+k)^{.50} + d_3(1+k)^{.25} + d_4}{P_0(1 - FC)} + g$$

SUMMARY OF DISCOUNTED CASH FLOW ANALYSIS FOR
S&P 500 COMPANIES

	COMPANY	STOCK PRICE (P_0)	RECENT DIVIDEND (D_0)	FORECAST OF FUTURE EARNINGS GROWTH	MODEL RESULT
1	3M	143.14	3.42	11.97%	14.8%
2	ABBOTT LABORATORIES	40.58	0.88	10.60%	13.1%
3	ABBVIE	54.03	1.68	9.23%	12.9%
4	ADT	32.99	0.80	9.27%	12.1%
5	AETNA	79.10	0.90	9.95%	11.3%
6	AGILENT TECHS.	56.77	0.53	9.33%	10.4%
7	AIR PRDS.& CHEMS.	125.33	3.08	9.77%	12.6%
8	AIRGAS	107.29	2.20	11.18%	13.6%
9	ALLERGAN	166.13	0.20	17.00%	17.1%
10	ALTERA	33.65	0.72	10.02%	12.5%
11	ALTRIA GROUP	41.76	1.92	7.57%	12.9%
12	AMER.ELEC.PWR.	53.54	2.00	4.79%	9.0%
13	AMERICAN EXPRESS	91.98	1.04	9.60%	10.9%
14	AMERISOURCEBERGEN	72.23	0.94	15.76%	17.3%
15	AMETEK	52.67	0.36	14.07%	14.9%
16	AMGEN	116.93	2.44	9.10%	11.5%
17	ANADARKO PETROLEUM	105.38	1.08	13.75%	15.0%
18	ANALOG DEVICES	52.65	1.48	11.67%	15.0%
19	APPLE	91.82	1.88	12.24%	14.7%
20	AT&T	35.79	1.84	5.00%	10.8%
21	AUTOMATIC DATA PROC.	79.42	1.92	10.33%	13.2%
22	AVERY DENNISON	49.67	1.40	8.23%	11.5%
23	BALL	61.16	0.52	9.77%	10.8%
24	BAXTER INTL.	74.22	2.08	8.04%	11.3%
25	BECTON DICKINSON	117.46	2.18	8.94%	11.1%
26	BEMIS	40.65	1.08	6.53%	9.5%
27	BOEING	130.17	2.92	10.38%	13.0%
28	C R BARD	144.53	0.88	13.97%	14.7%
29	CARDINAL HEALTH	69.28	1.37	9.42%	11.7%
30	CATERPILLAR	105.90	2.80	12.84%	16.0%
31	CBS 'B'	60.07	0.48	15.77%	16.7%
32	CF INDUSTRIES HDG.	243.57	4.00	8.40%	10.3%
33	CH ROBINSON WWD.	61.80	1.40	10.10%	12.7%
34	CHEVRON	127.81	4.28	5.15%	8.9%
35	CIGNA	90.48	0.04	10.73%	10.8%
36	CIMAREX EN.	136.09	0.64	16.72%	17.3%
37	CINTAS	62.28	0.77	10.35%	11.8%
38	CISCO SYSTEMS	24.63	0.76	7.36%	10.9%
39	CITIGROUP	48.01	0.04	11.19%	11.3%
40	CLOROX	90.09	2.96	7.00%	10.7%
41	CME GROUP	71.22	1.88	12.57%	15.7%
42	CMS ENERGY	30.04	1.08	6.80%	10.9%

	COMPANY	STOCK PRICE (P_0)	RECENT DIVIDEND (D_0)	FORECAST OF FUTURE EARNINGS GROWTH	MODEL RESULT
43	COCA COLA	41.17	1.22	6.10%	9.4%
44	COCA COLA ENTS.	46.94	1.00	11.30%	13.8%
45	COLGATE-PALM.	67.90	1.44	8.74%	11.2%
46	CONAGRA FOODS	30.79	1.00	6.48%	10.2%
47	CONOCOPHILLIPS	81.66	2.92	6.66%	10.7%
48	COSTCO WHOLESALE	116.06	1.42	10.20%	11.6%
49	COVIDIEN	81.05	1.28	9.21%	11.0%
50	CSX	29.90	0.64	9.60%	12.1%
51	CUMMINS	152.75	3.12	14.07%	16.5%
52	CVS CAREMARK	76.60	1.10	14.01%	15.7%
53	DANAHER	77.29	0.40	12.34%	12.9%
54	DEERE	90.73	2.40	8.00%	11.0%
55	DELPHI AUTOMOTIVE	68.75	1.00	15.96%	17.7%
56	DENTSPLY INTL.	46.90	0.26	8.80%	9.4%
57	DISCOVER FINANCIAL SVS.	60.45	0.96	7.29%	9.1%
58	DOMINION RESOURCES	69.93	2.40	6.02%	9.9%
59	DOW CHEMICAL	51.61	1.48	10.03%	13.4%
60	DR PEPPER SNAPPLE GROUP	58.42	1.64	7.63%	10.8%
61	DTE ENERGY	76.21	2.76	5.87%	10.0%
62	DUKE ENERGY	72.17	3.18	4.19%	9.1%
63	DUN & BRADSTREET DEL.	107.90	1.76	8.00%	9.9%
64	E I DU PONT DE NEMOURS	66.87	1.80	7.76%	10.8%
65	EASTMAN CHEMICAL	86.44	1.40	8.07%	9.9%
66	EATON	74.81	1.96	11.12%	14.2%
67	ECOLAB	108.72	1.10	15.40%	16.6%
68	EMC	26.81	0.46	10.08%	12.1%
69	EMERSON ELECTRIC	67.15	1.72	9.75%	12.7%
70	EOG RES.	109.67	0.50	12.03%	12.6%
71	ESTEE LAUDER COS.'A'	74.92	0.80	12.14%	13.4%
72	EXPEDITOR INTL.OF WASH.	44.45	0.64	8.13%	9.8%
73	FEDEX	145.40	0.80	15.18%	15.9%
74	FLOWSERVE	75.16	0.64	14.65%	15.7%
75	FLUOR	76.47	0.84	12.94%	14.3%
76	FMC	72.61	0.60	11.72%	12.7%
77	FORD MOTOR	16.82	0.50	12.23%	15.8%
78	GAP	40.68	0.88	12.98%	15.6%
79	GARMIN	58.44	1.92	6.57%	10.3%
80	GENERAL DYNAMICS	116.91	2.48	8.33%	10.8%
81	GENERAL ELECTRIC	26.57	0.88	7.16%	10.9%
82	GENERAL MILLS	53.40	1.64	6.88%	10.4%
83	GOLDMAN SACHS GP.	164.16	2.20	8.14%	9.7%
84	HERSHEY	96.42	2.14	9.86%	12.4%
85	HONEYWELL INTL.	94.17	1.80	10.63%	12.9%
86	HUMANA	124.39	1.12	9.58%	10.6%
87	INTEL	29.41	0.90	8.83%	12.4%

	COMPANY	STOCK PRICE (P_0)	RECENT DIVIDEND (D_0)	FORECAST OF FUTURE EARNINGS GROWTH	MODEL RESULT
88	INTERNATIONAL BUS.MCHS.	187.35	4.40	8.78%	11.5%
89	INTL.FLAVORS & FRAG.	101.67	1.56	10.73%	12.5%
90	INTUIT	79.64	0.76	13.09%	14.2%
91	INVESCO	37.04	1.00	14.55%	17.8%
92	J M SMUCKER	103.25	2.56	7.33%	10.2%
93	JOHNSON & JOHNSON	102.41	2.80	7.10%	10.2%
94	JOHNSON CONTROLS	48.56	0.88	14.97%	17.2%
95	JUNIPER NETWORKS	24.41	0.40	12.96%	14.9%
96	KELLOGG	66.56	1.96	6.04%	9.4%
97	KEYCORP	13.85	0.26	9.48%	11.7%
98	KOHL'S	53.23	1.56	5.20%	8.5%
99	KRAFT FOODS GROUP	58.84	2.10	7.10%	11.2%
100	KROGER	48.41	0.66	10.24%	11.8%
101	L BRANDS	57.84	1.36	11.13%	13.9%
102	LENNAR 'A'	40.17	0.16	9.27%	9.7%
103	LINEAR TECHNOLOGY	45.87	1.08	11.06%	13.8%
104	LOCKHEED MARTIN	164.01	5.32	7.73%	11.5%
105	LYONDELLBASELL INDS.CL.A	99.80	2.80	12.27%	15.6%
106	M&T BANK	122.20	2.80	5.77%	8.3%
107	MACY'S	58.12	1.25	11.84%	14.4%
108	MARATHON PETROLEUM	84.76	2.00	12.47%	15.3%
109	MASTERCARD	75.68	0.44	16.44%	17.2%
110	MCCORMICK & COMPANY NV.	70.72	1.48	7.63%	10.0%
111	MCDONALDS	100.39	3.24	6.16%	9.8%
112	MCGRAW HILL FINANCIAL	80.83	1.20	14.94%	16.7%
113	MCKESSON	184.75	0.96	13.90%	14.5%
114	MEAD JOHNSON NUTRITION	90.62	1.50	9.83%	11.8%
115	MEDTRONIC	61.55	1.22	6.66%	8.9%
116	MICROSOFT	41.40	1.12	7.50%	10.6%
117	MONDELEZ INTERNATIONAL CL.A	37.68	0.56	14.60%	16.4%
118	MONSANTO	120.06	1.72	13.13%	14.8%
119	MOODY'S	86.66	1.12	13.65%	15.2%
120	MOSAIC	49.07	1.00	8.53%	10.9%
121	NATIONAL OILWELL VARCO	78.38	1.84	13.10%	15.9%
122	NETAPP	36.39	0.66	11.84%	14.0%
123	NEWELL RUBBERMAID	30.41	0.68	9.93%	12.5%
124	NEXTERA ENERGY	98.50	2.90	6.48%	9.8%
125	NIKE 'B'	75.98	0.96	13.35%	14.9%
126	NORDSTROM	67.51	1.32	10.35%	12.6%
127	NORFOLK SOUTHERN	101.31	2.28	11.05%	13.7%
128	NORTHEAST UTILITIES	46.04	1.57	6.31%	10.2%
129	NVIDIA	18.64	0.34	7.11%	9.2%
130	OCCIDENTAL PTL.	100.34	2.88	6.12%	9.4%
131	ORACLE	41.20	0.48	9.42%	10.8%
132	PALL	84.41	1.10	11.77%	13.3%

	COMPANY	STOCK PRICE (P_0)	RECENT DIVIDEND (D_0)	FORECAST OF FUTURE EARNINGS GROWTH	MODEL RESULT
133	PARKER-HANNIFIN	124.65	1.92	10.80%	12.6%
134	PATTERSON COMPANIES	39.66	0.80	11.33%	13.7%
135	PAYCHEX	41.23	1.52	9.62%	13.9%
136	PENTAIR	74.02	1.20	14.33%	16.3%
137	PEPSICO	88.72	2.62	7.43%	10.8%
138	PERKINELMER	45.60	0.28	9.60%	10.3%
139	PERRIGO	143.53	0.42	12.80%	13.1%
140	PETSMART	61.92	0.78	10.63%	12.1%
141	PG&E	46.11	1.82	6.44%	10.9%
142	PHILIP MORRIS INTL.	86.66	3.76	6.83%	11.8%
143	PINNACLE WEST CAP.	55.89	2.27	4.00%	8.5%
144	PPG INDUSTRIES	204.12	2.68	12.90%	14.5%
145	PRAXAIR	131.56	2.60	11.07%	13.4%
146	PREC.CASTPARTS	253.45	0.12	12.78%	12.8%
147	PROCTER & GAMBLE	80.31	2.57	8.72%	12.4%
148	PULTEGROUP	19.45	0.20	8.06%	9.2%
149	PVH	122.39	0.15	12.13%	12.3%
150	QUEST DIAGNOSTICS	59.39	1.32	9.66%	12.2%
151	RALPH LAUREN CL.A	155.43	1.80	9.27%	10.6%
152	RAYTHEON 'B'	95.68	2.42	9.30%	12.2%
153	REPUBLIC SVS.'A'	36.40	1.12	8.63%	12.2%
154	ROCKWELL AUTOMATION	122.60	2.32	11.25%	13.5%
155	ROCKWELL COLLINS	78.19	1.20	8.95%	10.7%
156	ROPER INDS.NEW	144.00	0.80	13.30%	14.0%
157	ROSS STORES	67.08	0.80	11.50%	12.9%
158	SAFEWAY	34.28	0.92	8.80%	11.9%
159	SCRIPPS NETWORKS INTACT. 'A'	79.37	0.80	13.60%	14.8%
160	SEAGATE TECH.	55.24	1.72	12.00%	15.7%
161	SEMPRA EN.	100.98	2.64	6.95%	9.9%
162	SHERWIN-WILLIAMS	204.60	2.20	14.85%	16.2%
163	SOUTHERN	44.25	2.10	3.35%	8.6%
164	ST.JUDE MEDICAL	66.86	1.08	10.20%	12.1%
165	STARWOOD H&R.WORLDWIDE	79.87	1.40	8.30%	10.3%
166	STRYKER	83.11	1.22	8.95%	10.6%
167	SUNTRUST BANKS	38.95	0.80	9.60%	12.0%
168	SYMANTEC	22.21	0.60	6.97%	10.0%
169	SYSCO	36.93	1.16	6.97%	10.5%
170	T ROWE PRICE GROUP	82.01	1.76	13.83%	16.4%
171	TARGET	58.79	2.08	12.94%	17.2%
172	TEXAS INSTRUMENTS	46.97	1.20	10.00%	13.0%
173	THERMO FISHER SCIENTIFIC	118.67	0.60	12.23%	12.8%
174	TIFFANY & CO	97.62	1.52	12.50%	14.4%
175	TIME WARNER	70.63	1.27	13.14%	15.3%
176	TIME WARNER CABLE	144.14	3.00	12.98%	15.5%
177	TJX	54.89	0.70	11.08%	12.6%

	COMPANY	STOCK PRICE (P_0)	RECENT DIVIDEND (D_0)	FORECAST OF FUTURE EARNINGS GROWTH	MODEL RESULT
178	TOTAL SYSTEM SERVICES	31.36	0.40	13.87%	15.4%
179	TRACTOR SUPPLY	63.31	0.64	16.23%	17.5%
180	UNION PACIFIC	99.51	2.00	14.73%	17.2%
181	UNITED PARCEL SER.'B'	101.71	2.68	11.07%	14.2%
182	UNITED TECHNOLOGIES	115.12	2.36	11.18%	13.6%
183	UNITEDHEALTH GROUP	80.39	1.50	9.36%	11.5%
184	US BANCORP	42.22	0.98	7.09%	9.7%
185	V F	62.21	1.05	11.85%	13.9%
186	VALERO ENERGY	53.41	1.10	7.90%	10.3%
187	VERIZON COMMUNICATIONS	49.65	2.12	6.37%	11.2%
188	VIACOM 'B'	85.82	1.32	13.11%	15.0%
189	VISA 'A'	213.01	1.60	17.05%	18.0%
190	WAL MART STORES	76.62	1.92	8.11%	11.0%
191	WALGREEN	71.89	1.26	15.28%	17.4%
192	WALT DISNEY	84.00	0.86	16.15%	17.4%
193	WASTE MANAGEMENT	44.29	1.50	7.38%	11.3%
194	WELLPOINT	107.93	1.75	9.94%	11.8%
195	WELLS FARGO & CO	51.16	1.40	9.69%	12.9%
196	WESTERN UNION	16.72	0.50	10.50%	14.0%
197	WHOLE FOODS MARKET	40.56	0.48	12.65%	14.1%
198	WISCONSIN ENERGY	46.07	1.56	5.24%	9.0%
199	WW GRAINGER	254.15	4.32	13.10%	15.1%
200	WYNN RESORTS	207.99	5.00	13.87%	16.8%
201	XCEL ENERGY	31.34	1.20	4.49%	8.8%
202	XILINX	45.73	1.16	10.20%	13.2%
203	XYLEM	37.97	0.51	12.60%	14.2%
204	YUM! BRANDS	77.98	1.48	15.05%	17.4%
205	ZIMMER HOLDINGS	102.61	0.88	8.33%	9.3%
206	ZOETIS	31.65	0.29	12.72%	13.8%
207	Average				12.7%

Notes: In applying the DCF Model to the S&P 500, I include in the DCF analysis only those companies in the S&P 500 group which pay a dividend, have a positive growth rate, and have at least three analysts' long-term growth estimates. In addition, I exclude all companies in the I/B/E/S group of insurance companies. I also eliminate those companies with DCF results that varied from the mean by one standard deviation or more.

Notes:
D_0 = Latest dividend per Thomson Reuters.
d_0 = Latest quarterly dividend.
P_0 = Average of monthly high and low stock prices May, June, and July 2014 per Thomson Reuters.
FC = Selling and flotation costs.
g = I/B/E/S forecast of future earnings growth July 2014.
k = Cost of equity using the quarterly version of the DCF Model and a five percent allowance for flotation costs and market pressure (selling costs) as shown by the formula below:

$$k = \left[\frac{d_0 (1+g)^{\frac{1}{4}}}{P_0 (1-FC)} + (1+g)^{\frac{1}{4}} \right]^4 - 1$$

THE QUARTERLY DCF MODEL

The simple DCF Model assumes that a firm pays dividends only at the end of each year. Since firms in fact pay dividends quarterly and investors appreciate the time value of money, the annual version of the DCF Model generally underestimates the value investors are willing to place on the firm's expected future dividend stream. In this appendix, we review two alternative formulations of the DCF Model that allow for the quarterly payment of dividends.

When dividends are assumed to be paid annually, the DCF Model suggests that the current price of the firm's stock is given by the expression:

$$P_0 = \frac{D_1}{(1+k)} + \frac{D_2}{(1+k)^2} + \ldots + \frac{D_n + P_n}{(1+k)^n} \quad \textbf{(1)}$$

where

P_0	=	current price per share of the firm's stock,
$D_1, D_2, \ldots, D_n$	=	expected annual dividends per share on the firm's stock,
P_n	=	price per share of stock at the time investors expect to sell the stock, and
k	=	return investors expect to earn on alternative investments of the same risk, i.e., the investors' required rate of return.

Unfortunately, expression (1) is rather difficult to analyze, especially for the purpose of estimating k. Thus, most analysts make a number of simplifying assumptions. First, they assume that dividends are expected to grow at the constant rate g into the indefinite future. Second, they assume that the stock price at time n is simply the present value of all dividends expected in periods subsequent to n. Third, they assume that the investors' required rate of return, k, exceeds the expected dividend growth rate g. Under the above simplifying assumptions, a firm's stock price may be written as the following sum:

$$P_0 = \frac{D_0(1+g)}{(1+k)} + \frac{D_0(1+g)^2}{(1+k)^2} + \frac{D_0(1+g)^3}{(1+k)^3} + \ldots, \qquad \textbf{(2)}$$

where the three dots indicate that the sum continues indefinitely.

As we shall demonstrate shortly, this sum may be simplified to:

$$P_0 = \frac{D_0(1+g)}{(k - g)}$$

First, however, we need to review the very useful concept of a geometric progression.

Geometric Progression

Consider the sequence of numbers 3, 6, 12, 24,…, where each number after the first is obtained by multiplying the preceding number by the factor 2. Obviously, this sequence of numbers may also be expressed as the sequence 3, 3 x 2, 3 x 2^2, 3 x 2^3, … This sequence is an example of a geometric progression.

Definition: A geometric progression is a sequence in which each term after the first is obtained by multiplying some fixed number, called the common ratio, by the preceding term.

A general notation for geometric progressions is: a, the first term, r, the common ratio, and n, the number of terms. Using this notation, any geometric progression may be represented by the sequence:

$$a, ar, ar^2, ar^3, \ldots, ar^{n-1}.$$

In studying the DCF Model, we will find it useful to have an expression for the sum of n terms of a geometric progression. Call this sum S_n. Then

$$S_n = a + ar + \ldots + ar^{n-1} . \qquad (3)$$

However, this expression can be simplified by multiplying both sides of equation (3) by r and then subtracting the new equation from the old. Thus,

$$rS_n = ar + ar^2 + ar^3 + \ldots + ar^n$$

and

$$S_n - rS_n = a - ar^n \quad ,$$

or

$$(1 - r)\ S_n = a\ (1 - r^n) \quad .$$

Solving for S_n, we obtain:

$$S_n = \frac{a(1 - r^n)}{(1 - r)} \tag{4}$$

as a simple expression for the sum of n terms of a geometric progression. Furthermore, if $|r| < 1$, then S_n is finite, and as n approaches infinity, S_n approaches $a \div (1 - r)$. Thus, for a geometric progression with an infinite number of terms and $|r| < 1$, equation (4) becomes:

$$S = \frac{a}{1 - r} \tag{5}$$

Application to DCF Model

Comparing equation (2) with equation (3), we see that the firm's stock price (under the DCF assumption) is the sum of an infinite geometric progression with the first term

$$a = \frac{D_0(1+g)}{(1+k)}$$

and common factor

$$r = \frac{(1+g)}{(1+k)}$$

Applying equation (5) for the sum of such a geometric progression, we obtain

$$S = a \bullet \frac{1}{(1-r)} = \frac{D_0(1+g)}{(1+k)} \bullet \frac{1}{1-\frac{1+g}{1+k}} = \frac{D_0(1+g)}{(1+k)} \bullet \frac{1+k}{k-g} = \frac{D_0(1+g)}{k-g}$$

as we suggested earlier.

Quarterly DCF Model

The Annual DCF Model assumes that dividends grow at an annual rate of g% per year (see Figure 1).

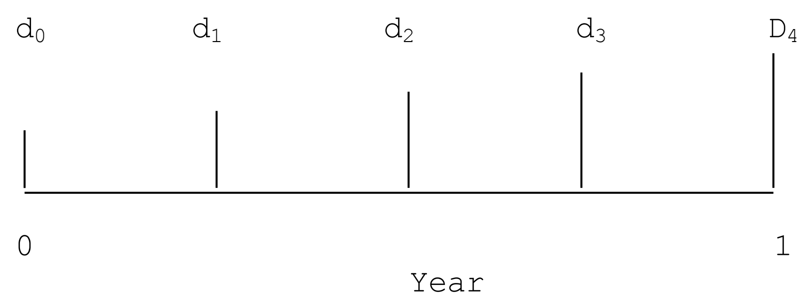
Figure 1

Annual DCF Model

$D_0 = 4d_0$ $\qquad$ $D_1 = D_0(1 + g)$

Figure 2

Quarterly DCF Model (Constant Growth Version)



$d_1 = d_0(1+g)^{.25}$ $\qquad$ $d_2 = d_0(1+g)^{.50}$

$d_3 = d_0(1+g)^{.75}$ $\qquad$ $d_4 = d_0(1+g)$

In the Quarterly DCF Model, it is natural to assume that quarterly dividend payments differ from the preceding quarterly dividend by the factor $(1 + g)^{.25}$, where g is expressed in terms of percent per year and the decimal .25 indicates that the growth has only occurred for one quarter of the year. (See Figure 2.) Using this assumption, along with the assumption of constant growth and ***k*** > ***g***, we obtain a new expression for the firm's stock price, which takes account of the quarterly payment of dividends. This expression is:

$$P_0 = \frac{d_0(1+g)^{\frac{1}{4}}}{(1+k)^{\frac{1}{4}}} + \frac{d_0(1+g)^{\frac{2}{4}}}{(1+k)^{\frac{2}{4}}} + \frac{d_0(1+g)^{\frac{3}{4}}}{(1+k)^{\frac{3}{4}}} + \ldots \qquad \textbf{(6)}$$

where d_0 is the last quarterly dividend payment, rather than the last annual dividend payment. (We use a lower case d to remind the reader that this is not the annual dividend.)

