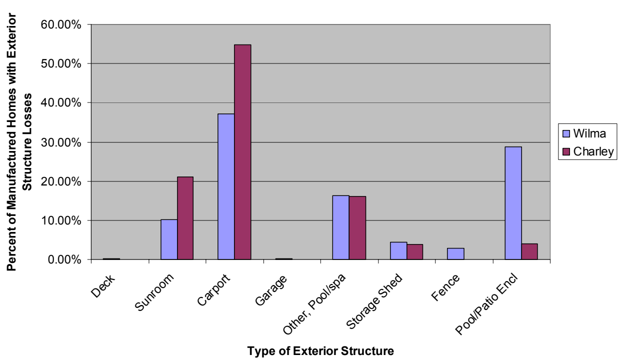
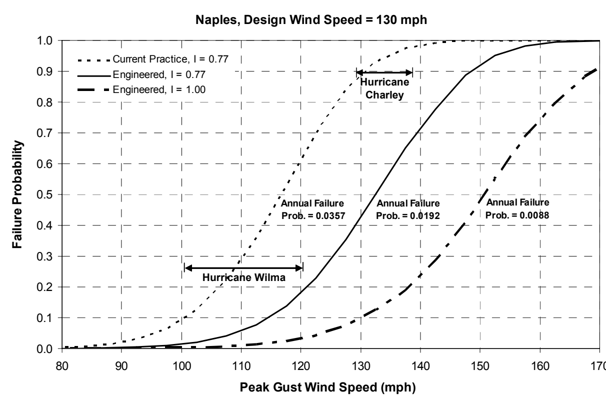
May 1, 2007

Final Report

Evaluation and Report on the Insurability of Attached and Free Standing Structures





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EXECUTIVE SUMMARY

The work described herein should be qualified as an initial research project on a complicated, large-scope problem. The findings should be considered preliminary, as more research is needed to develop effective long-term solutions to loss and insurability issues of exterior structures.

For purposes of this report, we will refer to residential attached and detached structures as "exterior" structures, meaning that these structures are "exterior" to the main dwelling.

The main findings of this research project on exterior structures include:

1. Exterior structures are common throughout Florida, averaging about one exterior structure per site-built home and almost three per manufactured home.
2. Exterior structures comprise a significant amount of the value of the average Florida home. Preliminary estimates from this study indicate that exterior structures average about 10.3% of the Coverage A insured value for site-built homes. For manufactured (mobile) homes, exterior structures average about 19% of the Coverage A insured value. The distributions of these data are skewed due to the fraction of homes that do not have exterior structures.
3. Exterior structures have widely varying building characteristics, are highly vulnerable to hurricane damage, can damage the dwelling at attachment points when they fail, and also provide a source of wind-borne debris upon failure.
4. Aluminum structures (patio enclosures and carports) are an important contribution to the total losses experienced in Florida hurricanes for both site-built and mobile homes.
5. Initial empirical estimates of insurance loss cost factors (loss costs of exterior structures divided by loss cost of dwelling) are about 2.1 for site-built single family homes and about 1.3 for mobile homes. More work is needed to confirm these crude estimates.
6. Exterior structures are generally classified as Category I structures in the ASCE 7 national standard and are not designed to the same loads as the dwelling (Category II structure). The importance factor on the design loads for Category I structures is 0.77 *vs.* 1.0 for Category II structures. Hence, based on past design approaches, exterior structures should be expected to fail at lower windspeeds than the dwelling.
7. The engineering design approaches, building department review, and construction quality for aluminum exterior structures have not been adequate, regardless of the importance factor. The use of "master file engineering" has been the predominate approach in the industry.
8. Building departments need to do a better job of reviewing the designs and inspecting aluminum structures in the field.
9. Failure of aluminum structures (enclosures and carports) is generally catastrophic, requiring total replacement.

10. Consumer-owners of aluminum structures that have failed appear to be frustrated and have been economically impacted by the poor performance of these structures.
11. The aluminum industry has been working to address known deficiencies by developing an updated guide. Both training and certification of engineers and contractors are also needed.
12. New and complementary research is also needed to further improve industry design guidance and confirm design performance/survivability of aluminum structures.
13. Hurricane losses from exterior structures (aluminum structures, in particular) are a significant problem in Florida due to: the large number and relatively high value of exterior structures; high hurricane wind hazard in most regions of the state; the use of a reduced importance factor in design; inadequate engineering designs for many structures; and poor construction practices by some contractors.
14. The potential reduction in loss costs for exterior aluminum structures properly designed and built to newly developed standards (resulting from a research program) is estimated to more than a factor of 4 to 5. Achieving such reductions would tend to solve the major insurability issues with these structures in Florida.
15. Benefit-cost analysis shows that the benefits of loss reduction far outweigh the estimated increased costs of constructing these structures to improved standards. Preliminary benefit-cost ratios greater than two were computed, indicating that design/construction improvements are economically justified.
16. Preliminary statewide estimates of the net present value of savings (loss reduction benefits minus costs of improved designs for new structures) resulting from improved standards were calculated as $857 million for aluminum pool/patio enclosures alone. Additional savings would be expected for improved standards for attached aluminum carports and enclosures for mobile homes.
17. Long term solution to the insurability problem for aluminum structures requires further research to: improve the design loads; conduct full-scale testing to verify design performance; evaluate mitigation options for existing structures; update and verify design guides; and develop training programs/certification requirements for engineers and contractors.
18. An effort is also needed to address terminology issues and make structure classifications in homeowner insurance contracts more consistent with building code requirements.

Section 6 provides more detailed discussion of the project summary and recommendations. The reader is urged to review the individual sections of the report and not to generalize or assume the results herein are more than “preliminary”.

1. INTRODUCTION

1.1 Background

Section 38 of Senate Bill 1980 in the 2006 Florida Legislative Session required the Office of Insurance Regulation (OIR) to submit a report on the insurability of attached and freestanding structures. Structures that are commonly attached to site-built residential homes in Florida include pool/patio enclosures, garages, carports, and sunrooms. Structures that are commonly attached to manufactured homes (mobile homes)[1] in Florida include carports, screen enclosures, and storage areas. Detached and freestanding residential structures commonly include storage sheds, garages, guest houses, pool houses, fences, and gazebos. For purposes of this report, we will refer to the attached and detached structures as "exterior" structures, meaning that these structures are "exterior" to the main dwelling and are not part of the main dwelling.

Exterior structures have widely varying building characteristics and generally have received much less attention in terms of engineering design details. Exterior structures are highly vulnerable to hurricane damage, including damage from direct wind pressure, wind-borne debris, and wind induced tree fall. When they fail, their components readily become wind-borne debris and can produce further damage down wind to dwellings and people. If attached to the main dwelling, the failure of an exterior structure can cause damage to the main dwelling or even initiate a cascading failure of the main dwelling (by producing a breach of the building envelope with resulting internal pressurization). In coastal locations, exterior structures are also vulnerable to storm surge damage (coastal flooding resulting from hurricane-driven storm surge).

The Florida hurricanes of 2004 and 2005 produced significant damage to both residences and exterior structures. However, in some cases, post-storm investigations suggested that exterior structures were observed to be damaged to a much higher level that the main dwelling. If the value of an exterior structure is relatively high compared to the value of the dwelling, then premature failure of the exterior structure may have a significant impact on losses, loss costs, and insurability.

Some of the basic questions on exterior structures include:

1. What types of exterior structures are most common?
2. What types of exterior structures have the highest value relative to dwelling value?
3. Are the building codes adequate for exterior structures?
4. Have exterior structures been designed and constructed properly to the building code requirements?
5. How can we mitigate existing exterior structures that are highly vulnerable to damage in future windstorms?
6. How do the loss costs of exterior structures compare to the loss costs of dwellings?

[1] Manufactured homes (mobile homes) are built to federal HUD standards and are regulated in Florida by the DHSMV. We use the terms "manufactured home" and "mobile home" interchangeably in this report. Note that modular homes are built to the FBC and must be installed on permanent foundations (just like site-built homes).

7. If the loss costs of certain exterior structures are much higher than the main dwelling and the exterior structures have high value relative to the value of the dwelling, what is the fairest way to design insurance options?
8. If certain exterior structures are not insurable, what are the impacts on the homeowner of not having insurance?

These questions are complicated by the wide variety of types of attached and detached residential structures and the fact that insurance losses for attached structures are generally buried in the Coverage A losses. That is, the losses for attached structures are not generally coded separately, and hence not easily separated and analyzed in terms of loss costs. Further, insurers generally do not know what their exposure is for these structures since they generally do not perform a separate value estimation.

1.2 Objective and Scope

The objective of this study is to produce a public domain report that addresses basic questions on exterior structures as they relate to wind damage/loss and insurance issues.

The scope of the work focuses on hurricane wind damage. Coastal flooding damage is not considered.

The schedule for the work has been highly compressed. The data collection tasks were designed within the budget available. The conclusions and findings are also limited by the availability and quality of data from past storms, including insurance data and engineering field data.

The scope of the engineering and building code review has been limited to a high-level review of structural performance. Detailed engineering analysis and design has not been attempted in this project.

Mitigation approaches are suggested only at a high level. Detailed mitigation approaches, including engineering design, costs estimation, and loss reduction potential will require further study.

Wind speed estimates of past hurricanes that are included in this work are limited to previous research/publications. These wind speeds are subject to estimation and measurement errors and have limited validation with known anemometer records. No new research has been attempted herein to further estimate hurricane wind speeds.

Legal issues associated with potential inadequate designs and/or poor construction quality are not addressed in this report. Failures of structures are complicated and require substantial forensic efforts to determine cause and effect. The observations and conclusions of structural performance herein are of a general nature and are not intended to assign blame or fault with any one industry or individual.

This project is the first of its kind in Florida, and likely nationwide. Hence, it needs to be viewed as a work in progress as opposed to a mature area of research.

1.3 Technical Approach

The technical approach involved five tasks, as illustrated in Figure 1-1. Tasks 1, 2, and 3 were conducted in parallel efforts.

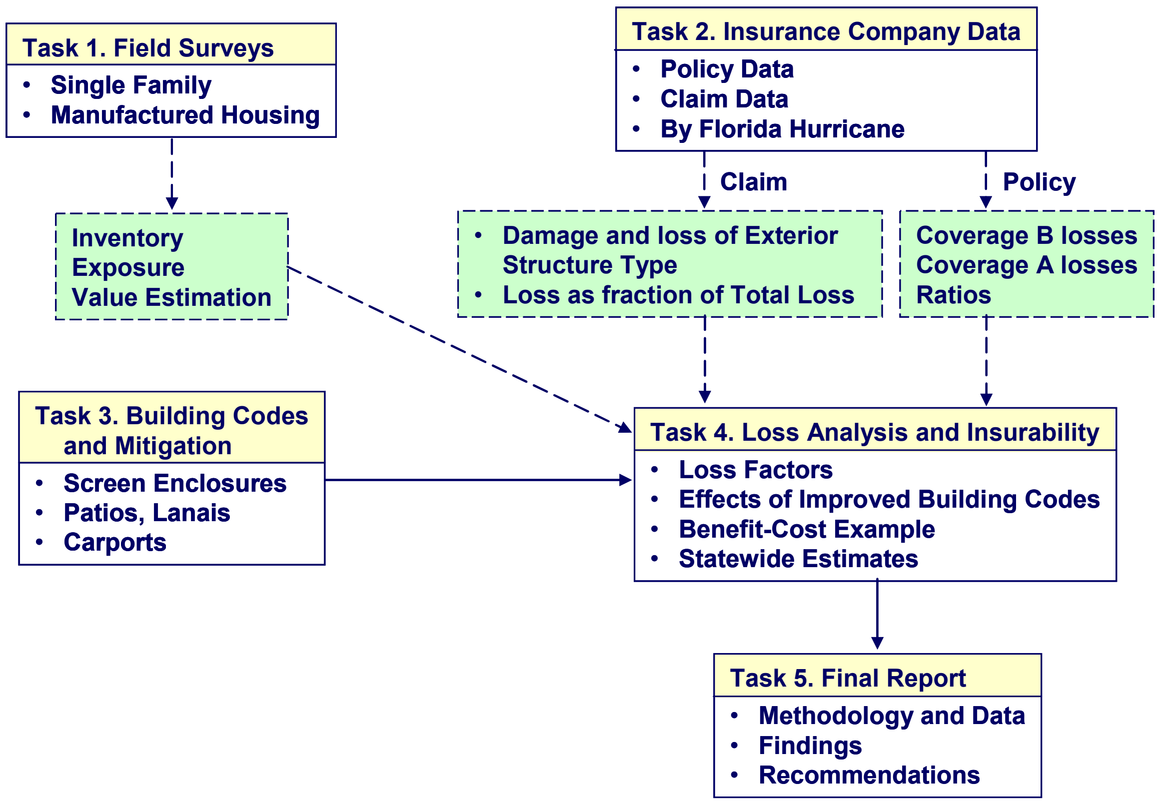


Figure 1-1. Exterior Structure Research Tasks.

The first task involves conducting a field survey to determine the types, construction characteristics, and frequencies of exterior structures. The scope of the field survey was limited to hundreds of surveys for the site-built single-family homes and manufactured homes. This type of data is needed to quantify the amount of exposure for exterior structures in Florida. However, due to budget and time limitations, these surveys must be viewed as providing approximate, initial estimates for exterior structures. No attempt was made in this initial project to collect and analyze tax record information or real estate data to support the field surveys performed in this project.

Task 2 involves collecting and analyzing insurance company data. This task was done with the help of the OIR. We collected both policy level data and detailed claim data. This data is used in anonymous form to help us understand what exterior structures are being damaged and what the losses are for different exterior structure types.

Task 3 involves an evaluation of building codes/mitigation for exterior structures. Since most exterior structures are governed by building codes, the vulnerability of exterior structures to hurricane damage and loss is directly related to the strength of the structure and its vulnerability to wind damage. Understanding the building code is essential to developing mitigation approaches to these types of structures and identifying needed code changes.

Task 4 involves integrating the results of the first three tasks to address short and long term feasibility issues. Preliminary loss factors are estimated for certain types of exterior structures. The effects of potential code improvements are analyzed in terms of loss cost reductions and insurability.

The findings and recommendations are developed in Task 5.

1.4 Organization of the Report

This report is organized according to task. Sections 2, 3, 4, and 5 cover Tasks 1 through 4, respectively. The summary and recommendations are included in Section 6. Section 7 includes references and the Appendices include survey forms and other data.

2. FIELD SURVEYS OF EXTERIOR STRUCTURES

2.1 General

Field surveys were conducted under this project in order to gather information on types, frequencies, and construction characteristics of exterior structures. Two separate surveys were performed: single family site-built homes and manufactured housing. Within the budget and time constraints of this project, we were able to survey 765 single-family site-built homes and 455 mobile homes.

The single family survey was performed as add-on surveys to My Safe Florida Home (MSFH) surveys and to insurance mitigation discounts inspections. This approach was the only practical and economic way to perform the survey for this project. An advantage of this approach is that insured value information was available for every home surveyed. However, the survey does not represent a scientifically-developed statistical design.

The manufactured housing survey was set up by contacting several insurers to get lists of mobile home parks in which they had a large number of insureds. The concept was to survey parks where we could match up the mobile home with an insured value on a high percentage of the homes. Due to time constraints, we were not able to get lists and identify individual homes to survey prior to the field work. This survey does not constitute a scientific sampling approach. However, the parks were selected from a list in a random fashion.

We developed definitions of attached and detached exterior structures for purposes of the surveys. The decision tree in Figure 2-1 illustrates the approach that we used to help our inspectors and engineers conduct the survey in a consistent manner. We defined a structure as an exterior structure if it is not covered by the same roof structure as the dwelling (Question 1 in Figure 2-1). The determination of attached vs detached follows from Question 2, “Are there structural connections to the house at the wall, roof surface, eave/fascia, or soffit?” Photos of examples are included in Figure 2-1 and enlarged photos with further description are shown in Figure 2-2.

These definitions of exterior structures were developed from a engineering. Insurance companies may define attached and detached in different ways, as will be discussed further in Section 5.

The following sections present preliminary information on the field surveys. The analysis of the data is not complete at this time.

2.2 Survey of Exterior Structures on Site-Built Housing

2.2.1 Survey Method

A survey of exterior structures on a sample of site-built homes in the state of Florida was conducted in January and February 2007. The survey was carried out by ARA inspectors while they were performing as a part of ARA’s windstorm evaluation service. The primary inspections

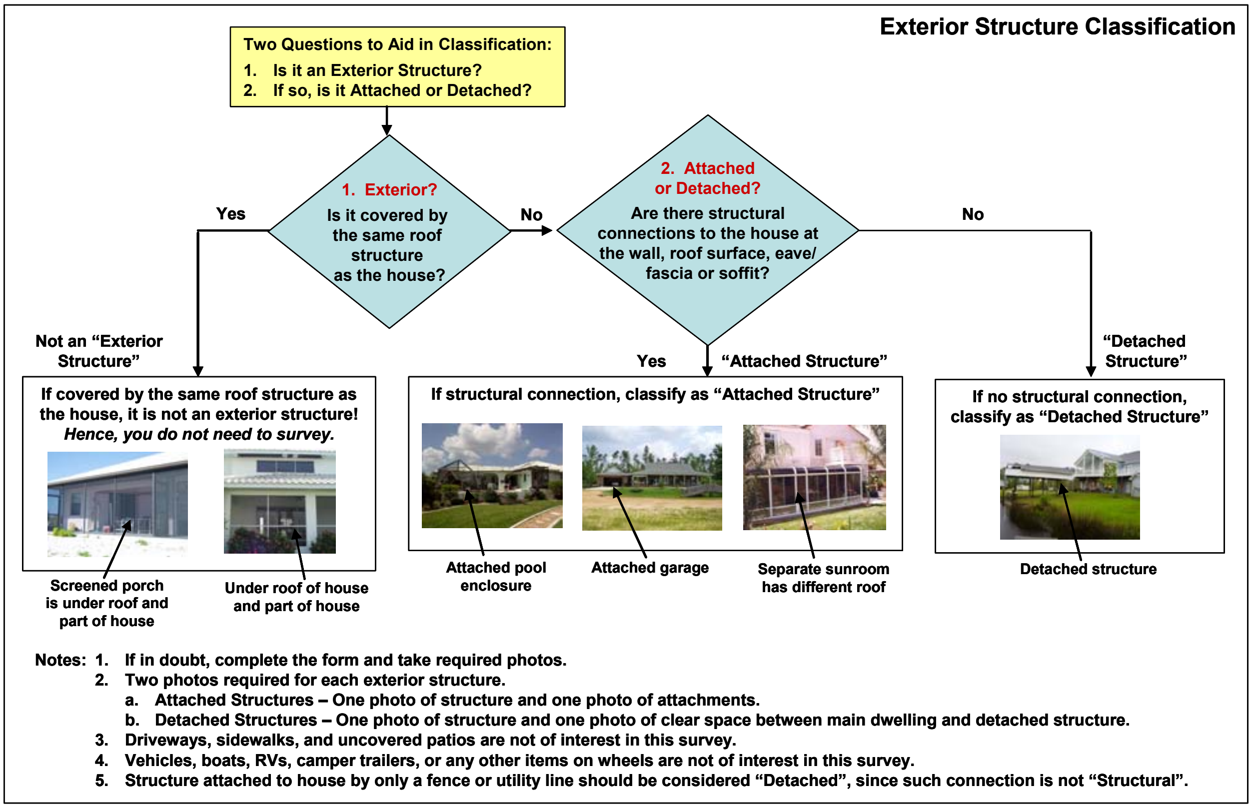


Figure 2-1. Exterior Structure Classification Approach for Field Surveys.

were being completed for individual homeowners and for the State of Florida as part of the My Safe Florida Home Program. The windstorm evaluation inspections focus on the structure of the home itself and not the exterior structures. For inspections completed in January and February, the ARA inspectors completed an additional survey form relating directly to the exterior structures on the property as well as providing photographs of the exterior structures.

Figure 2-3 shows the zip code locations of single family homes surveyed under this project. The data compiled from the survey is used to develop statistics to describe the in situ inventory of exterior structures for site-built homes. The characteristics of the exterior structures are also used as a basis for estimating the replacement value of these structures.

The exterior structure surveys that were completed in conjunction with the My Safe Florida Home Program inspections have the added benefit of having the coverage A insured value available for comparison to the estimated replacement value of each home's exterior structures.

Exterior structure survey forms were completed for 765 homes.

Figure 2-2. Exterior Structure Definitions and Examples.

2.2.2 Survey Form

The exterior structure survey form that was used as an addendum to the windstorm evaluation inspections consisted of three sections. The first section of the form is used to capture the characteristics of any structures that are attached to the outside of the home. The second section is used to capture the characteristics of any structures that are detached from the home, but still on the home's premises. Structure types documented in the first two sections include carports, pool/patio enclosures, garages, sunrooms, storage sheds, open structures, decks, guest houses, and pool houses. The third section is used to document the presence of other non-building structures including fences, docks, pools, spas, and playsets.

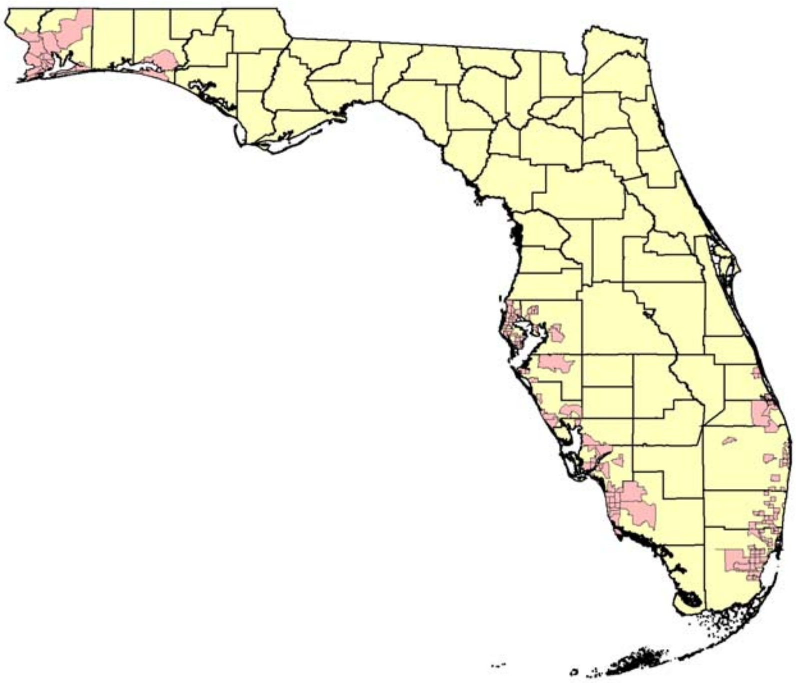


Figure 2-3. Zip Codes where Single-Family Exterior Structure Surveys were Completed.

Characteristics of exterior structures that are documented on the survey form include structure type, year built, wall structure and cover materials, roof cover materials, length, width, number of stories, foundation type, cost estimation class and condition.

A copy of the survey form used is provided in Appendix A of this report.

The following subsections describe the most common types of exterior structures observed during the survey process. Example photos are included for pool/patio enclosures, storage sheds, garages, and open structures.

Pool/Patio Enclosures. Pool/patio enclosures are generally framed in aluminum and are enclosed with screening material. Figure 2-4 shows examples of typical pool/patio enclosures observed during the survey process.

Storage Sheds. Storage sheds are commonly found detached from site-built homes. Figure 2-5 shows several examples of detached storage sheds as seen as part of the survey.

Garages. Figure 2-6 shows two examples of detached garages documented by the survey.

Open Structures. Open structures resemble carports in that they are just roofs supported over an open area like a patio, walkway, or breezeway. Two examples of open structures documented during the survey can be seen in Figure 2-7. Open structures form a special class of structures in terms of design requirements.

Figure 2-4. Examples of Pool/Patio Enclosures Observed During the Survey.

2.2.3 Survey Results

Survey results are presented in the form of statistics developed from the survey forms to describe the exterior structures observed. In total, 658 exterior structures (this total does not include fences, docks, pools, spas, or playsets) were observed on the 765 homes surveyed. This works out to about 0.86 exterior structures per home. Figure 2-8 shows the number of exterior structures observed per home by zip code. Just over half of the exterior structures surveyed (54%) were attached to homes and the remainder were detached.

Survey results presented in the following subsections provide greater detail on the results of this survey. The results are broken down by the attached and detached structures captured in the first two sections of the survey form as discussed above, and a third section that included fences, docks, pools, spas, and playsets.

Frequency. Attached and detached structures are the main focus of this study. Table 2-1 provides a summary of the percentage of homes with the various types of exterior structures observed, the percentage of each type that were attached structures (as opposed to detached), and the average area of the structures. As indicated in the table, the most common exterior structures observed were pool/patio enclosures and storage sheds. Nearly one in three of the homes surveyed had attached pool/patio enclosures and nearly one in four had a detached storage shed.

Figure 2-5. Examples of Detached Storage Sheds Observed in the Survey.

Figure 2-6. Examples of Detached Garages Observed in the Survey.

Economy Class and Condition. Tables 2-2 and 2-3 show how cost estimation class and structure condition break down by structure type for the exterior structures observed in the survey. Most exterior structures fall into the "standard" class with 20 to 30% falling into the "custom" class or better (except for storage sheds and carports). The cost estimation class is used to estimate values. From Table 2-3, we see that most exterior structures were in average to good condition.

Figure 2-7. Examples of Open Structures Observed in the Survey.

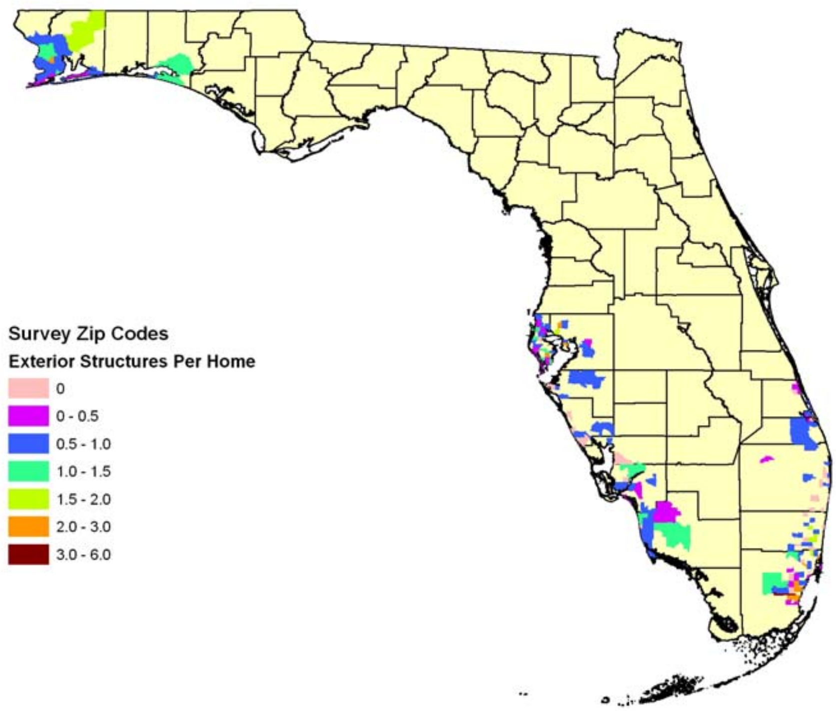


Figure 2-8. Number of Exterior Structures per Home by Zip Code.

Patio Enclosures and Storage Sheds. Additional information on pool/patio enclosures and storage sheds was extracted from the database because they represent the most common exterior structures in the survey. Eighty-two percent of the pool/patio enclosures have screen wall covering only and 91% of them are framed in Aluminum. Seventy-two percent of the pool/patio enclosures have screen roofs, 11% have metal roofs and 9% have shingle roofs.

Storage sheds, on the other hand, are most likely to have aluminum wall covering (45%), followed by wood (28%) and vinyl (10%). The wall structure materials of storage sheds were commonly found to be either wood (44%) or metal/aluminum (42%). Roofs of storage sheds

Table 2-1. Percent of Homes, Percent Attached, and Average Area of Exterior Structures by Structure Type

Structure Type	Percent of Homes with…	Percent Attached	Average Area (SF)
Pool/Patio Enclosure	31.1%	99.2%	989
Storage Shed	23.9%	2.4%	135
Garage	5.2%	63.4%	693
Open Structure	4.8%	10.0%	396
Sunroom	4.1%	28.1%	262
Other	3.1%	100.0%	1,002
Carport	3.0%	60.0%	440
Deck	1.4%	75.0%	526
Guest House	1.2%	60.0%	497
Pool House	0.3%	50.0%	525

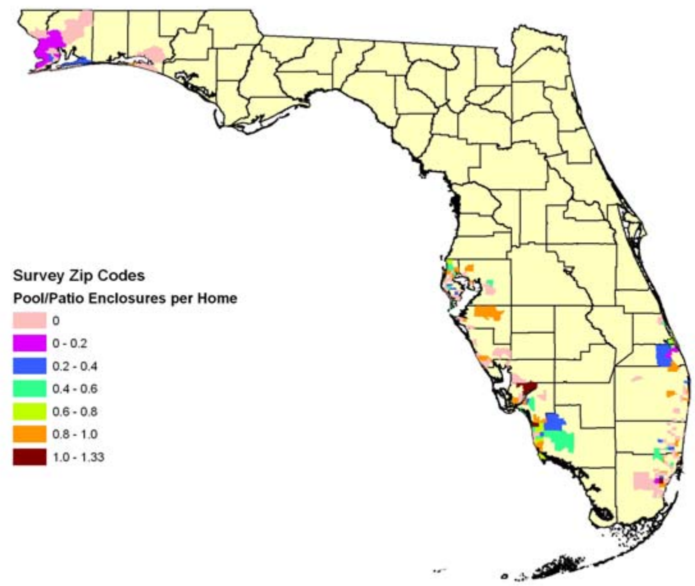
Table 2-2. Percentage of Exterior Structures in Each Cost Estimation Class by Structure Type

Structure Type	Percentage of Exterior Structures in Cost Estimation Class			
	Economy	Standard	Custom	Luxury
Pool/Patio Enclosure	4%	67%	28%	1%
Storage Shed	25%	67%	7%	1%
Garage	8%	67%	26%	0%
Open Structure	17%	61%	22%	0%
Sunroom	6%	66%	28%	0%
Other	38%	22%	31%	9%
Carport	32%	56%	12%	0%
Deck	0%	50%	50%	0%
Guest House	0%	30%	70%	0%
Pool House	0%	0%	100%	0%

Table 2-3. Percentage of Exterior Structures in Each Condition Class by Structure Type

Structure Type	Percentage of Exterior Structures by Condition		
	Poor	Average	Good
Pool/Patio Enclosure	2%	27%	71%
Storage Shed	11%	64%	26%
Garage	5%	38%	58%
Open Structure	12%	41%	46%
Sunroom	0%	56%	44%
Other	6%	59%	34%
Carport	8%	48%	44%
Deck	8%	83%	8%
Guest House	0%	20%	80%
Pool House	0%	50%	50%

tended to be either metal (50%) or shingle (32%). Figure 2-9 shows the number of pool/patio enclosures and storage sheds per home by zip code. The survey is too scattered and focused on the coast to draw any significant conclusions on geographic trend. House value is likely to be a more significant variable in correlating frequency of screen enclosures.



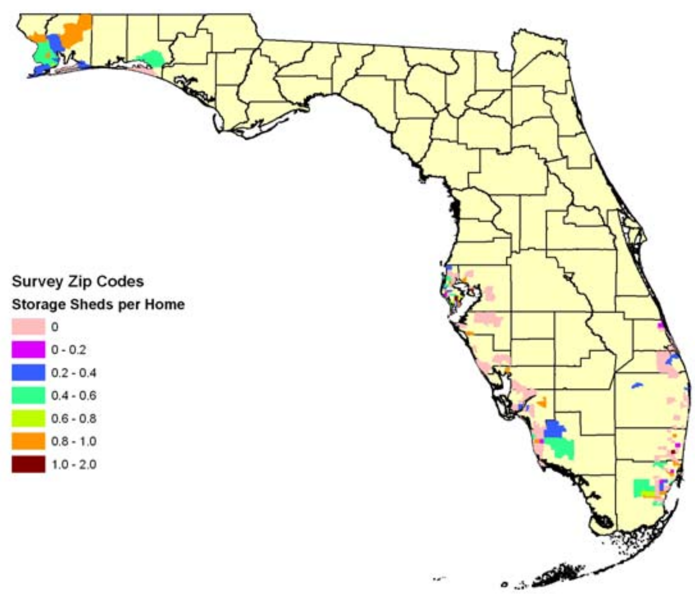


Figure 2-9. Number of Pool/Patio Enclosures (top) and Storage Sheds (bottom) per Home by Zip Code.

Other Structures. Other structures that were documented in the third section of the survey form include non-building structures including fences and walls, pools, spas, docks, and playsets. Table 2-4 shows the percentage of all homes where these structures were observed on homes. Table 2-5 breaks out the distribution of cost estimation class of these other structures by structure type.

Table 2-4. Percent of Homes with Non-Building Structures by Structure Type

Structure Type	Percent of Homes with…
Fence/Wall	45.5%
Pool	28.8%
Spa	11.5%
Dock	4.4%
Playset	3.0%

Table 2-5. Percent of Other Non-Building Structures in Each Cost Estimation Class by Structure Type

Structure Type	Percent of Exterior Sturctures			
	Economy	Standard	Custom	Luxury
Fence/Wall	10.3%	74.6%	13.6%	1.5%
Dock	2.9%	41.2%	55.9%	0.0%
Pool	1.4%	50.2%	43.8%	4.6%
Spa	1.1%	27.6%	66.7%	4.6%
Playset	17.4%	60.9%	21.7%	0.0%

Estimated Replacement Value. The data collected on the survey forms was used in conjunction with data extracted from SwiftEstimator to estimate the replacement value of the exterior structures observed in the study. SwiftEstimator is a cost estimation program available at www.swiftestimator.com. This program was used to develop square foot costs of exterior structures based on structure types, construction materials, size, and cost estimation class.

Square foot cost values were extracted from SwiftEstimator by defining a basic home with a series of exterior structures that reflect the trends observed from the survey in structure types, construction materials and methods, and dimensions. Estimates were generated for a range of cost estimation classes (measure of construction quality) and locations around the state. The square foot costs extracted are then used to estimate the value of exterior structures based on their individual characteristics and adjusted accordingly for their location within Florida.

Estimated average replacement values for each type of exterior structure are shown in Table 2-6. The values listed in this table represent the average value of all of the individual exterior structures of each type that were observed during the survey. In addition, Figure 2-10 shows a histogram of pool/patio enclosure values.

When the estimated value for all exterior structures on each home is considered, the average exterior structure replacement value per home surveyed is $22,982. Estimated exterior structure replacement values by home range from $0 (no exterior structures) to $264,717. These values include zero values for the 148 homes surveyed that did not have any exterior structures.

The average exterior structure replacement value per home surveyed with exterior structures is $28,495 (homes with no exterior structures removed). Estimated exterior structure replacement values by home with exterior structures ranges from $177 to $264,717. These values are derived from the 617 homes surveyed that had one or more exterior structures.

Table 2-6. Average Estimated Replacement Value of Exterior Structures Observed in the Survey

Structure Type	Average Value
Pool/Patio Enclosure	$29,201
Storage Shed	$1,719
Garage	$23,868
Open Structure	$5,184
Sunroom	$7,832
Carport	$5,891
Deck	$7,451
Guest House	$51,013
Pool House	$46,810
Fence/Wall	$4,388
Pool	$22,449
Spa	$5,327
Dock	$17,150
Playset	$3,584

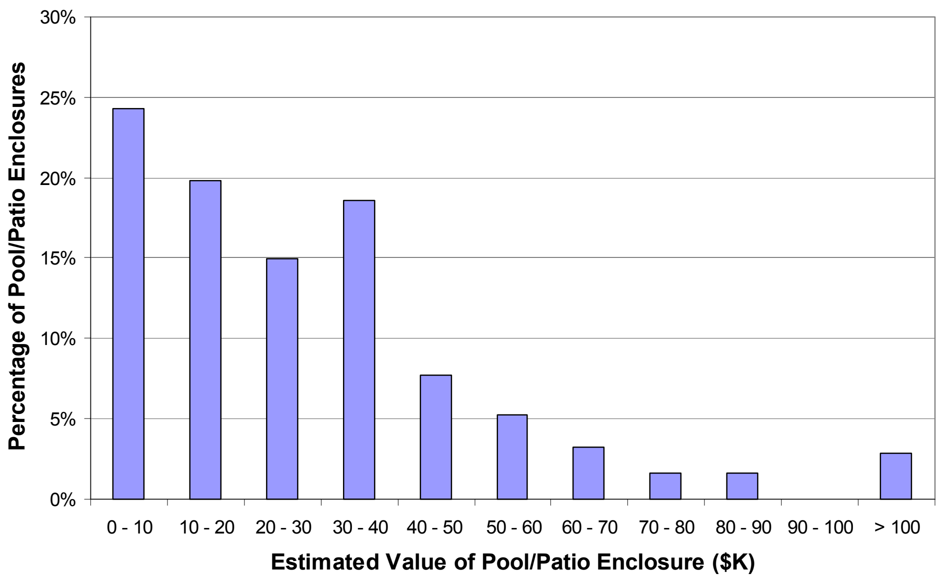


Figure 2-10. Distribution of Pool/Patio Enclosure Estimated Replacement Value.