Although equation (6) looks formidable at first glance, it too can be greatly simplified using the formula [equation (4)] for the sum of an infinite geometric progression. As the reader can easily verify, equation (6) can be simplified to:

$$P_0 = \frac{d_0(1+g)^{\frac{1}{4}}}{(1+k)^{\frac{1}{4}} - (1+g)^{\frac{1}{4}}} \qquad \textbf{(7)}$$

Solving equation (7) for ***k***, we obtain a DCF formula for estimating the cost of equity under the quarterly dividend assumption:

$$k = \left[\frac{d_0(1+g)^{\frac{1}{4}}}{P_0} + (1+g)^{\frac{1}{4}} \right]^4 - 1 \qquad \textbf{(8)}$$

<u>An Alternative Quarterly DCF Model</u>

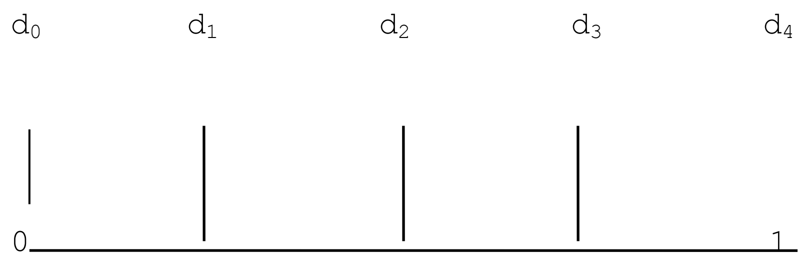
Although the constant growth Quarterly DCF Model [equation (8)] allows for the quarterly timing of dividend payments, it does require the assumption that the firm increases its dividend payments each quarter. Since this assumption is difficult for some analysts to accept, we now discuss a second Quarterly DCF Model that allows for constant quarterly dividend payments within each dividend year.

Assume then that the firm pays dividends quarterly and that each dividend payment is constant for four consecutive quarters. There are four cases to consider, with each case distinguished by varying assumptions about where we are evaluating the firm in relation to the time of its next dividend increase. (See Figure 3.)

Figure 3

Quarterly DCF Model (Constant Dividend Version)

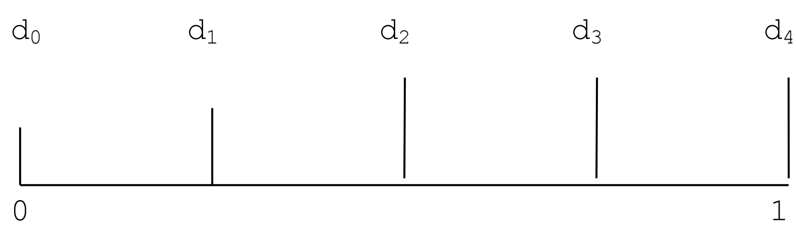
Case 1



Year

$$d_1 = d_2 = d_3 = d_4 = d_0(1+g)$$

Case 2



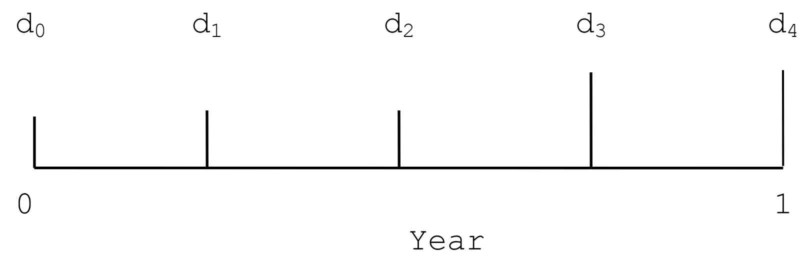
Year

$$d_1 = d_0$$

$$d_2 = d_3 = d_4 = d_0(1+g)$$

Figure 3 (continued)

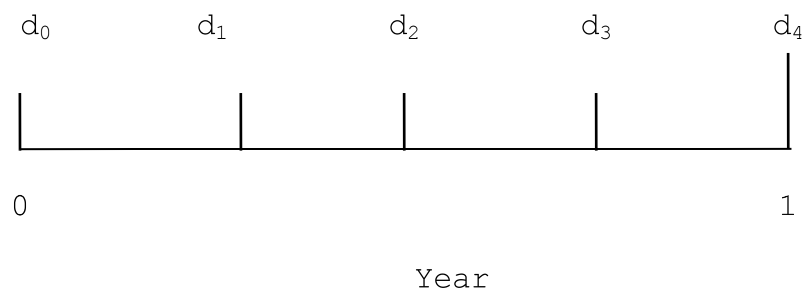
Case 3



$$d_1 = d_2 = d_0$$

$$d_3 = d_4 = d_0(1+g)$$

Case 4



$$d_1 = d_2 = d_3 = d_0$$

$$d_4 = d_0(1+g)$$

If we assume that the investor invests the quarterly dividend in an alternative investment of the same risk, then the amount accumulated by the end of the year will in all cases be given by

$$D_1^* = d_1 (1+k)^{3/4} + d_2 (1+k)^{1/2} + d_3 (1+k)^{1/4} + d_4$$

where d_1, d_2, d_3 and d_4 are the four quarterly dividends. Under these new assumptions, the firm's stock price may be expressed by an Annual DCF Model of the form (2), with the exception that

$$D_1^* = d_1 (1 + k)^{3/4} + d_2 (1 + k)^{1/2} + d_3 (1 + k)^{1/4} + d_4 \qquad \textbf{(9)}$$

is used in place of $D_0(1+g)$. But, we already know that the Annual DCF Model may be reduced to

$$P_0 = \frac{D_0(1+g)}{k-g}$$

Thus, under the assumptions of the second Quarterly DCF Model, the firm's cost of equity is given by

$$k = \frac{D_1^*}{P_0} + g \qquad \textbf{(10)}$$

with D_1^* given by (9).

Although equation (10) looks like the Annual DCF Model, there are at least two very important practical differences. First, since D_1* is always greater than $D_0(1+g)$, the estimates of the cost of equity are always larger (and more accurate) in the Quarterly Model (10) than in the Annual Model. Second, since D_1* depends on k through equation (9), the unknown "k" appears on both sides of (10), and an iterative procedure is required to solve for k.

COMPARATIVE RETURNS ON S&P 500 STOCKS
AND MOODY'S A-RATED UTILITY BONDS 1926-2013

LINE NO.	YEAR	S&P 500 STOCK PRICE	STOCK DIVIDEND YIELD	STOCK RETURN	A-RATED BOND PRICE	BOND RATE OF RETURN	RISK PREMIUM
1	2014	1,822.36	0.0210		$89.89		
2	2013	1,481.11	0.0220	25.24%	$97.45	-3.65%	28.89%
3	2012	1,300.58	0.0214	16.02%	$94.36	7.52%	8.50%
4	2011	1,282.62	0.0185	3.25%	$77.36	27.14%	-23.89%
5	2010	1,123.58	0.0203	16.18%	$75.02	8.44%	7.74%
6	2009	865.58	0.0310	32.91%	$68.43	15.48%	17.43%
7	2008	1,378.76	0.0206	-35.16%	$72.25	0.24%	-35.40%
8	2007	1,424.16	0.0181	-1.38%	$72.91	4.59%	-5.97%
9	2006	1,278.72	0.0183	13.20%	$75.25	2.20%	11.01%
10	2005	1,181.41	0.0177	10.01%	$74.91	5.80%	4.21%
11	2004	1,132.52	0.0162	5.94%	$70.87	11.34%	-5.40%
12	2003	895.84	0.0180	28.22%	$62.26	20.27%	7.95%
13	2002	1,140.21	0.0138	-20.05%	$57.44	15.35%	-35.40%
14	2001	1,335.63	0.0116	-13.47%	$56.40	8.93%	-22.40%
15	2000	1,425.59	0.0118	-5.13%	$52.60	14.82%	-19.95%
16	1999	1,248.77	0.0130	15.46%	$63.03	-10.20%	25.66%
17	1998	963.36	0.0162	31.25%	$62.43	7.38%	23.87%
18	1997	766.22	0.0195	27.68%	$56.62	17.32%	10.36%
19	1996	614.42	0.0231	27.02%	$60.91	-0.48%	27.49%
20	1995	465.25	0.0287	34.93%	$50.22	29.26%	5.68%
21	1994	472.99	0.0269	1.05%	$60.01	-9.65%	10.71%
22	1993	435.23	0.0288	11.56%	$53.13	20.48%	-8.93%
23	1992	416.08	0.0290	7.50%	$49.56	15.27%	-7.77%
24	1991	325.49	0.0382	31.65%	$44.84	19.44%	12.21%
25	1990	339.97	0.0341	-0.85%	$45.60	7.11%	-7.96%
26	1989	285.41	0.0364	22.76%	$43.06	15.18%	7.58%
27	1988	250.48	0.0366	17.61%	$40.10	17.36%	0.25%
28	1987	264.51	0.0317	-2.13%	$48.92	-9.84%	7.71%
29	1986	208.19	0.0390	30.95%	$39.98	32.36%	-1.41%
30	1985	171.61	0.0451	25.83%	$32.57	35.05%	-9.22%
31	1984	166.39	0.0427	7.41%	$31.49	16.12%	-8.72%
32	1983	144.27	0.0479	20.12%	$29.41	20.65%	-0.53%
33	1982	117.28	0.0595	28.96%	$24.48	36.48%	-7.51%
34	1981	132.97	0.0480	-7.00%	$29.37	-3.01%	-3.99%
35	1980	110.87	0.0541	25.34%	$34.69	-3.81%	29.16%
36	1979	99.71	0.0533	16.52%	$43.91	-11.89%	28.41%
37	1978	90.25	0.0532	15.80%	$49.09	-2.40%	18.20%
38	1977	103.80	0.0399	-9.06%	$50.95	4.20%	-13.27%
39	1976	96.86	0.0380	10.96%	$43.91	25.13%	-14.17%
40	1975	72.56	0.0507	38.56%	$41.76	14.75%	23.81%
41	1974	96.11	0.0364	-20.86%	$52.54	-12.91%	-7.96%
42	1973	118.40	0.0269	-16.14%	$58.51	-3.37%	-12.77%
43	1972	103.30	0.0296	17.58%	$56.47	10.69%	6.89%
44	1971	93.49	0.0332	13.81%	$53.93	12.13%	1.69%

COMPARATIVE RETURNS ON S&P 500 STOCKS
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LINE NO.	YEAR	S&P 500 STOCK PRICE	STOCK DIVIDEND YIELD	STOCK RETURN	A-RATED BOND PRICE	BOND RATE OF RETURN	RISK PREMIUM
45	1970	90.31	0.0356	7.08%	$50.46	14.81%	-7.73%
46	1969	102.00	0.0306	-8.40%	$62.43	-12.76%	4.36%
47	1968	95.04	0.0313	10.45%	$66.97	-0.81%	11.26%
48	1967	84.45	0.0351	16.05%	$78.69	-9.81%	25.86%
49	1966	93.32	0.0302	-6.48%	$86.57	-4.48%	-2.00%
50	1965	86.12	0.0299	11.35%	$91.40	-0.91%	12.26%
51	1964	76.45	0.0305	15.70%	$92.01	3.68%	12.02%
52	1963	65.06	0.0331	20.82%	$93.56	2.61%	18.20%
53	1962	69.07	0.0297	-2.84%	$89.60	8.89%	-11.73%
54	1961	59.72	0.0328	18.94%	$89.74	4.29%	14.64%
55	1960	58.03	0.0327	6.18%	$84.36	11.13%	-4.95%
56	1959	55.62	0.0324	7.57%	$91.55	-3.49%	11.06%
57	1958	41.12	0.0448	39.74%	$101.22	-5.60%	45.35%
58	1957	45.43	0.0431	-5.18%	$100.70	4.49%	-9.67%
59	1956	44.15	0.0424	7.14%	$113.00	-7.35%	14.49%
60	1955	35.60	0.0438	28.40%	$116.77	0.20%	28.20%
61	1954	25.46	0.0569	45.52%	$112.79	7.07%	38.45%
62	1953	26.18	0.0545	2.70%	$114.24	2.24%	0.46%
63	1952	24.19	0.0582	14.05%	$113.41	4.26%	9.79%
64	1951	21.21	0.0634	20.39%	$123.44	-4.89%	25.28%
65	1950	16.88	0.0665	32.30%	$125.08	1.89%	30.41%
66	1949	15.36	0.0620	16.10%	$119.82	7.72%	8.37%
67	1948	14.83	0.0571	9.28%	$118.50	4.49%	4.79%
68	1947	15.21	0.0449	1.99%	$126.02	-2.79%	4.79%
69	1946	18.02	0.0356	-12.03%	$126.74	2.59%	-14.63%
70	1945	13.49	0.0460	38.18%	$119.82	9.11%	29.07%
71	1944	11.85	0.0495	18.79%	$119.82	3.34%	15.45%
72	1943	10.09	0.0554	22.98%	$118.50	4.49%	18.49%
73	1942	8.93	0.0788	20.87%	$117.63	4.14%	16.73%
74	1941	10.55	0.0638	-8.98%	$116.34	4.55%	-13.52%
75	1940	12.30	0.0458	-9.65%	$112.39	7.08%	-16.73%
76	1939	12.50	0.0349	1.89%	$105.75	10.05%	-8.16%
77	1938	11.31	0.0784	18.36%	$99.83	9.94%	8.42%
78	1937	17.59	0.0434	-31.36%	$103.18	0.63%	-31.99%
79	1936	13.76	0.0327	31.10%	$96.46	11.12%	19.99%
80	1935	9.26	0.0424	52.84%	$82.23	22.17%	30.66%
81	1934	10.54	0.0336	-8.78%	$66.78	29.13%	-37.91%
82	1933	7.09	0.0542	54.08%	$79.55	-11.03%	65.11%
83	1932	8.30	0.0822	-6.36%	$70.67	18.23%	-24.59%
84	1931	15.98	0.0550	-42.56%	$84.49	-11.63%	-30.93%
85	1930	21.71	0.0438	-22.01%	$81.19	8.99%	-31.00%
86	1929	24.86	0.0336	-9.31%	$83.95	1.48%	-10.79%
87	1928	17.53	0.0431	46.12%	$86.71	1.43%	44.69%
88	1927	13.40	0.0502	35.84%	$83.28	8.92%	26.92%

COMPARATIVE RETURNS ON S&P 500 STOCKS
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LINE NO.	YEAR	S&P 500 STOCK PRICE	STOCK DIVIDEND YIELD	STOCK RETURN	A-RATED BOND PRICE	BOND RATE OF RETURN	RISK PREMIUM
89	1926	12.65	0.0446	10.39%	$80.81	8.01%	2.38%
90	Average 1926-2014			11.5%		6.8%	4.7%

Note: See Page 4 for an explanation of how stock and bond returns are derived and the source of the data presented.

COMPARATIVE RETURNS ON S&P 500 STOCKS
AND MOODY'S A-RATED UTILITY BONDS 1926-2013

RISK PREMIUM APPROACH

SOURCE OF DATA

Stock price and yield information is obtained from Standard & Poor's Security Price publication. Standard & Poor's derives the stock dividend yield by dividing the aggregate cash dividends (based on the latest known annual rate) by the aggregate market value of the stocks in the group. The bond price information is obtained by calculating the present value of a bond due in thirty years with a $4.00 coupon and a yield to maturity of a particular year's indicated Moody's A-rated Utility bond yield. The values shown on the ex post risk premium schedule are the January values of the respective indices.

CALCULATION OF STOCK AND BOND RETURNS

Sample calculation of "Stock Return" column:

$$\text{Stock Return (2012)} = \left[\frac{\text{Stock Price (2013) - Stock Price (2012) + Dividend (2012)}}{\text{Stock Price (2012)}}\right]$$

where Dividend (2012) = Stock Price (2012) x Stock Div. Yield (2012)

Sample calculation of "Bond Return" column:

$$\text{Bond Return (2012)} = \left[\frac{\text{Bond Price (2013) - Bond Price (2012) + Interest (2012)}}{\text{Bond Price (2012)}}\right]$$

where Interest = $4.00.

Exhibit RB-12

PREFILED TESTIMONY
OF
DAVID APPEL

MOBILE HOMEOWNERS INSURANCE (MH-F) RATE FILING
BY THE NORTH CAROLINA RATE BUREAU
DECEMBER 2014

I. QUALIFICATIONS AND SUMMARY

Q. Please state your name and present business address.

A. My name is David Appel, and my business address is 1 Pennsylvania Plaza, New York, NY.

Q. What is your occupation?

A. I am Director of Economics Consulting and a Principal with the firm of Milliman, Inc.

Q. What is Milliman, Inc?

A. Milliman (formerly Milliman & Robertson) is one of the nation's largest independently owned firms of actuaries and consultants. The company has more than 2600 employees, and operates offices in over 55 cities in the U.S., Europe, Asia and Latin America. Our clients number in the thousands: they include insurers, self-insured entities, Federal and State Governments, private corporations, non-profit organizations, unions, and many others. I am a Principal with the firm, and I am in charge of its Economics Consulting practice.

Q. Please describe your educational and employment history.

A. A complete statement of my educational, employment and academic credentials is included as Exhibit RB-13 filed with this testimony.

To summarize, I have a B.A. in economics from Brooklyn College, City University of New York, and M.A. and Ph.D. degrees in economics from Rutgers University. Prior to 1980, I was an instructor in economics at Rutgers University. For the following nine years, I was employed by the National Council on Compensation Insurance (NCCI), the nation's largest workers compensation insurance statistical, research and ratemaking organization. I joined NCCI as Research Economist in 1980, and ultimately became Vice President for Research in 1985. In 1989, I joined Milliman, where I founded the economics consulting practice for the firm.

Q. Would you please describe some of your other professional activities?

A. Yes. Throughout my professional career, I have participated in a variety of academic and business activities related to insurance. I have twice been a member of the Board of Directors of the American Risk and Insurance Association, the leading learned society of insurance academics. I am currently a member of the editorial board of the Journal of Insurance Regulation, the official research publication of the National Association of Insurance Commissioners, and I act as a peer referee for a number of scholarly journals in economics and insurance. I also maintain an active program of research and publication on issues of current interest in insurance economics. In addition, I was, for twelve years, an Adjunct Professor of Economics at Rutgers University.

Q. Have you ever published any papers or books?

A. Yes. I have authored many papers on various aspects of insurance that have been published in refereed books or scholarly journals. In addition, I have published a large number of papers in non-refereed journals as well. I have also co-edited three volumes of research papers dealing with various aspects of workers compensation and property-casualty insurance. My refereed publications are listed in Exhibit RB-13 filed with this testimony.

Q. Are you a member of any professional associations?

A. Yes. I am a member and have served two terms on the Board of Directors of the American Risk and Insurance Association, the leading association of insurance academicians. I am also an elected fellow of the National Academy of Social Insurance, a member of the panel of neutrals of the American Arbitration Association, and a certified arbitrator and umpire of ARIAS, the world's leading insurance and reinsurance arbitration society.

Q. Have you ever testified in insurance rate regulatory proceedings?

A. Yes. I have testified on many occasions in such proceedings, including several occasions in North Carolina in the past several years. A complete list is contained in Exhibit RB-13 filed with this testimony.

Q. What was the general nature of your testimony in these cases?

A. I have addressed a wide variety of insurance issues during public testimony, including such diverse topics as the impact of economic and demographic factors on insurance costs, the effects of regulation on insurance availability, the use of econometric and statistical models in insurance forecasting, and the use of modern financial theory in developing insurance prices. In North Carolina, my testimony has tended to focus on matters relating to the cost of capital and the returns expected from the underwriting profit provisions selected for use in the rates. However, in property rate filings, I have had substantial involvement in issues relating to catastrophe risk and the net cost of reinsurance, hence my testimony has addressed these issues as well.

Q. Have you been retained by the North Carolina Rate Bureau as a consultant in this rate case?

A. Yes. I have been asked to consider the following specific matters in connection with this case:

1. Whether Dr. Vander Weide's analysis provides a reasonable estimate of the cost of capital.

2. Whether other factors – notably interest rate sensitivity and the small firm size typical of mobile homeowners insurers in North Carolina – create additional sources of risk which affect insurers' cost of capital.

3. How the expected costs of reinsurance should be incorporated into the mobile homeowners insurance rates filed by the Rate Bureau and how those costs should be apportioned to regions within the state.

4. How the profits associated with underwriting mobile homeowners insurance in North Carolina should be apportioned to regions within the state.

5. How mobile homeowners insurers in North Carolina should be compensated for bearing the risk to their capital associated with exposure to assessments by the North Carolina Insurance Underwriting Association (commonly called the "Beach Plan") and the North Carolina Joint Underwriting Association (commonly called the "FAIR Plan") (the two organizations hereinafter referred to jointly as the "Beach/Fair Plans").

6. The returns insurers would expect to earn from underwriting mobile homeowners insurance in North Carolina, given that the filed underwriting profit provision is realized.

I have performed various studies and analyses on these matters.

I note one other important thing in connection with the filings at issue in this case. Since mobile homeowners insurance in North Carolina is sold under two different policy forms – one denoted MH-C and the other MH-F – there are two separate filings in this case, one for each policy form. As a consequence, I have produced two separate testimonies, to accompany the separate filings. I note, however, that the substantive issues in both filings are the same, hence the testimonies are identical with the exception that the numerical values differ due to differing underlying data for the two forms. The numerical values in this testimony pertain to the MH-F filing specifically.

Q. Can you please summarize the conclusions you have reached in regard to the matters noted above?

A. Yes. I will summarize them in bullet form here, and then discuss them each more fully later in the testimony.

1. I have reviewed Dr. Vander Weide's cost of capital estimates, which rely on the two most widely recognized models used for this purpose, and find them to be reasonable. However, Dr. Vander Weide's estimates are based on the implicit assumption that insurers present investors with roughly average risk, relative to all possible investment activities. I believe that investors in the property-casualty insurance industry are subject to an above average degree of risk, and therefore I think it would be prudent to view Dr. Vander Weide's estimates as a conservative estimate of the return to which insurers are entitled.

2. I have considered the impact of two other factors on the risk and required return for insurers – interest rate sensitivity and firm size. As regards interest rate sensitivity, because of the high degree of financial leverage and the substantial share of medium and long term bonds in insurer asset portfolios, insurers are particularly subject to interest rate risk that cannot be diversified away. Based on my previous analyses, I have found that investors must be compensated for this risk in the form of an additional risk premium above that required for the average security. As regards firm size, I have on many occasions studied the size distribution of insurers in North Carolina and found that the firms providing insurance coverage in the state tend to be smaller than those used in Dr. Vander Weide's cost of capital analysis. Since there is conclusive evidence that, over the long run, smaller firms have earned higher returns, this finding must be considered evidence that investors expect higher returns from small firms.

   These analyses provide support for my opinion that Dr. Vander Weide's cost of capital estimates should be viewed as a conservative estimate of the return to which insurers are entitled.

3. I have considered the differential risk associated with underwriting mobile homeowners insurance in different regions within North Carolina, and have concluded that the risk due to catastrophe exposure is substantially greater in and around the coastal regions of the state. I have also considered the high cost of catastrophe reinsurance that is regularly purchased by property casualty insurance companies writing mobile homeowners insurance, and have concluded that a provision must be included in the rates to cover the cost of a catastrophe

reinsurance program typical of the programs purchased by insurers in hurricane prone regions. Furthermore, I believe that it is appropriate to apportion this provision across regions of the state, proportional to the relative risk by region.

4. Even after the benefits of reinsurance are taken into account, the residual risk of writing mobile homeowners insurance in North Carolina may still differ across regions within the state. As a consequence, I believe that it is appropriate to allocate the statewide profit built into mobile homeowners rates across regions, proportional to the relative risk by region after consideration of reinsurance.

5. In addition to the risks attendant to the mobile homeowners directly written by insurers in North Carolina, there is substantial additional risk to insurers attributable to the exposures insured in the Beach/Fair Plans. This risk is associated with the potential for assessments that can be imposed on insurers in the state, should the Beach/Fair Plans incur a deficit arising from their insurance operations. Insurers must be compensated for bearing this risk and, to address this situation, I have developed a procedure to incorporate a provision in the rates that compensates insurers in the state for this risk.

6. In order to test the underwriting profit provisions selected and filed by the Rate Bureau, I have estimated the returns insurers would expect to earn from North Carolina mobile homeowners insurance assuming the filed underwriting profit provision is fully earned, and assuming all of the other assumptions embedded in the rate calculations actually materialize. I am aware that North Carolina law provides that insurers are entitled to expect to earn a return equal to the returns of industries of comparable risk and that, in calculating that expected return, investment income from capital and surplus funds is not to be considered. I refer to that operating return as the statutory return. However, as is evident from the attached exhibits, I have estimated insurer pro forma returns both including and excluding expected investment income from capital and surplus. (I refer to the return including investment income on surplus as the total return.) I have done this to demonstrate that, if the filed underwriting profit provisions are actually realized, and even if investment income on surplus is considered, insurer returns will not be excessive. Obviously, if returns are not excessive including investment income from capital and surplus, they will be non-excessive excluding such income.

Based on my calculations, the selected underwriting profit provision generates a statutory return on net worth of 7.4% for mobile homeowners insurance in North Carolina. In addition, the total return on net worth (i.e., including investment income on surplus) is 10.2%. Since these returns, even those that include investment income on surplus funds, are near or below the lower bound of Dr. Vander Weide's range for the fair rate of return, I conclude that the underwriting profit provision is clearly not excessive.

II. COST OF CAPITAL REVIEW

Q. You said your first assignment was to review Dr. Vander Weide's estimate of the cost of capital. Are you familiar with Dr. Vander Weide's approach to estimating the cost of capital in insurance rate cases?

A. Yes. I am aware of the methodology upon which Dr. Vander Weide relies to estimate the cost of capital and have reviewed it on a number of occasions in the course of previous rate cases in North Carolina. Dr. Vander Weide has used the most widely recognized and accepted models for this purpose, namely the Discounted Cash Flow (DCF) model and the risk premium method. These models, when taken together and properly applied to a reasonably selected data set, provide acceptable estimates of the cost of capital for regulated insurers.

Q. What has Dr. Vander Weide concluded with respect to the fair rate of return in this case?

A. Dr. Vander Weide has concluded that the fair rate of return for insurers is in the range of 9.0% to 12.7% on net worth as determined under generally accepted accounting principles (GAAP).

Q. In your opinion, is this an appropriate estimate of the required rate of return?

A. Yes, however as I indicated a moment ago, I believe that Dr. Vander Weide may have been conservative in his calculation of the required rate of return. Dr. Vander Weide has assumed that the property-casualty industry presents investors with average risk. However, based on my studies, I conclude the following:

1. There is evidence that the property casualty industry is considerably above average with respect to the volatility of the returns that it provides to investors. This higher volatility of returns makes the property-casualty industry an investment of above average risk.

2. Since investors require higher returns from smaller firms, and since the firms in Dr. Vander Weide's cost of capital analysis are significantly larger than the average property-casualty insurer in North Carolina, his approach tends to underestimate the true cost of capital for North Carolina mobile homeowners insurers.

III. ADDITIONAL FACTORS AFFECTING RISK

Q. Your comments suggest that Dr. Vander Weide’s cost of capital may be understated for insurers writing insurance in North Carolina. Can you please elaborate on this?

A. Certainly. As mentioned in the summary, I have considered whether other factors not addressed in the standard cost of capital analysis conducted by Dr. Vander Weide might indeed affect the risk and therefore the required return in this case. In fact, there were two such factors – interest rate risk and the small size of firms writing mobile homeowners insurance in the state - that I have been studying for a number of years and which clearly increase the cost of capital, or required return, in this case. Based on analyses I have conducted for previous rate hearings in North Carolina, I have concluded that both these factors create additional risks that require additional compensation above that demanded for the average security. I will discuss these issues briefly below.

Q. You have made reference to the term interest rate risk. Can you please define this term?

A. Yes. Interest rate risk refers to the risk that the value of fixed income investments (such as bonds) will fluctuate with changes in interest rates. This means that there is a risk associated with holding bonds, particularly those with a relatively long term to maturity. While investments in equities are still considerably riskier than investments in long term bonds, as evidenced by the fact that returns to large company stocks have had a much higher mean and standard deviation than returns on long term government bonds over the past 80+ years, bonds investments impose risk as well.

Q. Does interest rate risk affect investments in property-casualty insurance stocks?

A. Yes. Property-casualty insurance companies invest large amounts of funds in bonds issued by both corporations and governmental bodies. The risk that investors face is that when interest rates change, the values of the bonds also change, and hence their investments in property-casualty stocks are subject to interest rate risk. This fact is widely recognized by the financial community. Since investors cannot diversify away interest rate risk, only the prospect of higher returns will induce them to purchase interest-sensitive stocks. That is, investors must be compensated for purchasing interest-sensitive stocks because they are increasing their exposure to interest rate risk. This is a risk separate and apart from the market risk investors face.

Q. Why is interest rate risk different from market risk?

A. In general, risk that is not diversifiable is known as systematic risk, or market risk. Systematic risk stems from events that take place on an economy-wide basis. Investors can only diversify away risks that have offsetting factors somewhere else in the economy. For instance, if one company has a bad year due to reasons specific to it alone, it is highly likely that another company will have a good year which will offset the bad performance. That sort of risk is diversifiable. However, the risk associated with events that take place economy-wide without offsetting factors is not diversifiable. It is this risk that is referred to as systematic risk or market risk.

Interest rate risk is a separate source of volatility for insurance stocks. Interest rates often change as a result of changes in expectations of future inflation. These changes primarily affect firms that hold what are called nominal assets and liabilities. Nominal assets and liabilities have cash flows that are fixed in nominal terms (for example, accounts receivable, most contracts, and bonds) and are thus subject to erosion in value due to inflation. On the other hand, the cash flows associated with manufacturing and service operations tend to fluctuate with the price level. Since most non-financial firms hold relatively few nominal assets and liabilities, their stocks are not particularly sensitive to changes in interest rates that are due to changes in expected inflation. Therefore interest rate risk adds additional risk to insurance stocks, above and beyond market risk, that is not diversifiable.

Changes in interest rates that are not associated with changes in expected inflation will affect all stocks. This accounts for the moderate degree of correlation between changes in long term interest rates and returns to common stocks. However, the fact that most stocks are not very sensitive to changes in interest rates that are due to changes in expected inflation means that interest rate risk is not fully captured in measures of market risk.

Q. Is it possible to measure interest rate risk?

A. Yes, and in the past I have conducted a number of studies designed specifically to address this issue. The principal conclusions of those studies is that since insurer assets on average have a substantially longer financial duration than insurance liabilities, when interest rates change, the value of insurer equity is subject to potentially wide fluctuation. While the market risk for insurers as measured by beta is roughly average, the degree of interest rate risk to which the industry is exposed is considerably higher than average. Since this risk cannot be entirely diversified away, the overall risk associated with an investment in property/casualty insurance is greater than average. As a consequence, insurers are entitled to a rate of return above that allowed for the average risk investment in the U.S. economy.

Q. You also said that you considered whether the size distribution of North Carolina insurers should impact the cost of capital in this case. Can you please describe this issue briefly and discuss its implications for this case?

A. Yes. It is a well established fact of empirical finance that small stocks tend to outperform large stocks. Ibbotson Associates, for instance, reports that firms in the ninth and tenth deciles of stocks listed on the principal U.S. stock exchanges have outperformed the market as a whole by approximately 3.8 percentage points over the period 1926 to 2012, even after accounting for the fact that these firms have above average betas. Therefore an adjustment should be made to the cost of capital to the extent that the property-casualty insurance industry is composed of small stocks.

Q. Have you conducted any studies with respect to the significance of the small stock effect?

A. Yes. As with interest rate risk, I have conducted a number of studies of this issue in previous years, and in each instance I found that (1) investors have earned higher returns from small stocks than from large stocks, and (2) the insurers in Dr. Vander Weide's cost of capital analysis are among the largest companies in the U.S. economy. The insurers in Dr. Vander Weide's analysis are larger, on average, than the companies in the property-casualty insurance industry, and they are larger, on average, than the companies writing mobile homeowners insurance in North Carolina.

These facts suggest that the cost of capital for insurers writing mobile homeowners insurance in North Carolina should be higher than for those firms contained in Dr. Vander Weide’s cost of capital analysis. This reaffirms my conclusion that the cost of capital Dr. Vander Weide has presented is conservative.

Q. Are there other reasons that you believe Dr. Vander Weide’s cost of capital is conservative?

A. Yes. The insurance industry is in the business of bearing risk. Individuals and corporations transfer to property-casualty insurers the potential liability for a wide range of possible adverse events, ranging from property damage to professional liability. In light of the unforeseen events that can occur, and, in the recent past, actually have occurred, investors in property-casualty insurance stocks are subject to considerable risk. Also, insurance is in the unique position of being a highly competitive industry that is also subject to a high degree of regulation. This combination of regulation and competition creates an environment in which insurers are subject not only to the demands of the market but also to the pressures of the political process. There is substantial evidence that regulation can increase risk for a regulated enterprise, and when that is combined with an aggressively competitive industrial structure, risk is increased.

Q. You said that the combination of regulation and competition increased risk for insurers. Can you describe what you mean?

A. Yes. Traditionally, direct price and rate of return regulation has been imposed on industries known as "public utilities," such as generation and transmission of electric power, distribution of natural gas, provision of local water and sewer service and the like. Because of the nature of the production process, these industries are characterized as "natural monopolies," meaning that it is most efficient for a single producer to provide the service in question. In such circumstances, the state normally grants a monopoly to a single provider and then regulates that firm directly to prevent abuse of monopoly power.

Property-casualty insurance differs dramatically from this model. Rather than a single firm providing service, there are in most states literally hundreds of firms competing in the market, none of which typically have significant market power. These firms compete aggressively to increase market share and attract the best insureds by offering a variety of price and quality combinations that are best tailored to their business objectives. This vigorous competition provides discipline in the marketplace, and, when combined with direct rate of return regulation, the risk for insurers is increased.

I should note that, historically, a number of competitively structured industries (such as airlines, trucking, and telecommunications) were subject to regulation, but in the past several decades there has been a movement to deregulate these activities. This is due in part to the widespread agreement that competition itself is an adequate regulator.

Q. Can you please summarize your testimony on the cost of capital of the property-casualty insurance industry?

A. Yes. Dr. Vander Weide has assumed that the property-casualty insurance industry presents investors with risks comparable to the average investment in equities. My analysis has shown that property-casualty insurance stocks are subject to additional risks when compared with the broad cross section of publicly traded firms in the U.S. economy. Since these additional risks require compensation in the form of a higher return, I conclude that Dr. Vander Weide has been conservative in his calculation of the required rate of return on property-casualty insurance investments.

IV. NET COST OF REINSURANCE & REGIONAL ALLOCATIONS

Q. In your summary, you said you considered how the net cost of reinsurance should be included in mobile homeowners rates in North Carolina, and how the profit in the rates should be allocated proportional to risk. Can you please discuss your evaluation of these issues?

A. Yes. I have previously addressed these issues in homeowners, mobile homeowners and dwelling fire and extended coverage rate filings in North Carolina, where I have recommended that the indicated rates be developed to include the net cost of reinsurance. I will briefly outline the problem and then discuss each of the issues separately.

To begin with, mobile homeowners is one of several lines of insurance that is subject to the potential for catastrophic loss. In such lines (homeowners, earthquake, allied lines and other property coverages), individual catastrophic events can result in enormous losses, far in excess of what the typical insurer could bear. Thus, in these lines of business, insurers routinely purchase reinsurance to manage their exposure to extreme events, and it is appropriate to provide for the cost of this reinsurance in setting rates for these lines of insurance. Since ratemaking is often done on a direct basis, as compared to a net of reinsurance basis, an explicit adjustment must be made to provide for the cost of reinsurance.

Second, the exposure to catastrophic loss varies substantially by geographic region within North Carolina. It is well known that the coastal counties in the state are subject to severe exposure to the hurricane peril, while the interior regions to the west are subject to considerably less exposure, particularly on a per-policy basis. Since the need for reinsurance is a function of the degree of catastrophe exposure, the cost of reinsurance should reflect such regional differences as exist within the state. Accordingly, in considering the cost of reinsurance in primary rates, I allocate the statewide cost across regions, proportional to risk.

Finally, even after the consideration of reinsurance, substantial differences in risk across regions remain. Therefore, to the extent that the underwriting profit in the rates is intended to compensate the insurer for risk, that profit should also be spread regionally proportional to the risk that remains after the benefits of reinsurance are considered. Similar to the cost of reinsurance, the profit in the statewide rates is also allocated across regions, proportional to the residual risk that remains after the benefits of reinsurance.

Q. You mentioned that direct ratemaking does not include the cost of reinsurance. Can you please explain?

A. Yes. Direct ratemaking is an approach that is sometimes used when making insurance rates on an industrywide basis (where the terminology "direct" refers to an analysis done without consideration of reinsurance). While this approach is reasonable for some lines of insurance (such as auto insurance), it fails to reflect the market realities associated with writing property insurance in catastrophe prone environments such as North Carolina. In these environments, primary insurers are required to purchase reinsurance to manage their exposure to catastrophe risks, and such reinsurance comes at a substantial net cost.

Q. Why does reinsurance come at a substantial net cost?

A. Reinsurers generally cover the riskiest portion of the insurance loss distribution – the events that occur only rarely but impose extremely high costs. In order to provide a credible promise to pay claims resulting from extreme events, reinsurers carry substantially more capital per unit of exposure than primary insurers. This capital has a cost, which is included in the premiums paid for the reinsurance in the market. Since basic economic and actuarial principles require all costs of the risk transfer to be included in the price of insurance, and since reinsurance is required to efficiently manage catastrophe risk, its net cost should be included in the rates charged for mobile homeowners insurance.

Q. Did you perform any analysis to address this issue?

A. Yes. To address this issue and provide for a rate that will cover all the costs of the insurance transaction, I developed a procedure to include the "net cost of reinsurance" as an expense in the direct mobile homeowners rates in North Carolina. (By net cost of reinsurance, I mean the expense and profit components of the reinsurance rate, since the loss costs are already included in the calculation of the direct premium.) This procedure is conceptually identical to that employed in Florida, where insurers make rates using direct losses and expenses, but then add in a provision which covers the cost (to the primary insurer) of the reinsurer's profit and expense.

Q. Please describe your analysis.

A. To implement this procedure, I adopted the standard ratemaking assumption used in North Carolina – i.e., that there is a single aggregate company that is the composite of all carriers in the state. I then assumed that this company maintains a reinsurance program that is typical of property insurers writing in hurricane prone states such as North Carolina, with provisions as follows:

- An attachment point equal to the one in ten year hurricane loss event (i.e., the 90th percentile of the statewide loss distribution from the AIR Worldwide ("AIR") hurricane model results). The attachment point is the loss level at which the reinsurer begins to share in the loss.

- A limit equal to the difference between the attachment point and the one in a hundred year event (the 99th percentile of the statewide loss distribution). The limit is the maximum loss amount which the reinsurer will pay under the contract.

- A 5% coparticipation in the reinsured layer. (Coparticipation refers to a provision where the primary insurers share a specified percentage of the reinsured loss).

- One mandatory reinstatement of the original limit following insured events.

These provisions were based on my experience working with actuaries, risk managers and reinsurance brokers familiar with these types of exposures, and they reflect the types of reinsurance programs that insurers typically purchase to protect against the potentially catastrophic losses that are attendant to the hurricane risk to which the state is exposed.

Q. Before you continue, do you have any support for these assumptions beyond your experience working with actuaries, risk managers and reinsurance brokers familiar with these types of exposures?

A. Yes, in fact, this was a subject of substantial discussion during the recently completed homeowners insurance rate hearing. Without repeating all the evidence in that case, suffice it to say that I have testified for years that these assumptions are reasonable, and over that time strong support has been provided in the testimony of actuaries and officers of several of the largest insurers in North Carolina (e.g., Brian Donlan and Shantelle Thomas of Allstate Insurance Company, Roger Batdorff of North Carolina Farm Bureau) and by the president of AON Benfield Americas, the largest reinsurance broker in the world (Bryon Ehrhart). In addition, the assumptions were shown to be reasonable by comparison to the reinsurance purchased by the Beach Plan, the reinsurance programs of several Florida property insurers, and the reinsurance program of North Carolina Farm Bureau.

Q. Isn't it true that the Insurance Department witnesses question the basis of your assumptions regarding the structure of a typical reinsurance program?

A. Yes. However, never once has any Insurance Department witness stated that the attachment point, limit, co-participation or reinstatement provisions assumed in the proposed reinsurance program are *unreasonable,* or that they are atypical of reinsurance programs purchased by property insurers in catastrophe prone regions. They may question my expertise or the support I have provided for the assumptions, but they have neither asserted any alternative assumptions nor testified that mine are unreasonable.

Q. Can you please now continue with the discussion of your results.

A. Yes. Given the program I described above and the AIR statewide aggregate loss distributions, I then determined the amount of losses that would be subject to reinsurance coverage, as a share of the total hurricane losses in the state. Based on the projected reinsured losses, I then developed a "competitive market" reinsurance premium, following a series of steps that are described below. Before describing the individual steps in that process, however, I should note two considerations in connection with the use of the AIR model in this filing.

First, in developing the hurricane loss estimates for use in this filing, AIR ran two separate models, one based on 100,000 iterations of its model using the full 100+ year history of hurricane activity as the basis for projected hurricane frequency, and the other based on 100,000 iterations of the model using an alternative version known as the warm sea surface temperature (WSST) model. The WSST model reflects the higher frequency and severity of hurricanes in periods of warmer sea surface temperatures such as currently exist.

When calculating the base rates for this filing, the Rate Bureau relied upon the standard AIR model to estimate the level of hurricane losses to be included in the rates. However, reinsurers rely on models that use substantially higher hurricane frequencies and/or severities to estimate expected losses for property exposures, to reflect the widespread recognition that we are currently in a phase of increased activity in the hurricane cycle. Since it is appropriate to rely on the models used in the reinsurance market in setting the price of reinsurance, and later, in allocating that cost to zone, I relied on the AIR WSST model loss estimates in this portion of my analysis.

Second, I also note that, in projecting losses using either model, AIR's estimates reflect the phenomenon of "demand surge." Demand surge refers to the fact that, subsequent to the occurrence of a large natural catastrophe, the prices of labor and materials required to repair or replace damaged property tend to increase because of the surge in demand for such resources. This is exactly what one would expect given the underlying dynamics of supply and demand; with resources (particularly labor) that are relatively fixed in supply in the short run, a rapid increase in demand is expected to increase prices. This phenomenon has been observed following natural disasters such as Hurricane Andrew, the Northridge earthquake, Hurricane Katrina and the like. In estimating the damages attributable to catastrophic events, it is appropriate to include all factors that affect the level of expected losses, including, of course, factors that affect the price of the resources required to respond to those events.

Given the reinsurance program described above and the AIR loss distributions, I then determined the amount of losses that would be subject to reinsurance coverage, as a share of the total hurricane losses in the state. Based on the projected reinsured losses, I then developed a “competitive market” reinsurance premium, as follows:

- I loaded the reinsured loss for LAE, using the Incurred Loss/Incurred LAE ratio from the filing.

- I then loaded the incurred losses and LAE for assumed reinsurer expenses, using an expense factor of 0.70 (which results in a reinsurer expense provision of 14.7% of premium).

- I assumed the reinsurer set an underwriting profit provision that would yield a return on net worth, after consideration of all investment income, of 11.0%. I determined the reinsurer’s net worth such that the reinsurer premium to surplus ratio would be .30, a selected value that is in the range of such ratios for reinsurers that underwrite property catastrophe risks.

Having determined the reinsurance premium that a competitive reinsurance market would produce under the assumptions described above, I then subtracted expected losses and LAE from the premium to leave the net cost of reinsurance of $9,465,458. In the next step, that amount was added as a fixed expense in the rates. (This value, when divided by projected direct written premium at proposed rates, produces an expected net cost of reinsurance equal to 14.0% of direct premium, comprised of the reinsurance expense cost of 2.8% and the cost of reinsurer capital of 11.2%).

Q. Are the results of your calculations shown in an exhibit?

A. Yes. Exhibit RB-15 shows the calculations giving rise to the estimated net cost of reinsurance of $9,465,458. This exhibit contains two pages; the first page shows the derivation of the reinsurance premium, based on the portion of hurricane losses that are covered by reinsurance, and the reinsurer’s capitalization and required return. The end result of that calculation is the net cost of reinsurance, in dollars. (The net cost of reinsurance is the total premium less the primary insurer’s loss and LAE recovery, which is equal to the reinsurer’s expense cost and the cost of the reinsurer's capital). The second page shows the derivation of the statewide premium given the net cost of reinsurance, along with the net and gross cost of reinsurance displayed as a percent of statewide premium. As can be seen in the second page, the reinsurance premium is 19.4% of statewide direct premium, while the net cost of reinsurance is 14.0% of premium.

Q. Do you believe that your calculations accurately reflect the net cost of reinsurance in North Carolina?

A. Yes. In the past I have compared the estimates based on this methodology to the actual reinsurance costs incurred by insurers, and I have found they are typically consistent with the portions of premium expended by primary insurers in the purchase of reinsurance in catastrophe prone environments. As a consequence I believe that my estimates are reasonable.

Q. In your opinion, it is appropriate to include the net cost of reinsurance in mobile homeowners insurance rates in North Carolina?

A. Yes. Insurers in North Carolina incur a substantial cost for bearing the risk of mobile homeowners insurance in the state. The market cost of bearing that risk (whether the risk is retained by the insurer or transferred to a reinsurer) must be included in the rates. In the analysis described above, I have developed a competitive market reinsurance premium that reasonably reflects the net cost of reinsurance to the primary insurer. Since this is a legitimate cost of the risk transfer inherent in the purchase of mobile homeowners insurance, it should properly be included in the rates.

Q. You said that the next step was to allocate the cost of reinsurance across regions in the state proportional to risk. Can you please discuss your analysis of this issue?

A. Yes. As discussed above, it is widely agreed that mobile homeowners insurance in North Carolina is subject to substantial catastrophe exposure due to the possibility that hurricanes and other serious windstorms may strike the state. However that catastrophe potential differs significantly from region to region within the state; in coastal counties, for example, the hurricane risk is far higher than it is in the interior mountainous regions to the west. As a consequence, the risk to which insurers and reinsurers are exposed differs across the state as well. Since the need for reinsurance arises from the catastrophe exposure, regional differences in relative risk should be taken into account when determining the allocation of reinsurance costs within the state.

Q. How did you analyze the regional differences in risk and allocate reinsurance costs to region?

A. To address this issue, I developed a general simulation model that calculates regional differences in risk within North Carolina. Based on the model results, costs can be allocated to different regions in proportion to the risk each region contributes to the state as a whole. I used this model to allocate the net cost of reinsurance, as well as the underwriting profit and contingency provisions, to the different mobile homeowners territories in the state. As a general rule, since the risk in the coastal areas is far greater than the risk in the interior, the cost of reinsurance and the required profit in those territories is greater, as a percent of premium, than in the less risky territories.

In broad terms, my approach involved the following steps:

(1) Determine appropriate measures of risk;

(2) Build a Monte Carlo simulation model to calculate the risk measures in each territory;

(3) Allocate statewide values proportional to risk.

I describe each of these steps briefly below.

Q. Before discussing these steps, you mentioned allocating costs to different territories in North Carolina, based on measures of relative risk. Was your analysis conducted at the level of the individual territories?

A. No. As in the filings for other property lines, I conducted the analysis at the zone level rather than at the level of the individual territory. I aggregated the territories into three distinct zones for purposes of allocating profit, contingencies and reinsurance costs. Zone 1 includes Territories 5, 6, 42 and 43, which are the beach and coastal areas. Zone 2 includes Territories 32, 34, 41, 44, 45, 46, 47 and 53, which is the central part of the state. Zone 3 includes Territories 36, 38, 39, 57 and 60, which is the western part of the state. These zones happen to coincide with the three territory groups used in this filing for determining the proposed rates.

Q. Can you please continue with your explanation of the various steps required to implement your allocation model?

A. Yes. As noted, there were three broad steps required to develop an allocation method.

(1) Determine Appropriate Measures of Risk: I selected three bases for measuring risk: standard deviation of losses, variance/covariance of losses, and probability of ruin. Each of these has merit, and support in the literature, as a measure of relative risk across the various zones within the state.

(2) Build a Simulation Model to Calculate Risk by Zone: Calculating risk by zone using the measures noted above involves estimating the distribution of annual aggregate losses by zone. To do this, I built a two part simulation model that separately estimates hurricane and non-hurricane losses. For the hurricane loss estimates, AIR ran its proprietary model, and provided estimated losses by the zones described above. For non-hurricane losses, I built a Monte Carlo simulation model to estimate the annual aggregate loss distribution across all non-hurricane perils. I then summed hurricane and non-hurricane losses from each

iteration to derive the distribution of total losses by zone. From this distribution, I was able to calculate the variance, covariance and standard deviation of losses, as well as the probability of ruin.

I should note that I applied this model separately to both the reinsurer and the primary insurer, for two distinct purposes. In the case of the reinsurer, my intention was to allocate the net cost of reinsurance – that is, the reinsurance expense cost and the cost of reinsurer capital – to zone proportional to the risk borne by the reinsurer. In the case of the primary insurer, my intention was to allocate the underwriting profit in the rates – that is, the primary insurer's compensation for risk – to zone, proportional to the residual risk retained by the primary insurer after considering the losses ceded to the reinsurer.