Comparison to Insured Values. Insured values were readily available for 495 of the 765 homes surveyed. Seventy eight of the 495 homes where insured value was known do not have any exterior structures. Table 2-7 summarizes the exterior structure values and insurance values for these 495 homes.

Figure 2-11 shows the distribution of estimated exterior structure value per home as a percentage of coverage A insured value. Note that about two thirds of the homes surveyed (with insurance value) have an estimated exterior structure value of less than 10% of the Coverage A insured value of the home.

Table 2-7. Summary of Exterior Structure Value and Insured Value

Description	All Homes	Homes with Exterior Structures		Homes without Exterior Structures
Number of Homes with Insured Value Available	495	417		78
Number of Homes with Attached Structures	185	185		n/a
Number of Homes with Detached Structures	385	385		n/a
Percentage of Homes	100%	84.2%		15.8%
Percent of Homes with Attached Structures	37.4%	44.4%		n/a
Percent of Homes with Detached Structures	77.8%	92.3%		n/a
Average Exterior Structure Value per Home	$19,194	$22,785		n/a
Minimum Exterior Structure Value per Home	$0	$251		n/a
Maximum Exterior Structure Value per Home	$264,717	$264,717		n/a
Average Attached Exterior Structure Value	$7,870	$9,342	($21,058*)	n/a
Average Detached Exterior Structure Value	$11,324	$13,442	($14,560**)	n/a
Average Insured Value (Coverage A)	$186,998	$187,163		$186,114
Exterior Structure Value as Percent of Insured Value	10.3%	12.2%		n/a
Attached Exterior Structure Value as Percent of Insured	4.2%	5.0%	(11.3%*)	n/a
Detached Exterior Structure Value as Percent of Insured	6.1%	7.2%	(7.8%**)	n/a
Frequency of Attached Structure Value > 10% Insured	12.7%	15.1%		n/a
Frequency of Detached Structure Value > 10% Insured	20.6%	24.5%		n/a

* Value if only homes with attached structures considered.
** Value if only homes with detached structures considered.

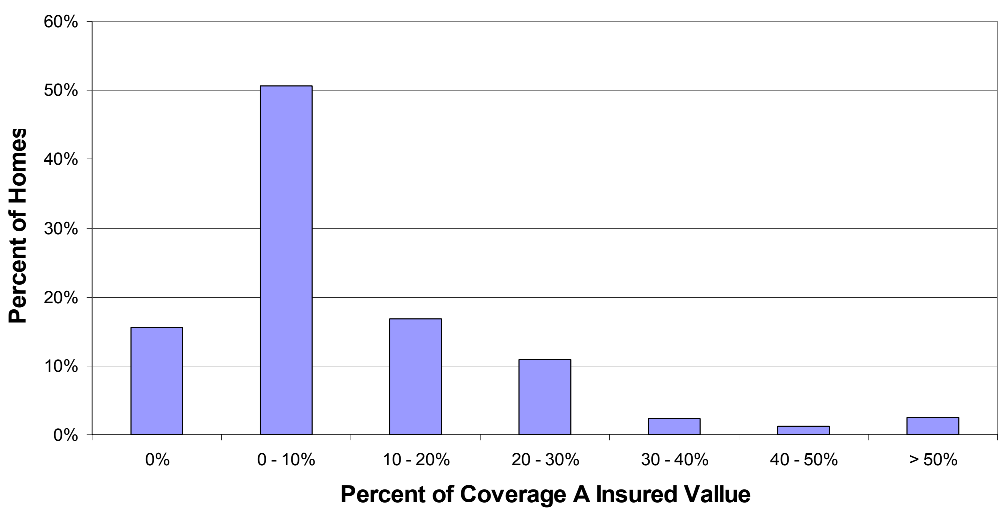


Figure 2-11. Distribution of Estimated Exterior Structure Values as a Percentage of Coverage A Insured Value.

Additional information on relationships between exterior structure replacement value and coverage A insured value can be found in Appendix B. This work is not complete at this time. We plan to use this data to estimate relative loss contributions of exterior structures in Section 5.

2.3 Manufactured Housing Survey

In addition to the survey conducted for exterior structures on site-built homes, a survey of exterior structures commonly found attached to and around manufactured homes in Florida was also conducted. While this survey had the similar goal of collecting essentially the same information at the site-built home survey, a different approach was necessary because ARA inspectors do not regularly inspect manufactured homes.

2.3.1 Survey of Exterior Structures

The manufactured home exterior structure survey was conducted by two ARA engineers during the week of January 29 to February 2, 2007. Surveys were conducted on randomly selected manufactured housing parks around the state where we were informed that insurance information would be at least partially available.

Manufactured Housing Parks Surveyed. Lists of potential parks to survey were provided by two insurance companies who write a substantial amount of manufactured homeowners insurance in Florida. These companies also agreed to provide basic policy information for the homes that they insure within these parks to create the most complete picture possible for the homes surveyed.

To make the most efficient use of the survey team's time, target counties were selected to generate a sample of homes in different areas of the state while limiting travel time between parks within the same day. Two parks within close proximity were chosen at random for surveying each day of the survey week (one for the morning, the other for the afternoon). In total, the nine manufactured housing parks listed in Table 2-8 were surveyed. This table also includes basic information on the size of the park, the number of homes surveyed, the approximate year the park was established, and whether or not the park was an age-restricted (55 plus) community.

Table 2-8. Summary of Manufactured Housing Parks Surveyed

County/Park #	# Lots	# Surveyed	Park Year	55 plus ?
Broward 1	780	37	1973	No
Broward 2	356	52	1973	No
Broward 3	269	53	1968	Yes
Miami-Dade 1	864	38	1980	No
Charlotte 1	201	46	1988	Yes
Charlotte 2	306	52	2000	Yes
Manatee 1	197	70	1995	Yes
Manatee 2	783	48	1968	Yes
Polk 1	112	59	1970	Yes

The names of the parks have been withheld to preserve the anonymity of the homes and the homeowners that participated in the survey. As such, the parks are identified by the county and a number.

The two parks surveyed in Charlotte County were also part of a Hurricane Charley damage survey in 2004. Before Charley, all of the homes in Charlotte Park 1 were manufactured between 1986 and 1992 (pre 2004 HUD Code). Approximately 100 of the 201 of the homes in this park were removed following Hurricane Charley and about 80 of those have been replaced by new manufactured homes.

The homes in park Charlotte 2 were manufactured between 1999 and 2003 (post 1994 HUD code) and experienced slightly lower wind speeds than Charlotte 1 during Charley. As a result, no homes were removed from Charlotte 2 following Charley.

2.3.2 Exterior Structure Survey Form

A standard survey form was created for this project and very much mirrored the survey form used for the site-built home exterior structure survey. The form allowed the survey team to easily record standard information about each manufactured home surveyed. A copy of the form used can be found in Appendix C. The form includes fields for:

- Home identification, location, manufacturer, and age
- Whether exterior structures are attached or detached
- Exterior structure information including:
  - Type and year built
  - Wall and roof construction materials
  - Length, width, and height
  - Foundation type
  - Quality level and condition assessment

Along with the completion of the survey form, digital photos were taken to document the homes and exterior structures surveyed. The following subsections describe the primary types of exterior structures on which the survey process was focused.

Carports. Carports are simple structures with 2 or more sides completely open and are generally found attached to the side or front of manufactured housing and are generally large enough to shelter one or two automobiles. Carports are generally covered with metal roofs that are attached to the fascia or wall of the host manufactured home along one side and are supported by a series of aluminum columns on the opposite side. Figure 2-12 contains four examples of typical arrangements of carports on manufactured homes.

Patio Enclosures. Patio enclosures are also known by other names like lanais, screened rooms, and glass enclosures. In general, patio enclosures attached to manufactured homes are founded on concrete (either on grade, or elevated via stem wall), framed with structural aluminum, and enclosed with a metal roof and either screen, glass, vinyl, or acrylic walls. Figure 2-13 shows several examples of patio enclosures observed during the survey.

Figure 2-12. Examples of Typical Carports Found Attached to Manufactured Housing.

Figure 2-13. Examples of Typical Patio Enclosures Found Attached to Manufactured Housing.

Storage Sheds. Storage sheds are commonly found both attached and detached to manufactured homes across the state. The newer parks surveyed all required that storage sheds be attached to the manufactured homes within the park. Both attached and detached storage sheds were observed in the older parks surveyed. Figure 2-14 shows examples of both attached and detached storage sheds observed during the survey process.

Figure 2-14. Examples of Typical Attached (upper photos) and Detached (lower photos) Observed During the Survey.

Open Structures. Open structures are constructed in a similar manner to carports, however, their purpose is not to protect vehicles, but rather to cover a walkway, porch, or breezeway. Examples of open structures observed attached to manufactured homes can be found in Figure 2-15.

Garages. Several manufactured homes surveyed had attached garages. On some older homes, these garages were basically carports that had been enclosed with solid walls and/or siding. Garages on newer homes tended to be originally designed as garages. Figure 2-16 shows examples of garages observed during the survey.

Decks. Two different styles of decks were observed during the survey. One type is a built-in style where the deck is founded on the chassis of the home and is covered by the roof of the home. This type is really built integrally with the home and is not attached after installation of the home. The second style is the more traditional site-built wood deck founded on embedded columns and built after the home is in place. Figure 2-17 shows examples of decks observed during the survey.

Figure 2-15. Examples of Typical Open Structures Found Attached to Manufactured Housing.

Figure 2-16. Examples of Typical Garages Observed Attached to Manufactured Homes.

2.3.3 Survey Results

A total of 1,257 exterior structures were associated with the 455 manufactured home surveyed by ARA (this total does not include fences, docks, pools, spas, or playsets). This amounts to about 2.76 exterior structures per manufactured home around the state. This is about 3 times the number of exterior structures observed on site-built homes (0.86 exterior structures per home). Figure 2-18 maps the locations of the parks surveyed and the number of exterior structures per home. Table 2-9 contains a breakdown of the number of structures observed by park and by structure type. The table indicates that homes in 8 of the 9 parks had more than 2.3 exterior structures per home, while park Broward 2 only had just over 1.5 exterior structures per home. Also, 2.45 of the 2.76 exterior structures per home are either carports, patio enclosures, or storage sheds.

Several homes surveyed included multiple exterior structures of the same type. For example, homes in park Manatee 1 have an average of 1.06 patio enclosures per home. Table 2-10 shows the percentage of homes in each park that have at least one of each type of exterior structure surveyed. In this table we see that 97.1% of the homes have at least one patio enclosure, even though that on average there are 1.06 patio enclosures per home as indicated in Table 2-9.

Table 2-11 begins to explore the attributes of the exterior structures surveyed by showing the average area of each type of exterior structure found in each park. Distributions of areas for carports and patio enclosures are shown in Figure 2-19. Table 2-12 shows a breakdown of cost estimation class of exterior structures by park and Table 2-13 shows a breakdown of exterior structure condition by park.

Figure 2-17. Examples of Typical Decks Observed Attached to Manufactured Homes.

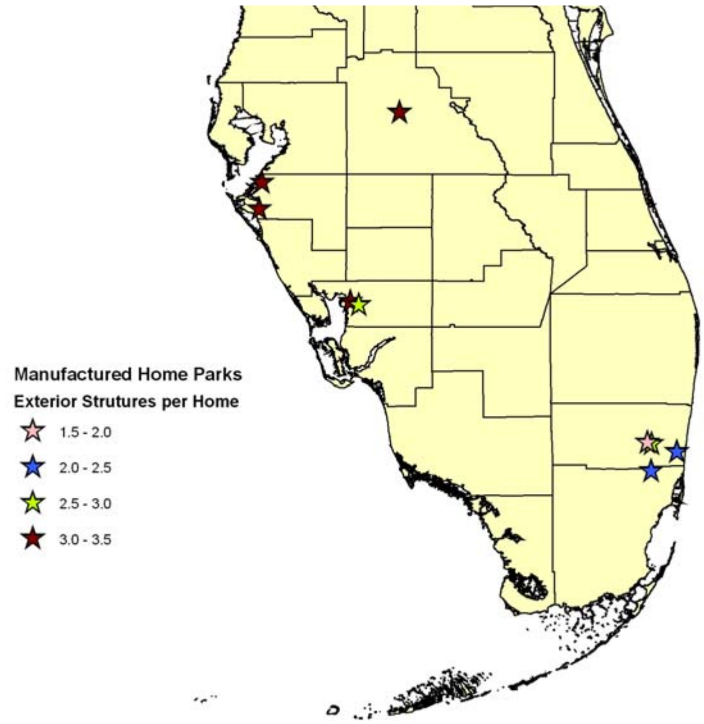


Figure 2-18. Number of Exterior Structures per Manufactured Home and Location of Manufactured Housing Parks Surveyed.

Table 2-9. Average Number of Exterior Structures per Home Surveyed by Exterior Structure Type and Manufactured Home Park

	Average Number of Exterior Structures per Home						
Park	**All Ext Struc**	**Carport**	**Patio Enclosure**	**Storage Shed**	**Open Structure**	**Garage**	**Deck**
Broward 1	2.59	1.03	0.54	0.81	0.00	0.00	0.19
Broward 2	1.54	0.19	0.54	0.67	0.08	0.00	0.06
Broward 3	2.34	0.51	0.94	0.72	0.09	0.00	0.06
Charlotte 1	3.11	0.87	1.00	0.72	0.37	0.15	0.00
Charlotte 2	2.96	0.94	1.02	0.85	0.06	0.10	0.00
Manatee 1	3.39	1.00	1.06	0.97	0.34	0.01	0.00
Manatee 2	3.06	1.02	0.67	0.92	0.38	0.08	0.00
Miami-Dade 1	2.45	0.82	0.42	0.61	0.24	0.16	0.21
Polk 1	3.10	1.00	0.98	0.83	0.29	0.00	0.00
All Parks	**2.76**	**0.82**	**0.83**	**0.80**	**0.21**	**0.05**	**0.05**

Table 2-10. Percentage of Manufactured Homes Surveyed with at Least One Exterior Structure by Exterior Structure Type and Park

	Percentage of Homes with At Least One					
Park	**Carport**	**Patio Enclosure**	**Storage Shed**	**Open Structure**	**Garage**	**Deck**
Broward 1	100.0%	51.4%	81.1%	0.0%	0.0%	18.9%
Broward 2	19.2%	48.1%	65.4%	7.7%	0.0%	5.8%
Broward 3	47.2%	83.0%	67.9%	7.5%	0.0%	5.7%
Charlotte 1	87.0%	87.0%	71.7%	34.8%	15.2%	0.0%
Charlotte 2	94.2%	96.2%	84.6%	5.8%	9.6%	0.0%
Manatee 1	100.0%	97.1%	95.7%	34.3%	1.4%	0.0%
Manatee 2	97.9%	62.5%	89.6%	35.4%	8.3%	0.0%
Miami-Dade 1	81.6%	39.5%	60.5%	23.7%	15.8%	21.1%
Polk 1	100.0%	88.1%	83.1%	27.1%	0.0%	0.0%
All Parks	**80.9%**	**75.4%**	**78.9%**	**20.4%**	**5.1%**	**4.6%**

Table 2-11. Average Area of Exterior Structure Observed by Exterior Structure Type and Park

	Average Area (Square Feet)					
Park	**Carport**	**Patio Enclosure**	**Storage Shed**	**Open Structure**	**Garage**	**Deck**
Broward 1	383	290	75	N/A	N/A	232
Broward 2	305	243	75	255	N/A	139
Broward 3	360	265	77	95	N/A	93
Charlotte 1	359	198	87	125	343	N/A
Charlotte 2	560	247	134	107	538	N/A
Manatee 1	427	171	92	147	192	N/A
Manatee 2	399	229	72	166	436	N/A
Miami-Dade 1	363	312	67	95	524	254
Polk 1	339	207	83	109	N/A	N/A
All Parks	**403**	**228**	**87**	**134**	**442**	**151**

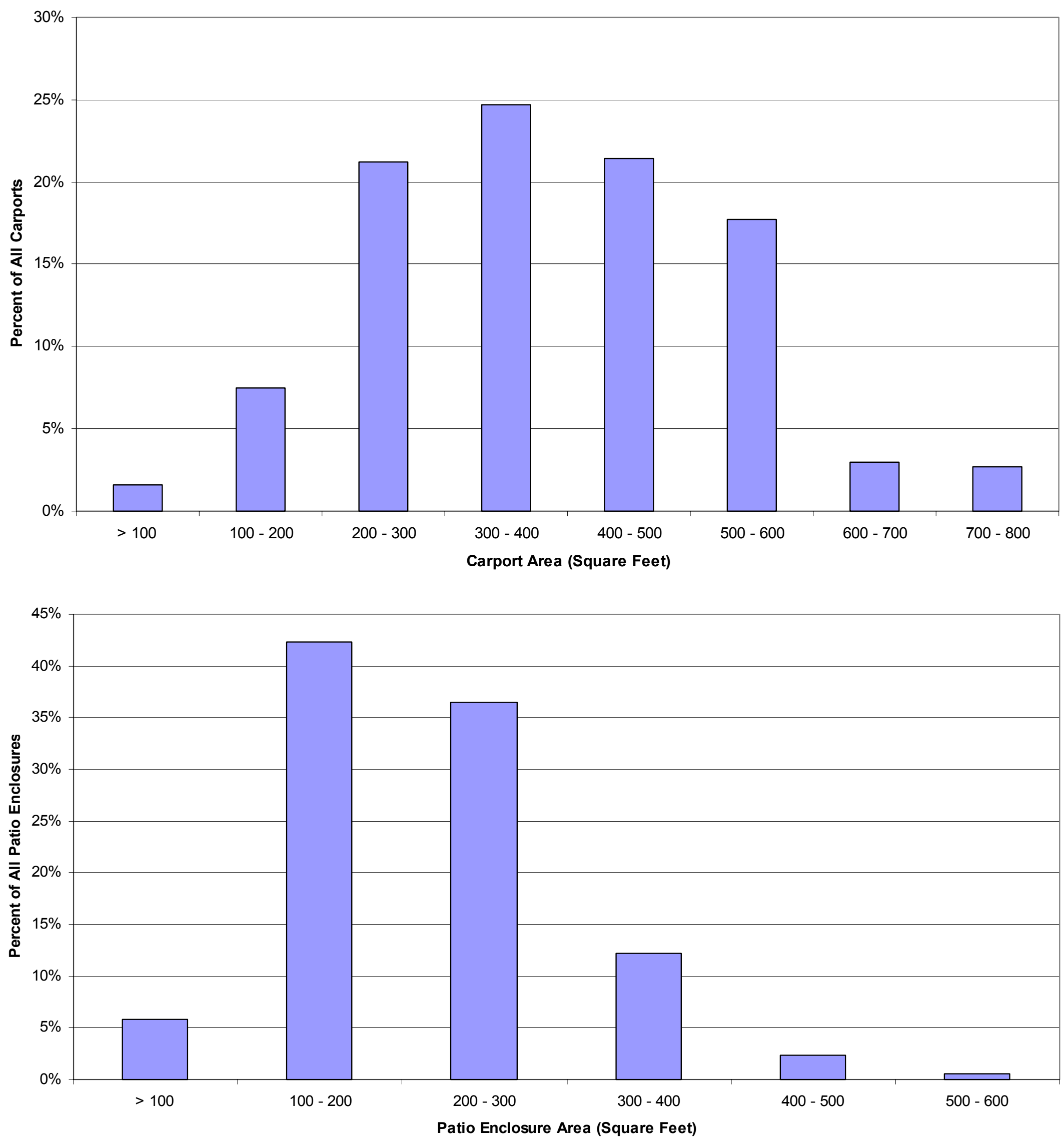


Figure 2-19. Distribution of Areas of Carports (top) and Patio Enclosures (bottom) Surveyed.

Table 2-12. Cost Estimation Class of Exterior Structures by Exterior Structure Type and Park

	Cost Estimation Class			
Park	**Economy**	**Standard**	**Custom**	**Luxury**
Broward 1	5%	95%	0%	0%
Broward 2	66%	34%	0%	0%
Broward 3	42%	57%	1%	0%
Charlotte 1	0%	96%	4%	0%
Charlotte 2	1%	79%	20%	0%
Manatee 1	0%	97%	3%	0%
Manatee 2	22%	78%	0%	0%
Miami-Dade 1	61%	39%	0%	0%
Polk 1	43%	54%	3%	0%
Total	**22%**	**74%**	**4%**	**0%**

Table 2-13. Condition of Exterior Structures by Exterior Structure Type and Park

	Exterior Structure Condition		
Park	**Poor**	**Average**	**Good**
Broward 1	1%	82%	17%
Broward 2	14%	80%	6%
Broward 3	2%	58%	40%
Charlotte 1	0%	20%	80%
Charlotte 2	0%	1%	99%
Manatee 1	0%	37%	63%
Manatee 2	0%	56%	44%
Miami-Dade 1	9%	76%	15%
Polk 1	0%	83%	17%
Total	**2%**	**51%**	**47%**

Estimated Replacement Value of Exterior Structures Surveyed

As with site-built home exterior structures, the information collected on the survey forms was used in conjunction with data extracted from SwiftEstimator to estimate the replacement value of the exterior structures observed in the manufactured home study. The square foot cost data used to estimate the values of manufactured home exterior structures was generated separately with SwiftEstimator because the program includes price adjustments for attaching structures to manufactured, as opposed to site-built housing.

Table 2-14 shows the average estimated replacement values of exterior structures by type and park. Table 2-15 contains the average sum total estimated value of all exterior structures by park.

Table 2-14. Estimated Average Replacement Value of Exterior Structures by Exterior Structure Type and Park

	Average Replacement Value of Exterior Structures					
Park	**Carport**	**Patio Enclosure**	**Storage Shed**	**Open Structure**	**Garage**	**Deck**
Broward 1	$4,565	$5,420	$1,075	N/A	N/A	$4,714
Broward 2	$3,413	$4,218	$740	$2,828	N/A	$2,859
Broward 3	$4,590	$7,395	$1,164	$1,266	N/A	$1,372
Charlotte 1	$4,494	$4,836	$1,640	$1,549	$9,917	N/A
Charlotte 2	$7,818	$6,023	$2,512	$1,674	$14,471	N/A
Manatee 1	$5,517	$4,444	$1,808	$1,933	$4,835	N/A
Manatee 2	$4,832	$6,445	$1,249	$2,022	$10,967	N/A
Miami-Dade 1	$4,506	$6,574	$1,086	$1,179	$11,586	$3,445
Polk 1	$4,002	$4,808	$995	$1,438	N/A	N/A
All Parks	**$5,075**	**$5,456**	**$1,424**	**$1,720**	**$11,304**	**$3,488**

Table 2-15. Estimated Average Replacement Value of All Exterior Structures per Home by Park

Park	Average Replacement Value
Broward 1	$9,528
Broward 2	$4,401
Broward 3	$11,214
Charlotte 1	$12,002
Charlotte 2	$17,119
Manatee 1	$12,703
Manatee 2	$12,047
Miami-Dade 1	$9,935
Polk 1	$9,969
All Parks	**$11,206**

Comparison of Estimated Replacement Values with Insured Value

Coverage A and C insured values were provided by two insurance companies for 172 of the 455 manufactured homes surveys. The estimated replacement value of the exterior structures was compared to the reported coverage A insured value for each homes where insurance information was provided. The results of this comparison are tabulated in Table 2-16. For all homes in all parks, the replacement value of exterior structures represents approximately 20% of the average coverage A insured value. The table also shows that for the three newer parks – Charlotte 1, Charlotte 2, and Manatee 1 – this percentage is slightly lower (15 – 17%), and climbs to 49% for Broward 3, one of the oldest parks surveyed.

Table 2-16. Comparison of Reported Coverage A Insurance Value and Estimated Average Exterior Structure Value by Park

	Average Values			
Park	Coverage A	Exterior Structure Replacement Value	Exterior Structure Value as Percent of Coverage A	Number of Homes with Insured Vale
Broward 1	$54,818	$10,263	18.7%	15
Broward 2	$35,614	$3,982	11.2%	29
Broward 3	$19,017	$9,343	49.1%	19
Charlotte 1	$73,424	$10,870	14.8%	9
Charlotte 2	$94,300	$16,072	17.0%	19
Manatee 1	$78,413	$12,715	16.2%	32
Manatee 2	$29,067	$9,985	34.4%	15
Miami-Dade 1	$39,880	$8,972	22.5%	8
Polk 1	$32,085	$10,709	33.4%	26
All Parks	**$50,973**	**$10,215**	**20.0%**	**172**

Figure 2-20 shows how the replacement value of exterior structures as a percentage of insured value varies with the age of the parks. Additional information on relationships between exterior structure replacement value and coverage A insured value can be found in Appendix D.

Exterior structures clearly represent a major component of value for manufactured housing. If these structured fail at a higher rate than the dwelling, then the effects on losses and insurance will be significant. These issues are discussed in Sections 4 and 5.

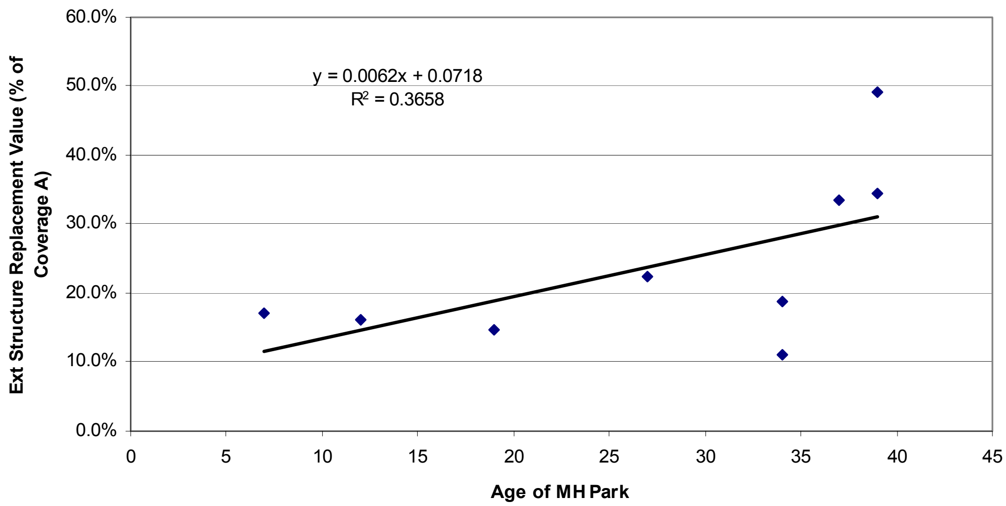


Figure 2-20. Estimated Average Exterior Structure Value as a Percentage of Reported Coverage A Insured Value versus Approximate Age of Manufactured Home Park

3. INSURANCE DATA

3.1 General

Insurance data provides a direct way to quantify coverage, damage, and loss data for the main dwelling and exterior structures. The analysis of exterior structure data requires reviewing individual claims on a home-by-home basis. Policy level (A, B, C, and D) loss data is useful to assess "other structures" included under coverage B and the relationship of wind speed to loss.

With the help of the OIR, we requested data from 10 insurance companies for use on this project. The information request included two components: (1) policy level exposure and loss information, and (2) claim folder level losses. We requested loss information for Hurricanes Wilma, Charley, Frances, Jeanne, and Ivan. A summary of the information request sent to insurers is provided in Appendix D.

We have received policy level data from three insurers. Two of these insurers provided data for each of the five hurricanes in the data call. The third insurer only provided loss data for Hurricane Wilma.

A fourth insurer provided data as total loss only and not broken down by coverage type. Follow-up inquiries with this insurance company revealed that they are not able to report the losses by coverage type to us. Because of this, their data is not included in our analysis.

We have received claim level information from only one insurer. Several other insurers have offered to let us review claim level information at their site. These reviews will need to take place in a follow-on project.

Section 3.2 presents the results of the analyses of the policy coverage level data and Section 3.3 presents the results of the claim folder level review. The claim folder level review is very time consuming, but it provides the detailed information needed to understand the losses resulting from exterior structures.

3.2 Policy Coverage Level Exposure and Loss Information

Policy level exposure and loss information from three separate insurers is discussed in this section. The data analyzed were provided to us with the losses broken down by coverage type. The objective of the analysis is to better understand how exterior structure losses contribute to overall losses as a function of wind speed.

The two coverage types of greatest interest to this study are coverages A and B. Coverage A represents the main dwelling and all exterior structures not separated from the main dwelling by clear space. Coverage B represents all exterior structures which are separated from the main dwelling by clear space. Table 2-7 in Section 2 of this report shows that detached exterior structures account for approximately 59% of the average value of all exterior structures for the site-built homes surveyed. This indicates that the coverage B losses discussed in this section will likely represent losses to approximately 59% of the exterior structure value associated with Florida homes. Note that 22% of the site-built homes (see Table 2-7) do not have detached exterior structures, and hence, would have no coverage B losses, nor a need for coverage B insurance.

Estimates of the peak gust wind speed in open terrain for each zip code in Florida for each of the five hurricanes considered in this study were computed using ARA's hurricane wind field model. The windfield for each storm in the study were validated using all available measurements of the wind speeds throughout the storms. Additional information on the wind fields developed for this study can be found in Appendix E of this report.

3.2.1 Analysis of Insurance Electronic Policy Data

Loss data presented in this section of the report are given as a function of wind speed and presented in two different ways.

The first presentation is through scatter plots of coverage A and B loss ratios versus wind speed for each zip code. This allows us to look for anomalous losses that tend to standout when plotted vs. wind speed and determine if there is a trend whereby the exterior structure losses have a different wind speed vs. loss dependency compared to that of the dwelling losses.

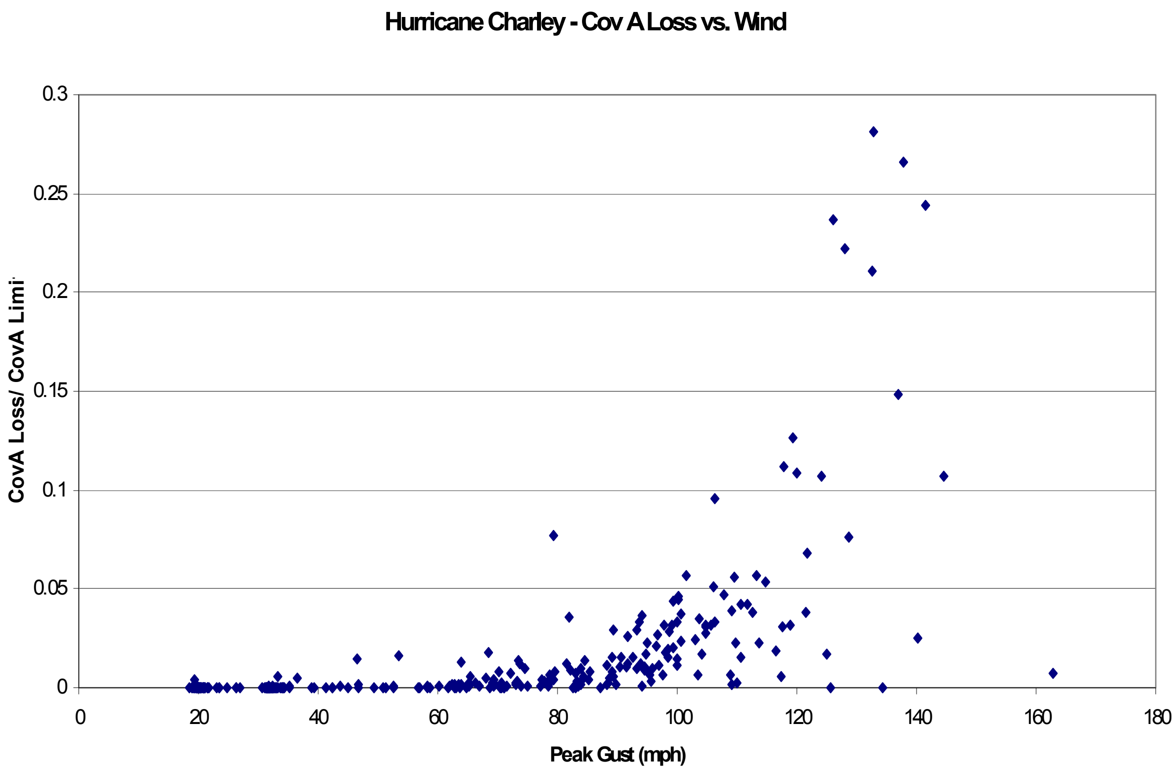
The second presentation expands upon the first by summarizing the zip code level data into groups with similar wind speeds and displaying the ratio of the coverage B losses to the associated coverage A losses in two different manners. The first considers the dollar B loss divided by the dollar A loss. The second considers the coverage B loss normalized by coverage B limit divided by the coverage A loss normalized by the coverage A limit. These measures provide a means to observe the relative differences in loss costs for coverage B (exterior structures) and coverage A (main dwellings). A limitation of this approach is that the coverage A loss also includes attached exterior structures.

The following sections of this report present a brief overview of the data from each insurance company along with the plots discussed above. Also included are the combined results over multiple insurance companies and hurricanes. All losses presented in section represent the paid loss net of deductible.

3.2.1.1 Insurance Company A. Insurance Company A provided loss data for two sets of data for all five Hurricanes. One of the datasets contains only coverage B losses and has an inordinately large number of policies with no coverage B loss. The other data set has more consistent reporting of coverage B losses and is used herein. The figures presented below for Insurance Company A are for site-built homes. Data for mobile homes and other lines of business were provided but these data are not presented here.

Figures 3-1 through 3-5 show scatter plots of coverage A and B losses as a proportion of the coverage A limit. The losses presented in the plots are aggregated by zip code so that each point on each graph represents the loss ratio of a separate zip code.

Figure 3-6 presents the ratio of coverage B to coverage A losses for Hurricanes Charley, Frances, Ivan, Jeanne and Wilma for insurance company A. These ratios are presented both as a dollar-to-dollar comparison (left-side plots) and a comparison of losses normalized by each



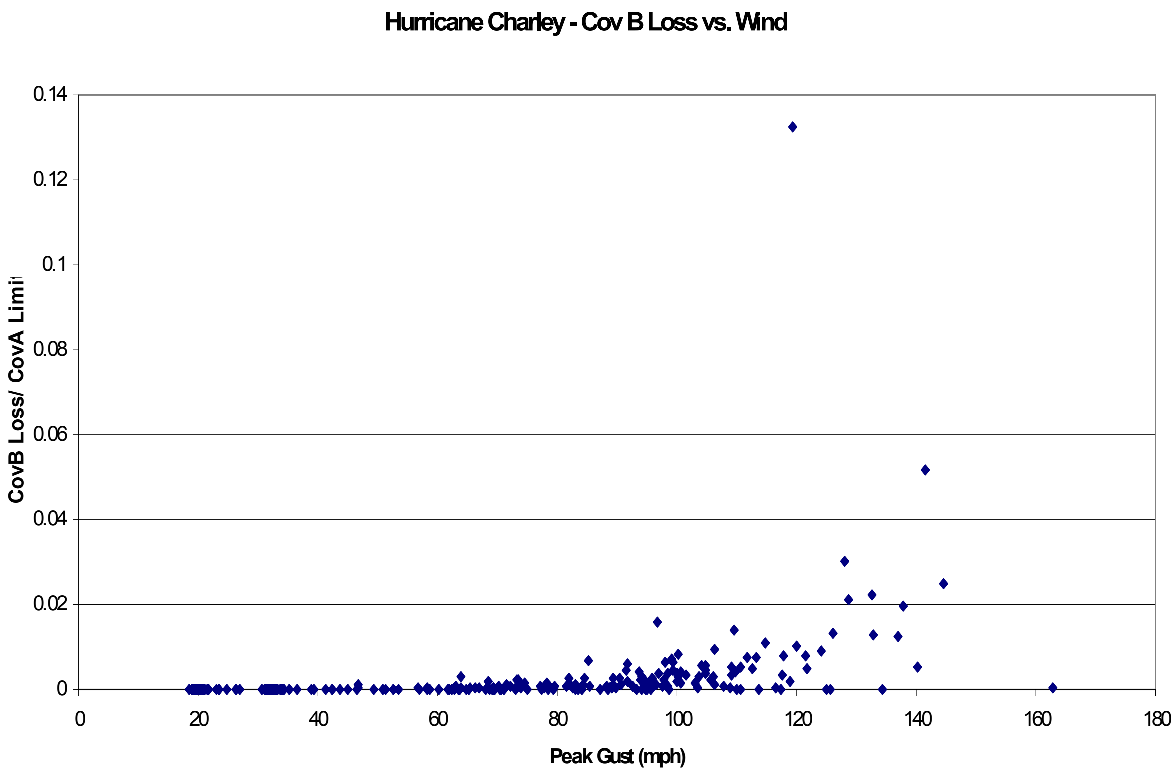


Figure 3-1. Coverage A and B Losses for Insurance Company A Plotted vs. Modeled Peak Gust Wind Speed in Open Terrain for Hurricane Charley.