(3) Allocate Reinsurance Costs and Statewide Profit Proportional to Risk: For the standard deviation method of measuring risk, I calculated the standard deviation of losses in each zone, and then took the sum across all the zones as an estimate of the statewide total value. (The assumption that the statewide total standard deviation is the sum of the individual zone standard deviations implies that there is perfect correlation of losses across zones.) For the variance/covariance method, I calculated the variance of losses at the statewide level, as well as the covariance between the losses in each zone and the statewide total losses. (It can be shown mathematically that the variance of the statewide total losses is identical to the sum of the covariances between the losses in each zone and the statewide total.) Each zone was then allocated a share of the net cost of reinsurance and total profit based on its share of total risk. (These approaches were applied separately for the reinsurer, based on ceded losses, and for the primary insurer, based on net or retained losses). Under the probability of ruin method, I ranked total losses (hurricane plus non-hurricane) across all iterations from largest to smallest, and found the iteration in which actual losses were equal to the losses that would produce ruin (i.e., the level of losses that would just exceed the sum of premium net of expenses, investment income and surplus). I then determined the proportion of those losses attributable to each zone, and allocated reinsurance costs and profit according to those percentages.

As I mentioned earlier, it is important to emphasize that the departure point for the risk based allocation process is the total cost of reinsurance and required profit in the state as a whole. That is, only after these amounts are determined are they then allocated to zone. Thus, there is no additional profit or return resulting from our analysis, and the allocation is independent of the methodology used to determine the cost of reinsurance or the overall profit.

Q. Can you please describe the results of your analysis?

A. The details of the analysis are contained in Exhibit RB-16 attached to this testimony. This exhibit, comprised of three pages, shows the allocation of reinsurance costs and statewide profit to zones depending on the selected allocation method. (The total statewide profit and reinsurance cost are displayed in Exhibit RB-15, described above.)

The underwriting profit, cost of reinsurer capital and reinsurer expenses for each zone, based on the three methods just described, are summarized in the table below. As can be seen, those values are expressed in dollars, consistent with the fact that the net cost of reinsurance is included as a fixed dollar expense when making rates.

Summary: Reinsurance Costs and Profit by Zone

		Zone 1	*Zone 2*	*Zone 3*	*Sum*
Standard Deviation Method	Underwriting Profit and Contingencies	1,188,742	3,827,528	1,111,847	6,128,117
	Reinsurer Profit	1,471,683	4,827,336	1,248,501	7,547,520
	Reinsurer Expenses	449,486	1,258,259	210,193	1,917,938
	Total Profit plus Reinsurance Cost	**3,109,911**	**9,913,124**	**2,570,541**	**15,593,575**
Variance/ Covariance Method	Underwriting Profit and Contingencies	1,107,641	4,249,979	770,497	6,128,117
	Reinsurer Profit	1,454,786	5,252,047	840,687	7,547,520
	Reinsurer Expenses	449,486	1,258,259	210,193	1,917,938
	Total Profit plus Reinsurance Cost	**3,011,914**	**10,760,285**	**1,821,377**	**15,593,575**
Probability of Ruin Method	Underwriting Profit and Contingencies	1,107,817	3,819,982	1,200,318	6,128,117
	Reinsurer Profit	1,701,760	5,101,284	744,476	7,547,520
	Reinsurer Expenses	449,486	1,258,259	210,193	1,917,938
	Total Profit plus Reinsurance Cost	**3,259,064**	**10,179,525**	**2,154,987**	**15,593,575**
Average of 3 Methods	Underwriting Profit and Contingencies	1,134,734	3,965,830	1,027,554	6,128,117
	Reinsurer Profit	1,542,743	5,060,222	944,554	7,547,520
	Reinsurer Expenses	449,486	1,258,259	210,193	1,917,938
	Total Profit plus Reinsurance Cost	**3,126,963**	**10,284,311**	**2,182,302**	**15,593,575**

Because each of the aforementioned methods has support in the risk measurement literature, and the results under the various models are reasonably similar, I averaged the per zone total profit and reinsurance cost from the three methods. The final values used in the calculations were then selected by the Rate Bureau.

Q. Have you recommended regional profit differentials in any other lines of insurance when you have testified in North Carolina?

A. Yes, but only in homeowners and dwelling extended coverage, since the other lines of insurance subject to the jurisdiction of the Rate Bureau are not subject to such extreme regional variation in risk. In the case of mobile homeowners insurance, however, it is important for reasons of equity and economic efficiency to address this question forthrightly.

Q. Does your methodology result in a higher overall cost than would have been the case without the allocations?

A. No, it does not; the allocation method itself is simply a manner in which to spread the costs across policyholders consistent with risk. Thus, it does not impose any additional costs on North Carolina policyholders in the aggregate; rather it simply apportions the costs in a manner that is consistent with the risks different policyholders impose.

Q. In your opinion, is it appropriate to allocate statewide profit and reinsurance costs proportional to these measures of risk?

A. Yes. It is both intuitively and empirically obvious that the relative risk of mobile homeowners insurance varies geographically. As such, the cost for bearing that risk should be allocated proportional to the measurement of the risk. The three measures selected for this analysis have broad support in the actuarial and economic literature, and in my opinion are quite reasonable for the purpose to which they are put.

V. COMPENSATION FOR RISK OF ASSESSMENTS FROM BEACH/FAIR PLANS

Q. You said earlier that you also considered the risks faced by insurers in North Carolina associated with the exposures insured in the Beach/Fair Plans. Can you please explain this issue?

A. Yes. In addition to the risks attendant to the mobile homeowners insurance directly written by insurers in North Carolina, there is substantial additional risk to insurers attributable to the exposures insured in the Beach/Fair Plans.

The Beach/Fair Plans serve as the so-called “residual market” for residential property insurance in the state. Residual markets exist to provide access to insurance coverage for policyholders who cannot obtain such coverage from insurers in the voluntary market. In states which have significant exposure to catastrophes, property insurance residual markets often grow to represent a very sizable portion of the total insured risk in the exposed regions of the state. This has been the experience in North Carolina, where the exposure growth in the Beach Plan has been very high over the past decade.

The Beach/Fair Plans provide either wind only or full residential property insurance coverage to North Carolina policyholders. The Plans use the premium from those policies to fund the future losses and expenses attributable to the coverages they write (including the purchase of reinsurance, issuance of catastrophe bonds and the like). The Beach/Fair Plans can accumulate surplus and that surplus is available to pay losses in the event that the losses exceed collected premiums plus investment income. However, if their surplus is exhausted, then additional losses (up to a $1 billion limit for the Beach

Plan but unlimited for the Fair Plan) are passed through to all insurers in the state in the form of assessments based upon each insurer's total property writings in North Carolina. (Beyond the $1 billion limit, additional losses in the Beach Plan are passed through directly to policyholders statewide.) Even if an insurer does not write property insurance in North Carolina's beach and coastal areas, it is nevertheless subject to any assessment by the Beach/Fair Plans due to its writings in other areas of North Carolina.

This risk of assessment has increased dramatically due to the growth in the Beach Plan in recent years. This growth in the Beach Plan is attributable to numerous factors, including the expansion of the Beach Plan territory, the addition of homeowners coverage to the coverages available in the Beach Plan, the increase in the number and value of insured properties in the beach and coastal areas of North Carolina, and most importantly, the inadequacy of primary property insurance rates in the state.

This risk of assessment is real and substantial, and insurers must be compensated for this additional risk to their capital. To address this situation, I have developed a procedure to incorporate a provision in the rates that compensates insurers for this risk.

Q. Can you please explain the procedure you developed?

A. Yes. The model I developed for this purpose involves two steps; the first is to quantify the magnitude of the exposure itself, and the second is to determine the fair compensation to be paid to insurers for bearing that risk.

To quantify the magnitude of the exposure, it was necessary to estimate the expected value of the assessments on insurers that arise because of catastrophic losses in the Beach/Fair Plans. Since assessments on insurers arise only after the plans have exhausted other resources available to pay losses, I needed to determine both the probability of that occurring as well as the amount by which the losses exceeded those other resources. Therefore, I obtained information from the Beach and Fair Plans regarding the reinsurance program in place for the 2014 storm season, along with assumptions of each plan's accumulated surplus available for the season as well – i.e., the "other resources" that would be available to pay for hurricane losses during the 2014 storm season. I then obtained the AIR hurricane model runs used by the Beach/Fair Plans, and for each iteration of the AIR model, I determined the amount of losses that would be covered by reinsurance and the remaining losses that would have to be funded either from the plans' accumulated surplus, through assessments on property insurers in the state, or ultimately through assessments on North Carolina property insurance policyholders. I then subtracted the accumulated surplus of the plans from the losses remaining after reinsurance, limited the assessable losses due to Beach Plan exposures to $1 billion, and calculated the average assessment on property insurers across all iterations of the model (which is the expected value of the losses that would have to be funded through assessments on North Carolina property insurers).

As noted, this is a measure of the magnitude of the exposure – i.e., it represents the risk to insurers' capital associated with the exposure to Beach/Fair Plans assessments. The next step is to develop a method of measuring the fair compensation to insurers for bearing this risk.

Q. Can you please explain how you measured the compensation for bearing this risk?

A. Yes. To measure the fair compensation for bearing this risk, I relied on data regarding the market price of catastrophe risk, taken from the market for insurance linked securities. Insurance linked securities (ILS) are securities (bonds, warrants and the like) that have conditional payoffs that are virtually identical to reinsurance. Investors purchase such securities at significant yield premiums to risk free bonds, because they are exposed to loss of principal and interest if certain "insured events" occur.

Q. Can you explain how such securities work in practice?

A. Certainly. As an example, consider an insurer that issues $100 million of a bond with a provision that, for every dollar of loss from an Atlantic hurricane in excess of $1 billion, one dollar of the bond would not have to be repaid. Since the investor in that bond would effectively be paying for up to $100 million of hurricane losses, such a security would be the functional equivalent of a reinsurance contract that provides $100 million in coverage excess of a $1 billion attachment point.

Now, with respect to the interest to be paid by the insurer on this bond, assume investors demand a premium of 10% in excess of the risk free rate in order to purchase such a security (because of the high degree of risk associated with the potential loss of principal and interest). This risk premium implies that the insurer would have to pay $10 million in interest in excess of the risk free rate to induce investors to purchase such securities, which is equivalent to paying a premium of $10 million for $100 million of reinsurance. This kind of information can be very illuminating in connection with evaluating the risk premiums required to bear catastrophe risk.

Q. What kind of information is available in these markets that can help you to assess the fair compensation for bearing catastrophe risk?

A. Markets for ILS have been growing in recent years, as they provide a financially efficient method of transferring risk. While smaller than reinsurance markets, they can provide extremely useful data about the cost of risk, because they reflect estimates of the pure cost of risk transfer, unencumbered by insurance specific issues (such as expenses, capital requirements, required returns, regulation and the like).

Lane Financial, LLC is a firm that specializes in and is the most prominent analyst of insurance linked securities. In April of each year, Lane publishes a data base that accumulates a variety of useful information that can help to evaluate the fair compensation for bearing catastrophe risk. For each ILS in the market, Lane publishes the following data: the yield on the security; the excess return over LIBOR (the risk free rate); the probability that the security will suffer a loss; and the expected value (or average) loss anticipated on the security. These data provide the foundation for my analysis of the proper compensation for bearing the risk of Beach/Fair Plans assessments.

Q. How are these data used to determine the compensation for assessment risk?

A. Before describing the mechanics of the analysis, I first define several terms that will prove useful in this discussion. The "*yield spread*" is simply the difference between the yield on the particular ILS and LIBOR. (LIBOR, or the London Interbank Offered Rate, is one traditional measure of the risk free rate in finance.) For example, in the case I cited above (where a $100 million bond had a provision that, for every dollar of hurricane loss in excess of $1 billion, one dollar of the bond would not have to be repaid) investors demanded a premium of 10% in excess of the risk free rate. In that case, the yield spread was 10% (or 1000 basis points), which implies that the insurer would have to pay $10 million in interest in excess of the risk free rate to induce investors to purchase such securities.

Now assume that the expected distribution of hurricane losses is such that this security had an average annual loss of $1 million, meaning that, based on the probability and amount of hurricane losses of varying sizes, an investor would anticipate having an average loss of $1 million per year. This is termed the "*expected loss*." Since the investor in this example receives compensation of $10 million in excess of the risk free rate for bearing the risk of loss, the "expected profit" to the investor is $9 million (the yield in excess of the risk free rate minus the expected losses).

Finally, I define a term known as the "*profit multiple*," which is the ratio of expected profit to expected loss – in this case $9 million divided by $1 million, or a profit multiple of 9.0. The profit multiple provides an estimate of the compensation investors require to bear catastrophe risk, insofar as it tells us what returns investors require in order to take on the risk of loss from a catastrophic event. One particularly important feature of this variable is that it is a measure of compensation per dollar of expected loss; given the Beach/Fair Plans assessments to which insurers are exposed, the profit multiple can be used to develop an estimate of the fair compensation for bearing such risk. This is the measure of risk I rely upon in evaluating the fair compensation for property insurers whose capital is exposed to Beach/Fair Plans assessments.

Q. Before you explain exactly how you used this information, is it true that all ILS have yield spreads that are 10.0 times, or profit multiples that are 9.0 times, their expected loss?

A. No. This value fluctuates depending on the risk characteristics of the particular securities in question. In my example there was a bond with an attachment point of $1 billion and an expected loss of $1 million, but each of the securities traded in capital markets has different attachment points and amounts of coverage, and different probabilities and amounts of expected loss. As you would expect, those securities that have more volatile exposures have larger risk premiums relative to expected loss than those with less volatility.

Q. Generally speaking, which securities are more volatile, and hence have higher risk premiums and profit multiples?

A. For exposures such as these, securities that have "higher" attachment points – meaning those which have a lower probability of incurring a loss – have greater volatility and larger risk premiums. While it is true that such securities have a lower probability of incurring a loss, it is also the case that the variability of the losses on such securities is greater than those with a higher probability of incurring a loss (i.e., those that attach at lower points on the loss distribution). As a result, ILS's with very low probabilities of attachment will have the highest risk premiums and profit multiples.

Q. How do you use the data on ILS's to develop the fair compensation to insurers for bearing the risk of Beach/Fair Plans assessments?

A. First, to get a more precise estimate of the risk premia in capital markets, I compiled the data on profit multiples for all ILS's issued on U.S. catastrophe exposures in the last six years. However, as I mentioned earlier, each ILS has a different profit multiple based on its specific risk characteristics. Therefore, to determine the profit multiples that are appropriate for the risks imposed by the Beach/Fair Plans exposures, I fit a curve which relates the profit multiple on each bond to the probability of loss occurring on that bond. This curve permits the measurement of profit multiples at any probability level

Next, I obtained information from the Beach/Fair Plans on the distribution of hurricane losses, based on the AIR hurricane model runs using the most current exposures for the plans. For each iteration of the AIR model, I estimated the hurricane losses that would be ceded to reinsurers (using the actual reinsurance purchased by the Plans for the 2014 storm season) and the amount of those losses that would be retained by the Beach/Fair Plans. Based on this analysis I was able to determine the expected value of hurricane losses retained by the Beach/Fair Plans, as well as the distribution of those losses within the various probability layers.

Finally, to determine the fair compensation for bearing this risk, I determined the amount of losses that would exceed the Beach/Fair Plans' capacity, and thus would be assessed to voluntary insurers in the state. For each dollar of such assessments, I multiplied the expected loss by the appropriate profit multiple (given the probability interval in which the losses reside). The product of the expected losses by interval or layer and the appropriate profit multiple for the layer represents the fair compensation insurers should receive for bearing such risk.

Q. Have you developed any exhibits that provide the details of these calculations?

A. Yes. Exhibit RB-17 contains eight pages of information required to develop projections of the fair compensation for bearing Beach and Fair Plans assessment risk.

The first page of Exhibit RB-17 shows a summary of the Beach/Fair Plans reinsurance program for the 2014 storm season, including the various layers of reinsurance purchased and the coverage levels within those layers. Although the Beach and Fair Plan are separate legal entities they purchase their reinsurance together in the same contracts, and the contracts apply to the combined losses of all Beach Plan accounts and the Fair Plan.

Page 2 of Exhibit RB-17 shows the curve I fit to the ILS profit multiples based on all ILS issued in the last six years, and the equation of the fitted curve that is used to determine the profit multiples for each layer to which insurer capital is exposed.

Page 3 of Exhibit RB-17 displays the profit multiples calculated for each layer of the Plans' loss distribution, based on the equation on page 2. In order to determine the fair compensation to voluntary insurers for bearing the risk of assessments, I need to determine which layers contain losses that will be funded by such assessments, and the appropriate compensation per dollar of expected loss within those layers. The profit multiples are the appropriate compensation per dollar of expected loss in each layer.

Pages 4 and 6 of Exhibit RB-17 illustrate how potential losses for the Beach Plan Residential Account and Fair Plan are funded. (The Beach Plan determines losses and assesses voluntary insurers separately for each account, while the Fair Plan has only one account.) The Beach Plan can assess voluntary insurers a maximum of $1 billion for any deficits resulting from a single calendar year across all accounts, while the Fair Plan assessments are unlimited. Any amounts needed to pay claims in excess of the assessable amounts are to be collected through surcharges to property insurance policyholders statewide.

The mechanics of the funding analysis are as follows. First, for each iteration of the AIR model, losses are segregated into loss layers separately by account (Beach Plan Residential, Beach Plan Commercial, and Fair Plan). Then, the losses by layer for each account are disaggregated based on the source of funding for those losses - Beach/Fair Plan surplus, the next $1 billion of Beach Plan losses to be covered by assessments on voluntary insurers, private reinsurance and ultimately any additional amounts in the Beach Plan to be covered by surcharges on property policyholders' premiums. Finally, the losses associated with each event are then accumulated in these categories for each of the loss layers. (Although I apply the reinsurance contracts and the $1 billion limit to commercial losses, no expected commercial hurricane losses are included in my calculations of the fair compensation for exposure to assessments for residential lines of business.)

While pages 4 and 6 illustrate the funding of potential losses within each layer, the purpose of this analysis is to determine the fair compensation for the risk of assessments on private insurers. As such, the analysis must take into account the probability of losses occurring within each layer and calculate the expected value (or annual average) loss that will be borne by private insurers. Pages 5 and 7 of RB-17 provides that analysis; they show the expected value of the losses that would be covered by the Beach Plan Residential and Fair Plan accounts, and the annual average amount of those losses that would be assessed to private insurers. In addition, these pages display the profit multiples associated with each layer of the loss distribution, and the product of the indicated profit multiple times the expected losses within the layer. The sum of those values is the indicated compensation for assessment risk for each account. (For example, the total cost of providing reinsurance to the Beach Plan Residential Account is $101.2 million.)

The final step in this calculation is to determine the appropriate provision to be included in the rates to compensate insurers for the risk of Beach and Fair Plans assessments. This provision, expressed as a percent of premium, is developed on page 8 of Exhibit RB-17. (I note that these calculations reflect only the residential portion of the Plans' deficits.) Since assessments for Beach/Fair Plans losses are applied to all property insurance lines in the state, the bottom table on Exhibit RB-17, page 8 shows the development of a charge that will produce an amount of revenue equal to the total required compensation of $129.69 million. As shown therein, that charge amounts to 4.4% of total property insurance premium in the state.

Q. In your opinion, is it appropriate to include the 4.4% compensation for assessment risk provision in mobile homeowners insurance rates in North Carolina?

A. Yes, not only is it appropriate, it is necessary in order that mobile homeowners insurance rates are fair and reasonable to insurers. Since insurers are exposed to the risk of Beach/Fair Plans assessments as a result of writing voluntary market mobile homeowners insurance in the state, they are entitled to receive fair compensation for bearing that risk. The model I have developed relies on a well established and widely accepted measure of compensation to determine a provision that will fairly reward insurers for bearing this additional risk to their capital.

VI. PROJECTED RETURN ATTRIBUTABLE TO INSURANCE OPERATIONS

Q. Earlier you said that you had calculated the statutory return insurers would expect from underwriting mobile homeowners insurance in North Carolina. Have you conducted such an analysis?

A. Yes, I have. I developed a model using traditional insurance profitability analyses and have calculated the statutory returns on equity that would be expected to arise assuming that actual underwriting and investment results materialize exactly as projected in this filing. The results are contained in Exhibit RB-14 filed with this testimony.

Q. What do you mean when you use the term pro forma in that exhibit in connection with rate of return?

A. I use this term to indicate that the rate of return presented in the exhibit is based on a series of assumptions regarding such inputs as underwriting profit, investment gain, leverage and the like. If these assumptions actually materialize, then the "pro forma" rates of return calculated in the exhibit will prevail. However, to the extent that these assumptions are not realized, the rate of return will differ from that calculated in the exhibit.

Q. Can you please now describe the components of the model you developed?

A. Yes. The model really consists of a single page that calculates the rate of return on equity attributable to undertaking the insurance activity. It sets forth estimates of income derived from underwriting, installment fees and investment of reserves and estimates of costs, comprised of losses, expenses and taxes. This exhibit is supported by several other exhibits which provide calculations of investment yield rates, tax rates, premium to surplus and net worth to surplus ratios, and installment fee income.

Q. Can you please describe the principal elements of the rate of return analysis?

A. Yes.

1. Underwriting profit is the difference between earned premiums and projected incurred losses and expenses. This provision was selected by the appropriate committees of the Rate Bureau.

2. Installment fee income is projected based on historical installment revenues over the past five years.

3. Taxes are calculated assuming that the regular corporate tax rate applies to statutory underwriting (plus installment fee) income, and that an additional tax liability applies due to the reserve discounting and revenue offset provisions that are applicable to property casualty insurers. Taxes on investment income are calculated assuming that the current statutory tax rates apply to the various classes of investment income earned.

4. Investment gain on the insurance transaction is estimated as the product of an investment yield rate and the investible funds available from loss, loss adjustment expense and unearned premium reserves (i.e., policyholder supplied funds). The investment yield rate is derived as the average of the "embedded yield" and the "current yield," based on the actual portfolios of securities held by insurers. This estimated yield rate includes income from interest, dividends, real estate, and other assets, as well as realized capital gains. The investible funds in this calculation are estimated using the well known ISO State-X model, with one modification as described below.

Q. In previous testimony in North Carolina, you identified certain changes you made to the traditional rate of return analysis that is performed using this model. Did you continue these changes for this year's filing?

A. Yes. I removed the reduction of investible funds by the amount of agents' balances from the ISO State-X calculation. However, it continues to be true that the funds represented by agents' balances are not available for investment by insurers. Therefore, in the rate of return calculation, the investment income from this modified State-X calculation is reduced by the investment income attributable to agents' balances. This calculation recognizes (1) that the majority of agents' balances represents premiums not yet paid by insureds because of installment payment plans, and hence is unavailable for investment and (2) that, for the small minority of agents' balances that is premiums collected by agents but not yet remitted to the companies, the investment income on that premium is additional compensation to the agents and a cost to the companies as part of the insurance transaction.

In addition, I adjusted the trended loss, LAE and fixed expense ratios to reflect the proposed rate change. That is to say, I have divided the trended loss and expense ratios at present rates by one plus the proposed rate change to reflect the change in these ratios that occur when rates are changed.

Q. Could you please clarify how the underwriting profit provision contained in the rate filing was determined?

A. Yes. The issue of how the Rate Bureau determines the underwriting profit and contingency factor has routinely arisen in rate hearings in North Carolina over the past several years. Although it is evident from my exhibits that the Rate Bureau selects an underwriting profit and contingency provision to be included in the rates, there has been lengthy cross examination on this issue in a number of rate hearings. Therefore, to clarify this matter, I will briefly discuss the procedure used by the Rate Bureau to determine the underwriting profit and contingency factor that is included in the proposed rates.

As part of the process of preparing a property insurance rate filing, the Property Rating Subcommittee of the Rate Bureau meets to review data and determine values for a number of the important components of the proposed rates. One of these components is the underwriting profit factor. To determine this value, a procedure is followed in which I provide the committee with the estimated returns on equity (both statutory returns as well as returns adjusted to include investment income on surplus) associated with alternative underwriting profit provisions, and the committee then selects a provision after considering the cost of capital that has been developed by Prof. Vander Weide. Thus, the process is best described as one in which I test alternative underwriting profit provisions, and the committee selects a value based on these tests.

Q. How do you know what values of the underwriting profit provision to test?

A. I have been performing this type of analysis on behalf of the Rate Bureau for many years, and I am quite familiar with the dynamics of these models. Therefore, it is relatively easy to know the general range of values around which the underwriting profit is likely to fall. Normally, I will select approximately five or six values of the underwriting profit provision to test, that comprise a range of perhaps two to three percentage points, and the committee typically selects a value within that range. (For example, for this filing, I tested underwriting profit provisions for mobile homeowners in one half percentage point increments ranging from 8.0% to 12.0%, and the committee selected a value of 9.0%.) Of course, if the committee is not satisfied with the range of values I propose, I provide the returns associated with alternative values proposed by the committee.

Q. From what you've said, it appears that the Rate Bureau *selects* an underwriting profit provision, rather than *deriving* such a provision from the cost of capital. Is that correct?

A. It is correct that the Rate Bureau committee selects an underwriting profit provision and then tests whether that provision results in an expected rate of return on net worth that is consistent with the cost of capital. This manner of developing an underwriting profit provision is addressed explicitly in Actuarial Standard Of Practice (ASOP) #30, entitled "Treatment of Underwriting Profit and Contingency Factors and the Cost of Capital in Property/Casualty Insurance Ratemaking." Section 3.1 of that ASOP states the following:

> <u>Estimating the Cost of Capital and the Underwriting Profit Provision</u> – Property/casualty insurance rates should provide for all expected costs, including an appropriate cost of capital associated with the specific risk transfer. This cost of capital can be provided for by estimating that cost and translating it into an underwriting profit provision, after taking leverage and investment income into account. Alternatively, the actuary may develop an underwriting profit provision and test that profit provision for consistency with the cost of capital. The actuary may use any appropriate method, as long as such method is consistent with the considerations in this standard.

The procedure utilized by the Rate Bureau is exactly the approach articulated in this section (i.e., "the actuary may develop an underwriting profit provision and test that profit provision for consistency with the cost of capital").

Q. Could you please clarify how you selected your investment yield rate and premium to surplus ratio?

A. Yes. To select the investment yield rate, I was asked by the Rate Bureau to compute the average of what are known as the "embedded" and "current" yields, where each was based on the actual asset portfolios insurers currently hold. There has been a long-standing debate regarding the choice between embedded and current yields in insurance profitability calculations. Since the Commissioner himself adopted an approach of averaging the embedded and current yields in his 1994 automobile decision (and in his decision in the 1996 case, he selected a yield which approximated the yield obtained from this approach), the Rate Bureau has chosen to follow that methodology since that time.

To estimate the embedded yield, I calculated the ratio of investment income divided by average invested assets and added to that an estimate of the ten year average ratio of realized capital gains to invested assets. The sum of these two is the estimated embedded yield.

To estimate the current yield, I determined the yields available in today's capital markets for the portfolio of securities currently held by the property-casualty insurance industry. I then calculated a weighted average of these yield rates based on the proportion of assets held by the industry in each of the various securities such as stocks, bonds, real estate and the like.

As far as the premium to surplus ratio is concerned, I also relied on information which reflects the actual degree of leverage for insurers writing mobile homeowners insurance in North Carolina. The premium to surplus ratio I used is the average premium to surplus ratio for all groups which wrote mobile homeowners insurance in North Carolina in the years between 2007 and 2012.

Q. Can you please provide the results of your calculations regarding the projected rate of return to the insurance transaction if your underlying assumptions are realized?

A. Yes. I estimate that insurers in North Carolina should expect to earn statutory returns on net worth of 7.4% for mobile homeowners insurance in the state. In addition, the total return on net worth (i.e., including investment income on surplus) is 10.2%. While the statutory return is below the lower bound of Dr. Vander Weide's range for the cost of capital, the total return falls within (albeit towards the lower end of) that range.

VII. CONCLUSION

Q. Based on the studies and analyses you have performed, have you come to any conclusions regarding the underwriting profit provision, net cost of reinsurance provision and compensation for assessment risk provision that have been filed by the Rate Bureau as part of the filing in this case?

A. Yes. Based on my evaluation of Dr. Vander Weide's cost of capital estimates, my consideration of insurer specific risk characteristics, and my estimation of projected and expected returns, I believe that the filed underwriting profit provision complies with North Carolina law and that the return expected to be realized by insurers will not be excessive. In addition, based on my analyses of the cost of reinsurance and the required compensation for the risk of Beach/Fair Plan assessments, I believe that my specific estimates of the net cost of reinsurance and the required compensation for assessment risk are both reasonable and not excessive. Finally, assuming that the actuarial estimates in the filing are reasonable, it is my opinion that including the filed underwriting profit provision, net cost of reinsurance provision, and compensation for assessment risk provision will produce rates that are just, reasonable and not excessive, inadequate or unfairly discriminatory.

Q. Does this conclude your testimony?

A. Yes, it does.

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DAVID APPEL

One Pennsylvania Plaza
New York, NY 10119
(646) 473-3000

PROFESSIONAL EXPERIENCE:

1989 to present	**MILLIMAN, INC.** Principal & Director - Economics Consulting Responsible for the formation, development and management of a national consulting practice in insurance economics.
1980 to 1989	**NATIONAL COUNCIL ON COMPENSATION INSURANCE** Economic and Social Research Division
1985 to 1989	Vice President
1983	Assistant Vice President Responsible for all economic and social research of NCCI
1982	Director of Economic and Social Research
1981	Senior Research Economist
1980	Associate Research Economist
1976 to 1997	**RUTGERS UNIVERSITY**
1981-97	Associate of the Graduate Faculty, Department of Economics, Newark, New Jersey
1981-93	Teach variety of graduate courses including: Microeconomic Theory, Industrial Organization, Public Finance
1978-80	Instructor, Department of Economics, New Brunswick, New Jersey
1976-78	Adjunct Instructor, Department of Economics, Newark, New Jersey

EDUCATION:

1980	Ph.D., Economics, Rutgers University
1976	M.A., Economics, Rutgers University
1972	B.A., Economics, Brooklyn College, CUNY Certified ARIAS Arbitrator and Umpire Member: AAA Panel of Neutrals Fellow: National Academy of Social Insurance

PAPERS AND PUBLICATIONS

"Comment on Jaffee and Russell" in Deregulating Property-Liability Insurance, J. David Cummins, Editor, Brookings Institution Press, Washington, DC, 2002

"Dynamic Financial Analysis of a Workers Compensation Insurer", CAS Call Papers Program, 1997 (with Susan Witcraft and Mark Mulvaney)

"The Impact of Managed Care on Workers Compensation Claim Costs," in a volume of conference proceedings published by the Workers' Compensation Research Institute, September 1994, (with Philip Borba).

"Health Care Costs in Workers' Compensation", Benefits Quarterly, Vol. 9, No. 4, Fourth Quarter, 1993

"The Transition From Temporary to Permanent Disability: A Longitudinal Analysis" in Workers' Compensation Insurance: Claims Costs, Prices and Regulation, David Durbin and Philip Borba, Editors, Kluwer Academic Publishers, Boston, 1992, (with Richard Butler, David Durbin and John Worrall)

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"Benefit Increases in Workers' Compensation", Southern Economics Journal, January 1990, (with Richard J. Butler)

"Internal Rate of Return Criteria in Ratemaking", NCCI Digest, Vol. IV, Issue III, September 1990, (with Richard J. Butler).

"Social Inflation in Workers' Compensation: The Phenomenon of Benefit Utilization", Proceedings of the Casualty Loss Reserve Seminar, 1988. Also in Contingencies, Nov./Dec., 1989.

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"1986 Tax Reform Act: Effects on Workers' Compensation Profitability", NCCI Digest, Vol. II, Issue II, July 1987 (with James Gerofsky)

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"Sex, Marital Status, and Medical Utilization by Injured Workers'", Journal of Risk and Insurance, Vol. LIV, No. 1, March 1987, (with John Worrall and Richard Butler)

"The Impact of Workers' Compensation Benefits on Low Back Claims" in Clinical Concepts in Regional Musculoskeletal Illness, Nortin M. Hadler, ed. (Boston: 1986, Grune and Stratton), (with John Worrall)

"Workers' Compensation and Employment: An Industry Analysis" in Disability and the Labor Market: Economic Problems, Policies and Programs, M. Anne Hill and Monroe Berkowitz, eds., (Ithaca:1986 ILR Press), (with James Lambrinos)

"Some Benefit Issues in Workers' Compensation", in Workers' Compensation Benefits: Adequacy, Equity, Efficiency. (Ithaca:1985 ILR Press), (with John Worrall)

Workers' Compensation Benefits: Adequacy, Equity, Efficiency. (co-editor with John Worrall), (Ithaca:1985 ILR Press)

"Survivorship and the Size Distribution of the Property-Liability Insurance Industry", Journal of Risk and Insurance, October 1985, (with John Worrall and Richard Butler).

"Regulating Competition-The Case of Workers' Compensation Insurance", Journal of Insurance Regulation, (with James Gerofsky), June 1985.

"The Wage Replacement Rate and Benefit Utilization in Workers" Compensation Insurance", Journal of Risk and Insurance, September 1982 (with John Worrall)

"Property Damages", in Joseph Seneca and Peter Asch, The Benefits of Air Pollution Control in New Jersey, Center for Coastal and Environmental Studies, Rutgers University, 1979

WORKING PAPERS

"Workers' Compensation Pricing: The Role of Policyholder Dividends" (with David Durbin)

"The Impact of Lifetime Work on Mortality: Do Unisex Pensions Matter?" (with Richard J. Butler)

"Regulatory Survival: Rate Changes in Workers' Compensation" (with Richard J. Butler and John D. Worrall)

"Framing, Firm Size and Financial Incentives in Workers' Compensation Insurance" (with Richard J. Butler and John D. Worrall)

"Application of NAIC Profitability Models to Long Tailed Lines of Insurance" (with James Gerofsky)

INVITED PRESENTATIONS

Huntington Beach, California, March 11, 2013
CAS RPM Seminar
"Risk Loads for Property Catastrophe Covers: Primary and Reinsurer Perspectives"

Huntington Beach, California, March 11, 2013
CAS RPM Seminar
"The Actuary as Expert Witness"

Philadelphia, Pennsylvania, March 20, 2012
CAS Ratemaking Seminar
"How Reinsurers Consider Risk Loads and Cost of Capital for Property Cat Covers"

Chicago, IL , March 17, 2010
CAS Ratemaking Seminar
"Logic, Fallacies and Paradoxes in Risk/Profit Loading in Ratemaking: A Socratic Dialogue"

Chicago, IL , March 16, 2010
CAS Ratemaking Seminar
"Quantifying Risk Loads for Property Catastrophe Exposure"

Las Vegas, NV, March 10, 2009
CAS Ratemaking Seminar
"Using Catastrophe Bonds to Infer Risk Loads/Profit Margins/Reinsurance Costs"

Boston, MA, March 17, 2008
CAS Ratemaking Seminar
"Using Catastrophe Bonds to Infer Risk Loads/Profit Margins/Reinsurance Costs"

Pinehurst, North Carolina, May 21, 2007
Workers Compensation Insurance Organizations Annual Meeting
"Enterprise Risk Management: What Is It and Why Is It Important?"

Salt Lake City, Utah, March 13, 2006
CAS Ratemaking Seminar
"Including Reinsurance Costs in Primary Insurance Rates"

New Orleans, Louisiana, March 11, 2005
CAS Ratemaking Seminar
"Including Reinsurance Costs in Primary Insurance Rates"

Philadelphia, Pennsylvania, March 11, 2004
CAS Ratemaking Seminar
"The Consideration of Risk Loads and Reinsurance Costs in Primary Insurance Ratemaking"

New York, New York, December 12, 2003
Goldman Sachs Insurance Conference
"Interest Rate Changes and Insurance Underwriting"

San Antonio, Texas, March 28, 2003
CAS Ratemaking Seminar
"The Consideration of Risk Loads and Reinsurance Costs in Primary Insurance Ratemaking"

San Antonio, Texas, March 27, 2003
CAS Ratemaking Seminar
"Rate of Return Models in Insurance Ratemaking"

San Diego, California, May 20, 2002
CAS Annual Meeting
“The Actuary as an Expert Witness”

Tampa, Florida, March 7, 2002
CAS Ratemaking Seminar
"Parameterizing Rate of Return Models in Insurance Ratemaking"

Chicago, Illinois, December 10, 2001
NAIC Meeting
“The Impact of Proposition 103 in California”

Kansas City, Missouri, April 30, 2001
NAIC Meeting
“Personal Lines Regulation”

Las Vegas, Nevada, March 12, 2001
CAS Ratemaking Seminar
"Parameterizing Rate of Return Models in Insurance Ratemaking"

Washington DC, January 18, 2001
Brookings Institution Conference on Insurance Regulation
“Auto Insurance Experience in California”

Bermuda, September 14, 2000
Ace Insurance Worldwide Actuarial Conference
“Rate of Return Models In Property Casualty Insurance Ratemaking”

Orlando, Florida, June 9, 1998
Florida Managed Care Institute Annual Conference
"Issues in Integrated Health Care"

Seattle, Washington, July 21, 1997
CAS Dynamic Financial Analysis Seminar
"Dynamic Financial Analysis of a Workers Compensation Insurer"

Boston, Massachusetts, March 14, 1997
CAS Ratemaking Seminar
"Discounted Cash Flow Models in Insurance Ratemaking"

East Lansing, Michigan, July 15, 1996
National Symposium on Workers Compensation
"Managed Care in Workers Compensation"

New Orleans, Louisiana, March 20, 1996
Global Business Research Seminar: Partnerships Between Insurers and Providers
"Integrating the Data Systems"

Orlando, Florida, November 15, 1995
Global Business Research Seminar: Documenting Savings From Managed Care
"Evaluating Savings From Managed Care"

Orlando, Florida, October 27, 1995
Self Insurance Association of America Annual Meeting
"Managed Care in Workers Compensation: A Magic Act or Humbug?"

San Diego, California, October 16, 1995
Global Business Research Seminar: Documenting Savings From Managed Care
"Technical Issues in Measuring Savings From Managed Care"

Durham, North Carolina, September 6, 1995
North Carolina HMO Association Annual Meeting
"Workers Compensation in North Carolina: Risks and Opportunities for HMO's"

Washington, DC, May 22, 1995
Global Business Research Seminar: Outcomes for Workers' Compensation Managed Care
"Measuring and Reporting the Savings"

Orlando, Florida, April 13, 1995
NCCI Annual Meeting
"Managed Care in Workers Compensation"

Phoenix, Arizona, April 3, 1995
Casualty Actuarial Society Seminar on Profitability
"Rate of Return Models - Selecting the Parameters"

New Orleans, Louisiana, March 16, 1995
Casualty Actuarial Society Ratemaking Seminar
"Discounted Cash Flow Models for Insurance Ratemaking"

Orlando, Florida, March 14, 1995
Standard & Poor's Rating Conference
"Consolidation in the Property/Casualty Insurance Industry"

Minneapolis, Minnesota, October 11, 1994
Casualty Actuarial Society Seminar on Medical Cost Containment
"Managed Care and Workers' Compensation"

Toronto, Ontario, August 22, 1994
American Risk and Insurance Association Annual Meeting
"Current Issues in Workers' Compensation"

Boston, Massachusetts, May 17, 1994
Casualty Actuarial Society Annual Meeting
"Standard Of Practice on Profit and Contingency"

Hartford, Connecticut, April 20, 1994
University of Connecticut Blue Cross/Blue Shield Symposium
"24 Hour Coverage - What Will It Involve"

Atlanta, Georgia, March 10, 1994
Casualty Actuarial Society Ratemaking Seminar
"Cash Flow Models for Insurance Ratemaking"

Cambridge, Massachusetts, March 2, 1994
Workers' Compensation Research Institute Health Care Reform Conference
"Early Results of the Florida Pilot Project"

Phoenix, Arizona, November 15, 1993
Casualty Actuarial Society Annual Meeting
"The Use Of Managed Care in Workers' Compensation"

New York, New York, October 20, 1993
Insurance Information Institute/Reinsurance Association of America Research Conference
The Impact of Health Care Reform on Casualty Insurance"

Somerset, New Jersey, July 13, 1993
National Symposium on Workers' Compensation
"Economic Analysis of Workers' Compensation Issues"

Boston, Massachusetts, June 30, 1993
Institute of Actuaries of Japan Special Meeting
"Health Care Costs in Workers' Compensation"

Dallas, Texas, June 15, 1993
Stirling-Cooke Workers' Compensation Seminar
"Workers' Compensation Medical Costs: Trends, Causes and Solutions"

New York, New York, June 3, 1993
New York Business Group On Health
"The Crisis in Workers' Compensation Health Care"

Mauna Lani Bay, Hawaii, May 3, 1993
Western Association of Insurance Brokers Annual Meeting
"Trends in Insurance Insolvency"

Kingston, Ontario, April 28, 1993
Queen's University Workers' Compensation Conference
"Exposure Bases for Workers' Compensation: Equity vs. Practicality"

Sanibel Island, Florida, March 29, 1993
Workers' Compensation Reinsurance Bureau Annual Meeting
"The Use of Managed Care in Workers' Compensation"

Baltimore, Maryland, March 23, 1993
CAMAR Annual Meeting
"Estimating the Cost of Capital in Insurance Ratemaking"

Philadelphia, Pennsylvania, December 1, 1992
Economic Issues in Workers' Compensation Seminar,
"Rate of Return Regulation in Workers' Compensation"

Seattle, Washington, October 16, 1992
Casualty Actuarial Society Seminar on Profitability
"Risk Based Capital Standards for Property Casualty Insurers"

Washington, DC, August 18, 1992
American Risk and Insurance Association Annual Meeting
"The Crisis in Workers' Compensation"

New York, New York, May 19, 1992
Executive Enterprises Institute Seminar: Winning Approval of Rate and Form Filings
"Determining a Fair Rate of Return for Property/Casualty Insurers"

Palm Beach, Florida, April 23, 1992
NCCI Annual Meeting
"Is the Workers' Compensation Industry Competitive?"

Philadelphia, Pennsylvania, March 20, 1992
University of Pennsylvania/Duncanson & Holt Special Seminar
"Current Issues in Workers' Compensation"

Dallas, Texas, March 12, 1992
Casualty Actuarial Society Ratemaking Seminar
"Profitability Models in Insurance Ratemaking: Estimating the Parameters"

Houston, Texas, December 11, 1991
NCCI/NAIC Commissioners Symposium
"Rate Adequacy: Solvency and Safety Implications"

New York, New York, November 17, 1991
Executive Enterprises Institute Seminar: Winning Approval of Rate and Form Filings
"Determining a Fair Rate of Return for Property/Casualty Insurers"

Philadelphia, Pennsylvania, November 12, 1991
Casualty Actuarial Society Annual Meeting
"The Impact of Medical Costs on Casualty Coverages"

New York, New York, May 17, 1991
Executive Enterprises Institute Seminar: Winning Approval of Rate and Form Filings
"Determining a Fair Rate of Return for Property/Casualty Insurers"

Kiawah Island, South Carolina, April 15 & 16, 1991
Casualty Actuarial Society Seminar on Profitability
"Cost of Capital Estimation: Lessons From Public Utilities"

Chicago, Illinois, March 14, 1991
Casualty Actuarial Society Ratemaking Seminar
"The Use of Profitability Models in Insurance Ratemaking"

Orlando, Florida, October 24, 1990,
Financial Management Association Annual Meeting,
"Current Issues in Insurance Rate Regulation: California Prop. 103 and Pennsylvania Act 6"

New Brunswick, New Jersey, May 18, 1990,
Joint Conference on Workers' Compensation,
"Current State Issues and Benefit Reforms"

Orlando, Florida, May 8, 1990,
National Association of Insurance Commissioners Southeast Zone Raters Conference,
"Loss Cost Rating for Workers' Compensation"

Orlando, Florida, April 3, 1990,
Workers' Compensation Reinsurance Bureau Annual Meeting,
"Medical Costs in Workers' Compensation: Recent Trends in Cost Containment"

Philadelphia, Pennsylvania, March 15, 1990,
CAS Ratemaking Seminar,
"Rate of Return Models in Insurance Regulation: Return on Sales vs. Return on Equity"

Chicago, Illinois, November 10, 1989,
Alliance of American Insurers Research Committee,
"Recent Developments in Rate Regulation: California Proposition 103"

New York, New York, October 5, 1989,
NCCI Legal Trends Seminar,
"Medical Cost Containment in Workers' Compensation"

Philadelphia, Pennsylvania, September 7, 1989,
Workers' Compensation Congress,
"Medical Cost Containment in Workers' Compensation"

Denver, Colorado, August 21, 1989,
American Risk and Insurance Association Annual Meeting,
"Regulatory Survival: Rate Changes in Workers' Compensation" (with Richard J. Butler)

Hilton Head, South Carolina, April 4,1989,
Workers' Compensation Reinsurance Bureau Annual Meeting,
"Prospects for Workers' Compensation in the 1990's"

Mountain Lakes, New Jersey, March 29, 1989,
St. Clares-Riverside Medical Center,
"Stress in the Workplace"

Dallas, Texas, March 16, 1989,
Casualty Actuarial Society Ratemaking Seminar,
"The Impact of Tax Reform on Insurance Profitability"

New Orleans, Louisiana, December 15, 1988,
NAIC-NCCI Commissioners School,
"A Forecast for Workers' Compensation"

Philadelphia, Pennsylvania, November 17,1988,
Economic Issues in Workers' Compensation Seminar,
"The Impact of Regulation on the Probability of Insolvency" (with John D. Worrall and David Durbin)

Boston, Massachusetts, November 14, 1988,
American Public Health Association Annual Meeting,
"Stress in the Workplace"

Atlanta, Georgia, September 14, 1988,
Casualty Loss Reserve Seminar,
"Estimating the Cost of Social Inflation in Workers' Compensation"

Reno, Nevada, August 15, 1988,
American Risk and Insurance Association Annual Meeting,
"Benefit Increases in Workers' Compensation"

New York, New York, June 13, 1988,
National Association Of Insurance Commissioners Annual Meeting,
"Alternative Rate of Return Models for Insurance Regulation"

Syracuse, New York, May 5, 1988,
Current Issues in Workers' Compensation Symposium,
"Workers' Compensation Stress Claims"

Hilton Head, South Carolina, April 22, 1988,
Workers' Compensation Reinsurance Bureau Annual Meeting,
"A Forecast for Workers' Compensation Insurers"

Absecon, New Jersey, April 19, 1988,
Pennsylvania Coal Mine Rating Bureau Annual Meeting,
"The Use of Rate of Return Models in Insurance Rate Regulation"

Philadelphia, Pennsylvania, November 17, 1987,
Economic Issues in Workers' Compensation Seminar,
"The Transition to Permanent Disability Status" (with John D. Worrall and David Durbin)

Charlotte, North Carolina, October 20, 1987,
American Insurance Association Government Affairs Conference,
"Prospects for Workers' Compensation in 1988"

Minneapolis, Minnesota, September 29, 1987,
Minnesota Workers' Compensation Reinsurance Association Annual Meeting,
"Economic and Demographic Characteristics of Workers' Compensation Claims"

Airlie, Virginia, July 7, 1987,
National Symposium on Workers' Compensation,
"Forecasting Workers' Compensation Experience"

Santa Clara, California, June 30, 1987,
Symposium on Recent Advances in Ratemaking,
"Econometric Models of Workers' Compensation Losses"

Storrs, Connecticut, May 1, 1987,
University of Connecticut Symposium on Current Issues in Workers' Compensation,
"Current Research in Workers' Compensation"

Philadelphia, Pennsylvania, April 16, 1987,
Wharton School Graduate Seminar Series,
"Impact of Tax Reform on Workers' Compensation Profitability"

Boca Raton, Florida, December 4, 1986,
National Association of Insurance Commissioners/NCCI Commissioners School,
Panel Discussion on Current Issues in Workers' Compensation

Philadelphia, Pennsylvania, November 7, 1985,
Wharton School, University of Pennsylvania, Graduate Seminar Series,
"Litigation in Workers' Compensation"

Vancouver, British Columbia, August 19, 1985,
American Risk and Insurance Association Annual Meeting,
"Earnings Loss and Permanent Disability"

Washington, D.C., April 23, 1985,
Washington Conference on the Economics of Disability,
"Employment Effects of Workers' Compensation Insurance"

Schenectady, New York, January 18, 1985,
Union University Graduate Business Seminar Series,
"The Use of Modern Portfolio Theory in Insurance Regulation"