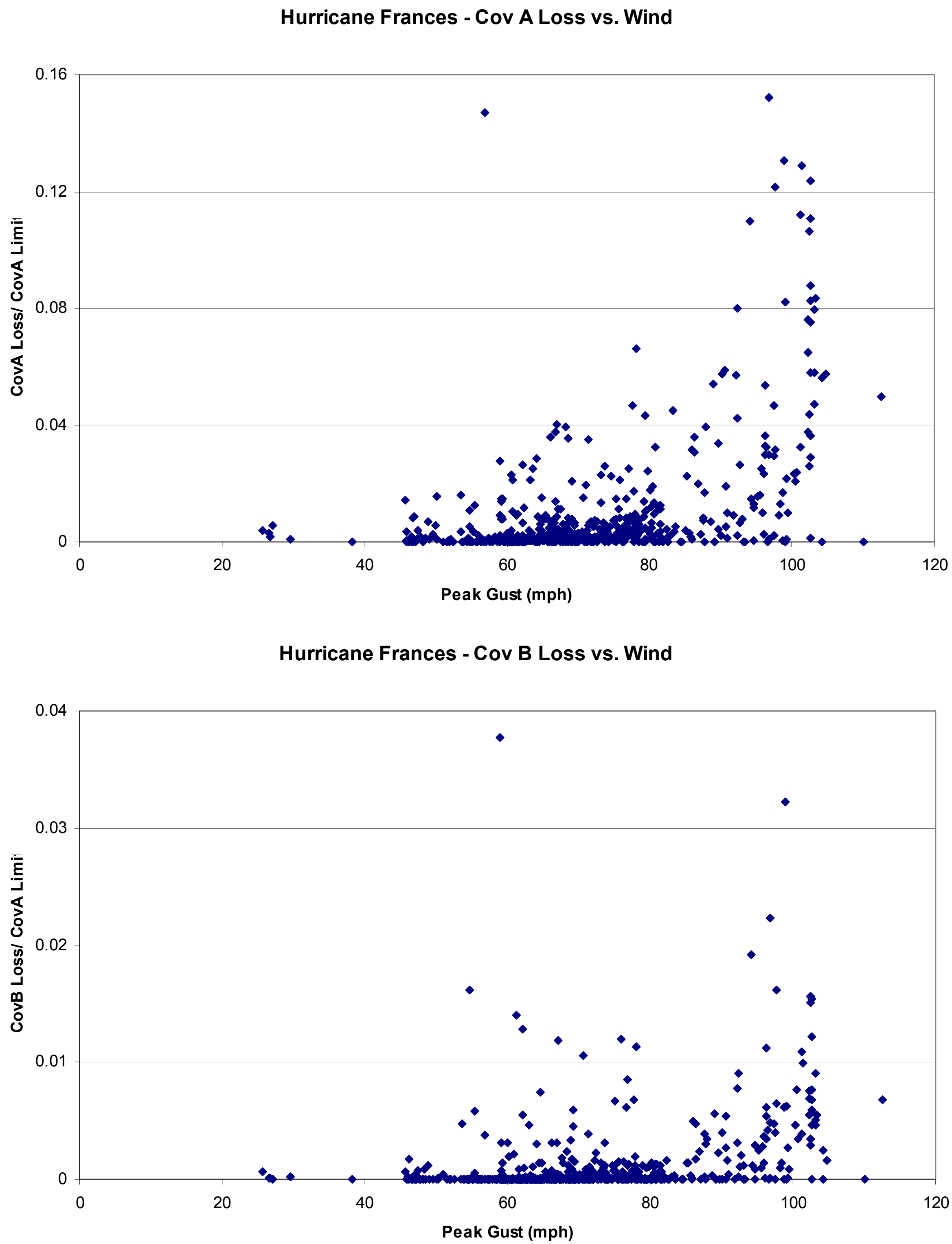
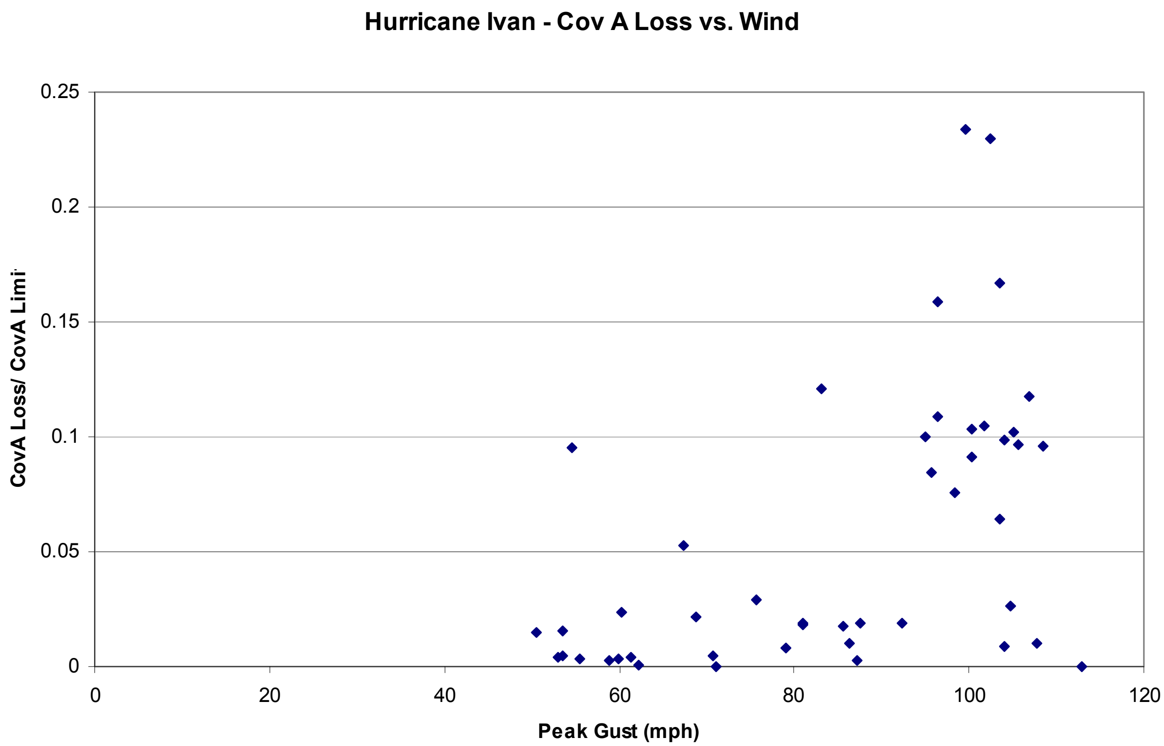


Figure 3-2. Coverage A and B Losses for Insurance Company A Plotted vs. Modeled Peak Gust Wind Speed in Open Terrain for Hurricane Frances.



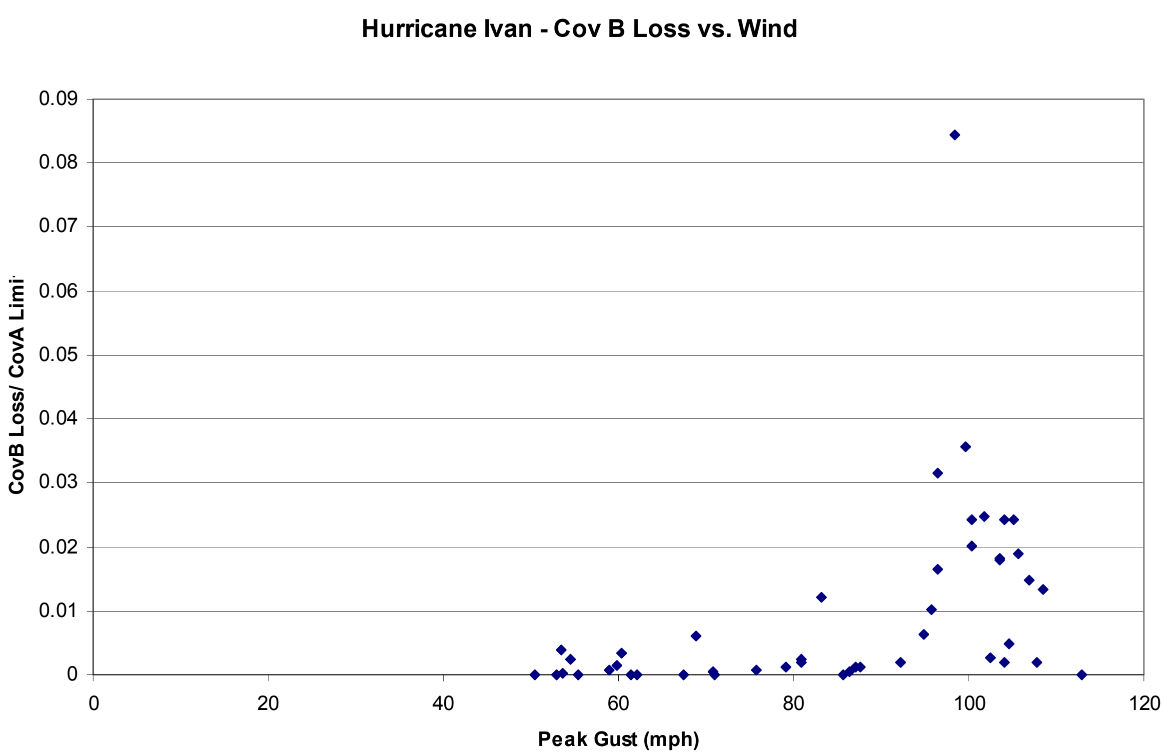


Figure 3-3. Coverage A and B Losses for Insurance Company A Plotted vs. Modeled Peak Gust Wind Speed in Open Terrain for Hurricane Ivan Showing Large Losses in Areas that Experienced Low Wind Speeds.

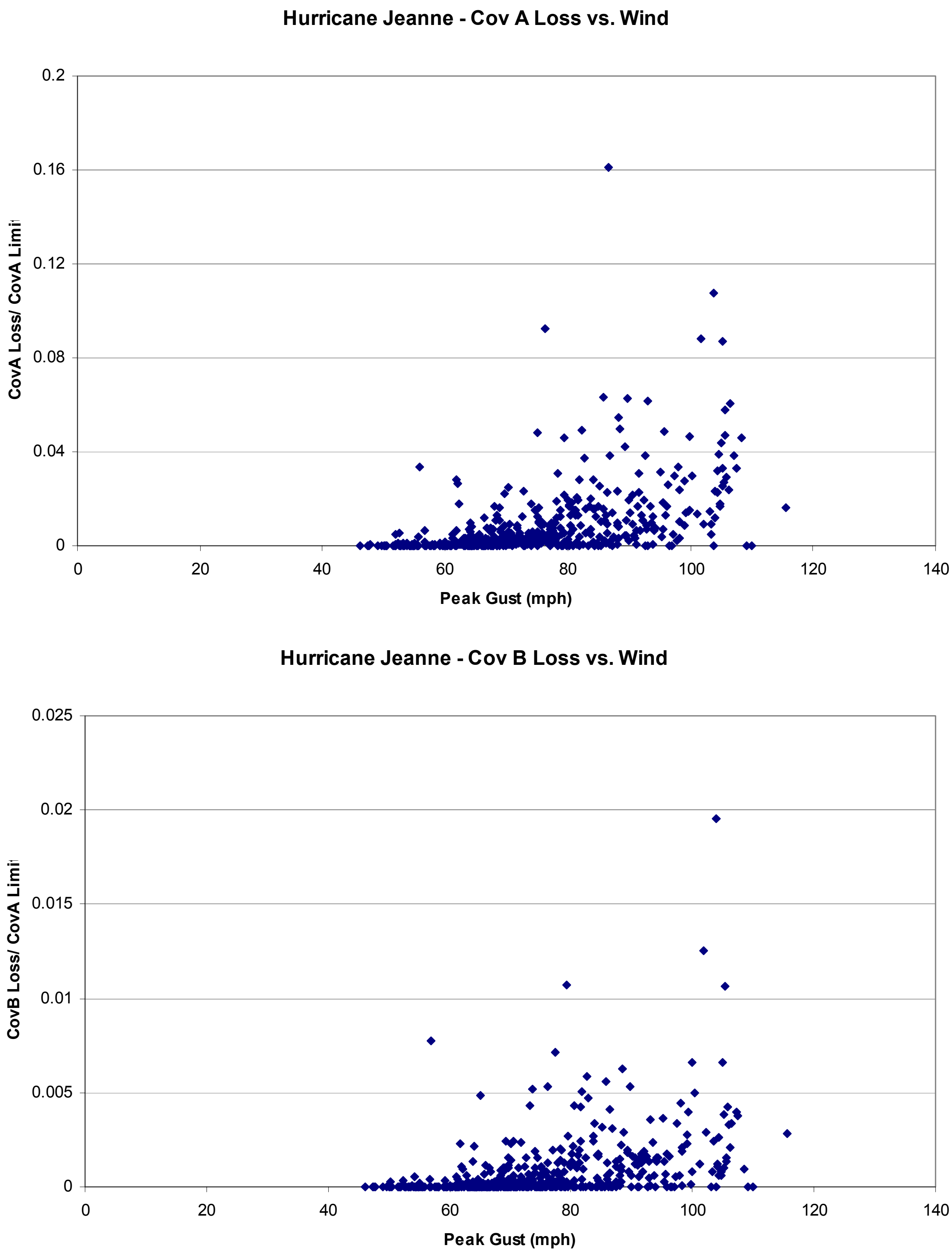
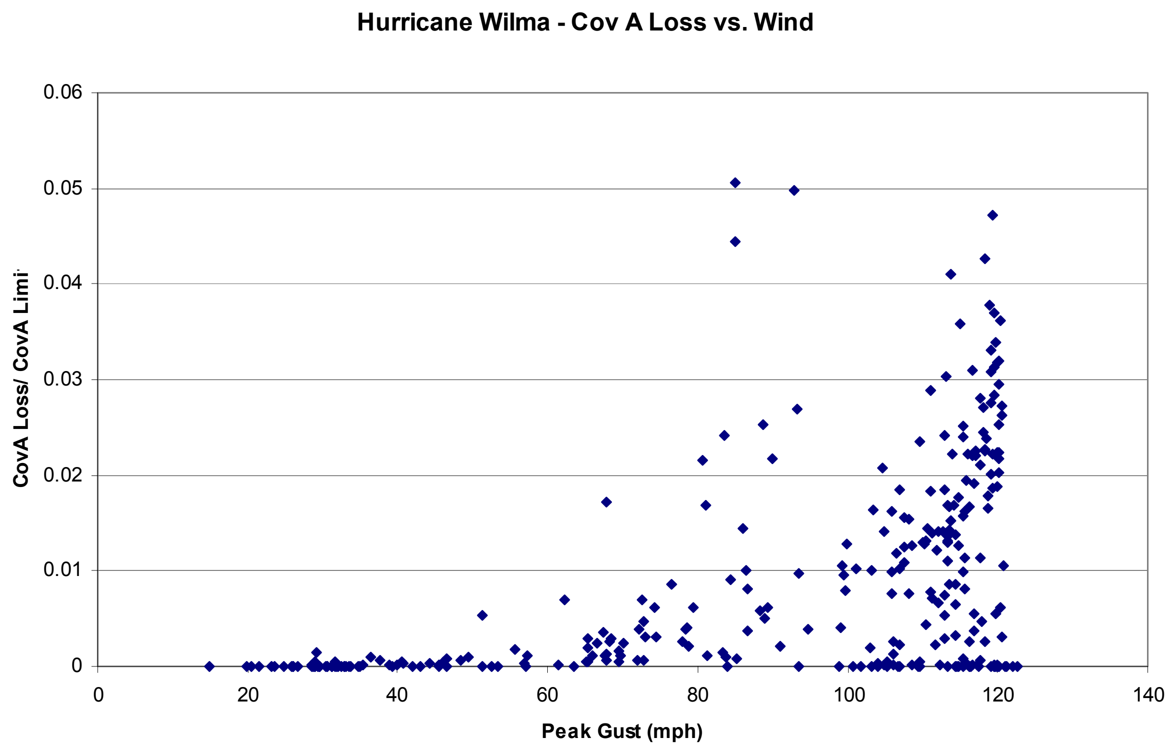


Figure 3-4. Coverage A and B Losses for Insurance Company A Plotted vs. Modeled Peak Gust Wind Speed in Open Terrain for Hurricane Jeanne.



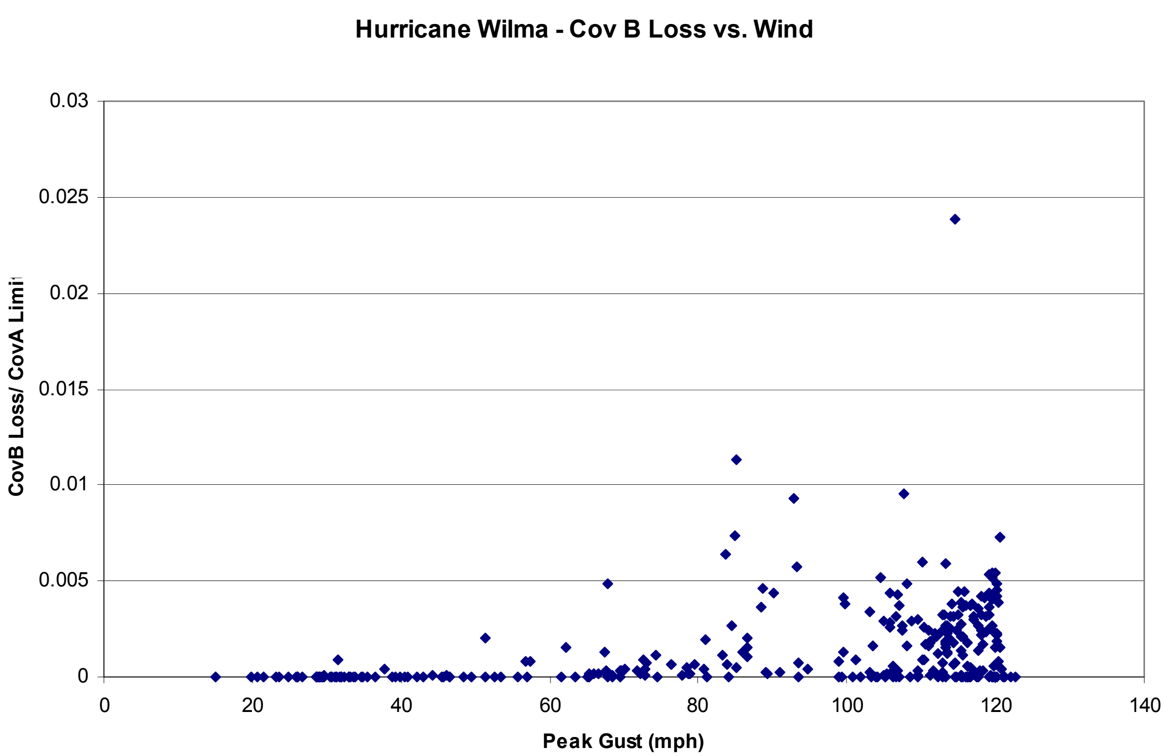


Figure 3-5. Coverage A and B Losses for Insurance Company A Plotted vs. Modeled Peak Gust Wind Speed in Open Terrain for Hurricane Wilma (continued).

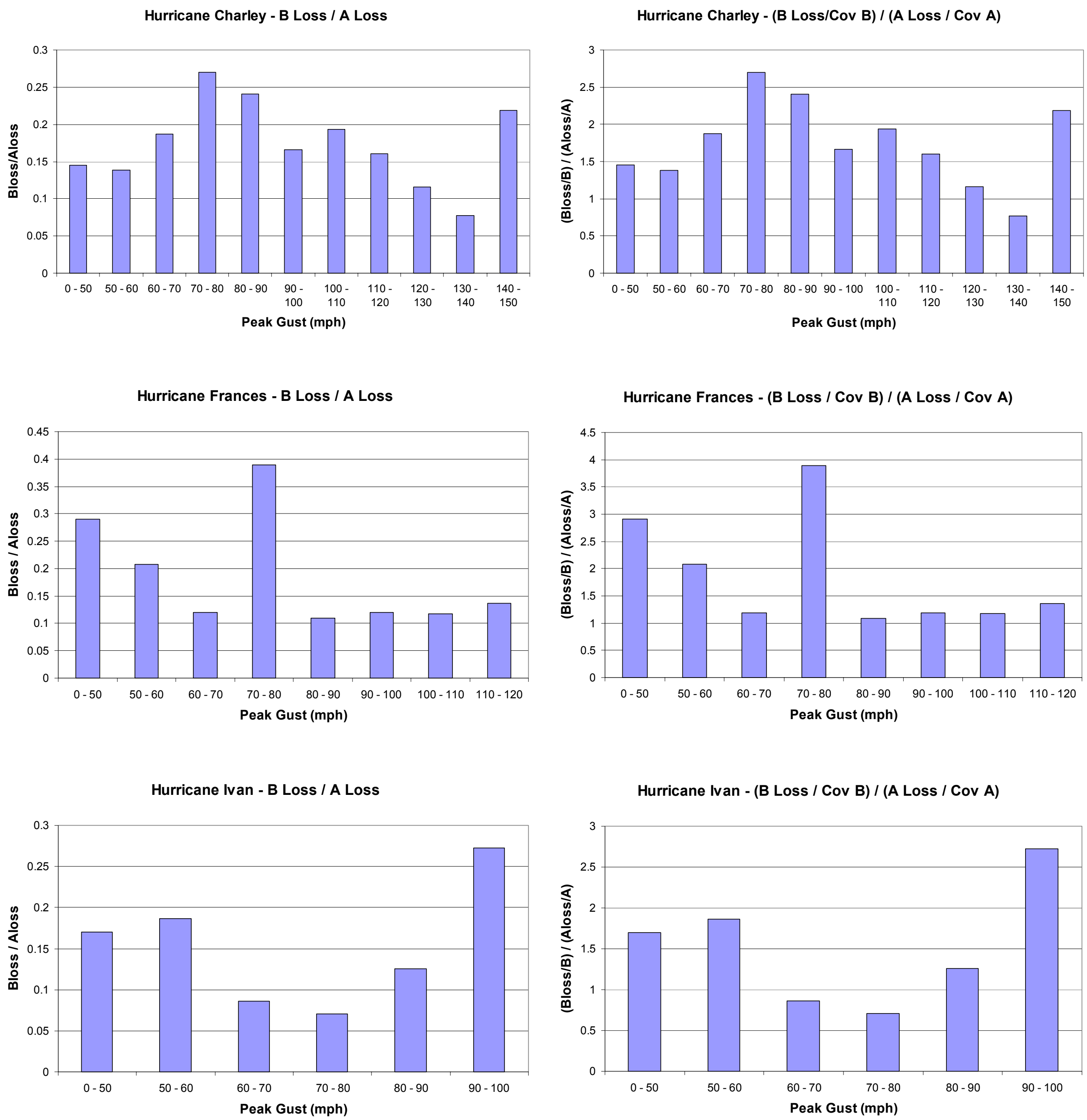


Figure 3-6. Ratio of Coverage B Losses to Coverage A Loss for Hurricanes Charley, Frances, Ivan, Jeanne, and Wilma for Insurance Company A concluded).

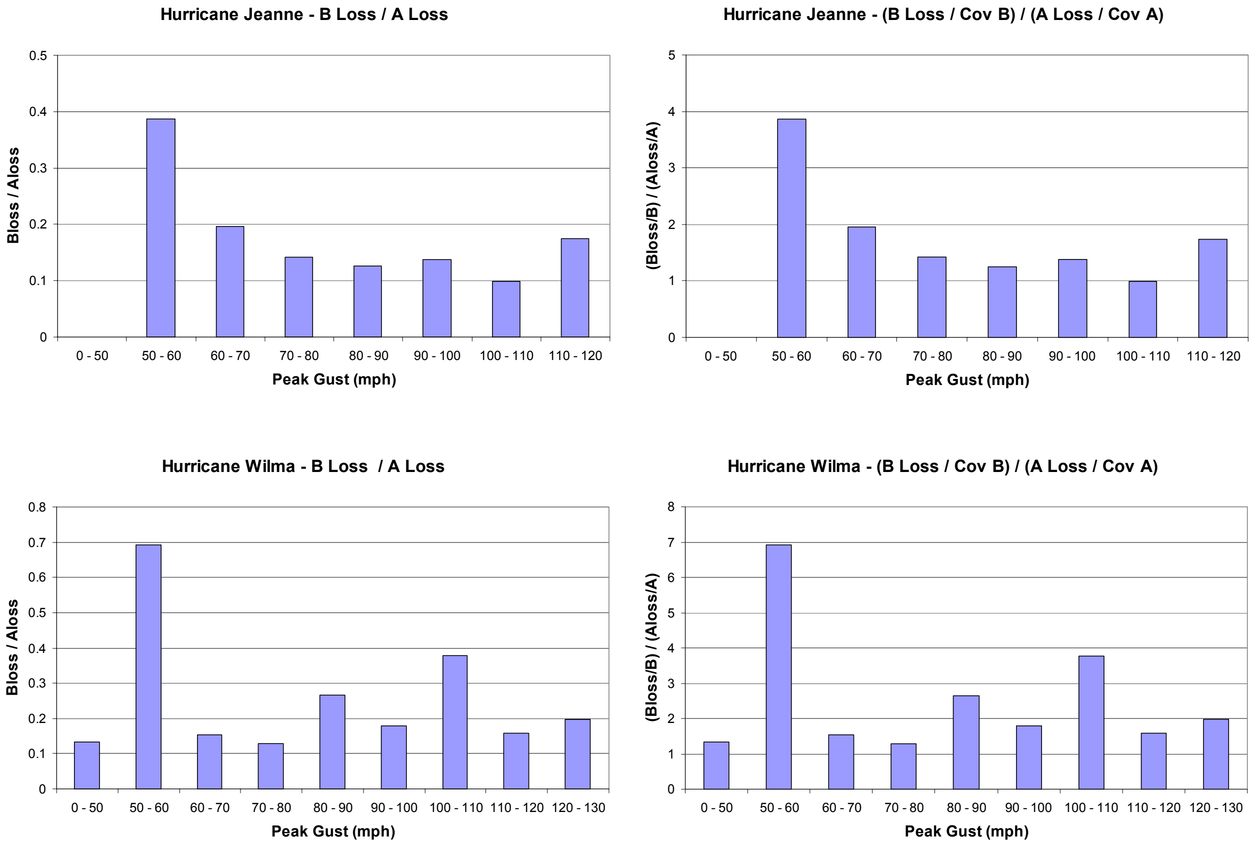


Figure 3-6. Ratio of Coverage B Losses to Coverage A Loss for Hurricanes Charley, Frances, Ivan, Jeanne, and Wilma for Insurance Company A.

coverage's respective limits (right-side plots). It should be noted that the majority of insurance company A policies have coverage B limits set to 10% of the coverage A limit. As such, the scale of the two plots for each storm will be different by a factor of 10.

The plots shown in Figure 3-6 clearly indicate that the normalized coverage B losses tend to be higher relative to the coverage B limits (10% of coverage A limits) than coverage A losses relative to the coverage A limits. This conclusion is based on the fact that coverage B losses are generally greater than 0.1 in the left side plots. However, since the coverage A losses include attached structures, one's interpretation should not assume that all A losses are for the dwelling.

3.2.1.2 Insurance Company B. Company B provided information that was well characterized in terms of separation of the losses by coverage type. One major difference in the company B data can be found in the coverage B limits. Recall that company A generally provides coverage B limits at 10% of the coverage A limit. Company B provides coverage B limits at 2% of the coverage A limit plus whatever additional coverage homeowners would like to add to coverage B. This results in the average coverage B limit for company B to represent about 2.7% of the coverage A limit.

Figures 3-7 through 3-11 present the loss ratios for both the coverage A and B plotted vs. peak gust wind speed in unobstructed open terrain. The losses are normalized by the actual coverage limit. These figures demonstrate that coverage B losses accrue at higher rates for lower wind speeds than coverage A losses.

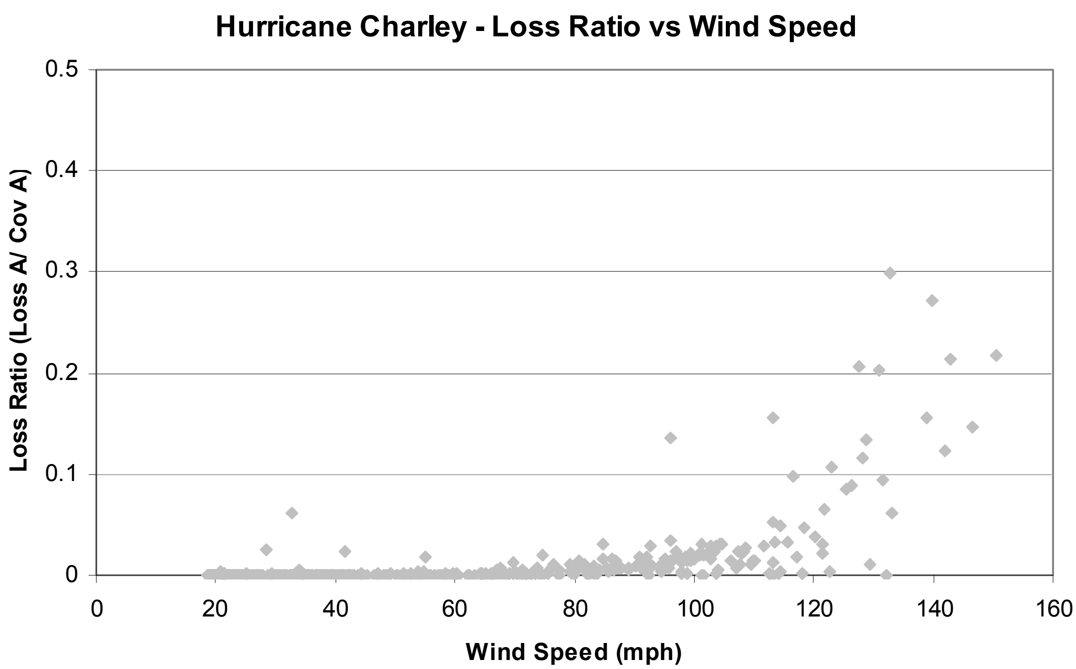
Figure 3-12 presents the ratio of coverage B to coverage A losses for Hurricanes Charley, Frances, Ivan, Jeanne and Wilma for insurance company B. These ratios are presented both as a dollar-to-dollar comparison and a comparison of losses normalized by each coverage's respective limits. A general trend evident in the comparison of the coverage B and A losses as a function of wind speed indicates that the loss costs associated with the detached structures (coverage B) exceeds that of the primary coverage (coverage A) for low wind speeds (i.e. gust wind speeds less than about 100 mph). Similar to the results presented for company A, the ratio of coverage B loss to coverage A loss decreases as wind speed increases.

Table 3-1 summarizes the percent contribution of the coverage B losses to the coverage total loss using the data provided by Insurer B. Note that the contribution to the total loss associated with the coverage B for each storm is higher than the nominal exterior structure coverage limit for this insurer, which is approximately 2.7% of the coverage A limit.

3.2.1.3 Insurance Company C. Insurance company C provided coverage level losses for Hurricane Wilma only. Similar to company B, company C uses a default coverage B limit of 2% of the coverage A value, with the option to purchase additional coverage. This yields an average coverage B limit of approximately 2.6% of the coverage A value for insurance company C. Figure 3-13 shows the coverage A and B losses as a percentage of the coverage A limit versus peak gust wind speed in open terrain for Hurricane Wilma. As for the other insurers, each point on the plot represents loss aggregated to the zip code level divided by the total coverage A exposure for that zip code.

Figure 3-14 presents the ratio of coverage B to coverage A losses for Hurricanes Charley, Frances, Ivan, Jeanne and Wilma for insurance company C. These ratios are presented both as a dollar-to-dollar comparison and a comparison of losses normalized by each coverage's respective limits. As seen with the previous insurers, the normalized coverage B loss tends to exceed the normalized coverage A loss, with the exceedance greatest for wind speeds less than about 120 mph.

3.2.1.4 Losses Aggregated Over All Storms. In order to better understand the differences between the way that losses for coverage A and B accrue as wind speed increases, the ratio of coverage B to coverage A losses were aggregated over all storms and companies from the available data. Insurance company B defines coverage B differently than insurance companies A and C. Because of this, data from insurers A and C are combined over all available storms and data from insurer B are separately combined over all available storms.



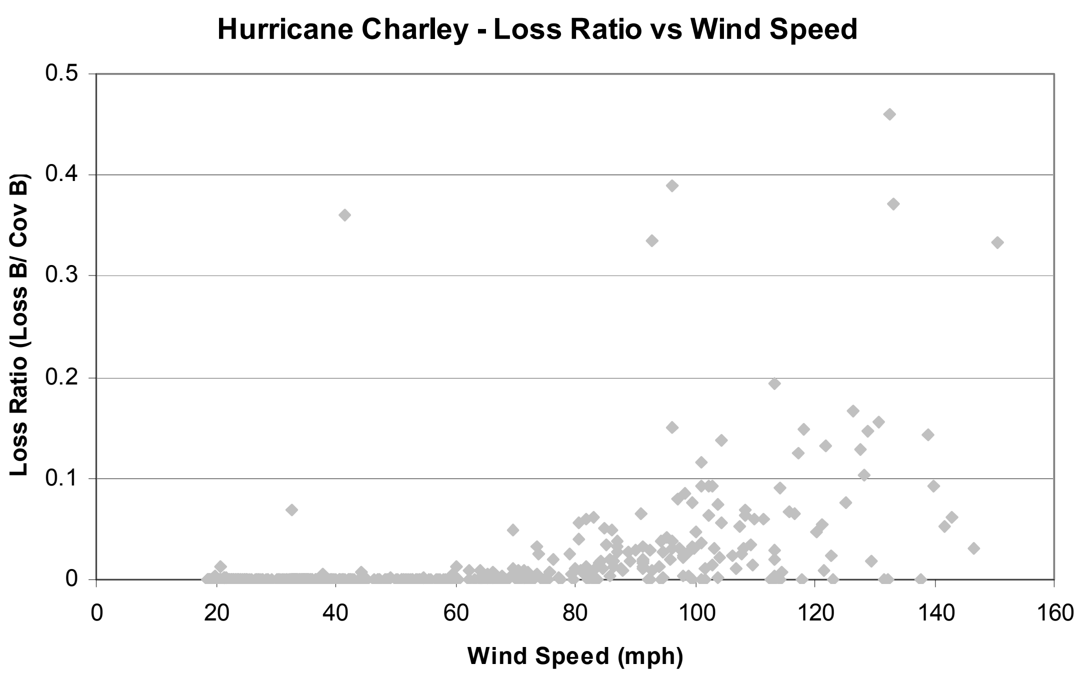
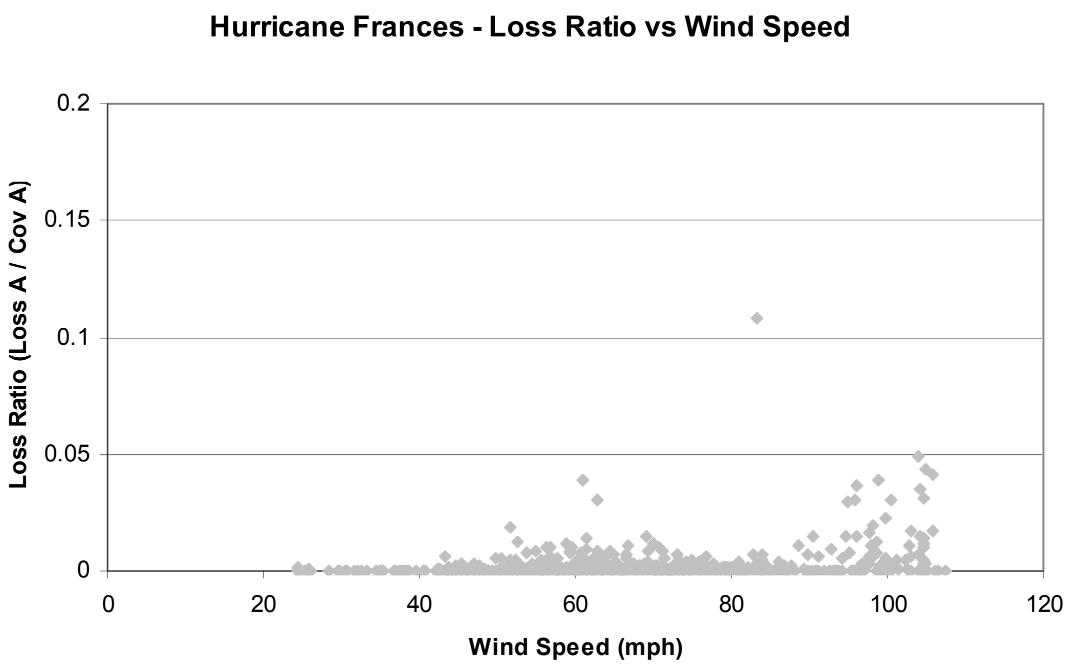


Figure 3-7. Coverage A and B Losses for Insurance Company B Plotted vs. Modeled Peak Gust Wind Speed in Open Terrain for Hurricane Charley.



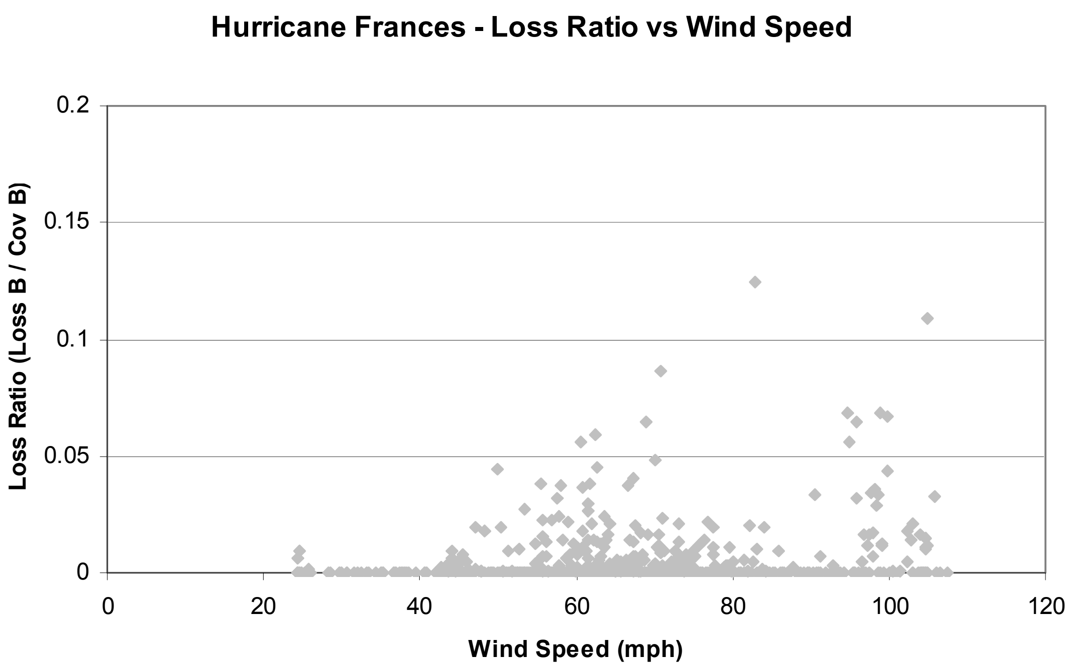
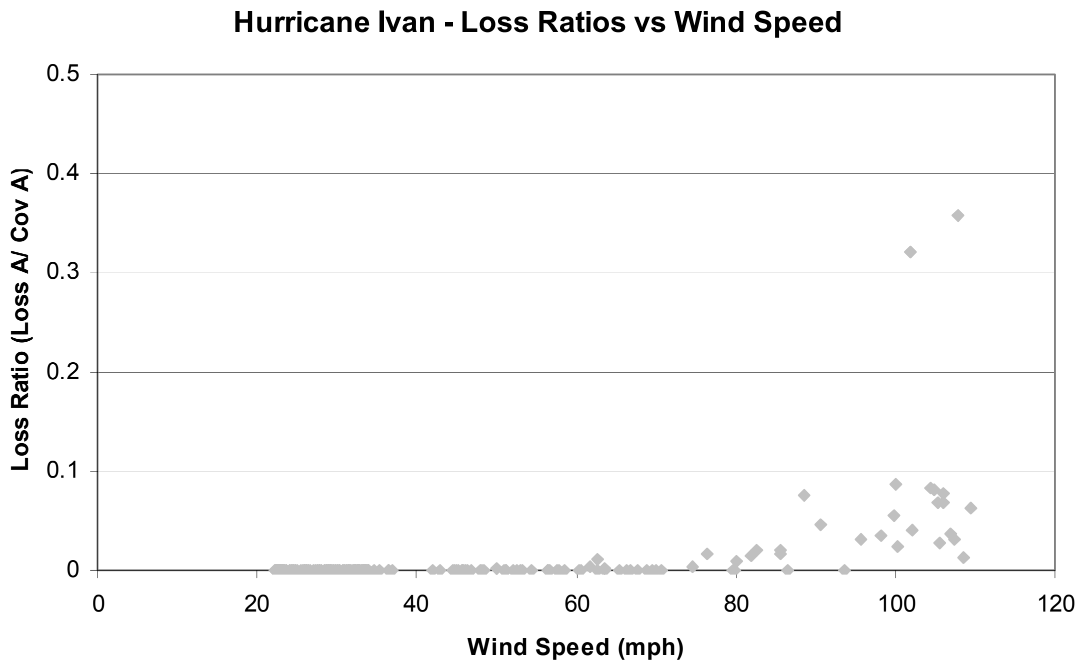


Figure 3-8. Coverage A and B Losses for Insurance Company B Plotted vs. Modeled Peak gust Wind Speed in Open Terrain for Hurricane Frances.



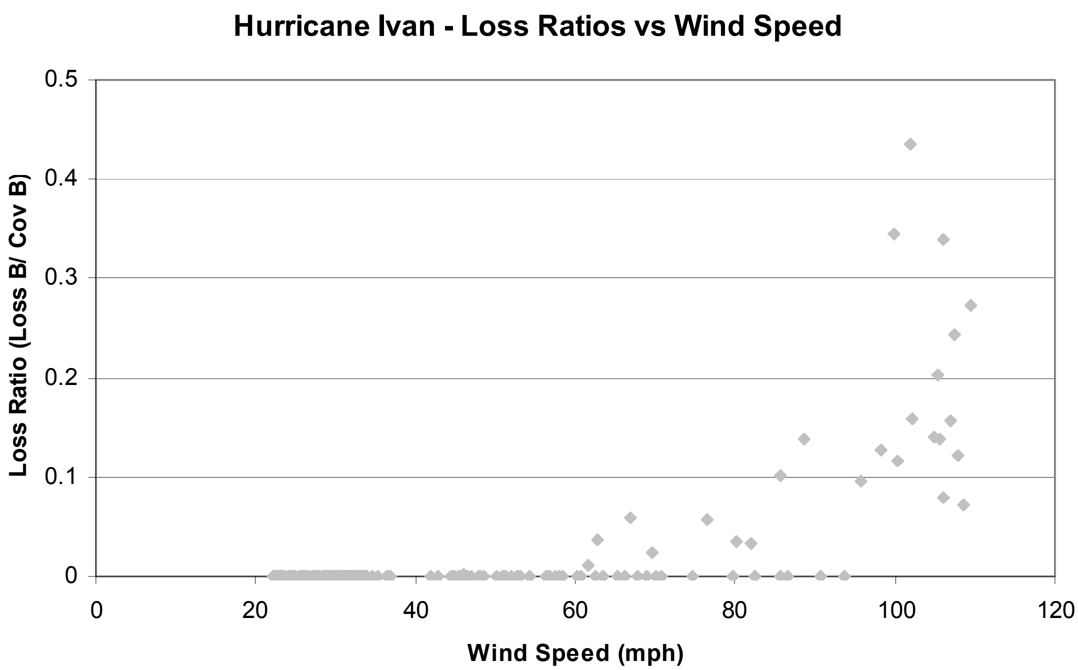


Figure 3-9. Coverage A and B Losses for Insurance Company B Plotted vs. Modeled Peak Gust Wind Speed in Open Terrain for Hurricane Ivan.

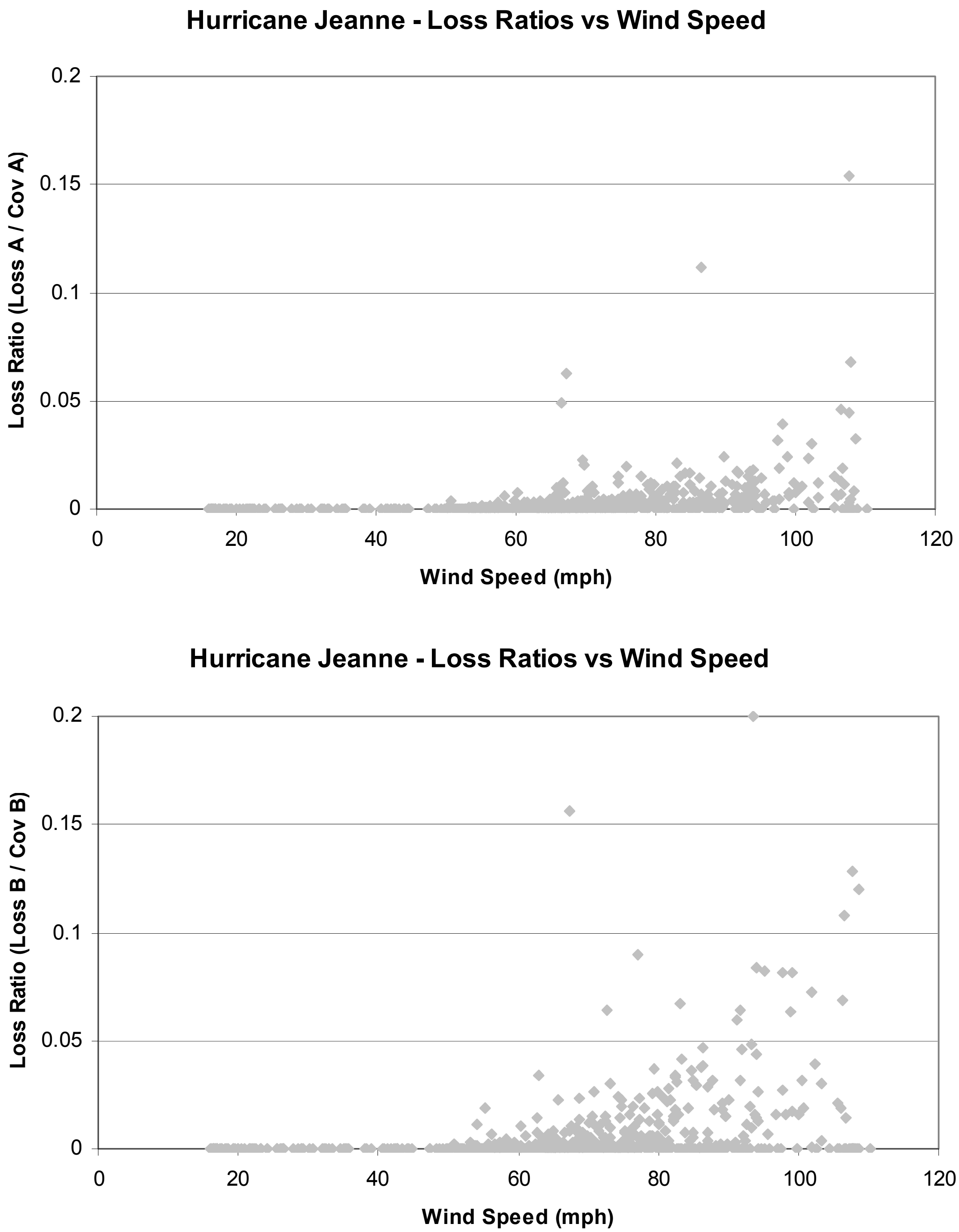
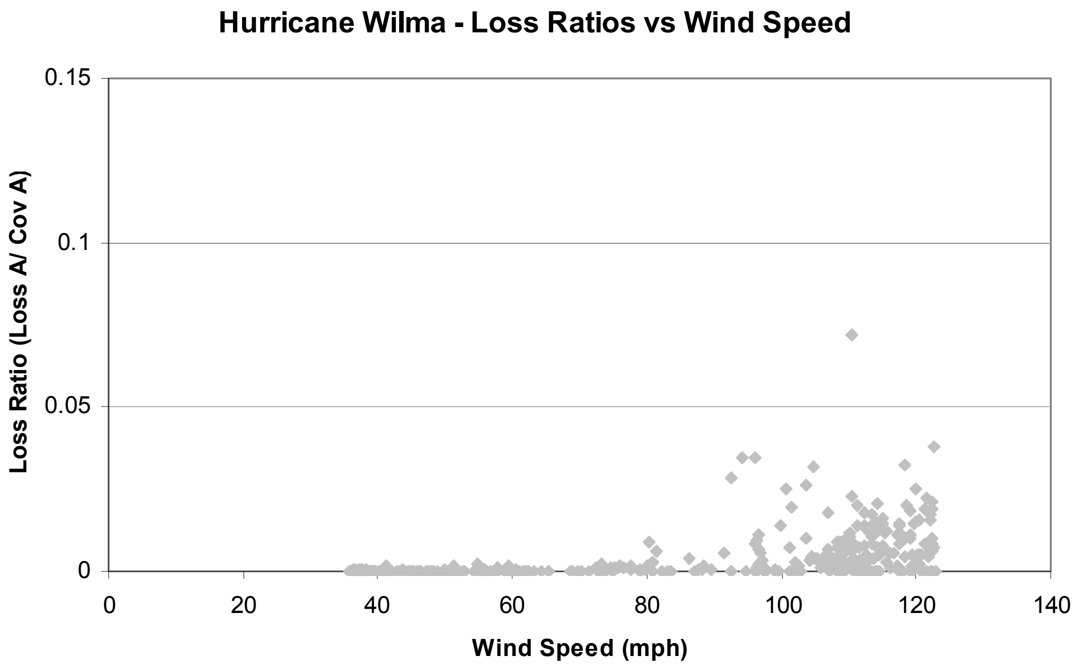


Figure 3-10. Coverage A and B Losses for Insurance Company B Plotted vs. Modeled Peak Gust Wind Speed in Open Terrain for Hurricane Jeanne.



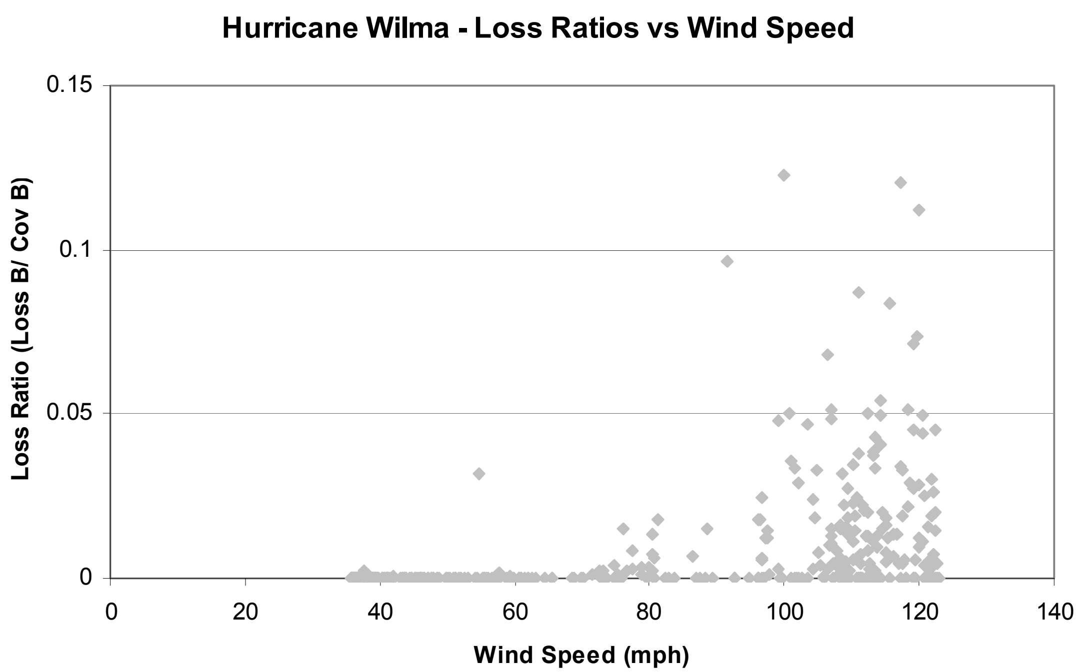


Figure 3-11. Coverage A and B Losses for Insurance Company B Plotted vs. Modeled Peak Gust Wind Speed in Open Terrain for Hurricane Wilma.

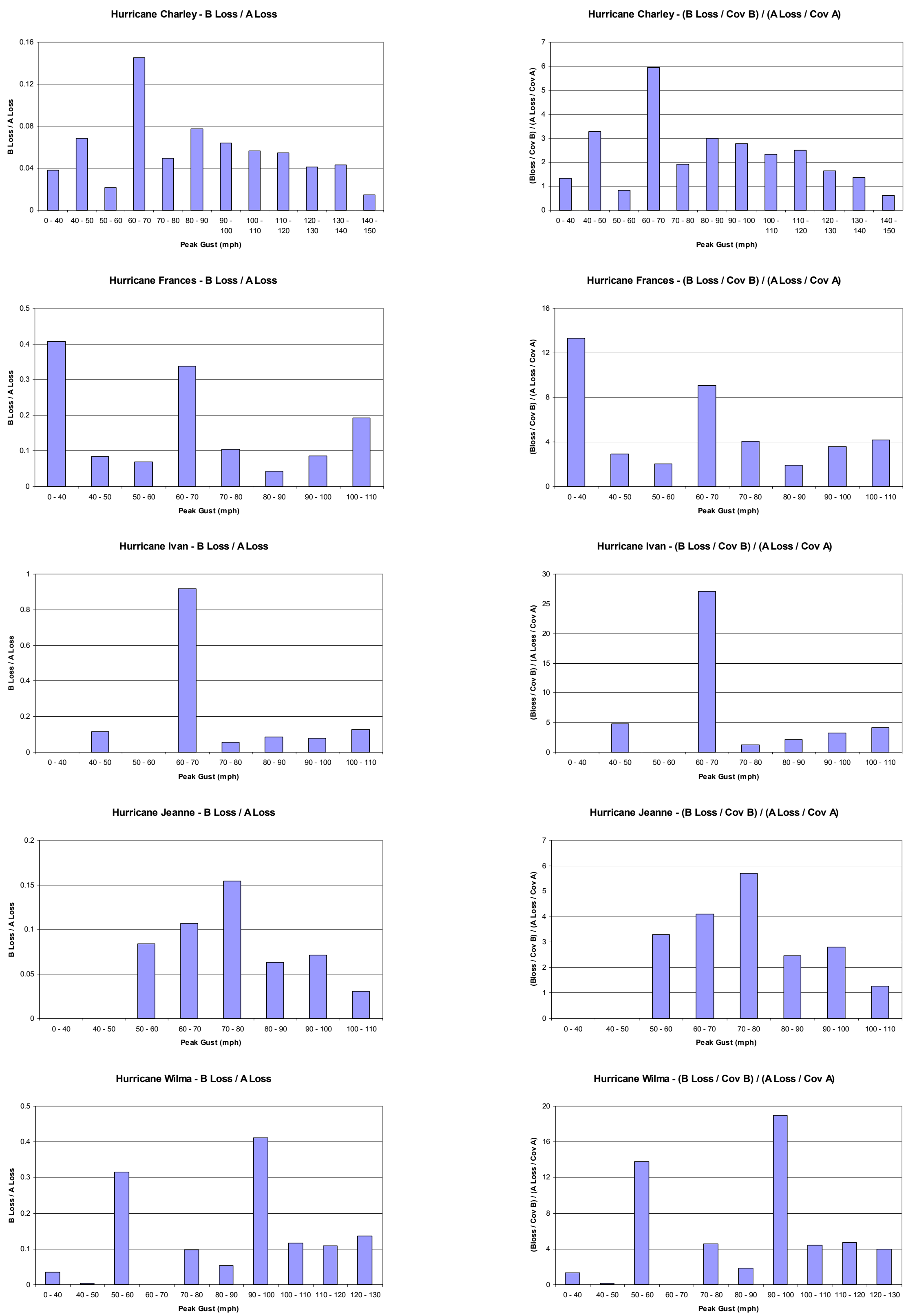


Figure 3-12. Ratio of Coverage B Losses to Coverage A Loss for Hurricanes Charley, Frances, Ivan, Jeanne, and Wilma for Insurance Company B.

Table 3-1. Coverage B Loss as a Percentage of Total Loss for Insurer B

Hurricane	Coverage B Loss/Total Loss (%)
Hurricane Charley	3.3%
Hurricane Frances	5.3%
Hurricane Ivan	10.1%
Hurricane Jeanne	4.5%
Hurricane Wilma	5.1%

Insurer A and C. Figure 3-15 presents the ratio of coverage B to coverage A losses for all storms available for insurance companies A and C combined. The ratios presented as a dollar-to-dollar comparison contain data from insurance company A and C. However, the comparison of losses normalized by each coverage's respective limits contains only data from insurance company A since insurance company C has a different default coverage B limit (2% versus 10%). Summarizing these data over all storms by wind speed range increases the overall sample size in each wind speed range and provides a more complete picture of the relationship between coverage B and coverage A losses. Also included on the figure is 2nd order polynomial fitted to the data for performing additional analyses, as discussed in Section 5.

The relationships shown in Figure 3-15 show that normalized coverage B losses are incurring at lower wind speeds than are normalized coverage A losses. However, the normalized coverage A and B losses begin to lessen at wind speeds over 120 mph, where the coverage A dwelling losses begin to increase.

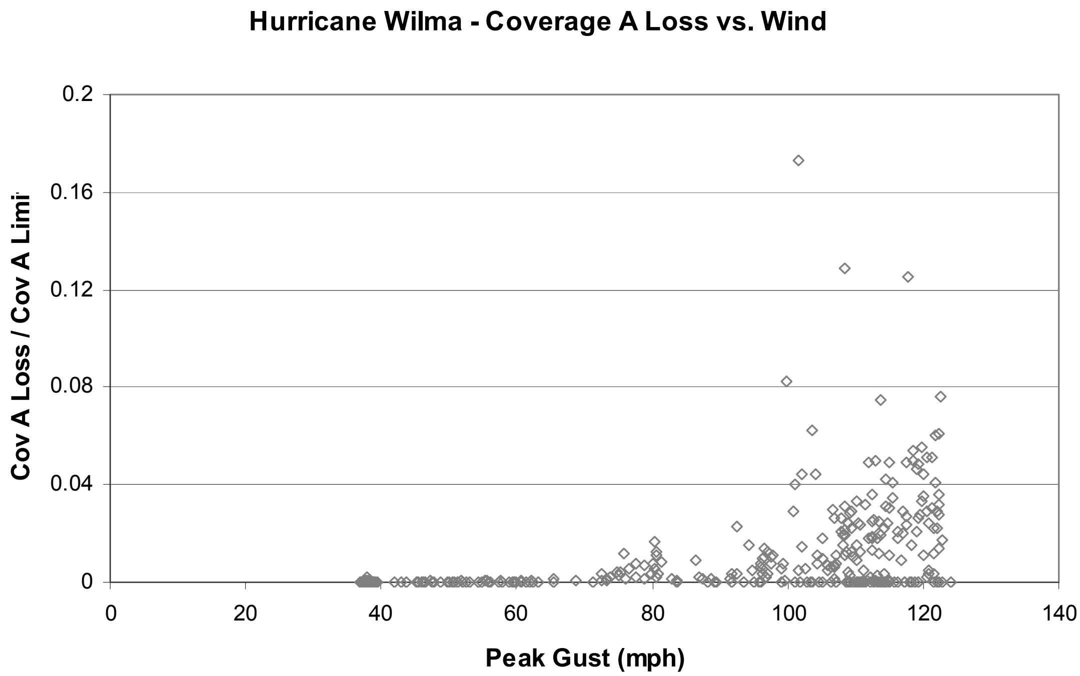
Insurer B. Figure 3-16 shows the ratio of coverage B to coverage A losses for all storms available for insurance company B. This relationship is shown as both a ratio of raw dollar losses as well as losses normalized by the coverage limits. Once again, we see a trend of coverage B losses accruing at lower wind speeds than coverage A losses, with normalized losses reducing dramatically as wind speeds increase to the 130 to 140 mph range.

3.3 Claim Folder Review

The insurance company response to the data request in Appendix C resulted in one company providing claims. Others subsequently have offered to allow ARA to review claims at their site. We have focused our efforts on reviewing the claims that were sent to us.

ARA received claim folder data from one insurance company for approximately 1000 claims, randomly drawn from Hurricanes Wilma, Charley, and Ivan. We set up a database to extract claim folder data, including the following information:

1. Dwelling Type
    a. Single Family 1 story
    b. Single Family 2 story
    c. Manufactured Home single wide
    d. Manufactured Home double wide



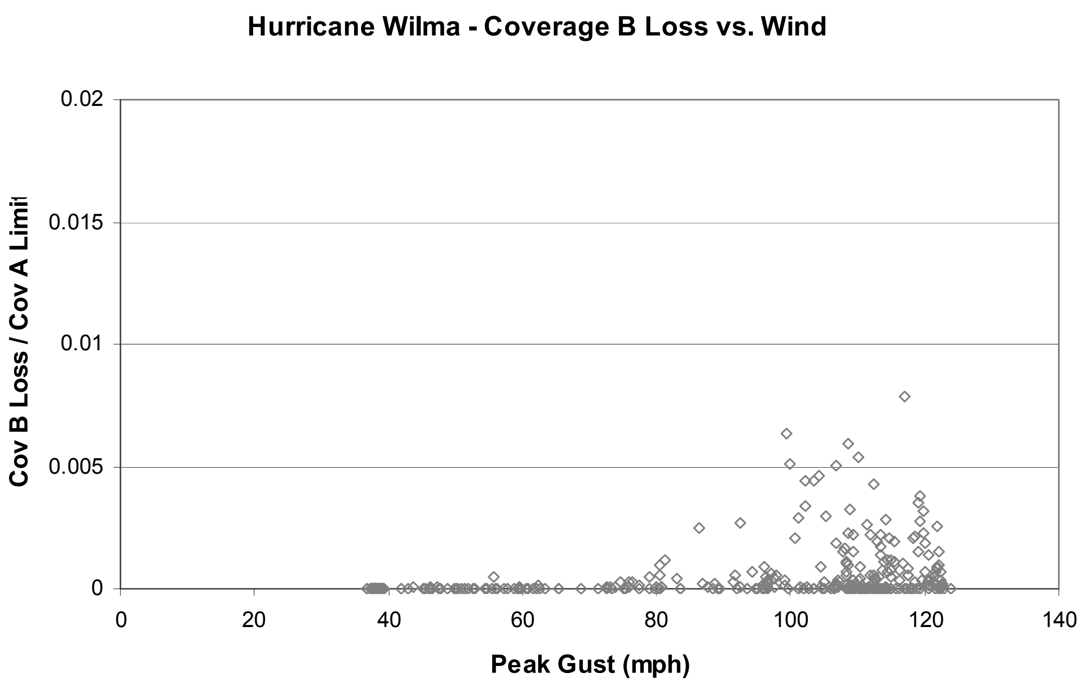


Figure 3-13. Coverage A and B Losses for Insurance Company C Plotted vs. Modeled Peak Gust Wind Speed in Open Terrain for Hurricane Wilma.

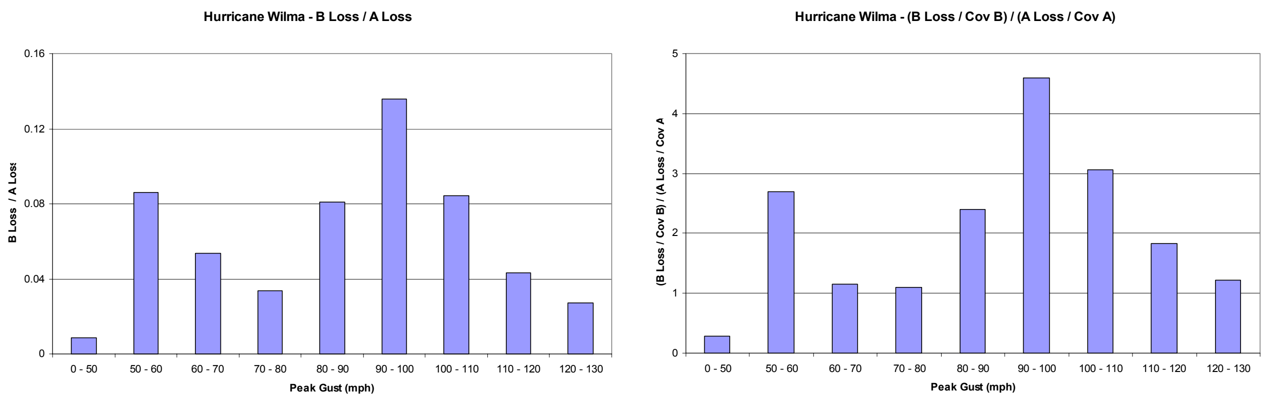


Figure 3-14. Ratio of Coverage B Losses to Coverage A Loss for Hurricane Wilma for Insurance Company C.

2. Damage Questions
   a. Does claim indicate exterior structure damage?
   b. If screen enclosure was present, was it damaged?
   c. If carport was present, was it damaged?
3. For each damaged exterior structure
   a. Attached or Detached
   b. Type
   c. If Screen enclosure, what was damaged?
      i. Screens
      ii. Frame
      iii. Both
   d. If exterior structure was attached, was main dwelling damaged by failure of exterior structure?
   e. For each exterior structure: Replacement Cash Value ($), Actual Cash Value ($), and Gross Claim ($).

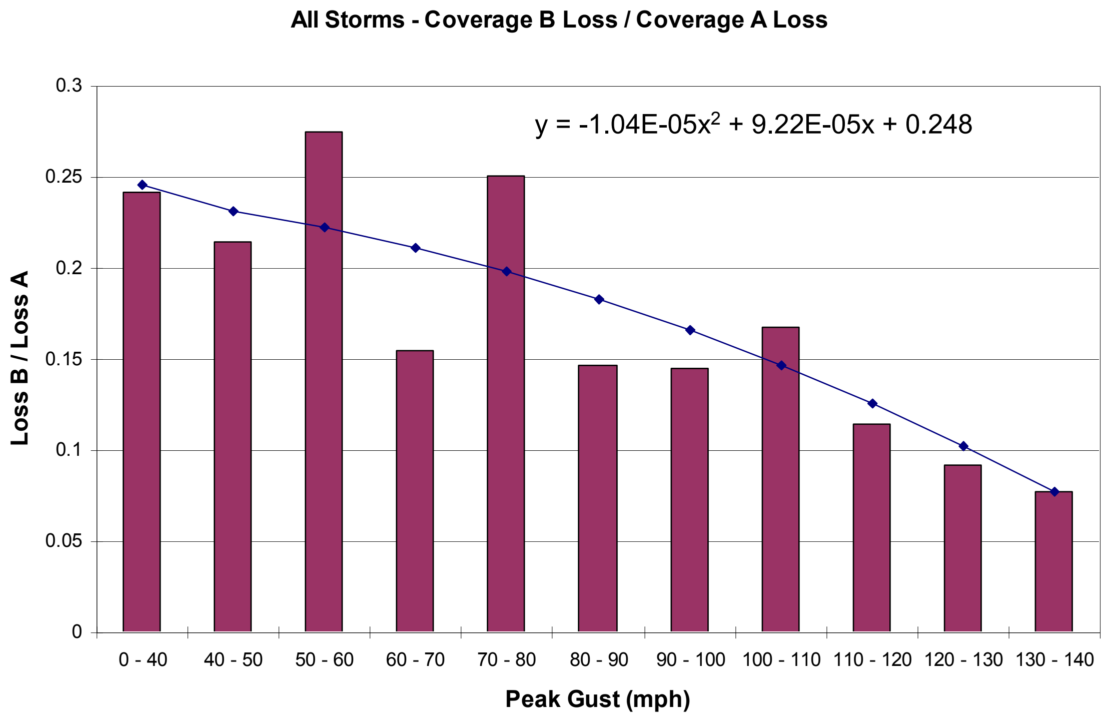
Two analysts reviewed the claim folders over a one month period. The claim review process is time consuming and requires a thorough review of a lot of information to figure out what was actually paid and how the adjustors determined the replacement value for each damaged component or element.

We analyzed a total of 528 claim folders within the time and budget available on this project. Tables 3-2 and 3-3 show the breakout of the reviewed claims. Figures 3-17 through 3-20 show the location of the claims in each zip code.

The analysis is not complete, but some of the key results follow.

Table 3-4 shows the breakout of the sum of claims by exterior structure type for single family homes in Hurricane Wilma. The notation of exterior structure type is the same as indicated on the survey form in Appendix A, namely:

1. PE= Pool/patio enclosure
2. PH= Pool house



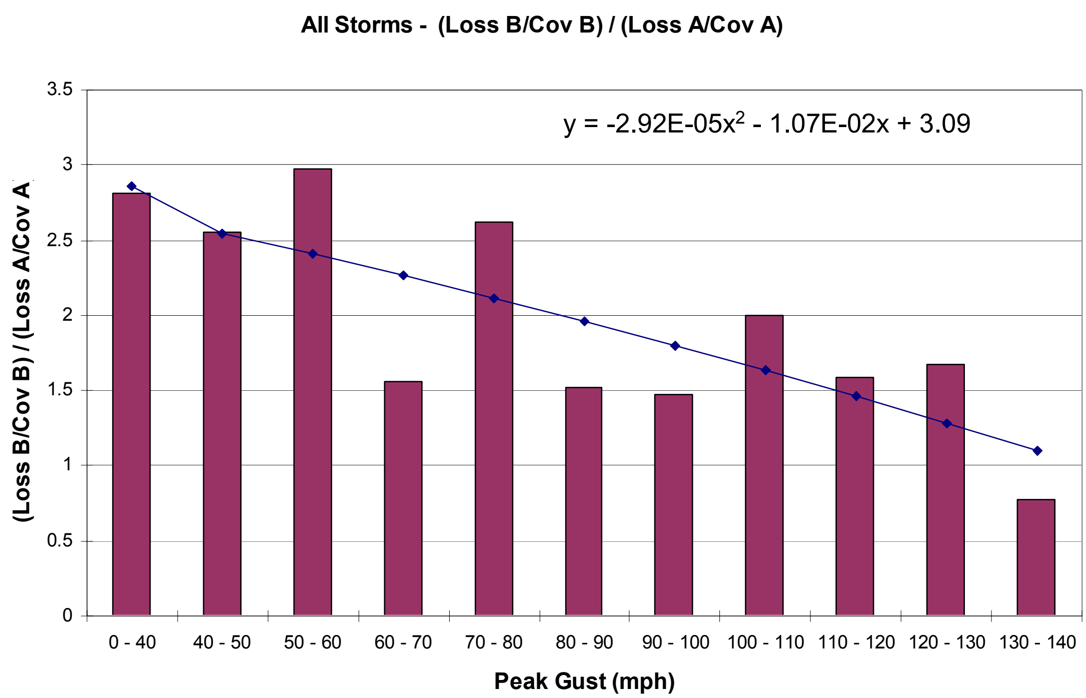
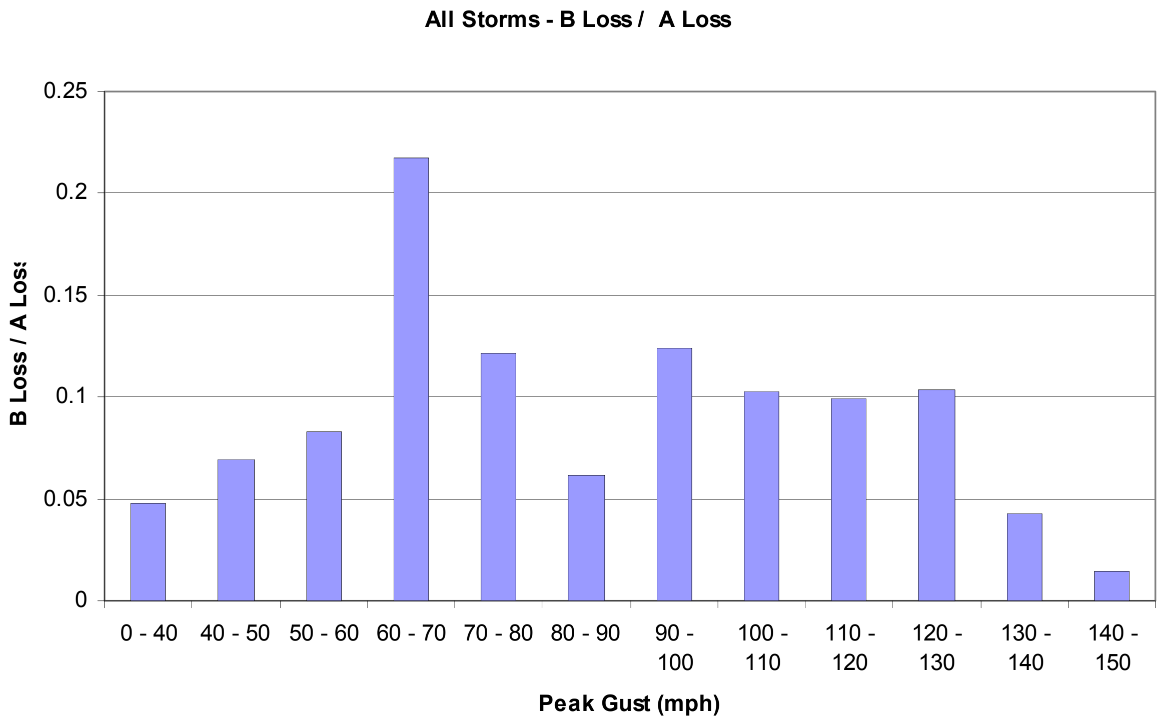


Figure 3-15. Ratio of Coverage B Losses to Coverage A Loss for All Storms for Insurance Companies A and C.