EXPERT TESTIMONY

Raleigh, North Carolina, October 27, 2014
Homeowners Insurance Rate Hearing

Tallahassee, Florida, October 14, 2014
NCCI Workers Compensation Insurance Rate Hearing

New York, NY, June 24, 2014
Omar Tigbao and Dorothy Tigbao, *et. al.*,v. QBE Financial Institutions Risk Services, Deposition

New York, NY, March 7, 2014
Thrift Development Corporation v. American International Group, et. al., Deposition

New York, New York, January 28, 2014
Cheryl Hall, *et. al.* v. Bank of America, N.A., *et. al.*, Deposition

Santa Fe, New Mexico, November 7, 2013
Biennial Title Insurance Rate Hearing

Tallahassee, Florida, October 1, 2013
NCCI Workers Compensation Insurance Rate Hearing

New York, New York, July 10, 2013
Larry Arnett and Ronda Arnett, *et. al.* v. Bank of America, N.A., *et. al.*, Deposition

Austin, Texas, April 25, 2013
State Farm Lloyds Homeowners Rate Hearing

Tallahassee, Florida, October 4, 2012
NCCI Workers Compensation Insurance Rate Hearing

Boston, Massachusetts, May 14, 2012
Massachusetts Workers Compensation Rate Hearing

New York, New York, February 17, 2012
Temporary Services, Inc. *et. al.* v. American International Group, *et. al.*, Deposition

San Francisco, California, January 19, 2012
Mercury Insurance Company Homeowners Insurance Rate Hearing

Santa Fe, New Mexico, November 16, 2011
Biennial Title Insurance Rate Hearing

Tallahassee, Florida, October 11, 2011
NCCI Workers Compensation Insurance Rate Hearing

Tampa, Florida, September 13, 2011
Citizens Property Insurance Corporation Homeowners Insurance Hearing

Raleigh, North Carolina, July 25, 2011
Dwelling Fire and Extended Coverage Insurance Rate Hearing

Tallahassee, Florida, October 6, 2010
NCCI Workers Compensation Insurance Rate Hearing

Irvine, CA, April 21, 2010
Eastwood Insurance Services, Inc. *et. al*., vs. Titan Auto Insurance of NM, *et. al.* Deposition

San Francisco, California, March 9, 2010
Century National Insurance Company Proposition 103 Rollback Hearing

Santa Fe, New Mexico, November 18, 2009
Annual Title Insurance Rate Hearing

Tallahassee, Florida, October 29, 2009
NCCI Workers Compensation Insurance Rate Hearing

Austin, Texas, September 14, 2009
Biennial Title Insurance Rate Hearing

Austin, Texas, April 1, 2009
State Farm Lloyds Homeowners Rate Hearing

Santa Fe, New Mexico, November 19, 2008
Annual Title Insurance Rate Hearing

New York, New York, November 13, 2008
Georgia Hensley, *et. al*., vs. Computer Sciences Corp. *et. al*., Deposition

Tallahassee, Florida, October 29, 2008
State Farm Florida Homeowners Insurance Hearing

Raleigh, North Carolina, July 1, 2008
Auto Insurance Rate Hearing

San Francisco, California, May 5, 2008
GeoVera Insurance Company Earthquake Rate Hearing

Tallahassee, Florida, January 23, 2008
Hartford Insurance Group Homeowners Insurance Rate Hearing

Boston, Massachusetts, January 9, 2008
Commerce Insurance Group Auto Insurance Rate Hearing

San Francisco, California, November 29, 2007
Explorer Insurance Company Automobile Rate Hearing

Santa Fe, New Mexico, November 19, 2007
Annual Title Insurance Rate Hearing

Reno, Nevada, June 14, 2007
Public Hearing Regarding Merger Between UnitedHealth Group and Sierra Health Systems

Austin, Texas, May 31, 2007
State Farm Lloyds Homeowners Rate Hearing

Reno, Nevada, October 26, 2006
Public Hearing Regarding Demutualization of Employers Insurance Group

San Francisco, California, August 30, 2006
Hearing on Proposed Title Insurance Rate Regulations

Austin, Texas, August 14, 2006
Biennial Title Insurance Rate Hearing

Raleigh, North Carolina, September 28, 2005
Auto Insurance Rate Hearing

Providence, Rhode Island, September 27, 2005
Norcal Medical Malpractice Insurance Rate Hearing

San Francisco, California, August 23, 2005
Safeco Insurance Company Earthquake Rate Hearing

Boston, Massachusetts, April 15, 2005
Massachusetts Workers Compensation Rate Hearing

Lawrence, Massachusetts, February 14, 2005
Highground, Inc. v. Mazonson

New York, NY, January 21, 2005
NFHA v. Prudential Deposition

Austin, Texas, July 13, 2004
Medical Protective Insurance Company Medical Malpractice Insurance Rate Hearing

Austin, Texas, December 16, 2003
Biennial Title Insurance Rate Hearing

Providence, Rhode Island, November 17, 2003
Norcal Medical Malpractice Insurance Rate Hearing

San Francisco, California, September 16, 2003
Century National Proposition 103 Rollback Hearing

Austin, Texas, September 11, 2003
Farmers Insurance Exchange Homeowner Rate Rollback Hearing

Austin, Texas, September 2, 2003
State Farm Lloyds Homeowners Rate Rollback Hearing

Austin, Texas, May 21, 2003
Farmers Insurance Group Settlement Hearing

Boston, Massachusetts, April 29, 2003
Massachusetts Workers Compensation Rate Hearing

Los Angeles, California, March 12, 2003
SCPIE Medical Malpractice Rate Hearing

Raleigh, North Carolina, July 17, 2002
Auto Insurance Rate Hearing

Tallahassee, Florida, February 25, 2002
NCCI Workers Compensation Insurance Rate Hearing

Austin, Texas, February 5, 2002
Biennial Title Insurance Rate Hearing

Raleigh, North Carolina, September 24, 2001
Auto Insurance Rate Hearing

Boston, Massachusetts, August 14, 2001
Massachusetts Auto Insurance Bureau Rate Hearing

Austin, Texas, March 6, 2001
Texas Auto Benchmark Rate Hearing

Boston, Massachusetts, August 23, 2000
Massachusetts Auto Insurance Bureau Rate Hearing

Austin, Texas, December 7, 1999
Texas Auto Insurance Plan Association Rate Hearing

Raleigh, North Carolina, December 3, 1999
Auto Insurance Rate Hearing

Austin, Texas, November 3, 1999
Biennial Title Insurance Rate Hearing

Austin, Texas, September 8, 1999
Texas Auto Benchmark Rate Hearing

Boston, Massachusetts, August 13, 1999
Massachusetts Auto Insurance Bureau Rate Hearing

Austin, Texas, June 22, 1999
Texas Property Benchmark Rate Hearing

Honolulu, Hawaii, December 16, 1998
NCCI Workers Compensation Insurance Rate Hearing

Richmond, Virginia, November 15, 1998
NCCI Workers Compensation Insurance Rate Hearing

Boston, Massachusetts, October 9, 1998
Massachusetts Auto Insurance Bureau Rate Hearing

Austin, Texas, May 19, 1998
Texas Auto Insurance Plan Association Rate Hearing

Austin, Texas, April 7, 1998
Auto Insurance Benchmark Rate Hearing

Austin, Texas, February 17, 1998
Property Insurance Benchmark Rate Hearing

Austin, Texas, November 18, 1997
Biennial Title Insurance Rate Hearing

Tallahassee, Florida, September 8, 1997
NCCI Workers Compensation Insurance Rate Hearing

Austin, Texas, April 8, 1997
Texas Auto Insurance Plan Association Rate Hearing

Austin, Texas, March 10, 1997
Auto Insurance Benchmark Rate Hearing

San Francisco, California, March 4, 1997
Insurance Department Hearing on Rating Factors

Raleigh, North Carolina, July 16, 1996
Auto Insurance Rate Hearing

San Francisco, California, March 11, 1996
Century National Proposition 103 Rollback Hearing

Sacramento, California, January 30, 1996
Hartford Steam Boiler Proposition 103 Rollback Hearing

San Francisco, California, January 8, 1996
SAFECO Insurance Company Earthquake Rate Hearing

Austin, Texas, December 21, 1995
Residential Property Insurance Benchmark Rate Hearing

Clearwater, Florida, December 8, 1995
Florida Windstorm Underwriting Association Rate Hearing

Austin, Texas, November 28, 1995
Private Passenger Auto Insurance Benchmark Rate Hearing

Austin, Texas, October 31, 1995
Texas Automobile Insurance Plan Association Rate Hearing

Sacramento, California, April 18, 1995
California Insurance Department Hearing on Auto Insurance Rating Factors

Portland, Maine, April 13, 1995
Workers Compensation Assigned Risk Pool Fresh Start Hearing

San Francisco, California, February 6, 1995
Farmers Insurance Group Earthquake Insurance Rate Hearing

Austin, Texas, January 6, 1995
Special Hearing on Classification Rules for Automobile Insurance

Austin, Texas, December 15, 1994
Residential Property Insurance Benchmark Rate Hearing

Austin, Texas, October 4, 1994
Texas Automobile Insurance Plan Association Rate Hearing

Austin, Texas, September 27, 1994
Private Passenger Auto Insurance Benchmark Rate Hearing

Raleigh, North Carolina, July 19, 1994
Private Passenger Auto Insurance Rate Hearing

San Francisco, California, December 22, 1993
Century National Homeowner's Insurance Rate Hearing

Raleigh, North Carolina, October 13, 1993
Homeowners/Farmowners Insurance Rate Hearing

Tallahassee, Florida, October 4, 1993
Workers' Compensation Insurance Rate Hearing

Boston, Massachusetts, September 9, 1993
Automobile Insurance Rate Hearing

Austin, Texas, March 4, 1993
Residential Property Insurance Benchmark Rate Hearing

Austin, Texas, February 10, 1993
Automobile Insurance Benchmark Rate Hearing

Honolulu, Hawaii, November 18, 1992
Liberty Mutual Insurance Automobile Rate Hearing

Raleigh, North Carolina, November 13, 1992
Workers' Compensation Insurance Rate Hearing

Tallahassee, Florida, October 29, 1992
Workers' Compensation Insurance Rate Hearing

San Francisco, California, October 14, 1992
Workers' Compensation Insurance Rate Hearing

Atlanta, Georgia, September 24, 1992
Workers' Compensation Insurance Rate Hearing

Nashville, Tennessee, May 27, 1992
Workers' Compensation Insurance Rate Hearing

San Francisco, California, May 13, 1992
Workers' Compensation Insurance Rate Hearing

Los Angeles, California, April 10, 1992
Mercury General Proposition 103 Rollback Proceedings

Austin, Texas, January 27, 1992
Texas Automobile Insurance Plan Rate Hearing

Austin, Texas, December 17, 1991
Automobile Insurance Rate Hearing

Raleigh, North Carolina, December 16, 1991
Workers' Compensation Insurance Rate Hearing

San Francisco, California, October 22, 1991
Workers' Compensation Rate Hearing

Los Angeles, California, May 23, 1991,
Proposition 103 RCD-2 Proceedings

San Francisco, California, April 9, 1991
California Workers' Compensation Rate Study Commission

Nashville, Tennessee, March 20, 1991
Workers' Compensation Insurance Rate Hearing

Los Angeles, California, March 12, 1991,
California Workers' Compensation Rate Study Commission

Olympia, Washington, February 26, 1991,
House Financial Institutions/Insurance Committee Hearing on Rules for Insurance Regulatory Legislation

Olympia, Washington, November 27, 1990,
Insurance Department Public Hearing on Proposed Rules for Ratemaking

Harrisburg, Pennsylvania, November 12, 1990,
Allstate Insurance Company Automobile Insurance Rate Hearing

Tallahassee, Florida, November 1, 1990,
Scanlan v. Martinez, et.al., Superior Court of Leon County

San Bruno, California, October 1, 1990,
SAFECO Insurance Group Proposition 103 Rate Rollback Hearing

Austin, Texas, July 23, 1990,
Texas State Board of Insurance Special Hearing on Investment Income in Ratemaking

Harrisburg, Pennsylvania, July 18, 1990,
Pennsylvania National Mutual Insurance Company Automobile Insurance Rate Hearing

Harrisburg, Pennsylvania, June 28, 1990,
Harleysville Mutual Insurance Company Automobile Insurance Rate Hearing

Columbia, South Carolina, March 30, 1990,
Workers' Compensation Insurance Rate Hearing

San Bruno, California, March 19, 1990,
California Proposition 103 Generic Hearing

Denver, Colorado, December 12, 1989,
Workers' Compensation Insurance Rate Hearing

Tampa, Florida, October 23, 1989,
Workers' Compensation Insurance Rate Hearing

Austin, Texas, October 17, 1989,
Workers' Compensation Insurance Rate Hearing

Los Angeles, California, September 25, 1989,
SAFECO Insurance Company of America Proposition 103 Rate Hearing

Austin, Texas, August 29, 1989,
Texas Insurance Advisory Association Property Insurance Rate Hearing

Providence, Rhode Island, April 13, 1989,
Workers' Compensation Insurance Rate Hearing

Augusta, Maine, January 24, 1989,
Workers' Compensation Insurance Rate Hearing

Hartford, Connecticut, November 14, 1988,
Workers' Compensation Insurance Rate Hearing

Tallahassee, Florida, November 3, 1988,
Workers' Compensation Insurance Rate Hearing

Austin, Texas, November 2, 1988,
Workers' Compensation Insurance Rate Hearing

Montgomery, Alabama, June 30, 1988,
Workers' Compensation Insurance Rate Hearing

Augusta, Maine, March 24, 1988,
Workers' Compensation Insurance Rate Hearing

Austin, Texas, October 27, 1987,
Workers' Compensation Insurance Rate Hearing

Tallahassee, Florida, October 9, 1987,
Workers' Compensation Insurance Rate Hearing

Atlanta, Georgia, August 6, 1987,
Workers' Compensation Insurance Rate Hearing

Augusta, Maine, February 24, 1987,
Workers' Compensation Insurance Rate Hearing

Tallahassee, Florida, November 14, 1986,
Workers' Compensation Insurance Rate Hearing

Austin, Texas, November 18, 1986,
Workers' Compensation Insurance Rate Hearing

Augusta, Maine, May 28, 1986,
Workers' Compensation Insurance Rate Hearing

Tallahassee, Florida, December 6, 1985,
Workers' Compensation Insurance Rate Hearing

Oklahoma City, Oklahoma, October 10, 1985,
Workers' Compensation Insurance Rate Hearing

Austin, Texas, July 23, 1985,
Workers' Compensation Insurance Rate Hearing

Austin Texas, June 14, 1985,
Workers' Compensation Insurance Rate Hearing

Tallahassee, Florida, November 18, 1984,
Workers' Compensation Insurance Rate Hearing

Austin, Texas, August 29, 1984,
Workers' Compensation Insurance Rate Hearing

Portland, Oregon, March 6, 1984,
NA IC Public Hearing on Investment Income and Insurance Profitability

Tallahassee, Florida, February 25, 1984,
Workers' Compensation Insurance Rate Hearing

Tallahassee, Florida, August 18, 1983,
Workers' Compensation Insurance Rate Hearing

Austin Texas, July 13, 1983,
Workers' Compensation Insurance Rate Hearing

Oklahoma City, Oklahoma, March 6, 1983,
Workers' Compensation Insurance Rate Hearing

Baton Rouge, Louisiana, March 16, 1982,
Louisiana Insurance Commission Public Hearing on Investment Income

Providence, Rhode Island, February 3, 1982,
Workers' Compensation Insurance Rate Hearing

Augusta, Maine, October 1, 1981,
Workers' Compensation Insurance Rate Hearing

NCRB - PRO FORMA STATUTORY RATE OF RETURN

MOBILE HOMEOWNERS (F) INSURANCE

	Pre-Tax	Tax Liability	Post-Tax
1. Premiums	100.00%		
Loss & Loss Adjustment Expense	49.46%		
Commission & Brokerage	15.65%		
General Expense	2.29%		
Other Acquisition Expense	3.00%		
Taxes, Licenses and Fees	2.74%		
Net Cost of Reinsurance	14.78%		
Compensation for Assessment Risk	3.09%		
2. Pro-Forma Underwriting Profit	9.00%		
3. Installment Fee Income	0.37%		
4. Regular tax		3.28%	
5. Additional tax due to TRA		0.04%	
6. Total Return from Underwriting (post-tax)			6.05%
7. Investment Gain on Insurance Transaction	1.58%		
Less Investment Income on Agents Balances	0.49%		
Net Investment Gain on Insurance Transaction	1.10%	0.28%	0.82%
8. Total Return as a % of Premium (post-tax)			6.87%
9. Premium-to-Net Worth Ratio			1.076
10. Total Return as a % of Net Worth (post-tax)			7.39%

Note: Lines (1) to (8) are all expressed as a % of premium.

Assumptions

(a) UW Tax Rate =	35.00%
(b) Inv. Income Tax Rate =	25.42%
(c) Inv. Yield =	3.37%
(d) P/S Ratio =	1.25
(e) NW/S Ratio =	1.16
(f) Installment Fee Income=	0.37%
(g) Additional TRA tax=	0.04%
(h) Net Cost of Reinsurance=	14.78%
(i) Compensation for Assessment Risk=	3.09%

NOTES TO EXHIBIT RB-14, Page 1

1. The expense provisions are those used in Exhibit RB-1, as adjusted for the proposed rate change

2. Selected by Rate Bureau.

3. See assumption (f) below.

4. [(2.)+(3.)] x (a.).

5. See assumption (g) below.

6. (2.) + (3.) - [(4.) + (5.)].

7. Pages 7-13. Investment income on agents' balances equals 0.140 x 1.031 x (c) x [1 - (h)], where 0.140 is agents balances for premiums due less than 90 days and 1.031 is the factor to include the effect of agents' balances or uncollected premiums overdue for more than 90 days.

8. (6.) + (7.).

9. (d.)/(e.).

10. (8.) x (9.).

ASSUMPTIONS

(a) Internal Revenue Code.

(b) See RB-14, pp. 11-13; 1-avg post-tax yield/avg pre-tax yield.

(c) See RB-14, pp. 11-13; average of current and embedded yields.

(d) See RB-14, p. 14

(e) See RB-14, pp. 15

(f) See RB-14, p. 3

(g) See RB-14, pp. 4-6

(h) See prefiled testimony

(i) See prefiled testimony

**NCRB - PRO FORMA TOTAL RATE OF RETURN
INCLUDING INVESTMENT INCOME ON SURPLUS
MOBILE HOMEOWNERS (F) INSURANCE**

	Pre-Tax	Tax Liability	Post-Tax
1. Premiums	100.00%		
Loss & Loss Adjustment Expense	49.46%		
Commission & Brokerage	15.65%		
General Expense	2.29%		
Other Acquisition Expense	3.00%		
Taxes, Licenses and Fees	2.74%		
Net Cost of Reinsurance	14.78%		
Compensation for Assessment Risk	3.09%		
2. Pro-Forma Underwriting Profit	9.00%		
3. Installment Fee Income	0.37%		
4. Regular tax		3.28%	
5. Additional tax due to TRA		0.04%	
6. Total Return from Underwriting (post-tax)			6.05%
7. Investment Gain on Insurance Transaction	1.58%		
Less Investment Income on Agents Balances	0.49%		
Net Investment Gain on Insurance Transaction	1.10%	0.28%	0.82%
8. Investment Gain on Surplus (Including Prepaid Expense Adjustment)	3.43%	0.87%	2.56%
9. Total Return as a % of Premium (post-tax)			9.43%
10. Premium-to-Net Worth Ratio			1.076
11. Total Return as a % of Net Worth (post-tax)			10.15%

Note: Lines (1) to (9) are all expressed as a % of premium.

Assumptions

(a) UW Tax Rate =	35.00%
(b) Inv. Income Tax Rate =	25.42%
(c) Inv. Yield =	3.37%
(d) P/S Ratio =	1.25
(e) NW/S Ratio =	1.16
(f) Installment Fee Income=	0.37%
(g) Additional TRA tax=	0.04%
(h) Net Cost of Reinsurance=	14.78%
(i) Compensation for Assessment Risk=	3.09%

NOTES TO EXHIBIT RB-14, Page 1A

1. The expense provisions are those used in Exhibit RB-1, as adjusted for the proposed rate change

2. Selected by Rate Bureau.

3. See assumption (f) below.

4. [(2.)+(3.)] x (a.).

5. See assumption (g) below.

6. (2.) + (3.) - [(4.) + (5.)].

7. Pages 7-13. Investment income on agents' balances equals 0.140 x 1.031 x (c) x [1 - (h)], where 0.140 is agents balances for premiums due less than 90 days and 1.031 is the factor to include the effect of agents' balances or uncollected premiums overdue for more than 90 days.

8. (c.) x [1/(d.) + (0.4098 x 0.5334)], where 0.4098 is the prepaid expense ratio from page 7 . and 0.5334 is the unearned premium reserve to premium ratio from page 7.

9. (6.) + (7.) + (8.).

10. (d.)/(e.).

11. (9.) x (10.).

ASSUMPTIONS

(a) Internal Revenue Code.

(b) See RB-14, pp. 11-13; 1-avg post-tax yield/avg pre-tax yield.

(c) See RB-14, pp. 11-13; average of current and embedded yields.

(d) See RB-14, p. 14

(e) See RB-14, pp. 15

(f) See RB-14, p. 3

(g) See RB-14, pp. 4-6

(h) See prefiled testimony

(i) See prefiled testimony

NORTH CAROLINA
MOBILE HOMEOWNERS (F) INSURANCE
INSTALLMENT PAYMENT INCOME

Year	Inst. Charges	Statutory P. 14 Written Premium	Inst. Charges as a % of Prem.
2012	321,053	107,192,903	0.30%
2011	331,271	102,781,146	0.32%
2010	363,371	99,874,324	0.36%
2009	439,816	96,942,169	0.45%
2008	409,186	95,008,380	0.43%
Selected Value			0.37%

Source: ISO.