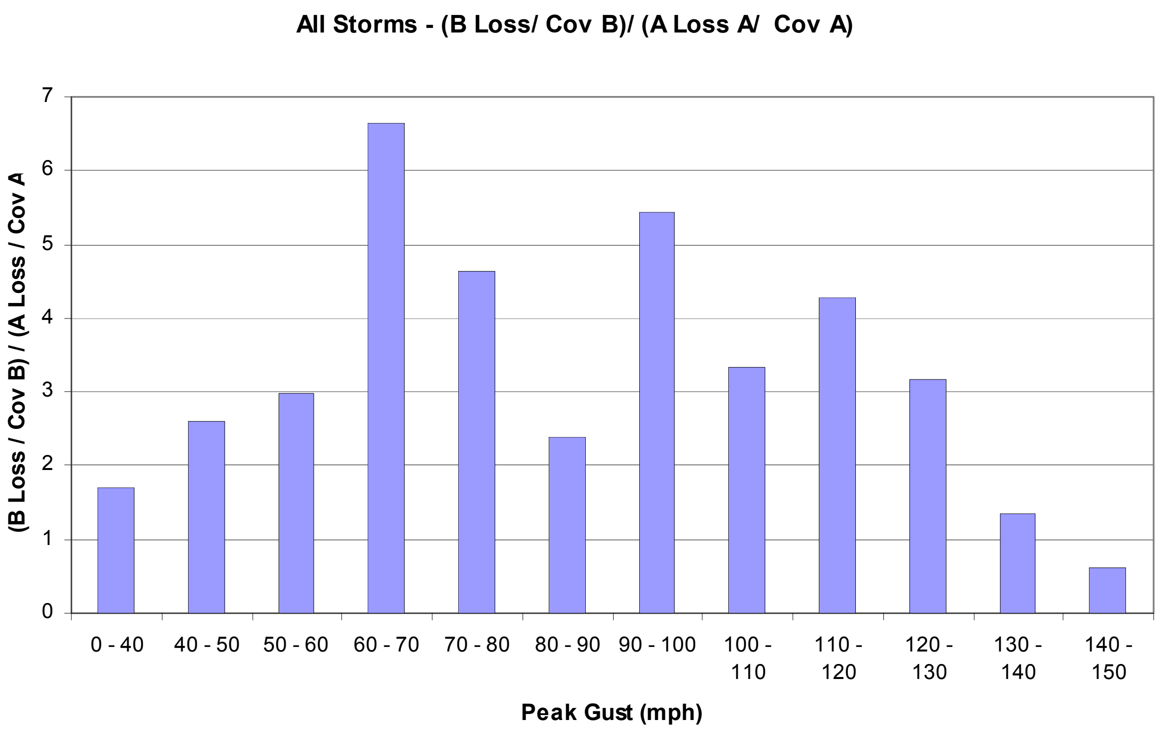


Figure 3-16. Ratio of Coverage B Losses to Coverage A Loss for All Storms for Insurance Company B.

Table 3-2. Hurricane Wilma Total Claims of Each House Type

House Types		Total Claims	% of Total Claims
Mobile Home[1]	DMH	34	37.8
	MHU	4	4.4
	SMH	52	57.8
	Total	90	100
House Types[2]	1SF	154	72.6
	2SR	41	19.3
	USF	17	8
	Total	212	100

[1] DMH = Double-wide Mobile Home; MHU = Mobile Home Unknown width; SMH = Single-wide Mobile Home
[2] 1SF = 1 Story Single Family (site-built) Home; 2SF = 2 Story Single Family Home; USF = Unknown Number of Stories

Table 3-3. Hurricane Charley Total Claims of Each House Type

House Types		Total Claims	% of Total Claims
Mobile Home	DMH	8	36.4
	MHU	1	4.5
	SMH	13	59.1
	Total	22	100.0
House Types	1SF	125	61.3
	2SF	69	33.8
	USF	10	4.9
	Total	204	100.0

3. CP= Carport
4. 4. GA= Garage
5. SR= Sunroom
6. GH= Guest House
7. DK= Deck
8. OP= Open Structure
9. SS= Storage Shed
10. OT= Other

Pool/patio enclosures and fences dominate the losses in the sample of claims reviewed in Hurricane Wilma. Table 3-5 shows the results of the mobile home claims for Wilma. Tables 3-6 and 3-7 show the same data for Hurricane Charley.

The dominance of pool/patio enclosures in the exterior structure claims for single family homes is shown in Figure 3-21. Pool/patio enclosures and fences account for about 90% of the claims for this insurer in these two storms.

For manufactured housing, Figure 3-22 shows that carports are about ½ of the exterior structure losses for this insurer in these storms. Sunrooms and patio enclosures are the other main contributors.

Much more information is being developed for the claim folder review, including correlation to home value.

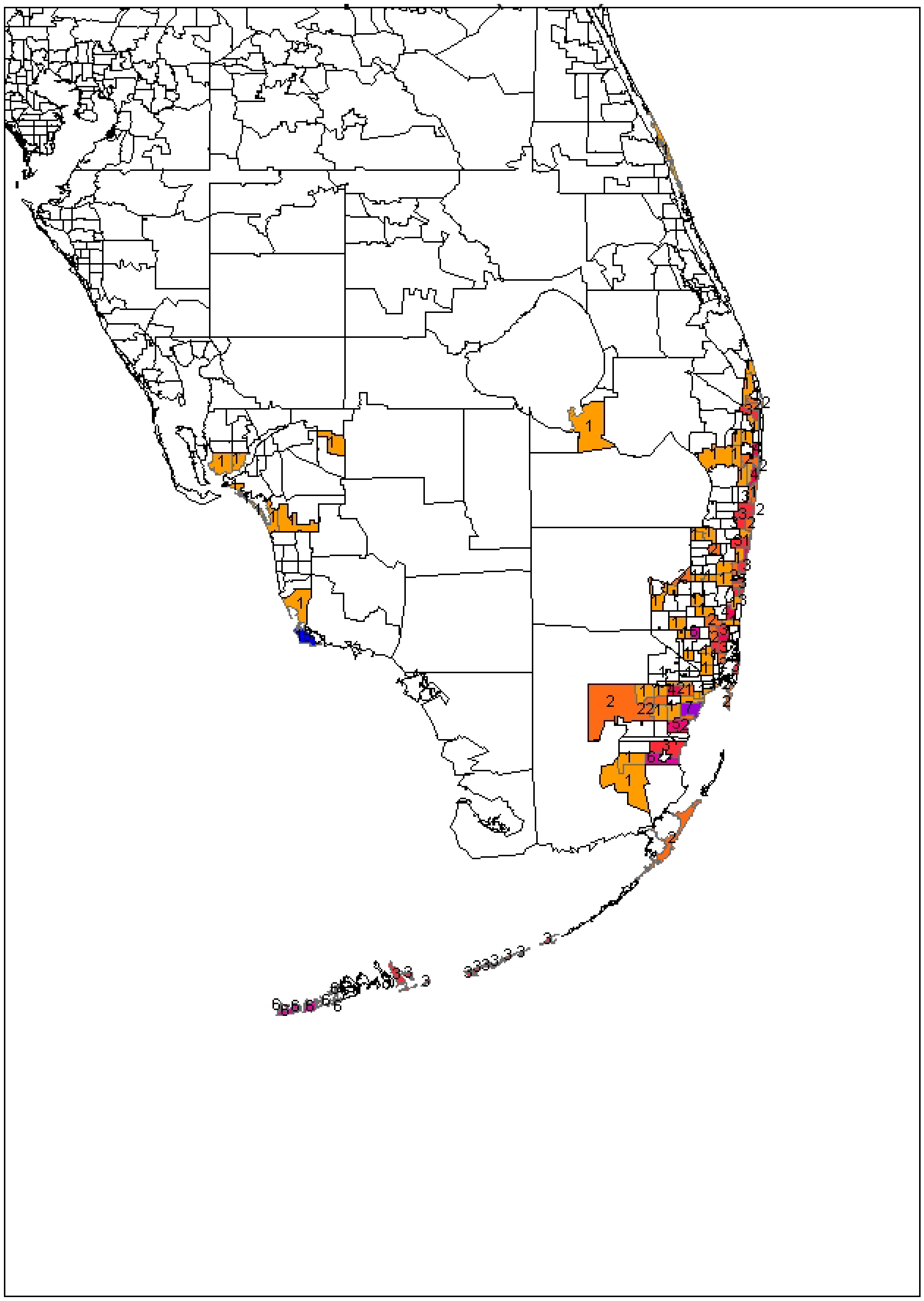


Figure 3-17. Hurricane Wilma – Claims Count by Zip Code (Single Family).

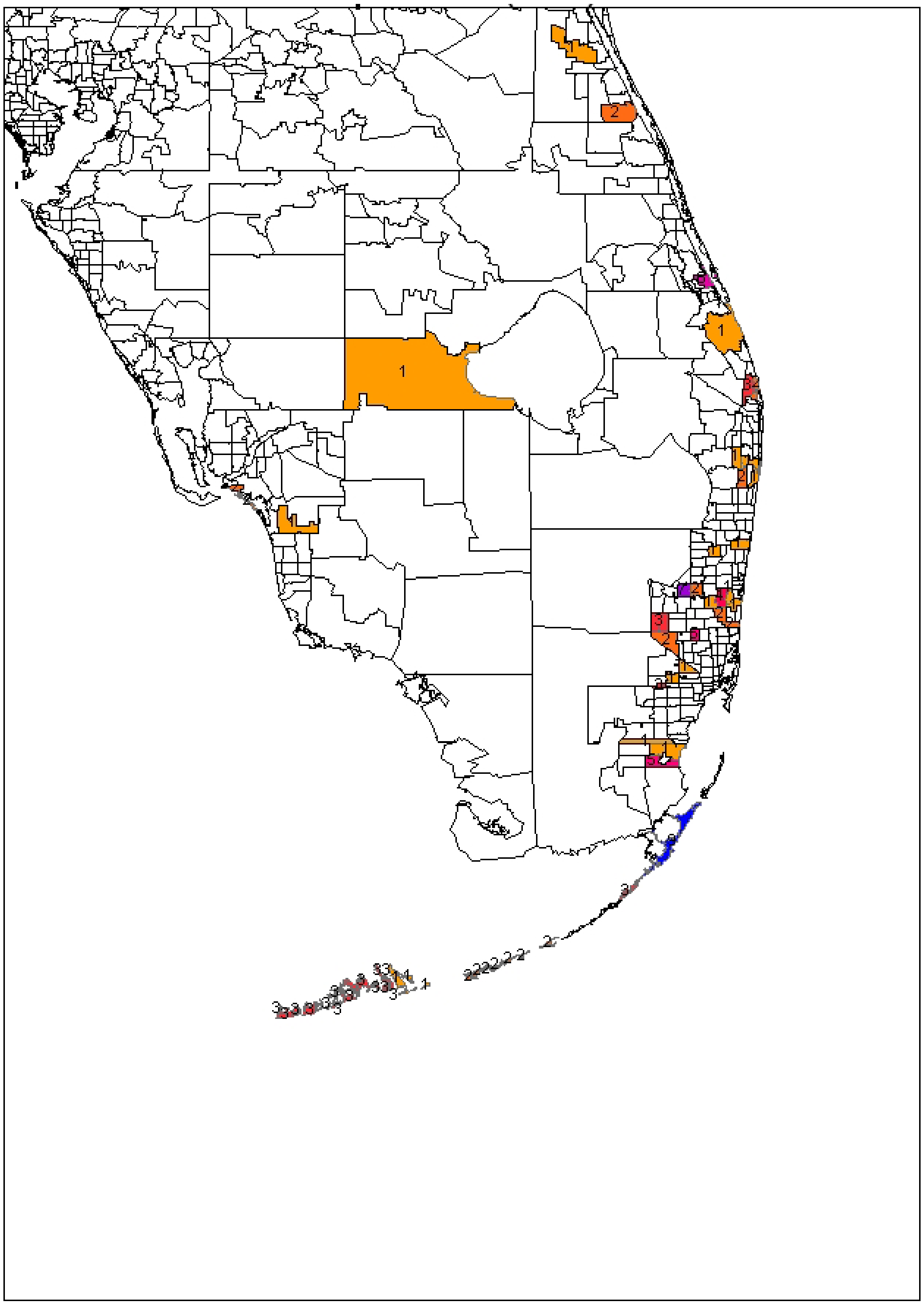


Figure 3-18. Hurricane Wilma – Claims Count by Zip Code (Mobile Home).

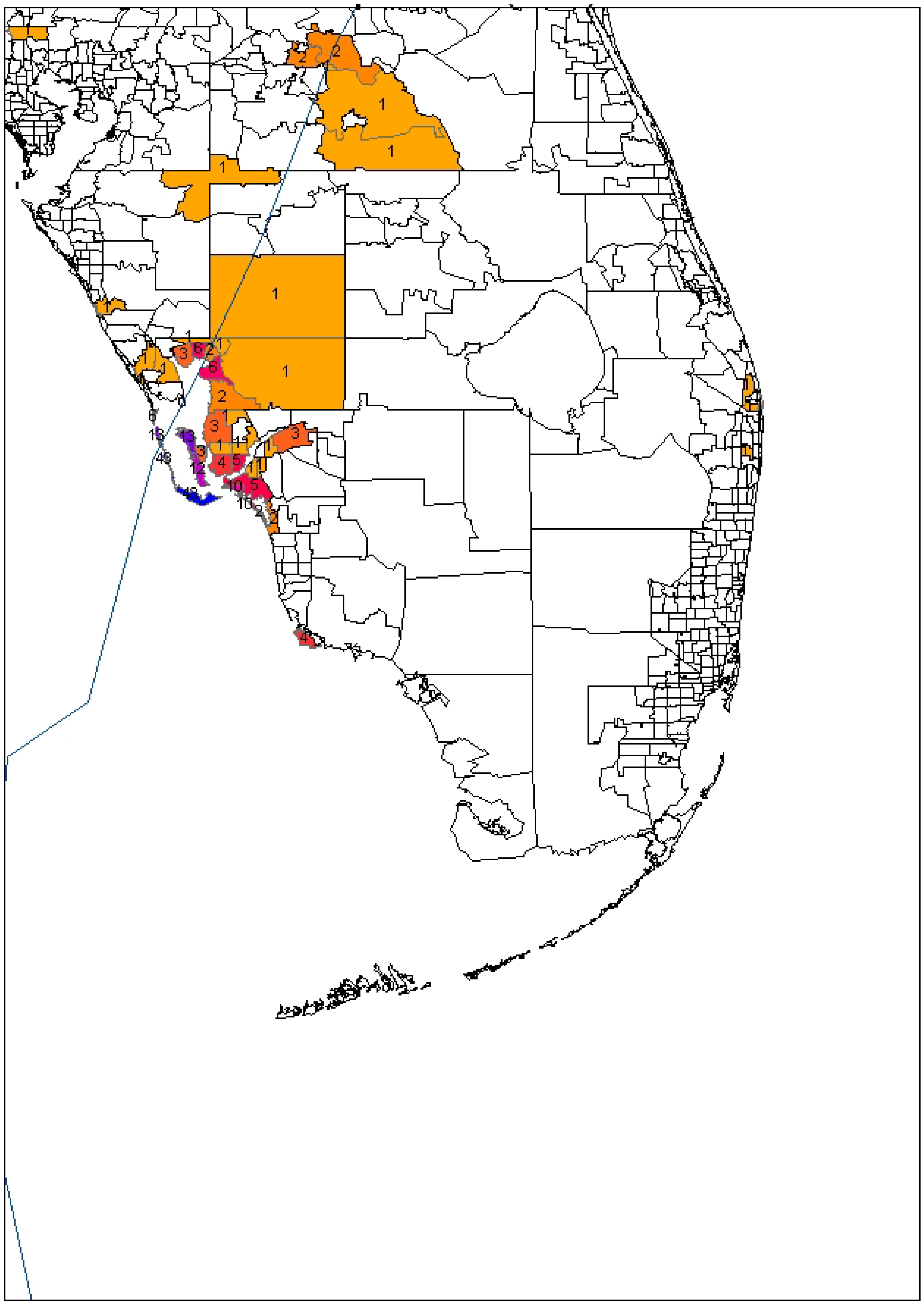


Figure 3-19. Hurricane Charley – Claims Count by Zip Code (Single Family).

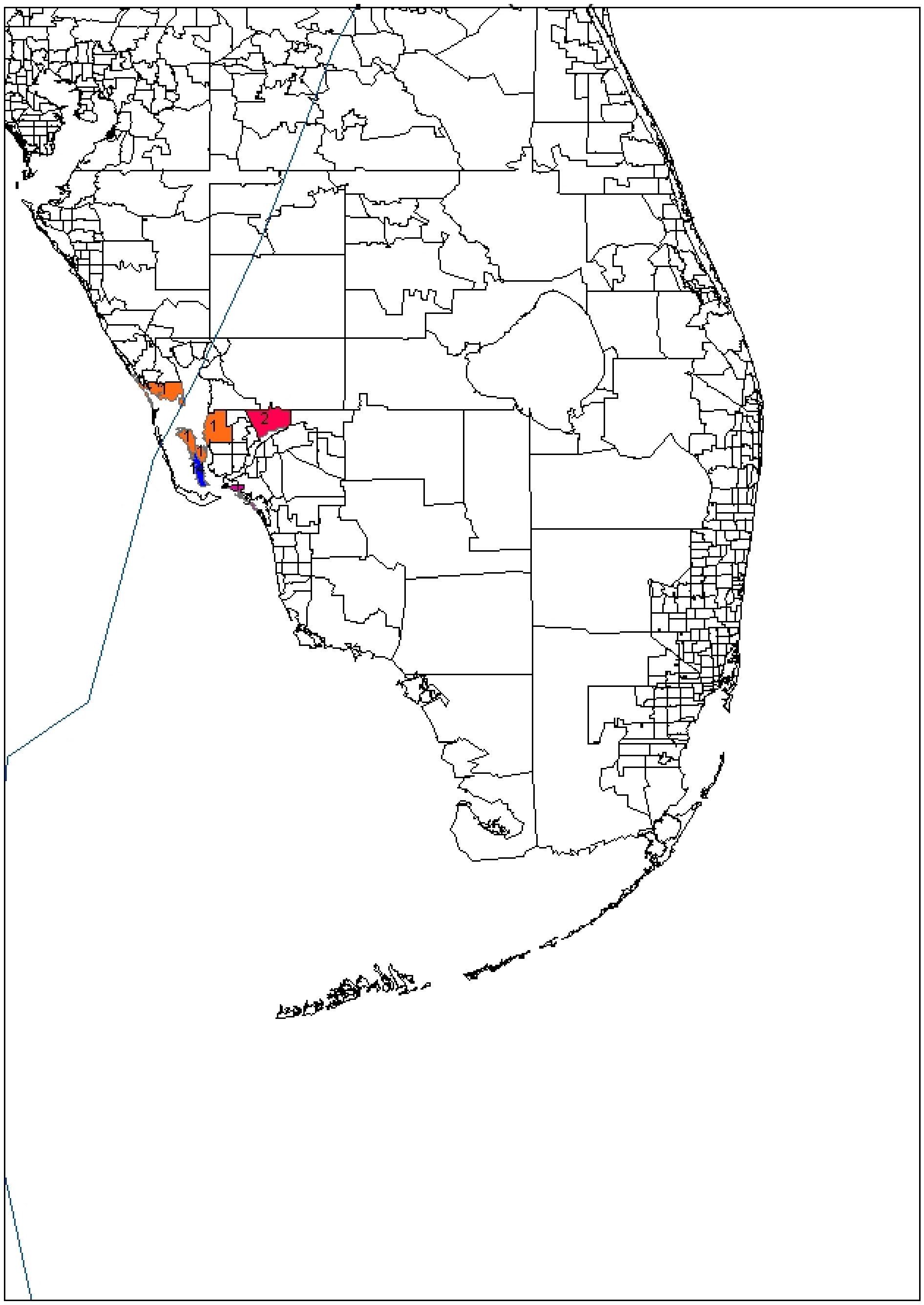


Figure 3-20. Hurricane Charley - Claims Count by Zip Code (Mobile Home).

Table 3-4. Hurricane Wilma Gross Claims of Each Exterior Structure for Single Family Houses

StructureType	Dwelling	Sum of Gross Claim	Percent
CP	1SF	$19,337	1.60%
CP	2SF	$9,844	0.81%
DK	1SF	$1,172	0.10%
Fence	1SF	$243,483	20.10%
Fence	2SF	$59,212	4.89%
Fence	USF	$17,822	1.47%
GA	1SF	$47,521	3.92%
GH	1SF	$5,508	0.45%
OP	1SF	$6,431	0.53%
OT	1SF	$125	0.01%
PE	1SF	$350,355	28.93%
PE	2SF	$269,207	22.23%
PE	USF	$90,038	7.43%
Playset	2SF	$720	0.06%
Spa/Hot Tub	1SF	$280	0.02%
SR	1SF	$23,717	1.96%
SS	1SF	$41,289	3.41%
SS	2SF	$400	0.03%
SS	USF	$4,031	0.33%
Swim Pool	1SF	$20,683	1.71%
	Total	$1,211,175	100.00%

Table 3-5. Hurricane Wilma Gross Claims for Each Exterior Structure for Mobile Homes

StructureType	Dwelling	Sum of Gross Claim	Percent
CP	DMH	$40,182	16.68%
CP	MHU	$9,702	4.03%
CP	SMH	$39,857	16.55%
DK	DMH	$284	0.12%
DK	SMH	$215	0.09%
Fence	DMH	$181	0.08%
Fence	MHU	$341	0.14%
Fence	SMH	$6,362	2.64%
GA	SMH	$260	0.11%
OP	SMH	$18,626	7.73%
OT	SMH	$20,546	8.53%
PE	DMH	$51,595	21.42%
PE	MHU	$9,682	4.02%
PE	SMH	$7,927	3.29%
SR	DMH	$18,475	7.67%
SR	SMH	$6,103	2.53%
SS	DMH	$3,844	1.60%
SS	MHU	$1,617	0.67%
SS	SMH	$5,072	2.11%
	Total	$240,871	100.00%

Table 3-6. Hurricane Charley Gross Claims of Each Exterior Structure for Single Family Homes

StructureType	Dwelling	Sum of Gross Claim	Percent
	1SF	$2,423	0.38%
	2SF	$512	0.08%
CP	1SF	$2,097	0.33%
CP	2SF	$5,543	0.86%
DK	2SF	$1,999	0.31%
Dock	2SF	$0	0.00%
Fence	1SF	$24,591	3.81%
Fence	2SF	$17,423	2.70%
Fence	USF	$4,756	0.74%
GA	1SF	$597	0.09%
GA	2SF	$1,814	0.28%
OP	1SF	$2,358	0.37%
OT	1SF	$614	0.10%
OT	2SF	$5,317	0.82%
PE	1SF	$338,375	52.46%
PE	2SF	$145,004	22.48%
PE	USF	$44,304	6.87%
Playset	2SF	$1,170	0.18%
SR	1SF	$738	0.11%
SS	1SF	$12,133	1.88%
SS	2SF	$1,653	0.26%
Swim Pool	1SF	$24,559	3.81%
Swim Pool	2SF	$7,024	1.09%
	Total	$645,004	100.00%

Table 3-7. Hurricane Charley Gross Claims of Each Exterior Structure for Mobile Homes

StructureType	Dwelling	Sum of Gross Claim	Percent
	DMH	$1,203	
	SMH	$7,948	
CP	DMH	$10,965	16.40%
CP	SMH	$25,750	38.51%
GA	DMH	$0	0.00%
GH	SMH	$1,716	2.57%
OP	MHU	$2,662	3.98%
OP	SMH	$260	0.39%
OT	DMH	$1,447	2.16%
OT	SMH	$4,745	7.10%
PE	SMH	$2,740	4.10%
SR	DMH	$7,137	10.67%
SR	SMH	$6,929	10.36%
SS	DMH	$484	0.72%
SS	SMH	$2,029	3.03%
	Total	$76,015	100.00%

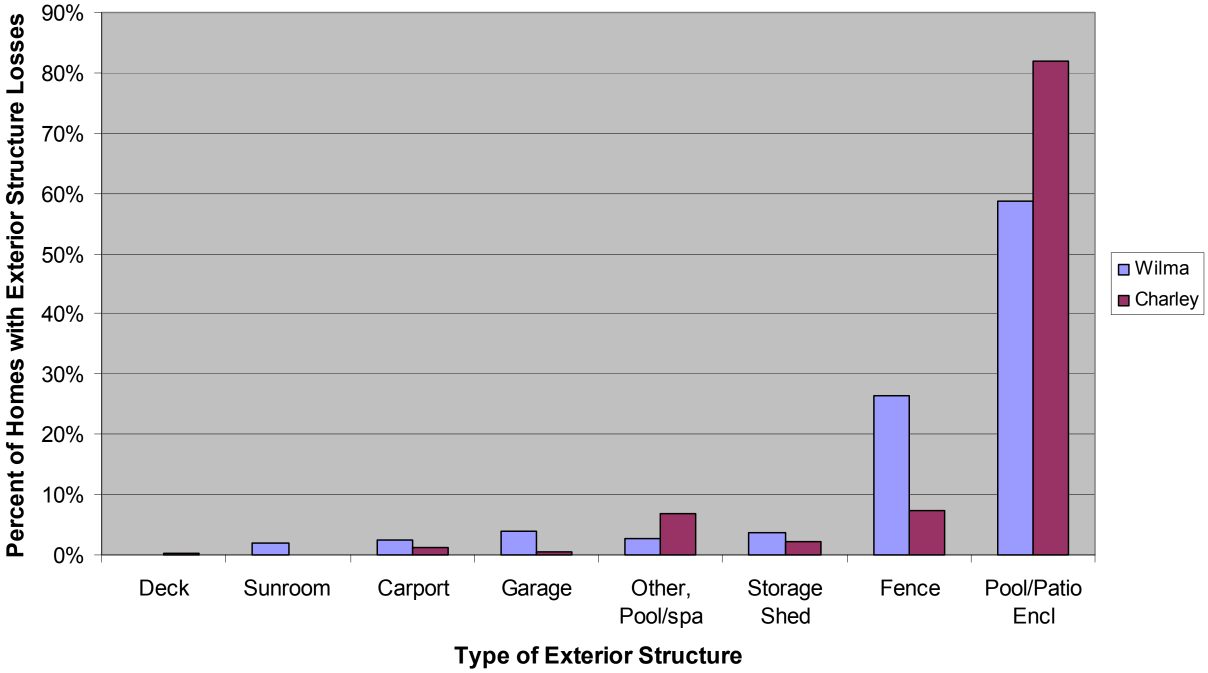


Figure 3-21. Single Family Total Exterior Structure Claim Losses.

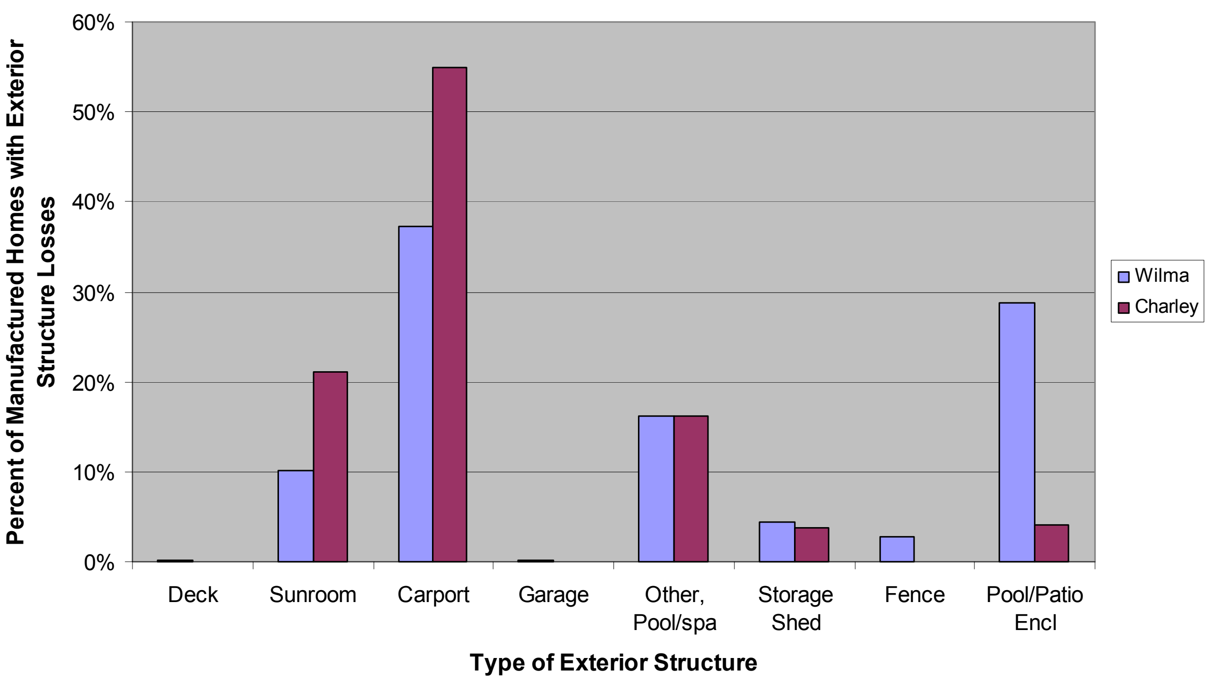


Figure 3-22. Mobile Home Total Exterior Structure Claim Losses.

3.3.1 Single Family Exterior Structure Losses Normalized to Total Losses

Table 3-8 shows how exterior structure claims contribute to the claims. The exterior structure losses are normalized by the total claim dollars in the top half of the table and by the coverae A losses in the bottom half of the table. These results indicate that exterior structures comprised 28% of the total claims in Hurricane Wilma for single family homes. This is a significant result, indicating that exterior structures were a significant percentage of the claims in a relatively modest hurricane. For Hurricane Charley, the exterior structure claims were much less, about 8% of the total claims. The higher wind speeds in Hurricane Charley produced much more damage to the homes and hence the contribution of exterior structures is less of the total amount paid.

These data are consistent with an interpretation that exterior structures are failing at low wind speeds and contribute a large percentage of the claims in weaker storms. The higher vulnerability indicates that the loss costs would be higher and the insurance rates would need to be higher to cover these losses. These preliminary inferences need to be examined in more detail with a larger sample from multiple insurers.

3.3.2 Manufactured Housing Exterior Structure Losses Normalized to Total Losses.

Table 3-8 also shows that exterior structures are between 20% and 30% of the total claims for this carrier for these two storms. The effect of a reduction in exterior structure loss with more intense storm is not seen for manufactured housing. More analysis is needed to determine if the exterior structures are more vulnerable than the mobile homes.

Table 3-8. Exterior Structure Claim as Percent of Total Claim

Normalizing Value	Hurricane	Mobile Home	Single Family
Total Claim	Wilma	21.03%	28.37%
	Charley	27.24%	8.16%
Coverage A	Wilma	22.11%	33.32%
	Charley	28.16%	9.30%

4. DESIGN REQUIREMENTS AND PERFORMANCE

4.1 General

This section documents high-level efforts to review building code requirements for exterior structures. We also analyze existing data from Hurricane Charley to estimate failure rates of certain types of exterior structures.

A review of the basic building code requirements for exterior structures was undertaken to better understand the expected performance of exterior structures in hurricanes. Exterior structures on both site-built and manufactured homes in Florida are required to be designed and constructed in accordance with the Florida Building Code (FBC). Recall that the field survey of site-built homes revealed the most common types of exterior structures are attached aluminum pool/patio enclosures and detached storage sheds. From the mobile home survey, we found that the most common exterior structures were aluminum carports, aluminum patio enclosures, and attached storage sheds. The insurance loss data from Hurricanes Charley and Wilma also confirmed that these same types of structures dominate the exterior structure losses. Hence, our high level review of building code requirements in Section 4.2 focuses primarily on aluminum structures. Section 4.3 includes a short discussion on attached/detached storage sheds.

We used detailed damage survey data from Hurricane Charley to quantify performance of aluminum frame exterior structures. ARA engineers surveyed 67 site-built homes in one subdivision and 221 mobile homes in another location with sufficient detail to facilitate performance assessments. The analyses of this data are documented in this section.

Mitigation is discussed in several of the subsections with an emphasis on improved design loads and increasing the building code "importance factor".

4.2 Building Code Requirements for Screen Enclosures

The aluminum structure industry in Florida is "home-grown" in the sense that Florida has led the nation in the construction of exterior aluminum structures. These structures began to appear in the late 1970's and their popularity has continued to increase. The field survey reported in Section 2 indicated that 31% of the 765 site-built homes surveyed had aluminum patio enclosures and about 75-80% of the mobile homes surveyed had an aluminum carport or patio enclosure.[1]

For the construction of aluminum structures including pool/patio enclosures and carports, the FBC allows use of the Aluminum Association of Florida's (AAF) Guide to Aluminum Construction in High-Wind Areas. The FBC adopted the AAF guide in 2005. Prior to the

[1] As discussed in Section 2, these frequencies are not based on a scientifically-designed sample. However, even if these frequencies are high by a factor of 2 to 3 statewide, the data still indicates there is a huge problem in the current building stock inventory. Extrapolation of these data in terms of statewide insurability issues is discussed in Section 5.

adoption of the guide, no code-adopted prescriptive guide existed.[2] An updated draft of the AAF guide is currently undergoing public comment.

The AAF guide provides users with information on maximum member lengths and connection details as a function of design wind speed and exposure category. The development of the AAF design guide is consistent with the development of other "deemed-to-comply" guides in that it prescribes minimum member sizes using standard allowable stress design methods (i.e., safety factors included in the yield and buckling capacity of the materials and members) for given wind loads. The AAF guide is a voluntary alternative method.[3]

The current FBC wind load criteria for screen structures is based primarily on wind loading data given in an unpublished paper by Reinhold, et al., (2000). The wind loading criteria given in the building code for aluminum structures is based on the winds being applied separately in two orthogonal directions. The wind loading criteria given in the building code recognizes the large contribution of the wind loads acting on the screens to the total loads experienced by the structure as a whole.

We note that prior to the adoption of the 2002 FBC, there was no guidance for designers of screen enclosures, and therefore a screen enclosure that was designed, was designed using the code minimum wind load of 10 psf irrespective of the wind region in which the enclosure was to be located.

The large number of failures of screen enclosures observed during recent Florida hurricanes has resulted in an aluminum industry review of the design and construction methods for aluminum structures. A number of meetings have been held and an advisory engineering group was formed.

ARA engineers spoke to a number of persons involved in this process. The following summary is an attempt to paraphrase the main comments. We have not been able to confirm all of these comments, but in most cases, similar comments were repeated by different individuals.

1. The aluminum extrusions produced by the manufacturers include members with actual sizes on the lower side of industry specified tolerances.
2. The demand for low cost structures and contractor competition has resulted in inadequate engineering fee schedules to design individual site-specific structures. The designs that were developed by engineers were often very different. The more conservative designs were apparently not cost competitive.
3. "Master plans" were propagated by one or more engineers and then extended/adapted by contractors.
4. Engineers have underappreciated both the value of the construction and the complexity of the design. The vast majority of the low-cost engineered designs produced thus far appear to be inadequate.

[2] Prior to the FBC recognition of the AAF guide, most building departments accepted "master file engineering" approaches for these Category I structures.

[3] Master file engineering has been available and promulgated since about 1980. It has long been the most prevalent and popular form of permitting for aluminum structures.

5. Contractors have a competitive incentive to select the lowest cost design and construction methods.
6. Building departments generally claim they do not have the time or expertise to properly evaluate the aluminum structure design documents. Many have not done an adequate job of evaluating design information or of inspecting projects in the field.
7. Evidence of poor construction quality by some aluminum contractors has been verified from field observations of failed structures.
8. The failures of these structures in wind events show evidence of inadequate lateral bracing, local buckling, overall frame instability given one or more member failures, and connection failures. Connection failures have been observed in both member-to-member connections and the foundation connections.

The industry is working to improve this situation with an updated prescriptive guide and ongoing education efforts. However, the above problems are pervasive and involve all segments of the industry: engineering, contracting, and building departments. It should also be noted that the AAF guide is controversial within the contracting industry.[4]

The solution to these inter-connected problems will require involvement of all aspects of the industry: engineering, contracting, and building officials. In addition, new research is needed to further improve the designs and validate performance. Additional work seems warranted from the consumer perspective to independently evaluate the adequacy of industry-proposed prescriptive guides.

The focus of the remainder of this section deals with high-level building code requirements and the engineering performance of these structures. The comments herein are based largely on observed performance and high-level review of the 2005 design guide.

4.2.1 Building Code Importance Factor

Building code "Importance Factor" is a factor used in design of structures. The Importance Factor is based on the building occupancy category. The loads are multiplied by the Importance Factor in the determination of the strength factors needed to resist the loads. Single-family residences are Occupancy Category II Buildings and have a design Importance Factor of 1.0. Structures that represent a low hazard to human life in the event of failure are Occupancy Category I and have an Importance Factor of 0.77.

In the FBC, and consequently in the AAF High Wind Guide, the screen enclosures have been generally treated as Category I structures. With an Importance Factor of 0.77 applied to the design loads, the design wind pressure for these structures is reduced by 23%, or the effective design wind speed is reduced by about 12%. Table 4-1 provides an image of the Occupancy Category Table taken from ASCE 7, and reproduced in the FBC.

[4] According to several sources, a large portion of the aluminum contracting industry believes the guide is too conservative. These contractors apparently prefer to "shop" for low-cost engineered design.

Table 4-1. ASCE 7 Occupancy Categories

TABLE 1-1 OCCUPANCY CATEGORY OF BUILDINGS AND OTHER STRUCTURES FOR FLOOD, WIND, SNOW, EARTHQUAKE, AND ICE LOADS

Nature of Occupancy	Occupancy Category
Buildings and other structures that represent a low hazard to human life in the event of failure, including, but not limited to: • Agricultural facilities • Certain temporary facilities • Minor storage facilities	I
All buildings and other structures except those listed in Occupancy Categories I, III, and IV	II
Buildings and other structures that represent a substantial hazard to human life in the event of failure, including, but not limited to: • Buildings and other structures where more than 300 people congregate in one area • Buildings and other structures with daycare facilities with a capacity greater than 150 • Buildings and other structures with elementary school or secondary school facilities with a capacity greater than 250 • Buildings and other structures with a capacity greater than 500 for colleges or adult education facilities • Health care facilities with a capacity of 50 or more resident patients, but not having surgery or emergency treatment facilities • Jails and detention facilities Buildings and other structures, not included in Occupancy Category IV, with potential to cause a substantial economic impact and/or mass disruption of day-to-day civilian life in the event of failure, including, but not limited to: • Power generating stations[a] • Water treatment facilities • Sewage treatment facilities • Telecommunication centers Buildings and other structures not included in Occupancy Category IV (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing sufficient quantities of toxic or explosive substances to be dangerous to the public if released. Buildings and other structures containing toxic or explosive substances shall be eligible for classification as Occupancy Category II structures if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in Section 1.5.2 that a release of the toxic or explosive substances does not pose a threat to the public.	III
Buildings and other structures designated as essential facilities, including, but not limited to: • Hospitals and other health care facilities having surgery or emergency treatment facilities • Fire, rescue, ambulance, and police stations and emergency vehicle garages • Designated earthquake, hurricane, or other emergency shelters • Designated emergency preparedness, communication, and operation centers and other facilities required for emergency response • Power generating stations and other public utility facilities required in an emergency • Ancillary structures (including, but not limited to, communication towers, fuel storage tanks, cooling towers, electrical substation structures, fire water storage tanks or other structures housing or supporting water, or other fire-suppression material or equipment) required for operation of Occupancy Category IV structures during an emergency • Aviation control towers, air traffic control centers, and emergency aircraft hangars • Water storage facilities and pump structures required to maintain water pressure for fire suppression • Buildings and other structures having critical national defense functions Buildings and other structures (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, or hazardous waste) containing highly toxic substances where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction. Buildings and other structures containing highly toxic substances shall be eligible for classification as Occupancy Category II structures if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in Section 1.5.2 that a release of the highly toxic substances does not pose a threat to the public. This reduced classification shall not be permitted if the buildings or other structures also function as essential facilities.	IV

[a] Cogeneration power plants that do not supply power on the national grid shall be designated Occupancy Category II.

The design of an exterior attached structure such as a screen enclosure with an Importance Factor of 0.77 introduces substantial risk that the attached structure will fail prior to the dwelling. A higher frequency of failure will result in higher loss costs, which would logically translate into higher insurance rates than the dwelling.

Discussion of ASCE Category Classifications. The basic question in the classification of screen enclosures in terms of ASCE 7 and the FBC is whether or not the failure of the structure poses a low hazard to human life. The purpose of a screen enclosure is to provide comfortable outdoor living space for humans. Therefore, these structures are built for the sole purpose of human occupancy. However, practice to date has relied on the reasonable assumption that screen enclosures will not be occupied during high wind events.[5] Following this assumption, the screen

[5] The wind events that affect Florida are dominated by hurricanes and there is generally plenty of warning so that rational people have time to evacuate a screen enclosure. There is less warning from thunderstorm winds, but, in general, people will tend to seek cover immediately as wind gusts begin to exceed comfort levels, say around 30-40 mph. If properly designed and constructed, screen enclosures should not fail in those relatively low windspeeds, unless struck by a falling tree.

enclosure category classification for wind load[6] depends solely on the failure hazard to people outside of the occupancy footprint of the structure. The failure hazard depends on proximity of people to the structure and the risk posed by structural failure. Since screen enclosures are either adjacent to or attached to the dwelling, it is reasonable to assume that people will be in the proximity of the structure should it fail. Hence, the fundamental question is whether or not there is "low hazard" to the dwelling occupants from the failure of the screen enclosure.

The hazard to humans posed by screen enclosure failure includes:

1. Failure of the enclosure at the attachment points to the dwelling. Can the failure at the attachments from the breakaway of the structure damage/weaken the dwelling? Can this "detachment" produce sufficient damage in which the dwelling structure fails at lower windspeeds than it would have otherwise?
2. Missiles and wind borne debris produced from the beams, columns, and other structural components during and following failure/collapse. Can the failure and wind-induced acceleration of the structure/components damage the dwelling, cause it to fail prematurely (from internal pressurization), or injure humans inside the dwelling?
3. Can wind borne debris from the failure of the enclosure pose additional hazards to people in other nearby dwellings?

These are difficult questions to answer. Most engineers would agree that it is difficult, if not impossible, to design a structure to fail in a repeatable and controllable fashion in extreme winds. In general, it seems reasonable that the failure of screen enclosures adds to the hazard risk to human life in the owner's dwelling and possible in other nearby dwellings. Large enclosures are likely to pose more risk than smaller enclosures. Two story enclosures are likely to pose more risk than one story enclosures. A residence with large areas of glazing facing the enclosure is likely to have higher risk than one with little glazing facing the enclosure.

The question remains "Does the risk to human life remain low given failure of the structure?" Most people would probably answer this question with "yes", until we have some documented deaths caused by failed aluminum screen enclosures or carports.

The ASCE 7 provides some discussion that deals with independence of the structural systems and multi-use buildings/structures. While screen enclosures attached to dwellings are not independent structures, screen enclosures that are adjacent to, but detached from, the dwelling are independent structures. ASCE says: "*The classification for each independent structural system of a multiple-use building or other structure shall be that of the highest usage group in any part of the building or other structure that is dependent on the basic structural system.*" If one views the house and the screen enclosure as a multiple-use occupancy (dwelling is occupied and the screen enclosure is non-occupied) building/structure, then one could make the

[6] ASCE 7 allows the assignment of multiple occupancy categories to a structure based on use and the type of load being evaluated. This means that one could classify a screen enclosure in an area with moderate to high seismic risk as a Category I structure, since (with typically no earthquake warning) people could just as easily be inside the enclosure as in their house and hence subject to life-threatening hazard should the structure fail. However, Florida has low seismic risk and the classification of screen enclosures should reasonably be based on wind hazards.

interpretation that outdoor living space enclosed by the screen enclosure should be treated in the same fashion as the indoor living space of the dwelling, i.e., as a Category II structure and designed to an importance factor of one. This interpretation is not one that the FBC, code consultants, professional engineers, or building officials have adopted to date.

Other Considerations. The question of whether or not large residential structures such as screen enclosures are life threatening when they fail is one consideration. There are other non-code related considerations that could impact residential design standards for large, attached and/or detached structures that are unlikely to be occupied during a wind event. While these considerations are not "importance factor" issues (since importance factor is a code life-safety issue), they are raised in the context of achieving balanced (risk vs cost) designs.

The first consideration deals with notification of the buyer (owner of the structure)). If large and expensive exterior structures, such as screen enclosures and mobile home carports, are designed and built to a lesser standard than the dwelling, should the owner/buyer be notified of this prior to purchase of the structure? Such notification should include information on: the reduced design loads; the higher expected failure rates (see Section 5 for rough estimates); the fact that some damage to the residence is likely in the event of failure; and the potential lack of insurance and/or higher cost of insurance for these structures.

The second consideration is economic. It is possible that some owners would opt for a stronger design to a higher design standard at higher initial cost (but likely lower lifetime costs). Section 5 discusses these economic and insurability issues.

4.2.2 Unique Structural Characteristics and Lack of Redundancy

Screen enclosures have some unique structural characteristics. The structural system is comprised of a relatively small number of long slender members (in order to provide an "open/outdoor" visual environment). These structures have many unbraced rectangular panels, which rely on moment-resisting joints for local stability. If the joints are not sufficiently rigid, these panels lack redundancy and stability. There is no stabilizing membrane like a roof deck or shear-resistant wall cladding. In addition, the loads on the members themselves may be an important contribution to the total load on the structural system.[7] The current design practice seems to lack the traditional and well-proven structural engineering concepts of multiple redundancies and inherent stability. In short, these structures seem vulnerable to fail in a catastrophic manner.

Complicated Loads on Individual Members. During any strong wind event, the individual members resist wind loads introduced through loads acting on the screens in addition to wind loads acting on the individual members themselves. The provisions of the FBC give the designer guidance as to the wind loads acting on the structural system as a whole (i.e. total horizontal wind loads, including loads on screens and members, applied separately in two orthogonal directions). The designer then uses these loads to design each member in the structural system, or uses the AAF prescriptive guide to select member sizes given spans and a design wind speed. Depending on the true wind direction, many of the long structural members

[7] In most structural systems, the wind loads on the members are small when compared to the loads imparted to the cladding and/or deck.

will be in compression, and will also experiencing biaxial lateral loads, and likely torsional loads. The combination of compressive, biaxial bending, and torsion will reduce the buckling capacity of the aluminum member.[8] Figure 4-1 presents an example frame for a screen enclosure showing example forces acting on a roof member for oblique winds. The buckling of one member totally changes the load path and can lead to overloading and failure of other member failures, coupled with permanent racking and/or collapse of the frame.

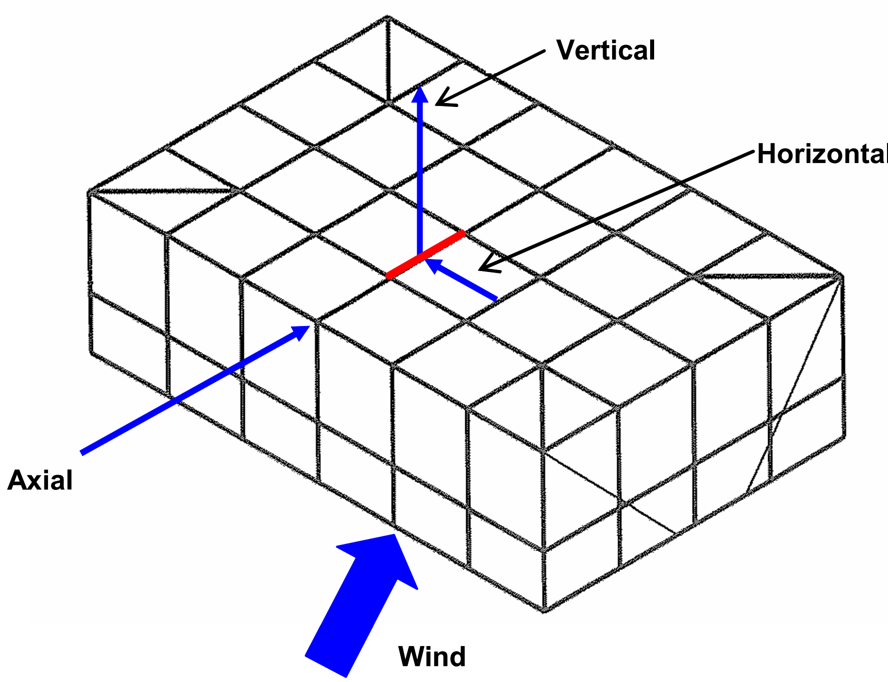


Figure 4-1. Forces Acting on Individual Member for Oblique Winds.

Lack of Redundancy. Typical bays in current design practice of aluminum structures are rectangular shapes without bracing or diaphragm-type membrane stiffening. The reliability of the system can potentially be degraded with the failure of single member. One could describe portions of this structural system more as a serial system in contrast to a highly redundant, "parallel" structural system. Serial systems are governed by their weakest "link", where the links include individual members and failure modes, such as: member buckling under combined loads, connection failure, foundation attachment failure, or cable bracing slippage, loosening over time, or failure. Serial systems need very high safety factors in each member to ensure adequate structural performance.

A single member failure that potentially leads to progressive failure appears to be a major drawback of the current design approach. If the system is vulnerable to progressive collapse from a single member failure, then this vulnerability tends to raise concerns regarding potential wind-borne debris (WBD) impact. In a design event, if impact on a single member could produce the added load to cause a buckling failure, then portions of the system could be vulnerable to a

[8] The effects of combined loads from oblique winds are generally accounted for by interaction formulas.

failure initiated by a single WBD impact on a single member.[9] Without adequate design redundancy, the failure could propagate to produce a partial or total frame collapse. Research is needed to investigate these issues from both performance-based and prescriptive-based requirements.

Structural Joints. Joint design and performance is another big concern. We understand that the prescriptive joints in the AAF are based on "rational design", and have not yet been verified through an experimental testing program that is part of an overall finite-element stability analysis.

Once the biaxial loads are developed in a wind tunnel test program, the adequacy of the joint designs can be determined. A second question on joints regards fastener performance. Will the fasteners still perform after years of environmental exposure, including heating, cooling, and cyclical fatigue loading? Fasteners have been noted as a problem for both screen enclosures and mobile home carports. If the aluminum structure was built with fasteners that are not corrosive resistant, corrosion may likely be a major issue in future performance under wind loads. Fatigue testing of joints and new concepts for joint connections need to be explored.

High Loss Costs. Figure 4-2 presents an example of a partially collapsed aluminum screen enclosure, where on the right-hand side of the photograph, there is an example of a vertical member that has failed due to buckling. One of the roof members has also started to buckle.

Summary. The combination of the lower importance factor and the lack of redundancy in aluminum structures indicate that the wind-induced failure rates of aluminum structures is expected to be higher than that evident for houses, even if properly designed to the AAF requirements. The failure mechanism is such that in most instances, if the structure does fail, a complete collapse is more likely than a partial collapse (which is rare in houses), and consequently, the loss costs for screen enclosures are expected to be much higher than for the residences themselves. The higher loss costs should not be expected to drop to the point of being equal to those associated with new code homes as long as the structures are designed as Category I structures, and until the structural design and performance becomes validated. To this end, we believe a rigorous testing and research program should be undertaken to supplement the efforts funded by the aluminum industry and verify performance before tens of thousands of new structures become part of the Florida building inventory.

4.2.3 Loss Mitigation

The field survey and insurance loss data confirm there is a serious problem with existing aluminum structures in Florida. We are not aware of a systematic effort to develop and verify

[9] If the system has redundant and residual capacity such that failure of one member will not lead to a progressive failure, then WBD would not likely be a contributing failure mode. However, given the large size of these structures and the resulting large presented area of the structures, WBD impact on at least one member is likely in a high wind design event. As part of the recommended testing program, typical members could be impacted while under compressive and bending loads to develop the design requirements for survivable structures.

Figure 4-2. Example of a Partially Failed Aluminum Screen Enclosure.

cost-effective mitigation approaches for aluminum structures.[10] Hence, there is a critical need for a loss mitigation research effort.

Loss mitigation strategies for existing aluminum structures must address the entire structural system. A simple approach to add bracing may not be effective. The distribution of loads under high wind conditions needs to be well understood in any mitigation concept for existing structures. With this qualification, additional cable bracing may be a viable approach for mitigation, although work is needed to ensure that this approach will be effective. Improving the connections between the structure and foundation (through the use of longer screws) can be done without any concern of changing the distribution of loads within the structure. Changing out rusted fasteners would be a likely cost effective mitigation approach for some structures.

A wind tunnel test program is required to quantify the magnitude of the combined lateral and compression loads acting on structural frame components used in the screen enclosure. The objective of the study is to supplement the requirements derived from the previous wind tunnel tests with a set of additional loads that would be applied perpendicular (across wind loads) to those derived using the current procedure. These additional loads would provide for a much better estimate of the true buckling capacity of the aluminum members.

The wind tunnel test program should also consider partially block sides of the enclosure, resulting from entrained water and light debris. One side blocked and others open could be a critical load case.

[10] A retrofit program has recently been introduced for mobile home aluminum carport structures. We are not aware of the level of design verification of the retrofit program. Wind tunnel testing coupled with full scale dynamic testing of these retrofit concepts would be a useful verification element of a research program.

Time series of wind loads derived from the wind tunnel tests should also be combined with finite element analyses to better understand how these 3-D (lateral, torsional and compression) loads affect the behavior of the connections.

Full scale dynamic testing should be performed as part of the mitigation program for both new design validation and investigation of mitigation options and effectiveness. Such a program is critically needed to ensure that the next generation of structures will perform as intended. In addition, if a prescriptive mitigation guide for existing structures could be developed, this would provide some relief to the insurability problems with the thousands of existing structures in the state.

4.3 Building Code Requirements for Storage Sheds

Unlike most aluminum structures, storage sheds are fully enclosed structures. As such, their walls are completely covered with solid covering and/or sheathing materials that help provide some redundancy than the largely open aluminum carports and pool/patio enclosures.

However, storage sheds, like exterior aluminum structures, are assumed "…to present a low hazard to human life in the event of failure…" (FBC Table 1604.5). This means that the design loads calculated for the structure are multiplied by an importance factor of 0.77 (reducing design wind pressures by 23%, or reducing the effective design wind speed by 12%).

One other factor in storage structure design and construction relates to whether the storage shed was built on site, or if it was manufactured and installed on site. Sheds that are built on site are reviewed and permitted by local jurisdictions only. Manufactured sheds must also be approved by the Florida Department of Community Affairs (DCA) through plan review and inspections by a third party agency before installation on site. Installation and site work is then reviewed and permitted by the local jurisdiction. Either way, storage sheds must meet the same requirements as set out in the FBC.

The net result is that storage sheds should perform better than open aluminum structures in high winds due to their increased redundancy, however, their performance will likely lag behind that of site-built and manufactured homes due to the lower importance factor specified for this type of construction.

4.4 ARA Single-Family Home Survey Following Hurricane Charley

Table 4-2 presents the results of a survey by ARA engineers following Hurricane Charley in the Punta Gorda area. A total number of 67 houses were surveyed in several neighborhoods. The survey focused on the residences, but sufficient pictures were taken to allow us to analyze the data in terms of pool/patio enclosures for this project. The maximum peak gust wind speeds (at a height of 10m in open terrain) were estimated to be about 140 mph. Figure 4-3 presents a plot of the modeled peak gust wind speeds at the locations of the homes used in the survey.

Figure 4-4 indicates that 79% of the aluminum screen enclosures experienced a complete collapse. Also, as indicated in Figure 4-4, of the 47 enclosures that experienced any frame damage, 42 had a complete collapse, supporting the hypothesis that the lack of redundancy tends

Table 4-2. Hurricane Charley ARA Damage Survey Results (Punta Gorda Area, Tile Roof Subdivisions)

House No.	ARA ID	Pool/Patio Enclosures	Catastrophic Failure	Partial Frame Failure	Screen Failure Only	No Failures	Comments	Figure
1	4006	Yes	Yes	-	-	-		4-4
2	4012	Yes	Yes	-	-	-	Small end sections with small spans survived	4-5
3	4031	Yes	Yes	-	-	-	Small end sections with small spans survived	
4	4037	Yes	Yes	-	-	-		
5	4043	Yes	Yes	-	-	-		
6	636	Yes	Yes	-	-	-		
7	4036	Yes	Yes	-	-	-		
8	4032	Yes	Yes	-	-	-		
9	3663	Yes	Yes	-	-	-		
10	3657	Yes	Yes	-	-	-		
11	3651	Yes	Yes	-	-	-		
12	3645	Yes	Yes	-	-	-		
13	3631	Yes	Yes	-	-	-		
14	3621	Yes	Yes	-	-	-		
15	3615	Yes	Yes	-	-	-		
16	3650	No	No	-	-	-		
17	363	No	No	-	-	-		
18	3593	Yes	No	Yes	-	-	Roof members buckled	4-6
19	3588	No	No	-	-	-		
20	3582	Yes	No	Yes	-	-	Roof members buckled	
21	3578	Yes	Yes	-	-	-	Small area with shorter span did not fail	4-7
22	3566	Yes	No	-	Yes	-	Cable braced	4-8
23	3518	Yes	Yes	-	-	-		
24	3512	Yes	Yes	-	-	-		
25	odd side	No	No	-	-	-		
26	3560	Yes	Yes	-	-	-		
27	3554	Yes	No	-	Yes	-	Not certain from photos, but visible portion of frame appears undamaged	
28	3541	Yes	Yes	-	-	-		
29	3555	Yes	Yes	-	-	-		
30	3561	Yes	Yes	-	-	-		
31	3575	Yes	-	Yes	-	-	Missile impact?	4-9
32	3587	No	No	-	-	-		
33	3518	No	No	-	-	-		
34	3512	Yes	-	Yes	-	-		
35	3519	Yes	Yes	-	-	-		
36	3513	Yes	Yes	-	-	-		
37	615	Yes	Yes	-	-	-		
38	605	-	-	-	-	-	Not certain from photos	
39	606	Yes	Yes	-	-	-		
40	616	Yes	Yes	-	-	-		
41	3740	Yes	Yes	-	-	-		
42	3732	Yes	Yes	-	-	-	Failed members make compact scrap pile	4-10(a), (b)
43	3712	Yes	Yes	-	-	-		
44	3706	Yes	Yes	-	-	-		
45	3700	No	No	-	-	-		
46	3717	Yes	Yes	-	-	-		
47	3739	-	-	-	-	-	Not certain from photos	
48	3749	-	-	-	-	-	Not certain from photos	
49	612	Yes	No	-	Yes	-		
50	600	Yes	Yes	-	-	-	2 story enclosure, failed at attachment	4-11(a), (b)
51	3765	Yes	Yes	-	-	-		
52	5007	Yes	No	-	Yes	-		
53	355	Yes	Yes	-	-	-	End section with short spans did not fail	
54	342	Yes	Yes	-	-	-		
55	324	Yes	Yes	-	-	-		
56	318	Yes	No	-	-	-	All observable screens are not torn	4-12(a), (b)
57	312	Yes	Yes	-	-	-		
58	306	Yes	No	-	-	Yes	Small short span enclosure	4-13
59	313	Yes	Yes	-	-	-		
60	504	-	-	-	-	-	Not certain from photos	
61	5052	Yes	Yes	-	-	-		
62	365	No	No	-	-	-		
63	375	No	No	-	-	-		
64	376	No	No	-	-	-		
65	370	No	No	-	-	-		
66	364	Yes	No	-	-	Yes	Cable braced	4-14
67	358	Yes	No	Yes	-	-	Buckling of a few members	
Total		52	42	5	4	2		
Percent		100%	78.8%	9.6%	7.7%	3.8%		

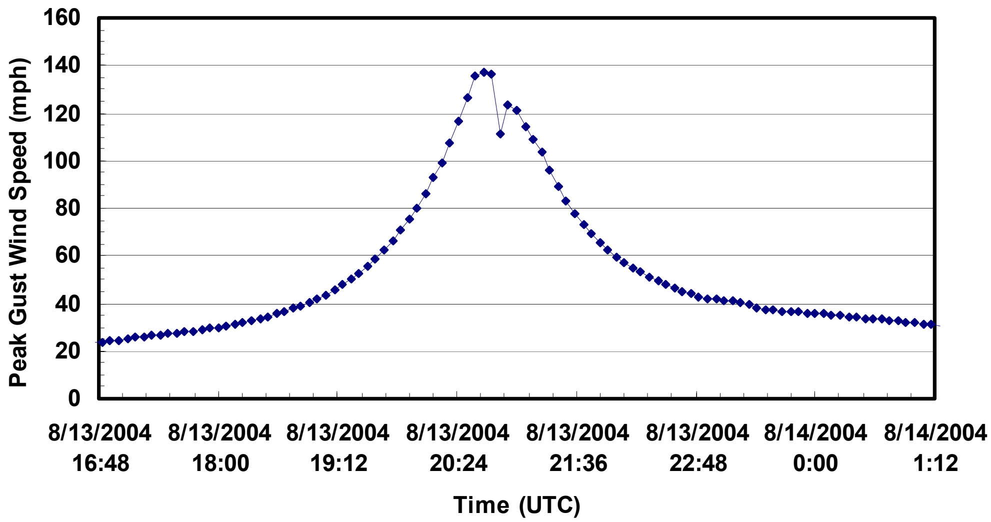


Figure 4-3. Modeled Peak Gust Wind Speeds for Hurricane Charley at the Location of the Surveyed Screen Enclosures.

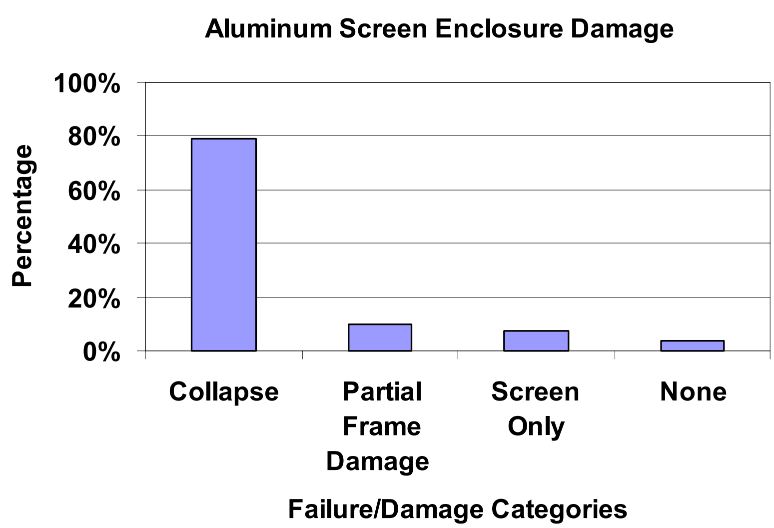


Figure 4-4. Performance of Screen Enclosures in Hurricane Charley.

to primarily result in a total failure rather than a partial failure. It was noted that for the two cases where no damage was observed, there was clear evidence of cable bracing evident in the photograph. In the examples where complete failure of the enclosure was observed evidence of cable bracing could not be seen, however; we cannot state that the bracing did not exist prior to collapse.

Figures 4-5 though 4-15 show the types of damage observed and referenced in Table 4-2.

Figure 4-5. House 1.

Figure 4-6. House 2.

Figure 4-7. House 18.

Figure 4-8. House 21.

Figure 4-9. House 22.

Figure 4-10. House 31.

Figure 4-11(a). House 42.

Figure 4-11(b). House 42.

Figure 4-12(a). House 50.

Figure 4-12(b). House 50.

Figure 4-13(a). House 56.

Figure 4-13(b). House 56.

Figure 4-14. House 58.

Figure 4-15. House 66.

4.5 Observed Damage to Patio Enclosures and Carports on Manufactured Homes – Hurricane Charley

ARA engineers conducted a survey of several mobile home parks following Hurricane Charley in 2004. Sufficient documentation was produced for us to evaluate carport and patio enclosures.

Photos of damage caused by Hurricane Charley of the exterior structures on 221 manufactured homes were examined to determine the distribution of damage states for patio enclosures and carports. Table 4-3 summarizes the data. Twenty-eight of the 221 homes were from a community where all the homes were between 0 and 4 years old when Charley came ashore. This community experienced peak gust wind speeds of roughly 135 mph. The remaining 193 homes considered were located in a community with homes built between 1986 and 1992. The second community experienced peak gust winds of roughly 140 mph.

Figure 4-16 shows the distribution of patio enclosure damage observed in the damage photos into damage states of catastrophic failure, partial frame failure, only screen failure, and no failures. Figure 4-17 shows the distribution of carport damage observed in the damage photos into damage states of catastrophic failure, partial failure, and no failures.

In reviewing and analyzing these data, we observed that:

- Patio enclosures and carports located on the leeward side of the home fared much better than those on the windward side (See Figure 4-18).
- Patio enclosures with solid walls (siding and/or vinyl, acrylic, or glass windows) appeared to suffer less damage than those with screen only walls (See Figure 4-19).
- Combined attachments of patio enclosures and carports along the front of homes appeared to be more vulnerable than those attached along the side of the home (See Figure 4-20).

Given that so many failures occurred at windspeeds near the design requirements, it is apparent that additional work is needed to develop improved loads and design concepts for attached carports/enclosures to manufactured homes.

Table 4-3. Hurricane Charley ARA Damage Survey Results
(Punta Gorda Area, Mobile Home Parks)

Park	House No.	photo start	**Pool/Patio Enclosures**	Catastrophic Failure	Partial Frame Failure	Screen Failure Only	No Failures	**Carport**	Catastrophic Failure	Partial Failure	No Failures	Comments
VL	74	1176	**-**	-	-	-	-	**Yes**	Yes	-	-	
VL		1168	**-**	-	-	-	-	**-**	-	-	-	
VL	70	1169	**Yes**	-	-	-	Yes	**Yes**	-	-	Yes	
VL		1170	**-**	-	-	-	-	**Yes**	-	-	Yes	
VL	72	1171	**-**	-	-	-	-	**Yes**	-	-	Yes	
VL	73	1172	**-**	-	-	-	-	**Yes**	-	-	Yes	
VL	75	1174	**Yes**	-	Yes	-	-	**Yes**	Yes	-	-	
VL		1175	**-**	-	-	-	-	**-**	-	-	-	under construction
VL		1176	**Yes**	-	-	-	Yes	**Yes**	Yes	-	-	
VL	289	1177	**-**	-	-	-	-	**-**	-	-	-	
VL	288	1178	**-**	-	-	-	-	**Yes**	Yes	-	-	
VL		1179	**-**	-	-	-	-	**-**	-	-	-	
VL	205	1180	**-**	-	-	-	-	**Yes**	-	Yes	-	
VL		1181	**-**	-	-	-	-	**-**	-	-	-	
VL	283	1182	**Yes**	-	-	-	Yes	**Yes**	-	-	Yes	
VL	282	1183	**-**	-	-	-	-	**Yes**	-	-	Yes	
VL	281	1184	**-**	-	-	-	-	**Yes**	-	-	Yes	
VL	280	1185	**-**	-	-	-	-	**Yes**	-	-	Yes	
VL	279	1186	**Yes**	Yes	-	-	-	**Yes**	-	Yes	-	
VL		1187	**-**	-	-	-	-	**Yes**	-	Yes	-	
VL		1188	**-**	-	-	-	-	**-**	-	-	-	
VL		1189	**-**	-	-	-	-	**-**	-	-	-	under construction
VL		1190	**-**	-	-	-	-	**-**	-	-	-	
VL		1192	**-**	-	-	-	-	**-**	-	-	-	
VL		1193	**-**	-	-	-	-	**Yes**	Yes	-	-	
VL	271	1194	**-**	-	-	-	-	**Yes**	-	-	Yes	1194-5 failure of anchor to concrete
VL	270	1198	**Yes**	-	Yes	-	-	**Yes**	-	-	Yes	
VL		1199	**-**	-	-	-	-	**-**	-	-	-	
EL	96	799-802	**Yes**	-	Yes	-	-	**Yes**	Yes	-	-	800 PE roof failuare
EL	97	803-6	**Yes**	-	Yes	-	-	**Yes**	Yes	-	-	
EL		807-10	**Yes**	-	Yes	-	-	**Yes**	-	Yes	-	
EL		811-14	**Yes**	-	Yes	-	-	**Yes**	Yes	-	-	
EL	18	815-22	**Yes**	Yes	-	-	-	**Yes**	-	Yes	-	
EL		823-6	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL	103	827	**Yes**	-	-	Yes	-	**Yes**	Yes	-	-	
EL		832	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL	104	839	**Yes**	Yes	-	-	-	**Yes**	-	Yes	-	
EL	105	844	**Yes**	-	Yes	-	-	**Yes**	-	Yes	-	
EL	106	850	**Yes**	-	-	Yes	-	**Yes**	Yes	-	-	
EL	107	863	**Yes**	-	-	-	Yes	**Yes**	Yes	-	-	
EL	108	869	**Yes**	Yes	-	-	-	**Yes**	-	Yes	-	
EL	109	874	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL	110	879	**Yes**	Yes	-	-	-	**Yes**	-	Yes	-	
EL		885	**Yes**	-	-	-	Yes	**Yes**	-	-	Yes	
EL		890	**Yes**	-	-	Yes	-	**Yes**	-	-	Yes	
EL		896	**Yes**	Yes	-	-	-	**Yes**	-	Yes	-	
EL	115	901	**Yes**	-	-	-	Yes	**Yes**	Yes	-	-	
EL	116	907	**Yes**	-	-	-	Yes	**Yes**	-	-	Yes	
EL	117	913	**Yes**	-	Yes	-	-	**Yes**	Yes	-	-	
EL	87	919	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL	16	921	**-**	-	-	-	-	**Yes**	-	-	Yes	
EL	17	923	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL		924	**Yes**	-	-	-	Yes	**Yes**	Yes	-	-	
EL	19	925	**-**	-	-	-	-	**Yes**	-	-	Yes	
EL		927	**Yes**	-	-	-	Yes	**Yes**	-	-	Yes	
EL		928	**Yes**	-	-	-	Yes	**Yes**	-	-	Yes	
EL	22	930	**Yes**	-	-	-	Yes	**Yes**	-	-	Yes	
EL		932	**Yes**	-	-	Yes	-	**Yes**	-	-	Yes	
EL		933	**Yes**	-	Yes	-	-	**Yes**	-	-	Yes	
EL		936	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL		937	**Yes**	-	-	-	Yes	**Yes**	-	-	Yes	
EL		939	**Yes**	-	-	Yes	-	**Yes**	-	-	Yes	
EL	27	940	**Yes**	-	Yes	-	-	**Yes**	Yes	-	-	
EL		943	**Yes**	-	-	-	Yes	**Yes**	-	-	Yes	
EL		944	**Yes**	-	-	Yes	-	**Yes**	-	-	Yes	
EL		945	**Yes**	-	Yes	-	-	**Yes**	Yes	-	-	
EL		946	**Yes**	-	-	Yes	-	**Yes**	-	-	Yes	
EL		947	**Yes**	-	-	Yes	-	**Yes**	Yes	-	-	
EL		948	**Yes**	-	-	-	Yes	**Yes**	-	-	Yes	
EL	33	949	**Yes**	-	Yes	-	-	**Yes**	Yes	-	-	
EL		950	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL		952	**Yes**	-	-	Yes	-	**Yes**	-	Yes	-	

Table 4-3. Hurricane Charley ARA Damage Survey Results (Punta Gorda Area, Mobile Home Parks) (continued)