NORTH CAROLINA
MOBILE HOMEOWNERS (F) INSURANCE
CALCULATION OF TAXABLE INCOME

1	Collected Earned Premium for current year	100.00%
2	UEPR 12/31/current	53.81%
3	UEPR 12/31/prior	53.25%
4	Increase = (2) - (3)	0.56%
5	20% of Increase = Taxable Income	0.11%
6	Tax Liability = (5)x.35	0.04%
7	Unpaid Losses current yr.	14.16%
8	Discounted unpaid losses current yr.	13.64%
9	Unpaid Losses prior yr	14.01%
10	Discounted unpaid losses prior yr.	13.49%
11	Additional Income	0.01%
12	Tax Liability	0.00%
	Other Tax Liabilities	
13	UEP	0.04%
14	Discounting of Loss Reserves	0.00%
15	Total	**0.04%**

NORTH CAROLINA
MOBILE HOMEOWNERS (F) INSURANCE
CALCULATION OF TAXABLE INCOME

(1) AY Avg Acc Date	(2) AY Pay Pattern	(3) Percent Unpaid	(4) Total Losses	(5) Unpaid Losses	(6) AY at 12/31/yr. t	(7) Discount Factor	(8) Discounted Weight	(9) AY at 12/31/yr. t-1	(10) Weight	(11) Discount Factor	(12) Discounted Weight
0.5	78.51%	21.49%	49.455	10.6	2012	0.967063	10.3				
1.5	95.24%	4.76%	48.940	2.3	2011	0.952890	2.2	2011	10.517	0.967063	10.2
2.5	98.48%	1.52%	48.430	0.7	2010	0.946789	0.7	2010	2.305	0.952890	2.2
3.5	99.43%	0.58%	47.925	0.3	2009	0.951520	0.3	2009	0.730	0.946789	0.7
4.5	99.76%	0.24%	47.425	0.1	2008	0.947811	0.1	2008	0.273	0.951520	0.3
5.5	99.89%	0.11%	46.931	0.1	2007	0.936765	0.0	2007	0.113	0.947811	0.1
6.5	99.95%	0.05%	46.442	0.0	2006	0.930150	0.0	2006	0.050	0.936765	0.0
7.5	100.00%	0.00%	45.957	0.0	2005	0.934323	0.0	2005	0.023	0.930150	0.0
8.5	100.00%	0.00%	45.478	0.0	2004	0.939272	0.0	2004	0.000	0.934323	0.0
9.5	100.00%	0.00%	45.004	0.0	2003	0.947512	0.0	2003	0.000	0.939272	0.0
10.5	100.00%	0.00%	44.535	0.0	2002	0.955863	0.0	2002	0.000	0.947512	0.0
11.5	100.00%	0.00%	44.071	0.0	2001	0.964337	0.0	2001	0.000	0.955863	0.0
12.5	100.00%	0.00%	43.611	0.0	2000	0.964337	0.0	2000	0	0.964337	0.0
13.5	100.00%	0.00%	43.157	0.0	1999	0.964337	0.0	1999	0	0.964337	0.0
14.5	100.00%	0.00%	42.707	0.0	1998	0.964337	0.0	1998	0	0.964337	0.0
15.5	100.00%	0.00%	42.262	0.0	1997	0.964337	0.0	1997	0	0.964337	0.0
16.5	100.00%	0.00%	41.821	0.0	1996	0.964337	0.0	1996	0	0.964337	0.0
17.5	100.00%	0.00%	41.385	0.0	1995	0.964337	0.0	1995	0	0.964337	0.0
18.5	100.00%	0.00%	40.954	0.0	1994	0.964337	0.0	1994	0	0.964337	0.0
19.5	100.00%	0.00%	40.527	0.0	1993	0.964337	0.0	1993	0	0.964337	0.0
20.5	100.00%	0.00%	40.104	0.0	1992	0.964337	0.0	1992	0	0.964337	0.0
21.5	100.00%	0.00%	39.686	0.0	1991	0.964337	0.0	1991	0	0.964337	0.0
22.5	100.00%	0.00%	39.273	0.0	1990	0.964337	0.0	1990	0	0.964337	0.0
23.5	100.00%	0.00%	38.863	0.0	1989	0.964337	0.0	1989	0	0.964337	0.0
24.5	100.00%	0.00%	38.458	0.0	1988	0.964337	0.0	1988	0	0.964337	0.0
25.5	100.00%	0.00%	38.057	0.0	1987	0.964337	0.0	1987	0	0.964337	0.0
26.5	100.00%	0.00%	37.661	0.0	1986	0.964337	0.0	1986	0	0.964337	0.0
27.5	100.00%	0.00%	37.268	0.0	1985	0.964337	0.0	1985	0	0.964337	0.0
28.5	100.00%	0.00%	36.879	0.0	1984	0.964337	0.0	1984	0	0.964337	0.0
29.5	100.00%	0.00%	36.495	0.0	1983	0.964337	0.0	1983	0	0.964337	0.0
30.5	100.00%	0.00%	36.115	0.0	1982	0.964337	0.0	1982	0	0.964337	0.0
31.5	100.00%	0.00%	35.738	0.0	1981	0.964337	0.0	1981	0	0.964337	0.0
32.5	100.00%	0.00%	35.366	0.0	1980	0.964337	0.0	1980	0	0.964337	0.0
33.5	100.00%	0.00%	34.997	0.0	1979	0.964337	0.0	1979	0	0.964337	0.0
34.5	100.00%	0.00%	34.632	0.0	1978	0.964337	0.0	1978	0	0.964337	0.0
35.5	100.00%	0.00%	34.271	0.0	1977	0.964337	0.0	1977	0	0.964337	0.0
36.5	100.00%	0.00%	33.914	0.0	1976	0.964337	0.0	1976	0	0.964337	0.0
37.5	100.00%	0.00%	33.560	0.0	1975	0.964337	0.0	1975	0	0.964337	0.0
38.5	100.00%	0.00%	33.210	0.0	1974	0.964337	0.0	1974	0	0.964337	0.0
39.5	100.00%	0.00%	32.864	0.0	1973	0.964337	0.0	1973	0	0.964337	0.0
40.5	100.00%	0.00%	32.522	0.0	1972	0.964337	0.0	1972	0	0.964337	0.0
41.5	100.00%	0.00%	32.183	0.0	1971	0.964337	0.0	1971	0	0.964337	0.0
42.5	100.00%	0.00%	31.847	0.0	1970	0.964337	0.0	1970	0	0.964337	0.0
43.5	100.00%	0.00%	31.515	0.0	1969	0.964337	0.0	1969	0	0.964337	0.0
44.5	100.00%	0.00%	31.187	0.0	1968	0.964337	0.0	1968	0	0.964337	0.0
45.5	100.00%	0.00%	30.861	0.0	1967	0.964337	0.0	1967	0	0.964337	0.0
46.5	100.00%	0.00%	30.540	0.0	1966	0.964337	0.0	1966	0	0.964337	0.0
47.5	100.00%	0.00%	30.221	0.0	1965	0.964337	0.0	1965	0	0.964337	0.0
48.5	100.00%	0.00%	29.906	0.0	1964	0.964337	0.0	1964	0	0.964337	0.0
49.5	100.00%	0.00%	29.595	0.0	1963	0.964337	0.0	1963	0	0.964337	0.0
50.5	100.00%	0.00%	29.286	0.0	1962	0.964337	0.0	1962	0	0.964337	0.0
51.5	100.00%	0.00%	28.981	0.0	1961	0.964337	0.0	1961	0	0.964337	0.0
52.5	100.00%	0.00%	28.679	0.0	1960	0.964337	0.0	1960	0	0.964337	0.0
53.5	100.00%	0.00%	28.380	0.0	1959	0.964337	0.0	1959	0	0.964337	0.0
54.5	100.00%	0.00%	28.084	0.0	1958	0.964337	0.0	1958	0	0.964337	0.0
55.5	100.00%	0.00%	27.791	0.0	1957	0.964337	0.0	1957	0	0.964337	0.0
56.5	100.00%	0.00%	27.501	0.0	1956	0.964337	0.0	1956	0	0.964337	0.0
57.5	100.00%	0.00%	27.215	0.0	1955	0.964337	0.0	1955	0	0.964337	0.0
58.5	100.00%	0.00%	26.931	0.0	1954	0.964337	0.0	1954	0	0.964337	0.0
59.5	100.00%	0.00%	26.650	0.0	1953	0.964337	0.0	1953	0	0.964337	0.0
60.5	100.00%	0.00%	26.373	0.0	1952	0.964337	0.0	1952	0	0.964337	0.0
61.5	100.00%	0.00%	26.098	0.0	1951	0.964337	0.0	1951	0	0.964337	0.0
62.5	100.00%	0.00%	25.826	0.0	1950	0.964337	0.0	1950	0	0.964337	0.0
63.5	100.00%	0.00%	25.556	0.0	1949	0.964337	0.0	1949	0	0.964337	0.0
64.5	100.00%	0.00%	25.290	0.0	1948	0.964337	0.0	1948	0	0.964337	0.0
65.5	100.00%	0.00%	25.026	0.0	1947	0.964337	0.0	1947	0	0.964337	0.0
66.5	100.00%		24.765	0.0	1946	0.964337	0.0	1946	0	0.964337	0.0
Sum				14.16	Sum		13.64	Sum			13.49

NOTES TO PAGES 4 AND 5

Page 4

1-3 Annual Statement, p. 14, HO data for companies writing MH (F) insurance in North Carolina.

4 Line (2) - line (3)

5 Line (4) x .20.

6 Line (5) x .35.

7 Unpaid current-year losses at year-end as a percent of premium. Sum of Page 5, Column (5).

8 Discounted unpaid current-year losses at year-end as a percent of premium. Sum of Page 5, Column (8).

9 Unpaid prior-year losses at year-end as a percent of premium. Sum of Page 5, Column (5) divided by 5% assumed growth rate.

10 Discounted unpaid current-year losses at year-end as a percent of premium. Sum of Page 5, Column (12).

11 Line (7) - Line (8) - {Line (9) - Line (10)]

12 Line (11) x .35

13 Line (6)

14 Line (12)

15 Line (13) + Line (14)

Page 5

1 Midpoint of number of years since end of accident period.

2 Accident year payout pattern developed from policy year developed losses.

3 1 - Column (2)

4 Losses, given historical growth rate.

5 Column (3) x Column (4)

6 Accident Year at current year end

7 Discount factor per IRS Regulations.

8 Column (5) x Column (7)

9 Accident Year at prior year end

10 Column (3), previous period x Column (4), current period

11 Discount factor per IRS Regulations.

12 Column (10) x Column (11)

NCRB INVESTMENT INCOME CALCULATION
MOBILE HOMEOWNERS (F) INSURANCE
Projected Investment Earnings on Loss, Loss
Adjustment Expense and Unearned Premium Reserves

A. UNEARNED PREMIUM RESERVES		
1. Direct Earned Premiums		1,000,000
2. Mean UEPR	53.34%	533,401
3. Deductions for prepaid expenses:		
Commissions & Brokerage	15.65%	
Taxes, Licenses & Fees (5/6)	2.28%	
Other Acquisition (1/2)	1.50%	
General Expense (1/2)	1.14%	
Cost of Reinsurance	20.41%	
Total	40.98%	
4. Deduction for Prepaid Expenses: (2) x (3)		218,601
5. Net UEPR Subject to Inv (2) - (4)		314,800
B. Loss and Loss Expense Reserves		
1. Direct Earned Premium		1,000,000
2. Expected Inc L & LAE to Premium Ratio	49.46%	494,554
3. Expected Mean L&LAE Reserve to Inc. L & LAE Ratio	31.33%	154,931
C. Net PH Funds Subj to Inv (A5 + B3)		469,731
D. Average Rate of Return		3.37%
E. Investment Earnings from Net Reserves (C) x (D)		15,822
F. Average Rate of Return as a Percent of Direct Earned Premium (E) / (A1)		1.58%

ESTIMATED INVESTMENT EARNINGS ON UNEARNED PREMIUM RESERVES AND ON LOSS RESERVES

EXPLANATORY NOTES

Line A-1

All calculations are displayed per $1,000,000 direct earned premiums.

Line A-2

The mean unearned premium reserve is determined by multiplying the direct earned premiums in line (1) by the ratio of the mean unearned premium reserve to the collected earned premium for calendar year ended 12/31/current year for all companies writing homeowners insurance in North Carolina. These data are from statutory page 14 of the Annual Statement.

1. Collected Earned Premium for Calendar Year ended 12/31/current year	834,423,626
2. Unearned Premium Reserve as of 12/31/current year	449,025,291
3. Unearned Premium Reserve as of 12/31/prior year	441,138,851
4. Mean Unearned Premium Reserve 1/2 [(2) + (3)]	445,082,071
5. Ratio (4) ÷ (1)	53.34%

Line A-3

Deduction for prepaid expenses:

Production costs and a large part of the other company expenses in connection with the writing and handling of homeowners policies, exclusive of claim adjustment expenses, are incurred when the policy is written and before the premium is paid. The deduction for these expenses is determined from data provided by the NCRB.

ESTIMATED INVESTMENT EARNINGS ON UNEARNED
PREMIUM RESERVES AND ON LOSS RESERVES

EXPLANATORY NOTES

Line B-2
The expected loss and loss adjustment expense ratio reflects the expense provisions utilized in the filing.

Line B-3
The mean loss reserve is determined by multiplying the incurred losses in line (2) by the North Carolina ratio of mean loss reserves to incurred losses. This ratio is based on North Carolina companies' statutory page 14 annual statement data and has been adjusted to include loss adjustment expense reserves.

6	Incurred Losses	2008	150,756,112
7	Incurred Losses	2009	164,291,553
8	Incurred Losses	2010	184,982,224
9	Incurred Losses	2011	196,884,849
10	Incurred Losses	2012	154,426,509
11	Loss Reserves	2007	126,208,618
12	Loss Reserves	2008	150,756,112
13	Loss Reserves	2009	164,291,553
14	Loss Reserves	2010	184,982,224
15	Loss Reserves	2011	196,884,849
16	Loss Reserves	2012	154,426,509
17	Mean Loss Reserve	2008	138,482,365
18	Mean Loss Reserve	2009	157,523,833
19	Mean Loss Reserve	2010	174,636,889
20	Mean Loss Reserve	2011	190,933,537
21	Mean Loss Reserve	2012	175,655,679
22	Ratio	2008	29.28%
23	Ratio	2009	30.43%
24	Ratio	2010	28.68%
25	Ratio	2011	17.97%
26	Ratio	2012	38.89%
27	Average Loss Reserve		29.05%
28	Ratio of LAE Reserves to Loss Reserves		0.242
29	Ratio of Incurred LAE to Incurred Losses		0.152
30	Loss and LAE Reserve [((27)x(1.0+(28)))/(1.0+(29))]		0.313

ESTIMATED INVESTMENT EARNINGS ON UNEARNED PREMIUM RESERVES AND ON LOSS RESERVES

EXPLANATORY NOTES

Line E

The average rate of return is calculated as the arithmetic mean of the embedded and current yields. The embedded yield is the sum of two ratios: the most recent ratio of investment income to invested assets (see page 12), plus the ten year average ratio of capital gains to invested assets (see page 13). The current yield is the estimated, currently available rate of return (including income and expected capital gains) on the property/casualty industry investment portfolio (see page 11).

Embedded Yield =	3.65% + 0.29% =	3.94%
Current Yield =		2.80%
Average =		3.37%

PORTFOLIO YIELD AND TAX RATE - CURRENT YIELD

(1) Investable Asset	(2) Percent of Assets	(3) Estimated Prospective Pre-Tax Return	(4) Tax Rate	(5) Estimated Prospective Post-Tax Return
Bonds				
U.S. Govt	10.24%	1.14%	35.00%	0.74%
States & territories	11.21%	1.76%	5.25%	1.67%
Special revenue	21.45%	1.92%	5.25%	1.82%
Industrial	28.82%	1.74%	35.00%	1.13%
Preferred stock	0.91%	5.76%	14.18%	4.94%
Common stock	19.59%	9.25%	30.73%	6.41%
Mortgage Loans	0.43%	4.29%	35.00%	2.79%
Real estate	0.80%	3.98%	35.00%	2.59%
Cash & short-term invs.	6.55%	0.04%	35.00%	0.03%
Rate of Return Pre-Inv Exp	100.00%	3.14%	26.43%	2.31%
Investment Expenses		0.35%	35.00%	0.23%
Portfolio Rate of Return		**2.80%**	25.37%	**2.09%**

Sources:
- Various issues of Federal Reserve Statistical Release, H.15(519).
- Mergent Bond Record.
- Standard & Poor's CreditWeek.
- Value Line Investment Survey, Part II.
- Ibbotson Associates, SBBI Valuation Edition 2013 Yearbook.
- Ibbotson and Siegel, AREUEA Journal, 1984.
- A.M. Best's Aggregates & Averages, 2013 edition.

PORTFOLIO YIELD AND TAX RATE
EMBEDDED YIELD

	Income	Tax Rate
Bonds		
Taxable	24,976,829	35.00%
Non-Taxable	12,612,176	5.25%
Stocks		
Taxable	5,584,133	14.18%
Non-Taxable	562,545	5.25%
Mortgage Loans	307,795	35.00%
Real Estate	1,780,449	35.00%
Contract Loans	1,080	35.00%
Cash / Short Term Inv.	175,985	35.00%
All Other	8,194,901	35.00%
Total	54,195,893	25.62%
Inv. Expenses	4,958,989	35.00%
Net Inv. Income	49,236,904	24.68%
Mean Invested Assets	1,350,656,619	
Inv. Inc. Yield Rate	3.65%	24.68%
Capital Gains (10 yr. avg) (% Of Inv. Assets)	0.29%	35.00%
Invest. Yield Rate (pre-tax)	**3.94%**	**25.45%**
Invest. Yield Rate (post-tax)	**2.94%**	

Source: Best's Aggregates and Averages, 2013 Edition, p. 12 (Exhibit of Net Investment Income, Col. 2 (Earned During Year)). Capital Gains, Exhibit RB-14A, page 13

**CAPITAL GAINS OR LOSSES
AS A PERCENT OF MEAN ASSETS**
(All amounts in thousands of dollars)

Calendar Year	Mean Total Admitted Invested Assets	Realized Capital Gains	
		Amount	Percent
2003	908,024,056	6,280,196	0.69%
2004	1,018,810,319	9,113,199	0.89%
2005	1,120,112,663	12,194,908	1.09%
2006	1,217,432,187	3,587,228	0.29%
2007	1,297,478,130	9,031,778	0.70%
2008	1,288,393,875	(21,018,623)	-1.63%
2009	1,274,678,809	(8,079,575)	-0.63%
2010	1,330,998,082	8,100,143	0.61%
2011	1,366,568,026	7,563,305	0.55%
2012	1,350,656,619	9,035,405	0.67%
Total	12,173,152,763	35,807,964	0.29%

*Mean total invested assets is the average of the current year and prior year values of total invested assets (annual statement page 2)

Source: "Best's Aggregates & Averages--Property-Casualty," various editions

NORTH CAROLINA

MOBILE HOMEOWNERS (F) INSURANCE

PREMIUM-TO-SURPLUS RATIOS

Year	MH (F) Insurance
2007	1.43
2008	1.22
2009	1.25
2010	1.14
2011	1.23
2012	1.23
Average	1.25

Notes:
Data from NCRB and Best's Aggregates & Averages, various editions

All groups writing MH insurance in NC in each year

NORTH CAROLINA MOBILE HOMEOWNERS INSURANCE
CALCULATION OF GAAP NET WORTH TO SURPLUS RATIO

	2007	2008	2009	2010	2011
Policyholder Surplus	517,875,621,253	457,293,555,877	511,396,566,997	559,247,073,797	553,794,328,471
+ Deferred Acquisition Costs	27,556,696,928	27,267,204,493	26,770,216,415	27,142,965,854	27,670,594,098
+ Non-Admitted DTA Provision	20,970,760,003	34,146,635,006	24,344,929,355	17,507,669,410	16,898,320,478
+ Non-admitted Assets (non-tax part)	28,591,349,752	28,634,028,619	31,004,819,190	33,948,822,530	34,839,553,748
+ Provision for Reinsurance	4,619,150,713	4,002,703,029	3,457,351,496	3,217,305,985	2,981,599,506
+ Provision for FASB 115(after-tax)	6,555,479,760	(14,840,617,729)	16,691,215,237	19,411,210,713	35,148,765,987
- Surplus Notes	(10,147,724,269)	(12,270,695,235)	(13,916,580,127)	(15,935,710,149)	(14,704,469,032)
GAAP-adjusted Net Worth	596,021,334,139	524,232,814,060	599,748,518,562	644,539,338,140	656,628,693,256
Ratio of GAAP Net Worth to Statutory Surplus	1.15	1.15	1.17	1.15	1.19
Five Year Average	1.16				

Source: ISO

NORTH CAROLINA RATING BUREAU
EXHIBIT RB-15, Sheet 1

Calculation of Reinsurance Cost
Statewide Total
Reinsurer Amounts

		Total
(1)	Hurricane Losses	8,458,201
(2)	Loss Adjustment Expense Factor	1.150
(3)	Hurricane Losses and Loss Expenses (1) x (2)	9,727,144
(4)	Percent Reinsured	0.460
(5)	Reinsured Losses and Loss Expenses [(3) x (4)]	4,475,189
	a. Losses& LAE Included in Base Rate	3,604,253
	b. Additional WSST Losses & LAE	870,936
(6)	Reinsurance Expense Factor	0.70
(7)	Reinsurance Loss+Expenses [(5) / (6)]	6,393,128
(8)	Reinsurance Premium to Surplus Ratio	0.30
(9)	Reinsurer Underwriting Return Percent of Surplus	15.3%
(10)	Reinsurer Underwriting Return Percent of Premium[(9) / (8)]	51.1%
(11)	Reinsurance Premium [(7) / (1.000-(10))]	13,069,711
(12)	Reinsurance Expense Cost [(7)-(5)]	1,917,938
(13)	Cost of Reinsurer Capital [(11) - (5a) -(12)]	7,547,520
(14)	Reinsurer Expenses plus Cost of Reinsurer Capital [(12) + (13)]	9,465,458

Notes:

(1), (4), (5) from Simulation.
(2) From ISO.
(4) Assumes hurricane losses reinsured from 1/10 year to 1/100 year event with 95% placement.
(6) Judgment based on Professional Reinsurers Expenses.
(8) Milliman Analysis.
(9) Underwriting return that produces reasonable after-tax return on surplus.

NORTH CAROLINA RATING BUREAU
EXHIBIT RB-15, Sheet 2

Calculation of Reinsurance Cost
Statewide Total
Direct Writer Amounts

	Total
(1) Expected Value of Net Losses	23,850,838
(2) Expected Value of Ceded Losses	3,134,065
(3) Expected Value of All Losses [(1)+(2)]	26,984,903
(4) Commission and Brokerage	15.65%
(5) Taxes Licenses and Fees	2.74%
(6) Fixed Expenses (Other Acquisition & General)	3,384,674
(7) Reinsurer Expenses plus Cost of Reinsurer Capital	9,465,458
(8) Underwriting Profit	9.00%
(9) Contingencies	1.00%
(10) Loss Adjustment Expense Factor	1.150
(11) Compensation for Assessment Risk (CAR)	2,764,171
(12) Deviations	0.050
(13) Total Indicated Premium [{((3) x (10) + (6) + (7)) / (1.0 - (4) - (5) - (8) - (9)) + (11)} / (1-(12))]	67,416,153
(14) Total Indicated Underwriting Profit [(8) x {((3) x (10) + (6) + (7)) / (1.0 - (4) - (5) - (8) - (9))] }	5,515,306
(15) Investment Income on Reserves as a Percentage of Losses & LAE	2.32%
(16) Total Indicated Investment Income on Reserves [(1) x (10) x (15)]	635,257
(17) Total Profit excluding Investment Income on Surplus [(14) + (16)]	6,150,563
(18) Reinsurance Expense Cost as % of Direct Premium [Exhibit RB-15, Sheet 1, (12) / (13)]	2.84%
(19) Cost of Reinsurer Capital as % of Direct Premium [Exhibit RB-15, Sheet 1, (13) / (13)]	11.20%
(20) Reinsurance Premium as % of Direct Premium [Exhibit RB-15, Sheet 1, (11)/ (13)]	19.39%

Notes:
1. (1)-(3) From Simulation
2. (4)-(6), (8)-(12) from ISO
3. (7) See Exhibit RB-15, Sheet 1, (14)
4. (15) Milliman Analysis

NORTH CAROLINA RATING BUREAU

EXHIBIT RB-16, Sheet 1

Using Standard Deviation to Allocate Profit

	Zone 1	Zone 2	Zone 3	Sum
Allocation of Primary Company Amounts				
(1) Standard Deviation of Net Losses	3,617,170	11,661,351	3,399,380	18,677,901
(2) Allocation Percent [(1) / Sum(1)]	19.4%	62.4%	18.2%	100.0%
(3) Expected Profit to Allocate	1,191,121	3,840,039	1,119,403	6,150,563
(4) Expected Contingencies to Allocate (Allocated with (7))	64,934	341,573	206,305	612,812
(5) Expected Losses	2,527,234	13,294,151	8,029,453	23,850,838
(6) Loss Adjustment Expense Factor	1.150	1.150	1.150	1.150
(7) Expected Losses and Loss Expenses [(5) x (6)]	2,906,382	15,288,608	9,234,073	27,429,064
(8) Expected Investment Income on Policy Reserves Percent	2.3%	2.3%	2.3%	2.3%
(9) Underwriting Profit and Contingencies [(3) + (4) - (7) x (8)]	1,188,742	3,827,528	1,111,847	6,128,117
(10) General and Other Acquisition Expense	358,640	1,886,574	1,139,460	3,384,674
(11) Variable Expense Percent	18.39%	18.39%	18.39%	18.39%
Allocation of Reinsurer Amounts				
(12) Standard Deviation of Ceded Losses	3,545,819	11,043,946	2,985,803	17,575,567
(13) Allocation Percent [(12) / Sum(12)]	20.2%	62.8%	17.0%	100.0%
(14) Expected Profit to Allocate	1,373,937	4,279,316	1,156,941	6,810,194
(15) Expected Ceded Loss & LAE	844,689	2,364,562	395,002	3,604,253
(16) Additional WSST Ceded Losses & LAE	126,749	637,653	106,534	870,936
(17) Expected Losses and Loss Expenses [(15) + (16)]	971,438	3,002,216	501,536	4,475,189
(18) Expected Investment Income on Policy Reserves Percent	3.0%	3.0%	3.0%	3.0%
(19) Cost of Reinsurer Capital [(14) - (17) x (18) + (16)]	1,471,683	4,827,336	1,248,501	7,547,520
(20) Reinsurer Expenses [Total (20) allocated with (15)]	449,486	1,258,259	210,193	1,917,938
Summary of Expense Provisions				
(21) Compensation for Assessment Risk	138,032	1,460,843	1,165,296	2,764,171
(22) Deviation Percentage	5.0%	5.0%	5.0%	5.0%
(23) Indicated Premium [[((7) + (9) + (10) + (15) + (19) + (20)) / (1.0 - (11)) + (21]) / (1 - (22))	9,457,394	39,526,970	18,431,790	67,416,153
(24) Underwriting Profit and Contingencies (Percent) [(9) / ((23) * (1 - (22)) - (21))]	13.4%	10.6%	6.8%	10.0%
(25) Cost of Reinsurer Capital (Percent) [(19) / (23)]	15.6%	12.2%	6.8%	11.2%
(26) Reinsurer Expenses (Percent) [(20) / (23)]	4.8%	3.2%	1.1%	2.8%

Notes:

1. (1), (5), (12), (15), (16) From Simulation.
2. Sum(3) from Exhibit RB-15, Sheet 2, (17). Zone amounts from Sum and Allocation Percentage (2).
3. (4), (6), (8), (10), (11) From Exhibit RB-15, Sheet 2.
4. Sum(14) from Exhibit RB-15, Sheet 1, [(13) - (5b) + (5) x Exhibit RB-16, Sheet 1, (18)]
5. Zone amounts (14) from Sum (14) and Allocation Percentage (13).
6. Sum(20) from Exhibit RB-15, Sheet 1, (12). Zone amounts from Sum and Allocation based on (17).