Park	House No.	photo start	**Pool/Patio Enclosures**	Catastrophic Failure	Partial Frame Failure	Screen Failure Only	No Failures	**Carport**	Catastrophic Failure	Partial Failure	No Failures	Comments
EL	123	960	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL		961	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL		962	**Yes**	-	Yes	-	-	**Yes**	-	Yes	-	roof cover damage only
EL	124	963	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL	41	964	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL	42	965	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL	43	966	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL	44	967	**Yes**	Yes	-	-	-	**Yes**	-	Yes	-	
EL		968	**Yes**	-	-	-	Yes	**Yes**	-	-	Yes	
EL		969	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL		970	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL	47	971	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL		972	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL	136	973	**Yes**	-	Yes	-	-	**Yes**	Yes	-	-	
EL	48	974	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL		975	**-**	-	-	-	-	**Yes**	-	Yes	-	
EL		976	**Yes**	-	-	Yes	-	**Yes**	-	-	Yes	
EL	49	977	**Yes**	-	Yes	-	-	**Yes**	Yes	-	-	
EL	50	978	**Yes**	-	Yes	-	-	**Yes**	Yes	-	-	
EL		980	**-**	-	-	-	-	**Yes**	-	-	Yes	CP on leeward side of home
EL	155	982	**-**	-	-	-	-	**Yes**	-	-	Yes	CP on leeward side of home
EL	156	983	**-**	-	-	-	-	**Yes**	-	-	Yes	CP on leeward side of home
EL	157	984	**-**	-	-	-	-	**Yes**	-	-	Yes	CP on leeward side of home
EL		985	**Yes**	-	Yes	-	-	**Yes**	Yes	-	-	
EL		986	**-**	-	-	-	-	**-**	-	-	-	
EL	55	987	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL		988	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL		989	**-**	-	-	-	-	**Yes**	-	-	Yes	
EL		990	**-**	-	-	-	-	**Yes**	-	-	Yes	
EL		993a	**Yes**	Yes	-	-	-	**-**	-	-	-	
EL		993b	**Yes**	-	Yes	-	-	**-**	-	-	-	
EL		994a	**Yes**	-	-	Yes	-	**-**	-	-	-	
EL		996	**Yes**	Yes	-	-	-	**-**	-	-	-	
EL		997	**Yes**	Yes	-	-	-	**-**	-	-	-	
EL		998	**Yes**	-	Yes	-	-	**-**	-	-	-	
EL		999	**Yes**	Yes	-	-	-	**-**	-	-	-	
EL		1000	**Yes**	-	-	Yes	-	**-**	-	-	-	
EL		1001a	**Yes**	-	Yes	-	-	**-**	-	-	-	
EL		1001b	**Yes**	Yes	-	-	-	**-**	-	-	-	
EL		1002	**Yes**	-	-	Yes	-	**-**	-	-	-	
EL		1003	**Yes**	-	-	Yes	-	**-**	-	-	-	
EL		1004	**Yes**	Yes	-	-	-	**-**	-	-	-	
EL		1005	**Yes**	-	-	Yes	-	**-**	-	-	-	
EL		1006	**Yes**	-	-	Yes	-	**-**	-	-	-	solid wall PE
EL		1007	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL		1008	**-**	-	-	-	-	**Yes**	-	Yes	-	
EL		1009	**-**	-	-	-	-	**-**	-	-	-	
EL		1010	**Yes**	-	-	Yes	-	**Yes**	-	-	Yes	
EL		1011	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL		1012	**-**	-	-	-	-	**Yes**	Yes	-	-	
EL		1013	**-**	-	-	-	-	**-**	-	-	-	
EL		1014	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL		1015	**Yes**	-	-	Yes	-	**Yes**	Yes	-	-	
EL		1016	**-**	-	-	-	-	**Yes**	Yes	-	-	
EL		1017	**Yes**	Yes	-	-	-	**Yes**	-	Yes	-	
EL		1018	**Yes**	-	-	Yes	-	**Yes**	Yes	-	-	
EL		1019	**Yes**	-	-	-	Yes	**Yes**	-	Yes	-	solid wall PE
EL		1020	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL		1021	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL		1022	**Yes**	-	-	-	Yes	**Yes**	-	Yes	-	
EL		1023	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL		1024	**Yes**	Yes	-	-	-	**Yes**	-	Yes	-	
EL		1025	**Yes**	Yes	-	-	-	**Yes**	-	Yes	-	
EL		1026	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL	127	1027	**Yes**	-	-	Yes	-	**Yes**	-	-	Yes	
EL		1028	**Yes**	Yes	-	-	-	**-**	-	-	-	
EL		1029	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL	126	1030	**Yes**	Yes	-	-	-	**Yes**	-	Yes	-	
EL	57	1031	**Yes**	-	-	-	Yes	**Yes**	Yes	-	-	solid wall PE
EL	161	1032	**-**	-	-	-	-	**-**	-	-	-	
EL		1034	**Yes**	Yes	-	-	-	**Yes**	-	Yes	-	

Table 4-3. Hurricane Charley ARA Damage Survey Results (Punta Gorda Area, Mobile Home Parks) (concluded)

Park	House No.	photo start	**Pool/Patio Enclosures**	Catastrophic Failure	Partial Frame Failure	Screen Failure Only	No Failures	**Carport**	Catastrophic Failure	Partial Failure	No Failures	Comments
EL	59	1038	**Yes**	Yes	-	-	-	**Yes**	-	Yes	-	
EL	61	1041	**Yes**	Yes	-	-	-	**Yes**	-	Yes	-	
EL		1042	**Yes**	Yes	-	-	-	**Yes**	-	Yes	-	
EL	62	1043	**Yes**	-	-	Yes	-	**Yes**	Yes	-	-	
EL		1045	**Yes**	-	-	-	Yes	**Yes**	Yes	-	-	
EL	64	1047	-	-	-	-	-	**Yes**	-	Yes	-	
EL	65	1048	**Yes**	-	-	Yes	-	**Yes**	Yes	-	-	
EL	66	1050	**Yes**	Yes	-	-	-	**Yes**	-	Yes	-	
EL		1051	-	-	-	-	-	**Yes**	-	-	Yes	
EL	67	1052	**Yes**	Yes	-	-	-	**Yes**	-	Yes	-	
EL	170	1053	-	-	-	-	-	**Yes**	Yes	-	-	
EL		1054	**Yes**	-	-	-	Yes	**Yes**	Yes	-	-	
EL	69	1055	**Yes**	Yes	-	-	-	**Yes**	-	Yes	-	
EL	70	1056	-	-	-	-	-	**Yes**	Yes	-	-	
EL		1060	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL	72	1061	**Yes**	Yes	-	-	-	-	-	-	-	
EL		1062	-	-	-	-	-	-	-	-	-	
EL		1066	**Yes**	Yes	-	-	-	**Yes**	-	Yes	-	
EL	74	1067	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL	75	1072	**Yes**	-	Yes	-	-	**Yes**	Yes	-	-	
EL		1073	**Yes**	Yes	-	-	-	**Yes**	-	Yes	-	
EL		7074	-	-	-	-	-	**Yes**	-	Yes	-	
EL	176	1075	-	-	-	-	-	**Yes**	-	Yes	-	
EL		1076	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL	177	1077	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	CP in front of garage
EL		1078	-	-	-	-	-	**Yes**	Yes	-	-	
EL		1079	-	-	-	-	-	**Yes**	Yes	-	-	
EL		1080	-	-	-	-	-	**Yes**	Yes	-	-	
EL	181	1081	-	-	-	-	-	**Yes**	Yes	-	-	
EL	190	1083	-	-	-	-	-	**Yes**	Yes	-	-	
EL	188	1085	-	-	-	-	-	**Yes**	-	-	Yes	
EL	184	1090	-	-	-	-	-	**Yes**	-	-	Yes	
EL		1091	**Yes**	-	-	Yes	-	-	-	-	-	
EL		1099	**Yes**	Yes	-	-	-	-	-	-	-	
EL		1094	**Yes**	-	-	Yes	-	**Yes**	-	-	Yes	
EL		1095	**Yes**	Yes	-	-	-	-	-	-	-	
EL		1096	**Yes**	Yes	-	-	-	-	-	-	-	
EL		1097	**Yes**	Yes	-	-	-	-	-	-	-	
EL		1098	**Yes**	Yes	-	-	-	-	-	-	-	
EL		1099	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL		1100	-	-	-	-	-	**Yes**	-	-	Yes	
EL	78	1101	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL	79	1102	**Yes**	-	-	Yes	-	**Yes**	Yes	-	-	
EL	80	1103	-	-	-	-	-	**Yes**	Yes	-	-	
EL		1104	**Yes**	-	-	Yes	-	**Yes**	Yes	-	-	
EL	82	1105	**Yes**	-	-	-	Yes	**Yes**	Yes	-	-	
EL	83	1106	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL	84	1107	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL		1108	**Yes**	-	-	Yes	-	-	-	-	-	
		1109	**Yes**	-	Yes	-	-	**Yes**	Yes	-	-	
EL	87	1110	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL	88	1111	**Yes**	-	Yes	-	-	**Yes**	Yes	-	-	
EL	89	1112	-	-	-	-	-	**Yes**	Yes	-	-	
EL	90	1115	-	-	-	-	-	**Yes**	-	-	Yes	
EL	91	1116	**Yes**	-	Yes	-	-	**Yes**	Yes	-	-	
EL		1117	**Yes**	-	Yes	-	-	**Yes**	-	Yes	-	
EL		1118	**Yes**	-	Yes	-	-	**Yes**	-	Yes	-	
EL		1119	-	-	-	-	-	**Yes**	-	Yes	-	
EL	192	1121	-	-	-	-	-	**Yes**	Yes	-	-	
EL		1123	-	-	-	-	-	**Yes**	-	-	Yes	
EL	198	1125	-	-	-	-	-	**Yes**	Yes	-	-	
EL	204	1131	-	-	-	-	-	**Yes**	Yes	-	-	
EL	205	1132	-	-	-	-	-	**Yes**	Yes	-	-	
EL	14	1133	-	-	-	-	-	**Yes**	-	Yes	-	
EL		1135	-	-	-	-	-	**Yes**	-	-	Yes	
EL		1136	**Yes**	-	Yes	-	-	**Yes**	-	Yes	-	
EL	10	1137	**Yes**	-	Yes	-	-	**Yes**	-	-	Yes	
EL	9	1138	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL	4	1144	**Yes**	Yes	-	-	-	**Yes**	Yes	-	-	
EL	3	1147	**Yes**	-	-	-	Yes	**Yes**	-	-	Yes	
EL	1	1149	**Yes**	-	Yes	-	-	**Yes**	Yes	-	-	
		Total	**155**	75	29	27	24	**180**	94	39	47	
		Percent	**100%**	48.4%	18.7%	17.4%	15.5%	**100%**	52.2%	21.7%	26.1%	

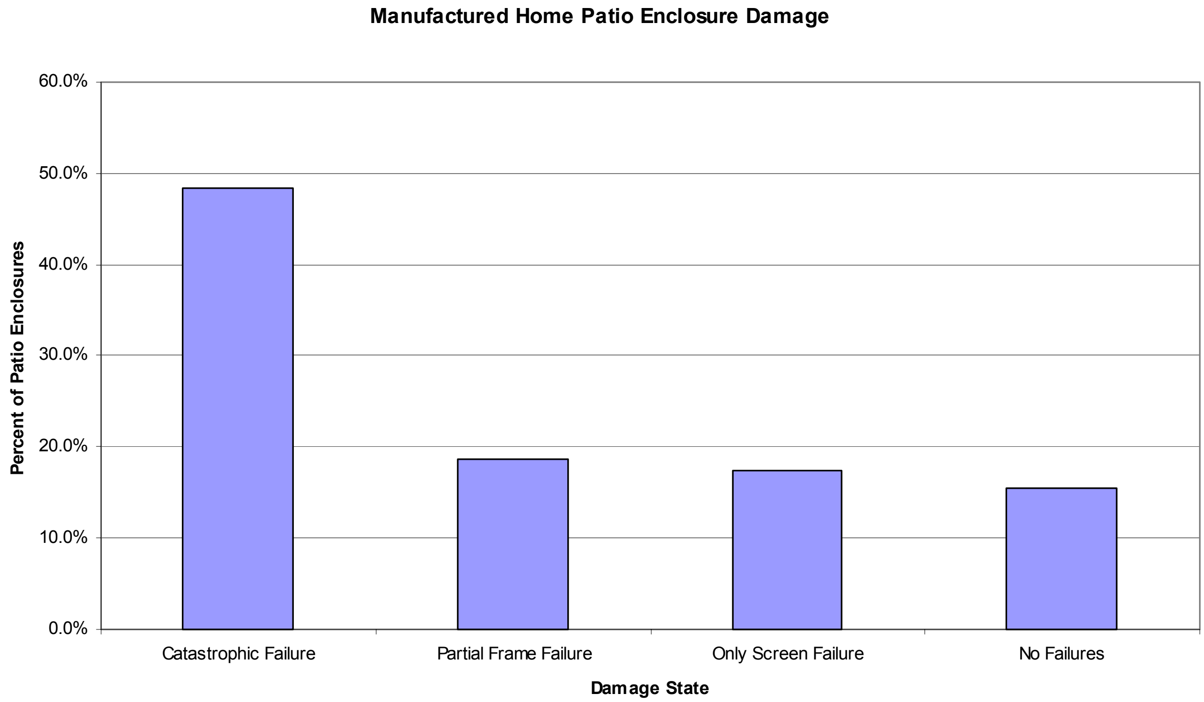


Figure 4-16. Distribution of Manufactured Home Patio Enclosure Damage in Hurricane Charley.

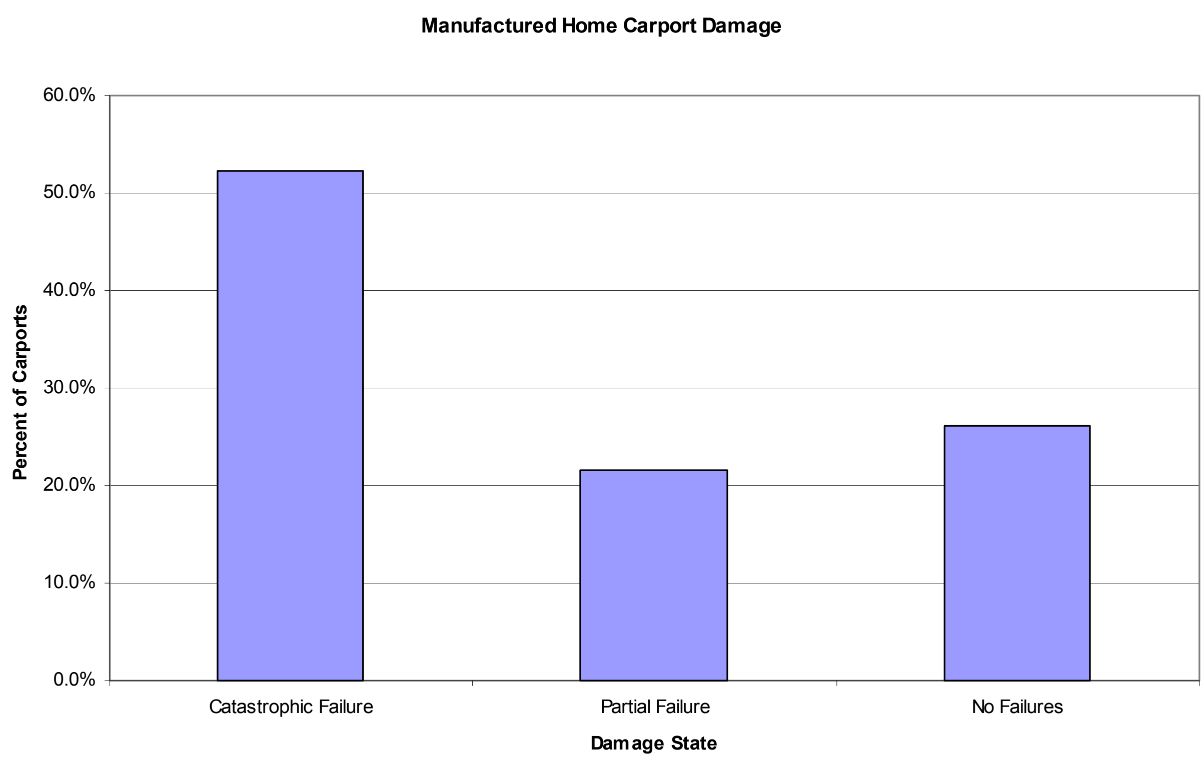


Figure 4-17. Distribution of Manufactured Home Carport Damage in Hurricane Charley.

Figure 4-18. Examples of Carports on Leeward Side of Manufactured Homes Faring Relatively Well (note extensive structure damage on windward side).

Figure 4-19. Example of Solid-Walled Patio Enclosure that Fared Well (note complete collapse of adjoining carport).

Figure 4-20. Example of Patio Enclosure and Carport Collapse Along Front of Home with Carport Section on Side of Home Still Standing.

5. INSURABILITY ISSUES: SHORT AND LONG TERM

5.1 Overview

The data developed in the preceding sections are used in this section to evaluate exterior structure loss and insurability issues. The insurability issues are discussed in terms of both short term (rate factors) and long term (building code and mitigation) viewpoints. A long term viewpoint is needed to fix the root causes of the problem.

While the examples in this section focus on an assessment of exterior structure insurability for site-built homes, the concepts illustrated herein apply equally to manufactured (mobile) homes. More work is needed to complete and finalize these results. These results should clearly be viewed as very preliminary since they are based on only a few sets of insurer data and a single field survey.

Some of the main issues in analyzing insurability issues for exterior structures include:

1. The almost infinite variety of exterior structures, including products, construction materials, shapes, attachment methods, levels of engineering design, and construction quality.
2. The traditional insurance treatment of attached structures as part of the dwelling coverage, whether or not the attached structure is designed and built to the same building code requirements as the dwelling.
3. The traditional lack of information on exposure values for insurance coverage B (other structures) and the use of coverage B limits than generally do not match the coverage B values at risk.
4. Except for a very small minority of carriers, the coding of losses provides no real insight into understanding insurability or identifying issues before they become major problems.
5. The fact that insurance deductibles generally apply to the total loss and separate deductibles are not applied for each coverage.

The variety of approaches employed in the previous sections of this report represents our attempt to deal with these challenges. Clearly, much more work is needed to standardize and streamline the treatment and classification of exterior structures. Also, as much of the continued building code improvements are focused on the dwelling, the contribution of exterior structures to the total loss will only increase over time without further work to “catch up” certain exterior structures to the dwelling requirements.

We evaluate insurability from the following perspectives:

1. ***Existing Loss Ratio Factors for Exterior Structures***. Based on the field survey, claims data, and policy level coverage data, we crudely estimate the loss cost differentials that currently exist between the dwelling and exterior structures. This

analysis represents only a short-term approach to reflect the vulnerability differences of existing aluminum frame structures.

2. ***Reduction in Losses from Improvements in Current Building Practices***. The potential reduction in loss costs for exterior structures that are properly designed to the correct loads using professional engineering design methods. We also evaluate the potential impact of changing the importance factor in the national design standards for attached aluminum structures that are dominating the loss costs.
3. ***Life Cycle Benefit Cost Analysis.*** We use the results of the estimated loss costs with estimates of the increased costs in building to new loads (with an Importance Factor equal to that of the dwelling) and perform a life cycle benefit cost analysis to determine if more costly and resistant designs are a good investment.
4. ***Statewide Magnitude of Problem and Benefits of Working Toward Long Term Insurability Solution***. The results from items 2 and 3 are combined to estimate the statewide average annual losses and the reductions in average annual loss if the state undertakes research and development to fix the root causes of the insurability problems.

These viewpoints are discussed in Sections 5.2 through 5.5, respectively. Section 5.2 illustrates some loss factors for exterior structures that could be viewed as generally representative of the existing vulnerabilities of these structures relative to the dwelling. These factors may be useful for short term (over the next year) insurability decision making. They should not be used over the long term, especially if the recommendations for improved design of aluminum frame exterior structures are followed and new “era” aluminum frame structures become a reality. Sections 5.3 through 5.5 develop recommendations for longer term solutions to insurability issues. Section 5.6 summarizes comments from press articles provided by OIR Consumer Advocate Office.

5.2 Empirical Loss Factors for Attached and Detached Structures

We examine the differences in loss costs for exterior structures using insurance data in two different ways in this section. The first is to estimate the loss cost factor ratios for exterior structures in an empirical way, using the claim folder data and field survey data. This calculation is performed for both site-built and mobile homes. Another approach to estimate insurability is to take the insurance coverage level losses to compute the loss cost penalty for Coverage B *vs*. Coverage A. These analyses give us crude estimates of the loss cost penalty for existing exterior structures when compared to the loss costs of the dwelling. Both of these analyses are approximate and require some strong assumptions, but should provide a reasonable estimate of the loss cost penalty for current structures.

5.2.1 Exterior Structure Empirical Loss Factors Based on Field Survey and Claim Folder Data

By combining the claim level review with the field survey results, a very crude ratio of the loss costs of exterior structures to the loss costs of the dwelling can be estimated. The following paragraphs provide estimates based on the limited data developed in this report. As noted below these results are judged to be most applicable to attached aluminum frame structures.

Preliminary Empirical Loss Factor for Exterior Structures for Site-Built Homes. We can estimate the loss cost factor for exterior structures to dwelling structure according to the equation

$$\text{Loss Penalty Factor} \sim (L_e/V_e)/(L_d/V_d) = (L_e/L_d)/(V_e/V_d), \qquad (5\text{-}1)$$

where L_e = Average Annual Loss of Exterior Structures ($), V_e = Value of Exterior Structures ($), L_d = Average Annual Loss of Dwelling ($), and V_d = Value of Dwelling ($). This factor is an approximate way (it is not an expected value calculation) to estimate the ratio of normalized losses of exterior structures divided by the normalized losses of the dwelling.[1] Since the losses used in this calculation do not consider deductible, this factor is for "ground-up" losses.

We approximate the Average Annual Loss (AAL) by averaging the L_e/L_d term for the two storms: Wilma and Charley. The claim folder review indicated that exterior structure losses average about 21% (see Table 3-8) of the Coverage A claims for these two storms, hence the L_e/L_d term in Eqn 5-1 is 0.21.The V_e/V_d term is taken from the field survey. The field survey and valuation indicated that exterior structures are 0.103 of the Coverage A value for single family homes (see Table 2-7). Hence, a ballpark estimate of the loss costs penalty ratio is about 2.1 for the data considered in this project for site-built homes.

Recall that since attached aluminum frame pool/patio enclosures dominate the exterior structure values and claim folder losses, this ratio mostly applies to these types of structure, but the data used does not make these factors exclusive to these structures.

A main limitation of this approach is that the ratios are formed from two separate data sets, instead of a single data set. The losses are estimated from a sample of claim folders and the values are estimated from a separate field survey data sample. The errors from these two samples accumulate and hence these results are subject to potentially larger errors. Considering the many assumptions made in this simple calculation, a reasonable range in this loss costs penalty ratio is a factor of about 1.5 on these results, hence a reasonable range would be 1.4 to 3.2.

Preliminary Empirical Loss Factors for Exterior Structures for Mobile Homes. By combining the claim level review with the field survey results, we can similarly estimate a very preliminary ratio of the loss costs of exterior structures to the loss costs of the mobile home dwelling. The field survey and valuation indicated that exterior structures average 19% of the Coverage A value for manufactured homes (see Table 2-19). The claim folder review indicated that exterior structure losses average about 25% of the claims for the two storms considered (Table 3-8). Thus, a crude preliminary estimate of the loss cost penalty for exterior structures for manufactured homes is estimated from Eqn. 5-1 as about 1.34.

[1] Equation 5-1 is nonlinear in the random variables and hence the computation of an expected value factor from the mean values of the variables is an approximation to the true expected value.

We note that the mobile home exterior structure claim and value data is dominated by attached aluminum frame carports and patio enclosures. Hence these empirical ratios are believed to be most applicable to these types of exterior structures.

Considering the assumptions and limitations in this simplified approach, an estimated range of loss cost penalty for exterior structures for manufactured housing is from 1 to 2. This range is over all exterior structures, whereas a single type of exterior structure may actually have a higher or a lower ratio.

It is important to note that the application of a loss cost factor for exterior structures requires the insurer to take the effect of attached structures out of the loss cost of the dwelling (Cvoerage A) before applying a loss factor to attached structures. That is, double counting of the effects of attached structures should be eliminated if a separate buy back is used for attached structures.

5.2.2 Exterior Structure Factors Based on Analysis of Insurance Coverage Losses

In Section 3.2, insurer losses are analyzed by Coverage A (dwelling) and B (other structures). Since the dwelling losses generally include attached structures, the Coverage B losses cover mostly detached structures. We recognize that coding practices vary by insurer, but the data used in this analysis should be consistent with an interpretation of losses for detached structures.

The analysis of ratios of Coverage B losses to Coverage A losses as a function of windspeed is discussed in Section 3. We analyzed the coverage level losses using two approaches to produce different measures to gain further insights from the data sets. Both use expected value calculations to estimate mean loss penalty factors.

Loss Cost Penalty Factor Using Coverage Limits. We use this data to estimate the expected loss cost ratios of B loss to A loss according to the expected value calculation

$$E(L) = \sum_{n=0}^{+\infty} \left[\int_{0}^{+\infty} D(v) p_v(v) dv \right] \cdot n \cdot p_n(n) \qquad (5\text{-}2)$$

where: v is the wind speed; $D(v)$ is the vulnerability or loss function (the averaged damage or loss ratio given a wind speed); and $p_v(v)$ is the probability density function (PDF) of wind speed affecting the location given a hurricane occurrence; n is the variable number of hurricane occurrences in a year that affect the area; and $p_n(n)$ is the PDF for n. The variable L is the expected loss variable, which, in this case, is the normalized ratio of B to A losses.

Figure 3-15 (bottom figure) shows the mean ratio $(B_l/B_L)/(A_l/A_L)$ plotted *vs*. windspeed for five hurricanes and one insurer. We have fit this loss with a second order polynomial (r^2 = 0.63) and integrated it over the wind hazard curve for two locations in Florida: Naples and Orlando. The integration expressed by Eqn 5-2 has been performed using Mont Carlo simulation with the hurricane hazard model used to develop the ASCE 7 design wind map (same map used in the FBC). Hence the resulting loss cost ratios are based on a standard theoretical approach used to estimate loss costs, but in this case the loss cost parameter is defined as the expected loss ratio of Coverage B to Coverage A losses, normalized by the coverage limit instead of the "value" of the structures under each coverage. Hence, this ratio assumes that the coverage limits represent the value what is being covered. For this insurer, the Coverage B limit was 10% of the Coverage A limit.

The results of the integration are 1.45 for Naples and 1.3 for Orlando. These expected values provide a measure of the fractional ratios for coverage B losses (assumed to be mostly detached structures) relative to Coverage A losses. These values are also summarized in Table 5-1.

Table 5-1. Approximate Estimates of Loss Penalty Factors for Exterior Structures

Reference Section	Interpretation	Data Sources	"Mean" Factor:
5.2.1	Ratio of mean losses of exterior structures (normalized by mean values) to mean losses of dwelling (normalized by mean values). Applies mostly to **attached aluminum structures** for site-built homes and attached aluminum carports, enclosures, and storage areas for mobile homes.	Mean losses are based on one insurer claims review for 2 Florida hurricanes (416 site-built and 112 mobile home claims). Mean values are based on 765 single family home surveys and 455 mobile home surveys.	2.1 Site-built 1.34 Mobile Homes
5.2.2	Ratio of Coverage B losses, normalized by Coverage B limit to Coverage A losses, normalized by Coverage A limit. Applies to **site-built homes with detached "other" structures included under Coverage B.** Lower bound type of estimate since coverage A losses also includes vulnerable attached structures.	One insurer coverage level loss data for 5 Florida hurricanes	1.45 Naples 1.36 Orlando
5.2.2	Fractional ratio of B loss to A loss with no normalization to value or coverage limits. A different approach and measure. **Provides a ratio that can be used with coverage limits to see if the fractional losses are similar to coverage limits. Also provides a measure of Coverage B limit penalty from the consumer's perspective.**	One insurer coverage level loss data for 5 Florida hurricanes plus a second insurer for Hurricane Wilma.	0.129 Naples 0.121 Orlando

Fractional Loss Costs Ratios. We analyzed the ratio of Coverage B loss to Coverage A loss, B_l/A_l as a new statistic without regard to Coverage limits. This measure was done for each policy loss for two insurance companies. Figure 3-15 (top figure) shows the mean of this ratio plotted *vs.* windspeed. The ratio was fit with a second order polynomial ($r^2 = 0.74$) and integrated to produce the expected value over the hurricane wind climate for two locations. The results are given in the last row of Table 5-1.

The interpretation of the expected fractions can be illustrated by considering Coverage B limits. For example if the Coverage B limit is 10% of the Coverage A limit and the factional mean ratio is 0.129, then 0.129/0.1 = 1.29, which says that the expected Coverage B losses over all storms will exceed the Coverage B limit. If the Coverage B limit is 2% of coverage A, then the mean Coverage B losses will exceed the limit significantly, since 1.29/0.02 = 6.45. Hence, this measure is an indication of the impacts on the homeowner if the Coverage B limit is not sufficient to cover his Coverage B values. The expected losses can easily exceed the Coverage B limit, since the Coverage B structure losses are higher proportionally to the Coverage A losses for windspeeds up to about 120-140 mph.

5.3 Reduction in Losses from Improvements in Current Building Practices

Based on the damage survey data presented in Section 4, we illustrate the potential reduction in losses for aluminum frame screen enclosures. We consider damage to the frame and neglect damage to the screen. These estimates are based on the integration of the vulnerability function and the hurricane hazard probability density function, as give by Eqn. 5-2. These examples should be viewed as very preliminary results at this point.

Approach. Hypothetical loss functions are developed to represent the performance of aluminum screen enclosures. The first loss function corresponds to current (as-built) practice and was developed by approximately matching: (1) the observed failure rates of aluminum screen enclosures in Hurricane Charley (~88+% at peak gust wind speeds of ~130+ mph)[2]; and (2) an estimated ~20%-30% for gust wind speeds in the range of 100-120 mph range, typical of Hurricane Wilma. This "as-built" loss function given in Figure 5-1 is for a design wind speed of 130 mph, an importance factor of 0.77, and existing design/construction flaws. The peak gust windspeeds in Figure 5-1 are referenced to open terrain windspeeds at 10 m height.

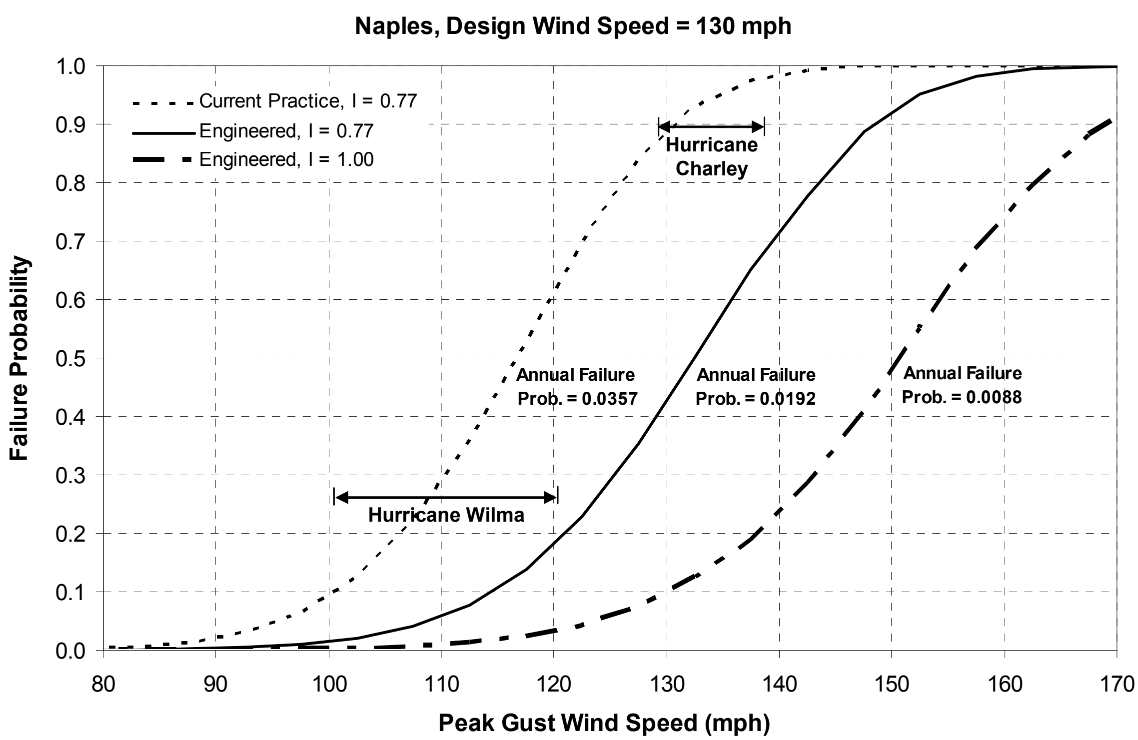


Figure 5-1. Hypothetical Vulnerability Functions for Aluminum Frame Enclosure in Naples.

[2] See Table 4-2, where the catastrophic and partial frame failure rates sum to about 88% failure rate. The windspeeds at this location were around 130-140 mph (Figure 4-2). This high of a failure rate should not have occurred due to inherent design safety factors, even considering the use of a 0.77 importance factor.

The middle loss curve in Figure 5-1 represents our estimate of a properly engineered aluminum screen enclosure, designed to 130 mph design winds (design winds in Naples) using an importance factor of 0.77 (the current importance factor required by ASCE 7 and the FBC). Considering the importance factor, the effective design wind speed is about 115 mph for the middle curve.

The far right loss curve is the result of designing the aluminum frame enclosure in the middle curve to 23% higher loads, which also corresponds to an importance factor of 1.0. This sensitivity analysis will show the effect of higher design loads, regardless of how those loads are specified.[3]

These simplified vulnerability functions were developed by the wind load equation

$$W=0.00256*V^2$$

where W = wind load, which is proportional to the wind speed squared, V is the peak gust wind speed at 10m. The resistance, R, of the aluminum frame is given as

$$R=0.00256*V^2_{design}I*S$$

where I is the importance factor, and S is an effective (considering practical as-built construction) safety factor.

The current practice vulnerability function corresponds to I = 0.77 with S is assigned a mean value of 1.0 and a coefficient of variation of 0.2. In the Monte Carlo integration of the hazard and the loss curves, the screen enclosure fails if the wind load, W, exceeds the sampled resistance, R. In the development of the middle loss curve, S is assigned a mean value of 1.3, with a CoV of 0.2, and for the right-hand loss curve S is assigned a mean value of 1.3, with a CoV of 0.2 and the importance factor is increased to 1.0. These models produce about a 10% probability of failure at the design wind speeds, reflecting likely imperfect construction practices and aging effects.

Results. In the example given in Figure 5-1, the screen enclosure is located near the Naples area, and the loss functions have been integrated with a hurricane hazard model, applicable to coastal Naples, to produce estimates of the average annual failure rates for the three loss curves.

The average annual failure rate for the “as-built” current practice case is 3.6%, reducing to 1.9% for the engineered case with adequate loads and an importance factor of 0.77, and reducing again to 0. 88% for the case where the structure is engineered using an importance factor of 1.0. The estimated ground-up loss cost factors for these three cases, normalized to the weakest (existing practice) are given in Table 5-2. They show that a reasonable expectation for

[3] Without further work, we do not really know if increased loads are warranted. Proper designs to the right loads for an I = 0.77 could, in fact, be near optimal These sensitivity analyses need to be verified/updated with further work.

Table 5-2. Loss Cost Reduction Factors for Improved Designs with New Research and Importance Factors

Location	Current Practice	Engineered with New Loads, $I = 0.77$	Engineered with New Loads, $I = 1.00$
Naples (130 mph)	1.00	0.54	0.25
Orlando (110mph)	1.00	0.43	0.18

the reduction in current loss costs for an aluminum frame screen enclosure in Naples is about 25%. That is, the loss costs would be reduced by a factor of about 4 over current practice. This reduction requires research to developed improved load and design procedures and changes to the building codes for importance factors structures attached to residential structures.

Figure 5-2 presents a similar set of results for a screen enclosure located in Orlando, where in this case, the current practice as-built loss function is developed assuming a design wind speed of 110 mph. We see that the reductions in loss cost in Table 5-2 are generally similar to Naples and show significant reductions with proper designs to the “right” loads, coupled with a change in importance factor. In Orlando, the loss cost reduction would be expected to be a factor of about 5.5.