NORTH CAROLINA RATING BUREAU

EXHIBIT RB-16, Sheet 2

Using Covariance to Allocate Profit

	Zone 1	*Zone 2*	*Zone 3*	*Sum*
Allocation of Primary Company Amounts				
(1) Covariance of Zone Net Losses with Total Net Losses (in billions)	48,501	186,246	33,996	268,744
(2) Allocation Percent [(1) / Sum(1)]	18.0%	69.3%	12.7%	100.0%
(3) Expected Profit to Allocate	1,110,020	4,262,490	778,054	6,150,563
(4) Expected Contingencies to Allocate (Allocated with (7))	64,934	341,573	206,305	612,812
(5) Expected Losses	2,527,234	13,294,151	8,029,453	23,850,838
(6) Loss Adjustment Expense Factor	1.150	1.150	1.150	1.150
(7) Expected Losses and Loss Expenses [(5) x (6)]	2,906,382	15,288,608	9,234,073	27,429,064
(8) Expected Investment Income on Policy Reserves Percent	2.3%	2.3%	2.3%	2.3%
(9) Underwriting Profit and Contingencies [(3) + (4) - (7) x (8)]	1,107,641	4,249,979	770,497	6,128,117
(10) General and Other Acquisition Expense	358,640	1,886,574	1,139,460	3,384,674
(11) Variable Expense Percent	18.39%	18.39%	18.39%	18.39%
Allocation of Reinsurer Amounts				
(11) Covariance of Zone Ceded Losses to Total Ceded Losses (in billions)	48,811	169,198	26,945	244,954
(13) Allocation Percent [(12) / Sum(12)]	19.9%	69.1%	11.0%	100.0%
(14) Expected Profit to Allocate	1,357,040	4,704,027	749,126	6,810,194
(15) Expected Ceded Loss & LAE	844,689	2,364,562	395,002	3,604,253
(16) Additional WSST Ceded Losses & LAE	126,749	637,653	106,534	870,936
(17) Expected Losses and Loss Expenses [(15) + (16)]	971,438	3,002,216	501,536	4,475,189
(18) Expected Investment Income on Policy Reserves Percent	3.0%	3.0%	3.0%	3.0%
(19) Cost of Reinsurer Capital [(14) - (17) x (18) + (16)]	1,454,786	5,252,047	840,687	7,547,520
(20) Reinsurer Expenses [Total (20) allocated with (15)]	449,486	1,258,259	210,193	1,917,938
Summary of Expense Provisions				
(21) Compensation for Assessment Risk	138,032	1,460,843	1,165,296	2,764,171
(22) Deviation Percentage	5.0%	5.0%	5.0%	5.0%
(23) Indicated Premium [[((7) + (9) + (10) + (15) + (19) + (20)) / (1.0 - (11)) + (21]) / (1 - (22))	9,330,994	40,619,665	17,465,495	67,416,153
(24) Underwriting Profit and Contingencies (Percent) [(9) / ((23) * (1 - (22)) - (21))]	12.7%	11.4%	5.0%	10.0%
(25) Cost of Reinsurer Capital (Percent) [(19) / (23)]	15.6%	12.9%	4.8%	11.2%
(26) Reinsurer Expenses (Percent) [(20) / (23)]	4.8%	3.1%	1.2%	2.8%

Notes:

1. (1), (5), (12), (15), (16) From Simulation.
2. Sum(3) from Exhibit RB-15, Sheet 2, (17). Zone amounts from Sum and Allocation Percentage (2).
3. (4), (6), (8), (10), (11) From Exhibit RB-15, Sheet 2.
4. Sum(14) from Exhibit RB-15, Sheet 1, [(13) - (5b) + (5) x Exhibit RB-16, Sheet 1, (18)]
5. Zone amounts (14) from Sum (14) and Allocation Percentage (13).
6. Sum(20) from Exhibit RB-15, Sheet 1, (12). Zone amounts from Sum and Allocation based on (17).

NORTH CAROLINA RATING BUREAU

EXHIBIT RB-16, Sheet 3

Using Losses at Probability of Ruin to Allocate Profit

	Zone 1	*Zone 2*	*Zone 3*	*Sum*
Allocation of Primary Company Amounts				
(1) Net Losses at Probability of Ruin	9,934,112	34,293,429	10,808,147	55,035,689
(2) Allocation Percent [(1) / Sum(1)]	18.1%	62.3%	19.6%	100.0%
(3) Expected Profit to Allocate	1,110,196	3,832,493	1,207,874	6,150,563
(4) Expected Contingencies to Allocate (Allocated with (7))	64,934	341,573	206,305	612,812
(5) Expected Losses	2,527,234	13,294,151	8,029,453	23,850,838
(6) Loss Adjustment Expense Factor	1.150	1.150	1.150	1.150
(7) Expected Losses and Loss Expenses [(5) x (6)]	2,906,382	15,288,608	9,234,073	27,429,064
(8) Expected Investment Income on Policy Reserves Percent	2.3%	2.3%	2.3%	2.3%
(9) Underwriting Profit and Contingencies [(3) + (4) - (7) x (8)]	1,107,817	3,819,982	1,200,318	6,128,117
(10) General and Other Acquisition Expense	358,640	1,886,574	1,139,460	3,384,674
(11) Variable Expense Percent	18.39%	18.39%	18.39%	18.39%
Allocation of Reinsurer Amounts				
(11) Ceded Losses at Probability of Ruin	16,230,444	46,072,835	6,606,616	68,909,895
(13) Allocation Percent [(12) / Sum(12)]	23.6%	66.9%	9.6%	100.0%
(14) Expected Profit to Allocate	1,604,014	4,553,264	652,915	6,810,194
(15) Expected Ceded Loss & LAE	844,689	2,364,562	395,002	3,604,253
(16) Additional WSST Ceded Losses & LAE	126,749	637,653	106,534	870,936
(17) Expected Losses and Loss Expenses [(15) + (16)]	971,438	3,002,216	501,536	4,475,189
(18) Expected Investment Income on Policy Reserves Percent	3.0%	3.0%	3.0%	3.0%
(19) Cost of Reinsurer Capital [(14) - (17) x (18) + (16)]	1,701,760	5,101,284	744,476	7,547,520
(20) Reinsurer Expenses [Total (20) allocated with (15)]	449,486	1,258,259	210,193	1,917,938
Summary of Expense Provisions				
(21) Compensation for Assessment Risk	138,032	1,460,843	1,165,296	2,764,171
(22) Deviation Percentage	5.0%	5.0%	5.0%	5.0%
(23) Indicated Premium [[((7) + (9) + (10) + (15) + (19) + (20)) / (1.0 - (11)) + (21)] / (1 - (22))	9,649,776	39,870,583	17,895,795	67,416,153
(24) Underwriting Profit and Contingencies (Percent) [(9) / ((23) * (1 - (22)) - (21))]	12.3%	10.5%	7.6%	10.0%
(25) Cost of Reinsurer Capital (Percent) [(19) / (23)]	17.6%	12.8%	4.2%	11.2%
(26) Reinsurer Expenses (Percent) [(20) / (23)]	4.7%	3.2%	1.2%	2.8%

Notes:

1. (1), (5), (12), (15), (16) From Simulation.
2. Sum(3) from Exhibit RB-15, Sheet 2, (17). Zone amounts from Sum and Allocation Percentage (2).
3. (4), (6), (8), (10), (11) From Exhibit RB-15, Sheet 2.
4. Sum(14) from Exhibit RB-15, Sheet 1, [(13) - (5b) + (5) x Exhibit RB-16, Sheet 1, (18)]
5. Zone amounts (14) from Sum (14) and Allocation Percentage (13).
6. Sum(20) from Exhibit RB-15, Sheet 1, (12). Zone amounts from Sum and Allocation based on (17).

NCIUA & NCJUA - North Carolina Beach Plan & Fair Plan

Summary of 2014 Catastrophe Reinsurance

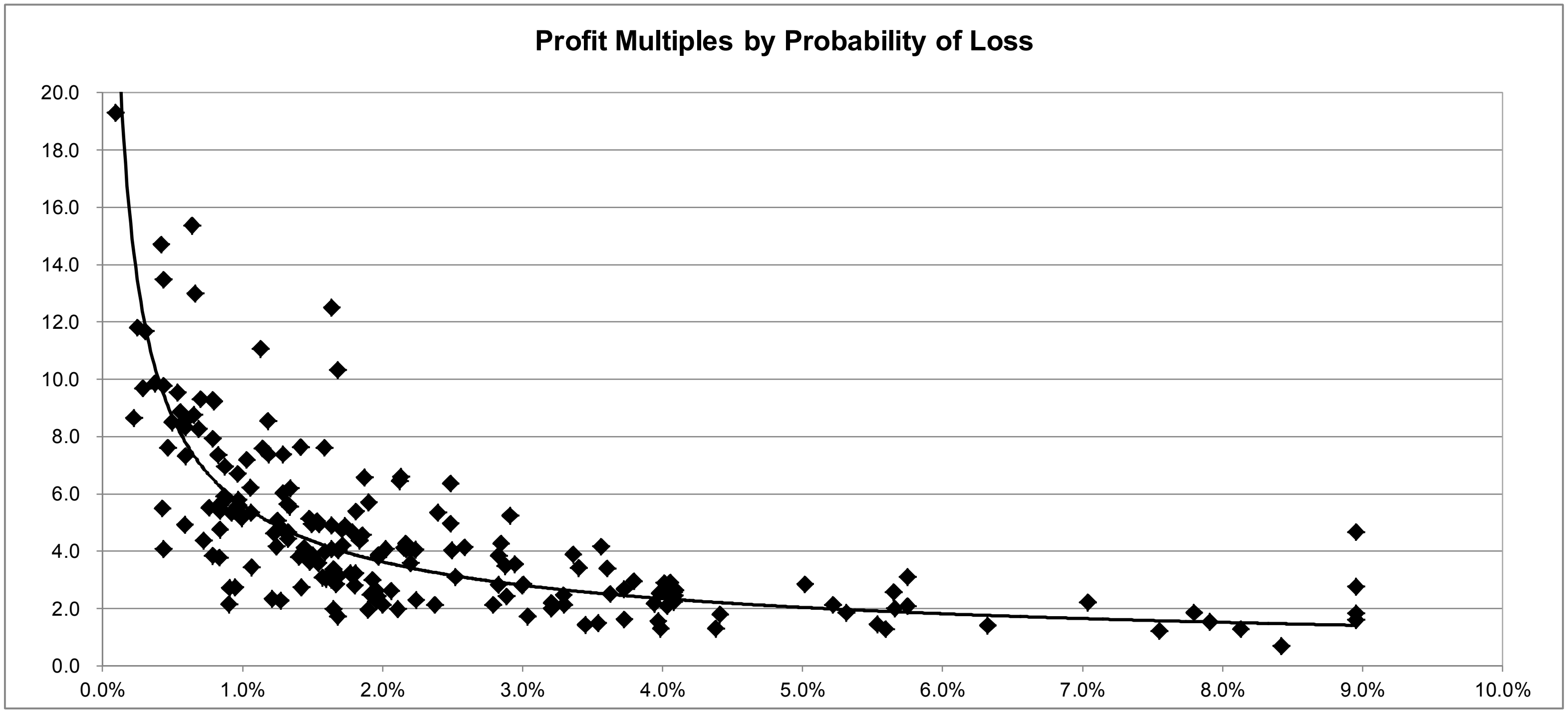
Contract [1]	Attachment Point ($ Millions)	Exhaustion Point ($ Millions)	Coverage	Reinstatement
Reinsurance Layers:				
Layer 1	$1,800.0	$1,950.0	100.0%	No
Layer 2	1,950.0	2,183.0	100.0%	No
Layer 3	2,183.0	2,324.0	100.0%	No
Layer 4A	2,324.0	2,884.0	10.7%	No
Layer 5	2,884.0	3,334.0	100.0%	No
Layer 6	3,334.0	3,715.0	100.0%	No
Layer 7	3,715.0	4,015.0	100.0%	No
Cat Bond Layer:				
Layer 4B - Tar Heel Re	$2,324.0	$2,884.0	89.3%	No
Combined Reinsurance & Cat Bond Layers:				
Layer 4A & 4B	$2,324.0	$2,884.0	100.0%	

Notes: The above reinsurance covers aggregate loss in the Beach & Fair plans combined, and for all accounts combined (Residential & Commercial)

(1) All contracts provide Annual Aggregate coverage except Layer 2, which provides Aggregate Multi-Year Drop Down coverage.
In the following exhibits, losses allocated to Layer 2 are evaluated in the same manner as the other Annual Aggregate contracts.

NCIUA & NCJUA - North Carolina Beach Plan & Fair Plan

Catastrophe Bond Profit Multiples



Source: Lane Financial LLC, Annual Securitization Reviews

Notes: Based on near-term cat bonds issued from January, 2006 to March, 2014

Includes all U.S. bonds with a probability of loss between 0.05% and 20.0%; excludes bonds with no stated profit multiples

Equation of the fitted curve: $y = 0.31009\,x^{-0.62878}$

Equation to determine average Profit Multiple over specific interval: $\text{Avg PM} = \int_a^b 0.31009\,x^{-0.62878}\,dx \,/\, (b-a)$

NCIUA & NCJUA - North Carolina Beach Plan & Fair Plan

Catastrophe Bond Profit Multiples

	Total Beach Plan & Fair Plan				
Annual Aggregate Layer (1)	Layer Attachment	Layer Exhaustion (2)	Attachment Probability	Exhaustion Probability	Profit Multiple
$0 to 1,800	$0.0	$1,800.0	49.22%	5.17%	0.83
$0 to 912	*0.0*	*912.0*	*49.22%*	*9.29%*	*0.74*
$912 to 1,800	*912.0*	*1,800.0*	*9.29%*	*5.17%*	*1.64*
$1,800 to 1,950	1,800.0	1,950.0	5.17%	4.89%	2.03
$1,950 to 2,183	1,950.0	2,183.0	4.89%	4.35%	2.14
$2,183 to 2,324	2,183.0	2,324.0	4.35%	4.07%	2.27
$2,324 to 2,884	2,324.0	2,884.0	4.07%	3.15%	2.51
$2,884 to 3,334	2,884.0	3,334.0	3.15%	2.66%	2.87
$3,334 to 3,715	3,334.0	3,715.0	2.66%	2.25%	3.19
$3,715 to 4,015	3,715.0	4,015.0	2.25%	2.00%	3.50
$4,015 & Higher	4,015.0	20,780.5	2.00%	0.01%	8.45

(1) The first layer (up to $912 million) was selected to be equal to an event that would exhaust the BP-Residential allocated surplus of $728.5 million.
The allocated surplus of $728.5 million is the BP-Residential's portion of $800 million, which is based on Guy Carpenter's estimate of the NCIUA's & NCJUA's Retained Earnings during a covered event.
The $800 million of surplus is allocated to each account based on the following amounts of members equity as of 12/31/13:
Current surplus: BP-Residential = $783.8 million; BP-Commercial = $57.7 million; FP = $19.3 million
Allocated surplus: BP-Residential = $728.5 million; BP-Commercial = $53.6 million; FP = $17.9 million

(2) The Layer Exhaustion for the highest layer was selected to be equal to the year with the greatest amount of modeled hurricane losses.

NCIUA - North Carolina Beach Plan
Residential Accounts Only

Illustration of How Hurricane Losses are Funded
Voluntary Market Assessments Limited to $1 Billion on All Beach Plan Accounts Combined
($ in Millions)

	Total Beach Plan & Fair Plan			Beach Plan:	Hurricane Losses Funded by:			
Annual Aggregate Layer	Layer Attachment	Layer Exhaustion	Total Loss in Layer	Residential Portion	Beach Plan Surplus	Private Reinsurance	Assessments on Member Companies (1)	Policyholder Surcharges
$0 to 912	$0.0	$912.0	$912.0	$728.5	$728.5	-	-	-
$912 to 1,800	912.0	1,800.0	888.0	705.5	-	-	$705.5	-
$1,800 to 1,950	1,800.0	1,950.0	150.0	119.7	-	$119.7	-	-
$1,950 to 2,183	1,950.0	2,183.0	233.0	186.0	-	186.0	-	-
$2,183 to 2,324	2,183.0	2,324.0	141.0	112.6	-	112.6	-	-
$2,324 to 2,884	2,324.0	2,884.0	560.0	447.4	-	447.4	-	-
$2,884 to 3,334	2,884.0	3,334.0	450.0	359.9	-	359.9	-	-
$3,334 to 3,715	3,334.0	3,715.0	381.0	305.0	-	305.0	-	-
$3,715 to 4,015	3,715.0	4,015.0	300.0	240.3	-	240.3	-	-
$4,015 & Higher	4,015.0	20,780.5	16,765.5	13,543.9	-	-	134.8	$13,409.1
TOTAL					$728.5	$1,770.9	$840.3	$13,409.1

(1) Total losses paid by Member Companies ($840.3 M) reflects the Residential portion of the $1 Billion Beach Plan assessment on the total Voluntary Market

NCIUA - North Carolina Beach Plan
Residential Accounts Only

Determination of the Cost of Reinsurance Provided to the NCIUA by the Voluntary Market

Voluntary Market Assessments Limited to $1 Billion on All Beach Plan Accounts Combined

($ in Millions)

Annual Aggregate Layer	Beach Plan: Residential Losses in Layer	Assessments Paid by Member Companies (1)	Expected Losses (2) Total	Expected Losses (2) Exposed (3)	Indicated Profit Multiple (4)	Cost of Providing Reinsurance (5)
$0 to 912	$728.5	-	$120.95	-	0.74	-
$912 to 1,800	705.5	$705.5	48.47	$48.47	1.64	$79.49
$1,800 to 1,950	119.7	-	6.01	-	2.03	-
$1,950 to 2,183	186.0	-	8.57	-	2.14	-
$2,183 to 2,324	112.6	-	4.75	-	2.27	-
$2,324 to 2,884	447.4	-	15.91	-	2.51	-
$2,884 to 3,334	359.9	-	10.36	-	2.87	-
$3,334 to 3,715	305.0	-	7.46	-	3.19	-
$3,715 to 4,015	240.3	-	5.13	-	3.50	-
$4,015 & Higher	13,543.9	134.8	49.62	2.57	8.45	21.71
TOTAL		$840.3	$277.23	$51.04		$101.20

(1) See Exhibit 4
(2) From AIR model
(3) Expected loss subject to Beach Plan assessments of Voluntary Market
(4) See Exhibit 3
(5) = Exposed Expected Losses x Profit Multiple (from Cat Bond data)

NCJUA - North Carolina Fair Plan
Residential & Commercial Accounts

Illustration of How Hurricane Losses are Funded
Reflecting Unlimited Industry Exposure to Fair Plan Assessments
($ in Millions)

	Total Beach Plan & Fair Plan				Hurricane Losses Funded by:		
Annual Aggregate Layer	Layer Attachment	Layer Exhaustion	Total Loss in Layer	Fair Plan Portion	Fair Plan Surplus	Private Reinsurance	Assessments on Member Companies
$0 to 912	$0.0	$912.0	$912.0	$17.9	$17.91	-	-
$912 to 1,800	912.0	1,800.0	888.0	80.3	-	-	$80.3
$1,800 to 1,950	1,800.0	1,950.0	150.0	8.0	-	$8.0	-
$1,950 to 2,183	1,950.0	2,183.0	233.0	12.5	-	12.5	-
$2,183 to 2,324	2,183.0	2,324.0	141.0	7.6	-	7.6	-
$2,324 to 2,884	2,324.0	2,884.0	560.0	30.2	-	30.2	-
$2,884 to 3,334	2,884.0	3,334.0	450.0	24.3	-	24.3	-
$3,334 to 3,715	3,334.0	3,715.0	381.0	20.6	-	20.6	-
$3,715 to 4,015	3,715.0	4,015.0	300.0	16.3	-	16.3	-
$4,015 & Higher	4,015.0	20,780.5	16,765.5	918.6	-	-	918.6
TOTAL					$17.9	$119.4	$998.9

NCJUA - North Carolina Fair Plan
Residential & Commercial Accounts

Determination of the Cost of Reinsurance Provided to the NCJUA by the Voluntary Market

Reflecting Unlimited Industry Exposure to Fair Plan Assessments
($ in Millions)

Annual Aggregate Layer	Fair Plan Losses in Layer	Assessments Paid by Member Companies (1)	Expected Losses (2) Total	Expected Losses (2) Exposed (3)	Indicated Profit Multiple (4)	Cost of Providing Reinsurance (5)
$0 to 912	$17.9	-	$4.12	-	0.74	-
$912 to 1,800	80.3	$80.3	7.48	$7.48	1.64	$12.27
$1,800 to 1,950	8.0	-	0.40	-	2.03	-
$1,950 to 2,183	12.5	-	0.58	-	2.14	-
$2,183 to 2,324	7.6	-	0.32	-	2.27	-
$2,324 to 2,884	30.2	-	1.07	-	2.51	-
$2,884 to 3,334	24.3	-	0.70	-	2.87	-
$3,334 to 3,715	20.6	-	0.50	-	3.19	-
$3,715 to 4,015	16.3	-	0.35	-	3.50	-
$4,015 & Higher	918.6	918.6	3.37	3.37	8.45	28.44
TOTAL		$998.9	$18.89	$10.85		$40.71

(1) See Exhibit 6
(2) From AIR model
(3) Expected loss subject to Fair Plan assessments of Voluntary Market
(4) See Exhibit 3
(5) = Exposed Expected Losses x Profit Multiple (from Cat Bond data)

NCIUA & NCJUA - North Carolina Beach Plan & Fair Plan
Residential Accounts Only

Determination of the Compensation for Bearing the Risk of Beach Plan & Fair Plan Assessments
($ in Millions)

(1) Cost of Reinsurance Provided by the Voluntary Market to the Residential Accounts in the NCIUA (Beach Plan):	$101.20
(2) Cost of Reinsurance Provided by the Voluntary Market to the NCJUA (Fair Plan):	$40.71
(3) Residential Premium as % of Total Fair Plan Assessment Base:	70%
(4) Cost of Reinsurance Provided by the Voluntary Market to the Residential Accounts in the NCJUA (Fair Plan):	$28.49
(5) Total Cost of Reinsurance Provided by the Voluntary Market to the Residential Accounts in the NCIUA & NCJUA:	$129.69

	(6)	(7) = (6) / Total (6)	(8) = (5) x (7)	(9) = (8) / (6)
Policy Form	Estimated 2014 Industry Written Premium @ Manual Rates	% of Total Industry Premium	Allocated Compensation for Risk of Assessment	Compensation for Assessment Risk as % of 2014 Manual Premium
Homeowners	$2,450.6	83.5%	$108.32	4.4%
Dwelling Fire & EC	334.7	11.4%	14.79	4.4%
MobileHome	148.7	5.1%	6.57	4.4%
Total	$2,934.1	100.0%	$129.69	4.4%

(1) From Exhibit 5
(2) From Exhibit 7
(4) = (2) x (3)
(5) = (1) + (4)
(6) Industry Premium includes NCIUA and NCJUA"