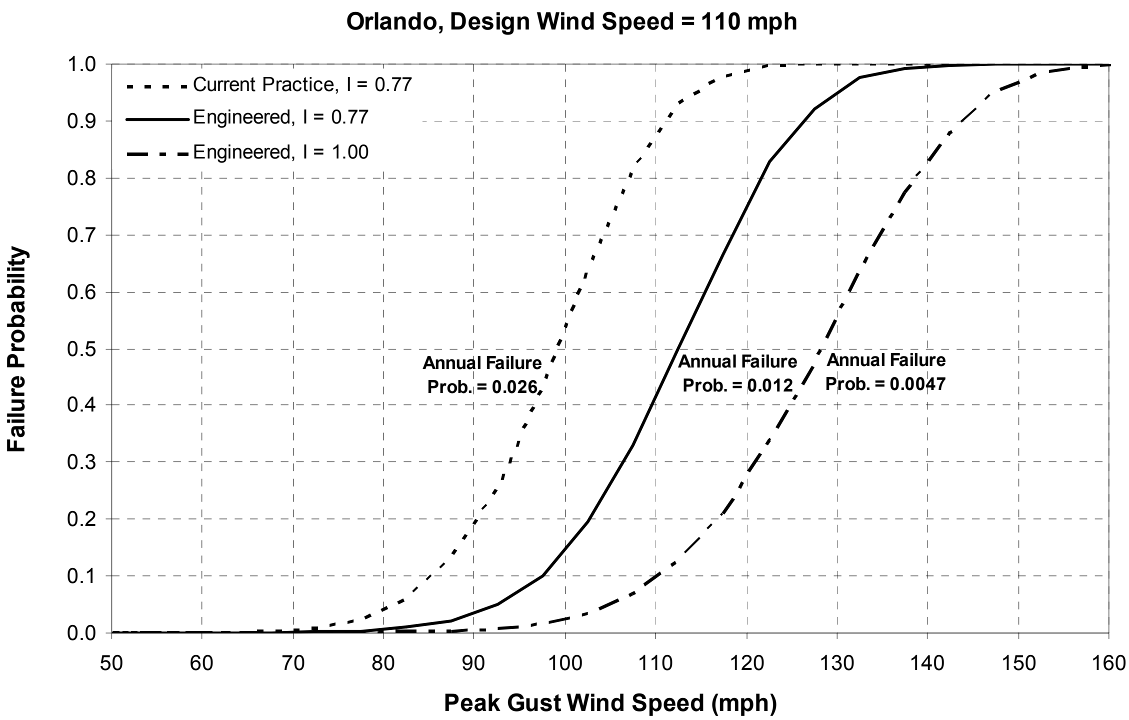


Figure 5-2. Hypothetical Vulnerability Functions for Aluminum Frame Enclosure in Orlando.

The results in Table 5-2 are dependent on the assumed shape of the vulnerability functions. These are approximate, but should give us ballpark estimates of loss reduction potential. Achieving these types of loss reductions for the improved vulnerability would have a significant impact on insurability. These structures would not fail nearly as often and both insured losses and homeowner losses would be appreciably reduced.

5.4 Life Cycle Benefit-Cost Example Analysis

Insurability issues arise when structures are not built properly for the hazards to which they are exposed. If the hazard is high and the structural resistance is low, repeated failure of the structure causes insurance costs to skyrocket. This situation produces a huge waste of societal resources with the burden eventually falling back on the owner of the structure (consumer) through either: (1) the lack of insurance coupled with high out-of-pocket costs, (2) high insurance rates, and/or (3) higher taxes/assessments.

In our view, the best way to tackle insurability issues is to minimize the life cycle cost of an asset. Some of the main components of life cycle costs for a structural asset include:

1. Initial cost of the asset
2. Annual maintenance cost
3. Repair and replacement costs from failures
4. Insurance costs

Structures fail when the load exceeds the resistance for one or more key components. The dominant wind loads in Florida occur with hurricanes. Hence, we can use the results on failure frequency developed in the Section 5.3 in a simplified illustration of life cycle costs for exterior structures.

Concept of Minimum Life Cycle Costs. A well-known concept in balanced engineering risk-based design is illustrated in Figure 5-3. This figure shows how the tradeoff of designing structures to higher reliabilities (reduced probability of failure) with higher initial costs can be compared with designs that cost less, but fail more frequently. A balanced design is one with minimal total cost, which is the sum of the two expected cost curves. We want to achieve designs that are near the bottom of the total cost curve. Designs with too low a reliability fail too often and the total costs are not optimal. Designs with very high performance reliabilities (relative to the hazard risk) have high initial costs (reflecting more materials, higher quality, more engineering, etc.) and the total life cycle costs are relatively high. In either case, the owner of the structure is saddled with unnecessary costs, including excessive insurance costs for structures with high failure probabilities. Insurability, therefore becomes a problem for all structures with high failure rates.

As can be seen from Figure 5-3, consumers pay the ultimate costs through high total life cycle costs, which would include failure (repair and replacement) costs, which can be viewed as insurance costs.

For simplicity, Figure 5-3 does not include annual maintenance costs. The insurance cost element of Figure 5-3 is assumed to be reflected directly by the expected losses, which is the product of the probability of failure times the cost of failure (repair and replacement). The failure costs should increase linearly with failure probability and the insurance loss costs would also follow this linear relationship.

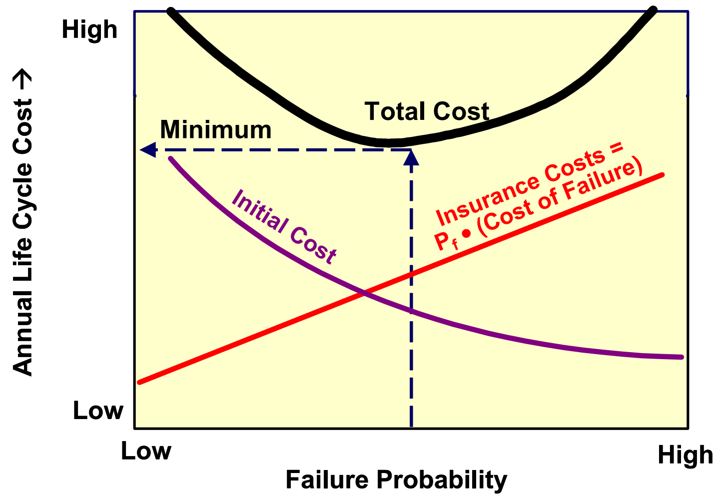


Figure 5-3. Developing Minimal Life-Cycle Costs for Exterior Structures.

Under this initial project, we obviously cannot fully develop design requirements that ensure minimal life cycle costs for the dominant exterior structures that are producing insurability problems in Florida. However, we will produce a simple example that examines the minimum life cycle costs in terms of a benefit-cost analysis.

Benefit Cost (B/C) Example. Our example will be for an aluminum frame screen enclosure. From the damage survey analysis results in Section 4.3, we see that failure of these structures almost always requires total replacement. From the field survey in Section 2, we found that the average value of the enclosure is about $30,000. From the hazard integration of the vulnerability curve in Figure 5-1 (for Naples area), the annual failure probability is 0.0357 and hence the average annual loss (AAL) for this average existing practice screen enclosure is $30,000 x 0.0357 =$1071. This estimate corresponds to the annual "pure hurricane wind premium" with no deductible.[4]

The estimated AAL for an engineered screen enclosure, with new loads (23% increase corresponding to an importance factor of 1.0) is estimated by $30,000 x 0.0088 = $264. The difference in the two AAL's represents an annual savings of $807 in loss reduction. These savings would accrue to the owner and the insurer. The structure fails much less often and those reductions in losses accrue at an average rate of $807 per year in Naples.

Figure 5-4 illustrates how this information is used in a benefit- cost analysis. We will compare two options to produce the benefits and cost differential for screen enclosures. The first option is to continue with current practice and the associated failure rates and average annual losses. The second option is to invest in research to develop better loads and design guidance to produce optimal life-cycle preference.

[4] This estimate follows from the vulnerability function and the hurricane wind climate model, both of which are subject to uncertainties and estimation errors.

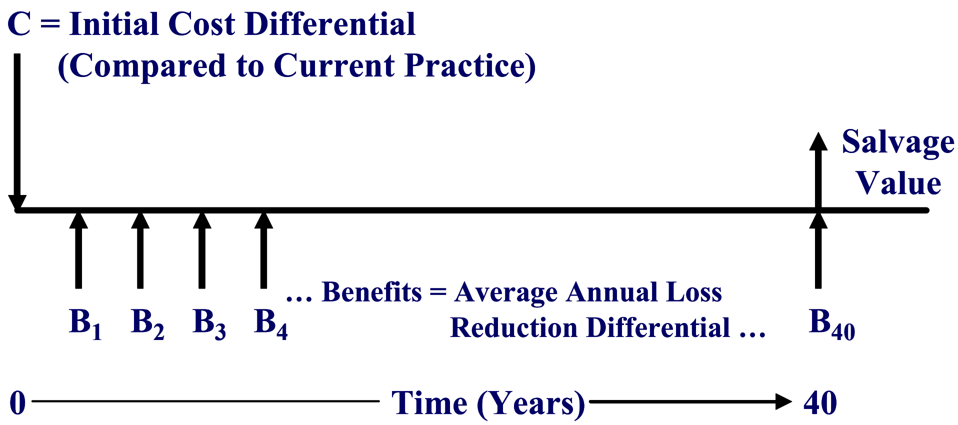


Figure 5-4. Time Line of Benefit-Cost Analysis.

We use real dollars and a real discount rate of 3% in the benefit-cost analysis[5]. The B/C ratio is the ratio of the present (discounted) value of all benefits divided by present value of all costs.

We use a rough estimate of 30% as the cost differential to build stronger enclosures, properly engineering with new code loads and an importance factor of 1.0 (*vs*. 0.77). Hence, a $30,000 screen enclosure would cost about $39,000 with improved design/construction. The net cost increase to the owner is $9,000, which is the differential value of C in Figure 5-4. The B_i in Figure 5-4 are the average annual benefits, which is the difference ($807) in AAL. Using these values with a conservative salvage differential of zero, we compute the B/C ratio of 2.07. That is, our $9,000 differential investment in a strong patio enclosure pays off more than two to one in present value dollars. The net present value of the $807 differential in average annual loss reduction over the assumed 40 year life amounts to $18,654. This amount is 2.07 times the $9,000 differential investment in a stronger enclosure, using a real discount rate of 3%.

This simple example shows we are clearly not in the region of minimal life cycle costs. The aluminum frame structures are failing far too often and the net effect is a large waste of resources in rebuilding these enclosures. These total costs clearly affect insurability with large costs to both the insurer and homeowner.

Table 5-3 summarizes some sensitivity results for some variations in the parameters used in the above B/C calculation. For the salvage value sensitivity, we estimated future (year 40) salvage value as 25% of the initial total cost and discounted that value back to the present value, producing a present value benefit of $1,993. This assumption (that the improved design would add differentially to the value of the property at the end of the assumed time period) increases the B/C ratio, as shown in the table.

5 Real dollars and real discount rates (*vs*. nominal dollars and nominal discount rates) are used in this example, as is often done in benefit cost analysis. The real discount rate is approximately equal to the nominal discount rate minus the expected rate of return of inflation. A real discount rate of 3% is often used for benefit cost studies of natural hazard risk reduction. See Boardman et. al. for more discussion.

Table 5-3. Benefit-Cost Example Results (Past Practices vs Improved Designs)

Case	Benefit-Cost Ratios[1]	
	Naples	Orlando
Base	2.07	1.64
Base + Salvage Benefit	2.40	1.97
Base + Regret	2.28	1.81
Base + Salvage + Regret	2.61	2.14

[1] NPV Benefits ÷ NPV Costs

A second benefit was included in the sensitivity analysis. We considered "regret" costs to include: loss of use; time and headache involved with more frequent repair and rebuilding; and time and effort required for dealing with contractors after hurricanes. We arbitrarily set this annual average regret "cost" equal to 10% of the AAL differential reduction, which amounts to $80. In Table 5-2, we see the effect of these sensitivities is to increase the B/C ratio to a maximum of 2.82 for Naples.

We also increased the real discount rate to determine the breakeven rate (B/C =1.00). By increasing the real discount rate to 8.5% (meaning a nominal rate of about 11.5%), the B/C = 1.00 for the base case (no salvage differential and no regret benefits). Thus, even using an excessive discount rate, the analysis indicates that improved designs are warranted to minimize the total life cycle costs.

Repeating this process for Orlando (see Figure 5-2), for a $30,000 patio enclosure value, the AAL reduces from the current practice case of $780 to $141 for the engineered screen enclosure, with limited construction defects and an importance factor of 1.0. This reduction represents an annual savings of $639. The B/C ratio for Orlando is 1.64, again showing a benefit of $1.64 for every $1.00 invested in an improved design. The sensitivity results for Orlando are also shown in Table 5-3.

These illustrative results emphasize that we are far from optimal with current practice for aluminum structures. The optimum in Figure 5-3 will generally occur for B/C near 1.0, which represents a perfect balance of cost and risk. In these examples, we show that the current practice is on the high side of the total cost curve, well above the minimum total life cycle costs. Florida homeowners and insurers are paying for this inefficient use of resources through frequent failures of structures than can be designed to perform reliably and at lower total life-cycle costs. Until these issues are addressed, the insurability issues are not likely to go away.

We did not have the time or resources to work the aluminum carports and enclosures that dominate the losses for mobile homes. But the high failure rates of these structures indicate similar problems. As recommended in Section 6, minimal life-cycle cost analyses should be performed for these structures to help develop a long-term solution to the insurability issue.

5.5 Estimate of Statewide Exposure and Statewide Benefits in Improved Designs

We extend the previous results to statewide exposure and loss by examining both new construction and mitigation of existing structures.

New Construction. There are about 200,000 site-built homes constructed in Florida each year. The survey indicated that about 31% of homes had a pool/patio enclosure (Table 2-1). Recognizing that the survey locations were concentrated along the southern coast (Figure 2-8), this percentage likely overestimates the statewide frequency. For purposes of estimating an approximate number of new screen enclosures being added per year, let's say that only 5% of new homes are built with pool/patio enclosure, which translates into about 10,000 new structures per year. Using the Orlando results for AAL reduction ($639) per enclosure with improved designs and importance factors, an estimate of statewide average annual savings in the first year of new construction standards alone is about $6.39 million. In the second year the loss reduction would be $12.8 million, and so forth. If we assume 10,000 new structures are added per year for 20 years, the total present value of differential cost is $1.34 billion. Using the 1.64 B/C ratio of Orlando, the present value of avoided losses is $2.20 billion. Hence, the net present benefit is $2.20 – 1.34 billion, which equals $857 million. Even if these preliminary estimates are off by a factor of 2, the NPV of loss reduction would be over $400 million.

Based on these results, if the state funds research to:

1. Develop improved loads,
2. Test full scale structures, validate design performance, and developed practical and proven design guidance, and
3. Develop justification for changing the ASCE and FBC importance factors

then the net result would be significant cumulative statewide saving. Assuming such a comprehensive research program cost $800,000, it would produce a huge return on investment over many years. Based on these preliminary results and statewide assumptions, every dollar invested in solving the problem is estimated to save over $500 ($400 million/0.8 million) in avoided losses.

This same type of logic can be applied to aluminum carports and enclosures that are attached to mobile home structures. In the mobile home parks surveyed, about 75% of all homes had attached aluminum frame structures. That number probably overstates the statewide frequency, but the survey also found that such structures were more likely on newer homes. The failures rate of these structures is also high, indicating that we are far from optimal in terms of minimal life cycle costs. The result is high insurance rates and lack of coverage availability. Improving the design of these structures will likely have a similar benefit in terms of reducing total costs and solving the insurability problems.

Mitigation of Existing Exterior Structures. The path toward mitigation of existing structures has not been developed in this initial project. Engineering solutions need to be designed, evaluated, and tested. The results need to be analyzed to determine cost-effectiveness and minimal life cycle costs.

The magnitude of the problem can be estimated for site-built homes by extrapolating the data developed in this project. If we assume 5% of the homes have pool/patio enclosures and the average value is $30,000, then for 5 million existing site-built Florida homes, the total value of enclosures is about $7.5 billion in exposure. If the average annual loss is taken from the Orlando example, the statewide AAL of the existing stock of aluminum frame screen enclosures is about

$780 x 0.05 x 5,000,000 = $195 million. This is a crude estimate, but likely accurate to a factor of about 2.

If we invest $200,000 to investigate and develop proven cost effective mitigation methods, the payoffs could be significant. We are not sure at this time what the payoff would be for cost-effective mitigation of these structures, but the payoff could be notable, say ¼ or more of the AAL. This type of payoff would result in about $50 million or more in annual savings.

If cost effective and proven mitigation techniques are not developed and tested, then there is no solution to the insurability problems for homeowners with existing aluminum frame screen enclosures for site-built homes in Florida. The homeowners are stuck with inadequate structures and with long-term insurability problems.

5.6 Review of Information Provided by OIR Consumer Advocate Office

The OIR Consumer Advocate Office provide a series of press articles dealing with failed screen enclosures following recent Florida hurricanes. ARA reviewed these articles to gain some understanding of the consumer concerns.

The articles tend to confirm the findings of this study. Homeowners have been surprised by the failure (generally catastrophic) of their screen enclosure. Residents were angry and building officials generally frustrated, not knowing who to turn to for help.

The articles discuss certain engineers that created "master files" that were used again and again in the industry. They discuss how contractors sought out engineers that would provide master files with long spans and minimal bracing ("the man with the span"). One engineer claims to have been priced out of the business because his improved post-Andrew designs cost 10% more.

One company with performance problems claims to have built more than 69,000 enclosures since 1987. Another article points out that 5,238 construction permits were issued for enclosures in unincorporated Palm Beach County over just a two and a half year period.

The problems of screen performance are mentioned, including homeowner actions to remove screen panels as a hurricane approaches. While denser screen meshes are good for keeping more bugs out, they impart more wind load to the structure.

Post-storm problems of failed pool enclosures have also resulted in homeowners having to erect fences around swimming pools to comply with local safety ordnances.

The articles point out a great deal of consumer frustration with poorly designed/built aluminum enclosures. Significant measures are warranted to find the optimum life-cycle designs. With optimum life-cycle designs, there are no losers since the total cost to the consumer is minimized.

6. SUMMARY AND RECOMMENDATIONS

6.1 Summary

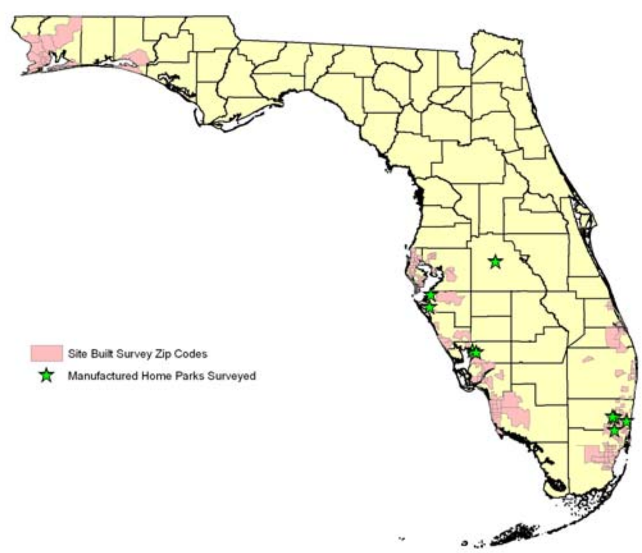
Section 38 of Senate Bill 1980 in the 2006 Florida Legislative Session required the Office of Insurance Regulation (OIR) to submit a report on the insurability of attached and freestanding structures. Structures that are commonly attached to site-built residential homes in Florida include pool/patio enclosures, garages, carports, and sunrooms. Structures that are commonly attached to manufactured houses in Florida include carports, screen enclosures, and storage areas. Detached and freestanding residential structures commonly include storage sheds, garages, guest houses, pool houses, fences, and gazebos. Some key insurability issues include risk of damage and loss, insurance coverage options and costs, building code adequacy, and loss mitigation.

This report is the first research effort in the public domain to develop a data-driven, scientific approach to understanding the exposure, risk, and losses associated with attached and detached structures in Florida. Such an understanding is critical to developing a long-term solution to insurability issues for these types of structures. For purposes of this report, we will refer to attached and detached structures as “exterior” structures, meaning that these structures are “exterior” to the main dwelling and are not part of the main dwelling.

The research involved multiple tasks. The first task was to conduct field surveys to better understand the types, frequency, and values of exterior structures; that is, to understand the exposure risk of exterior structures in Florida. The second task focused on obtaining and analyzing insurance loss data for recent Florida hurricanes. The third task involved investigating building code requirements in order to understand: (1) if the design requirements are generally adequate for exterior structures and (2) to determine if loss mitigation is practical for existing exterior structures. These tasks combine to provide multidimensional inputs to the overall insurability issues in terms of both short and long term solutions.

6.1.1 Field Survey Results

Two field surveys were performed to develop data on the types and values of exterior structures in Florida. We surveyed 765 single-family homes and, in a separate survey, 455 mobile homes. While not uniformly distributed across the state, nor randomly sampled, these relatively small-sized surveys do provide reasonable measures of the exposure risk of exterior structures in Florida.

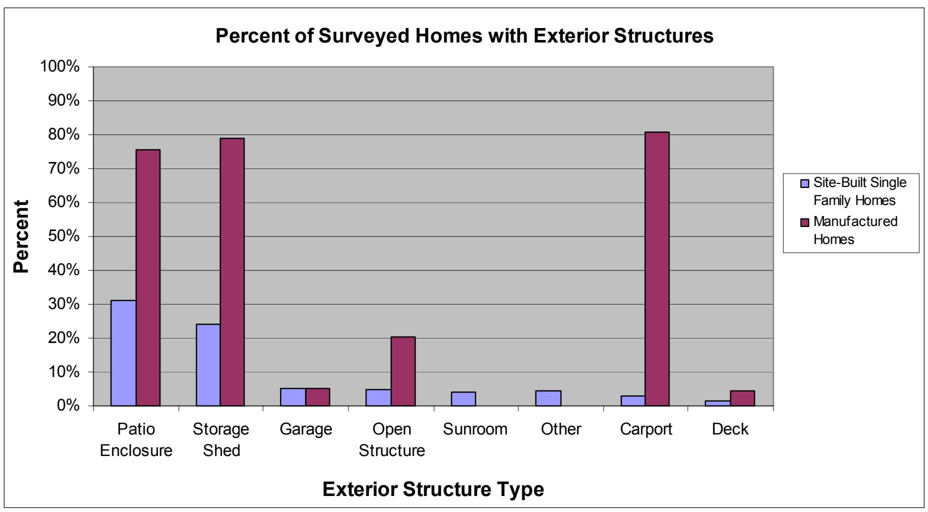


Site-Built Homes. For the single-family home survey, we found an average of about one (0.86) exterior structure per home.

The most common exterior structure was attached, aluminum frame, screened pool/patio enclosures. These structures have an estimated average replacement value of $29,000. The average total value of exterior structures was 10.3% of the Coverage A (dwelling) value. However, about 16% of the surveyed homes had no exterior structures of any kind, while 62% has no attached exterior structures, and 22% had no detached exterior structures. Hence, the distribution of exterior structures is skewed in the sense that homes with exterior structures often have values that may exceed the standard coverage limits. About 15% of homes with attached structures have attached structure values greater than 10% of Coverage A, while 25% of homes with detached exterior structures have values greater than 10% of Coverage A. The skewed nature of these data bears directly on insurability issues.

Manufactured (Mobile) Homes. For mobile homes, there were an average of 2.76 exterior structures per surveyed home of which 81%, 75%, and 80% of the homes had a carport, patio enclosure, and storage shed, respectively. The estimated average value of the exterior structures was $11,206, which is about 18% of the dwelling insured Coverage A value. Hence, exterior structures represent a significant amount of the dwelling value for manufactured housing.

The main conclusion from the surveys are the relatively significant value invested in exterior structures in Florida and the dominance of aluminum frame screen enclosures and carports in terms of frequency and contribution to the total value of these structures.

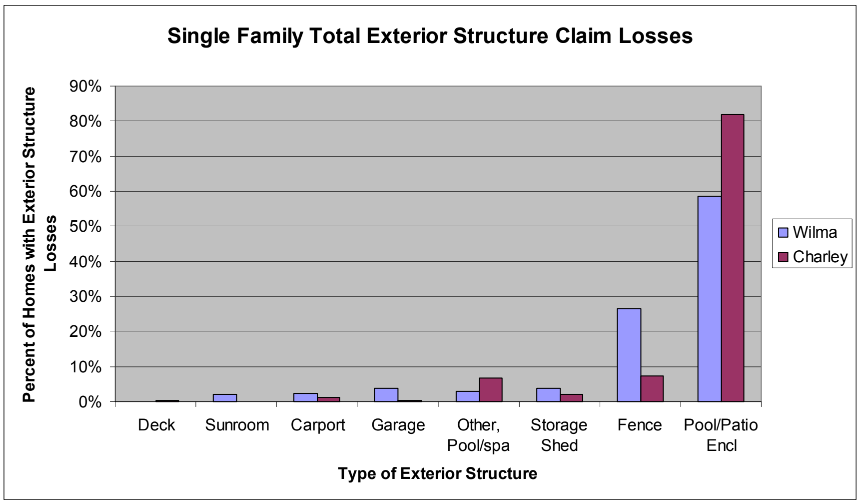


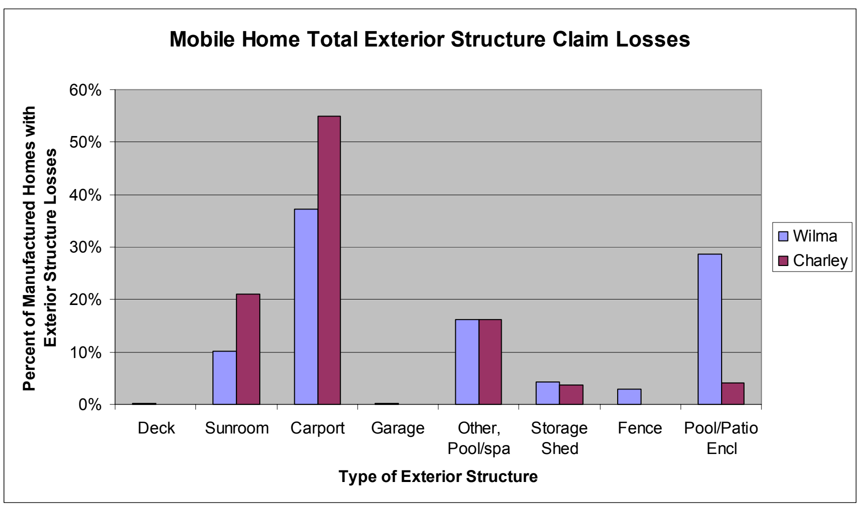
6.1.2 Insurance Company Loss Data

Insurance company loss data was analyzed at two levels: coverage level and claim folder level. Coverage losses provide insights on how Coverage A (dwelling) and Coverage B (other structures) losses accrue, recognizing that Coverage B includes primarily detached exterior structures. Claim folder level losses facilitate the understanding of the contribution of exterior structures to the total losses, regardless of whether theses structures are treated under A or B Coverage.

Coverage Level Losses. Coverage level loss data for site-built homes was analyzed for several insurance companies. We analyzed coverage losses for multiple Florida hurricanes (depending on the specific insurance company data availability), including Hurricanes Wilma, Charley, Jeanne, Frances, and Ivan. These data, when analyzed against peak gust windspeeds for each zip code, indicate that Coverage B losses (other structures) accrue at lower windspeeds at a much higher proportional rate than Coverage A (dwelling) losses for site-built homes. Since most of the coverage B losses are detached structures, these results suggests that detached exterior structures are more vulnerable to damage and loss at lower windspeeds than the dwelling structure. As peak gust windspeeds exceed about 120 mph, the Coverage A proportional loss generally catches up as the dwelling structure itself experiences more damage.

Claim Level Losses. We were able to evaluate a total of 528 claim folders from one insurance company for this project. Claim folder losses were selected at random from the loss claims for Hurricanes Wilma and Charley. A total of 112 claims were evaluated for manufactured housing and a total of 416 claims were evaluated for site-built homes. Pool/patio screen enclosures were found to be the largest contributor of exterior structure losses for single family homes, followed by fences, storage sheds, and pools/spas. For manufactured homes, carports dominate the exterior structure losses, followed by sunrooms and patio enclosures.





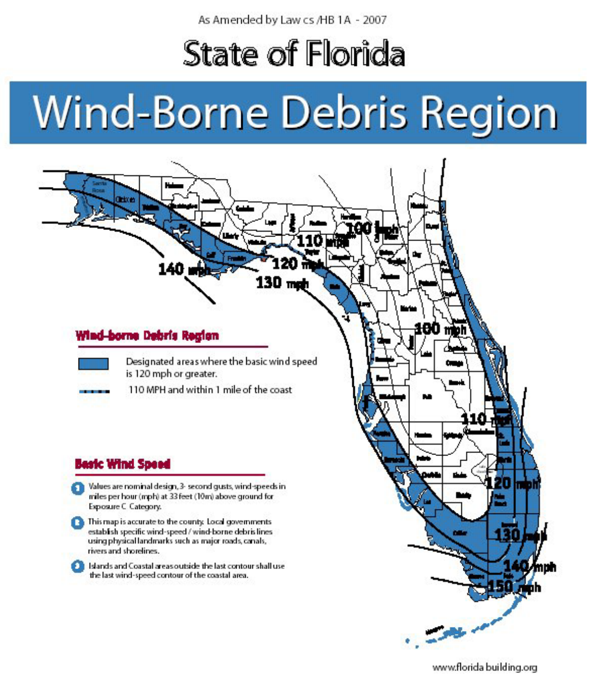
For the site-built home claims, exterior structure losses comprised 28% of the total claims in Hurricane Wilma. Hence exterior structures, while representing an average of about 10.3% of the Coverage A value, accounted for a much larger percentage of the losses in this storm for this insurer. For Hurricane Charley, which had much higher windspeeds than Wilma, the exterior structure losses amounted to about 8% of the total claim. The higher windspeeds in Charley produced more damage to the dwelling and, hence, the contribution of exterior structures is a smaller amount of the total claim paid.

The manufactured housing claim review indicated that exterior structures accounted for between 20 and 30 percent of the total claim. The effect of the reduction in exterior structure loss with more intense storm is not seen for manufactured housing.

Exterior structures clearly account for a notable potion of the total loss in the claims that we reviewed. There is a distinct wind speed dependence, particularly for site-built homes. At lower wind speeds (Wilma), exterior structures fail and constitute a higher portion of the total claim. At higher wind speeds (Charley), the dwelling is damaged and the fraction of the total loss attributed to exterior structures is reduced. In both cases, exterior structures are contributing a higher relative portion of the losses than the dwelling.

Preliminary Loss Factor for Site-Built, Single-Family Exterior Structures. By combining the claim level review with the field survey results, a very preliminary ratio of the loss costs of exterior structures to the loss costs of the dwelling was estimated in Section 5.2.1. The field survey and valuation indicated that exterior structures are 10.3% of the Coverage A value for site-built homes. The claim folder review indicated that exterior structure losses average about 21% of the Coverage A claims for the two storms considered. Hence, a ballpark estimate of the loss costs factor ratio is about 2.1 for the data considered in this project. Considering the many assumptions made in this simple calculation, a reasonable range in this loss costs penalty ratio is about 1.40 to 3.2. This range is over all exterior structures, whereas a single type of exterior structure may actually have a higher ratio. We do not believe the larger factors should be used by insurers in pricing at this point until more detailed analysis is performed and cost-effective mitigation options are developed and validated.

Preliminary Loss Factor for Mobile Home Exterior Structures. By combining the claim level review with the field survey results, we can similarly estimate a very preliminary ratio of the loss costs of exterior structures to the loss costs of the mobile home dwelling. The field survey and valuation indicated that exterior structures average 19% of the Coverage A value for manufactured homes. The claim folder review indicated that exterior structure losses average about 25% of the claims for the two storms considered. Thus, a crude preliminary estimate of the loss cost penalty for exterior structures for manufacture homes is about 1.34. Considering the uncertainties and assumptions, an estimated range of loss cost penalty for exterior structures for manufactured housing is from 1 to 2. Again, large factors should not be used by insurers in pricing at this point, until more data is analyzed and cost-effective mitigation options developed and validated.



6.1.3 Building Code Requirements and Mitigation

Almost all types of exterior structures fall under the general requirements of the Florida Building Code (FBC). Chapter 3, "Use and Occupancy Classification", describes the building classification system. Several types of exterior structures fall under FBC Category U, "Utility and Miscellaneous Group". Chapter 20 covers aluminum structures.

The FBC has its foundation in model codes and national standards. The ASCE 7 Standard, "Minimum Design Loads for Buildings and Other Standards" is generally used for design windspeeds and wind loads. ASCE 7 has a category for structures that represent a low hazard to human life if they fail, and these structures are designed with a reduced importance factor.

Importance Factor in Design. The "Importance Factor" is a factor used in design of structures and is based on the building occupancy category. The loads are multiplied by the Importance Factor in the determination of the strength factors needed to resist the loads. Single-family residences are Occupancy Category II Buildings and have a design Importance Factor of 1.0. Structures that represent a low hazard to human life in the event of failure are Occupancy Category I and have an Importance Factor of 0.77. Hence, the design wind pressure of Category I structures is 23% less than the design wind pressure for Category II structures.

The Florida Building Code follows the ASCE 7 national standard in terms of Importance Factors. This means that aluminum frame screen enclosures, which are a dominant contributor to exterior structure losses for single family homes, are viewed as Category I structures and hence are built with an Importance Factor of 0.77. Thus, even if the structures had been designed perfectly, they would fail at lower windspeeds than a similar structure built as a Category II Structure. The design windspeed is reduced by the square root of 0.77, which is 0.88. This effectively reduces the return period of the design wind from about 100 years for a Category I structure to about 40-60 year mean return period for a Category II structure. Hence, based on the design requirements, the loss costs of Category II structures should be much higher than the loss costs of Category I structures.

Building Practices. Building and construction practices of aluminum frame screen enclosures have been undergoing review in Florida due to the large number of failures of screen enclosures. These reviews confirm several potential systemic problems ranging from member sizes on the low side of specified tolerances, inadequate lateral bracing, lack of structural redundancy, connection failures, lack of adequate engineering design, and construction/installation problems.

Design Loads Are Potentially Not Adequate. The current design wind pressure loads on screen enclosures are based on results of wind tunnel tests of screen enclosures and are a vast improvement over the requirements that existed before the wind tunnel test results were included in the FBC. Prior to the 2002 FBC, there was no guidance for designers of screen enclosures and the design of the enclosures could be performed using the code minimum 10 pounds per square foot, regardless of the wind zone. However, the current design loads appear to neglect the possible effects of entrained water and light weight debris in reducing the effective porosity of the screens on the windward side only, and potentially adding to the overall wind loads, particularly for quartering wind cases. Furthermore, the effect of wind borne debris on the performance of aluminum structures (individual members) is ignored, and this may be a problem due to the lack of structural redundancy.

Damage Observations. Prior surveys of both site-built homes and mobile homes following Hurricane Charley were analyzed in this project. The data for site-built homes provides additional confirmation of the high failure rate of attached aluminum frame screen enclosures. Out of 67 homes surveyed in detail, a total of 52 had screen enclosures and 42 of those failed catastrophically (78%). Another 10% experienced partial frame failures, while 8% experienced only screen failures. Overall, we saw a frame failure rate of about 88% for these structures in reference peak gust winds of about 130-140 mph.

A total of 221 mobile home damage surveys were reviewed from Hurricane Charley. Of the mobile homes with patio enclosures, 48% experience catastrophic failure, while 19% experience partial frame failures, and 17% experience only screen failures. Of the mobile homes with carports, 52% experience catastrophic failures and 21% experience partial failures.

These observations confirm the high rate of failure of exterior structures with aluminum frame construction. These structures, particularly pool/patio enclosures lack structural redundancy and bracing. Damage surveys confirm that they structures generally fail with a total collapse. Hence, the cost to replace is generally the total value of the structure plus the cost to remove the damaged structure and repair the dwelling at the attachment points.

6.1.4 Insurability Issues

Insurability issues often arise when structures are not built properly for the hazards to which they are exposed. If the hazard is high and the structural resistance is low, repeated failure of the structure causes insurance costs to skyrocket. This situation of vulnerable structures produces a huge waste of societal resources with the burden eventually falling back on the owner of the structure (consumer) through either: (1) the lack of insurance coupled with high out of pocket costs, (2) high insurance rates, and/or (3) higher taxes/assessments.

This project confirms that the main contributors to exterior structure damage and loss are attached aluminum structures for both site-built homes and mobile homes. These structures are failing in lower windspeeds than the dwelling and their losses are accumulating much faster than the dwelling. They contribute a notable portion of the losses in lower intensity hurricanes.

In general, these structures have not been adequately designed and constructed. They lack adequate structural redundancy. The determination of combined design loads for these structures needs further research. More survivable design concepts need to be investigated. Also, the importance factors that are currently allowable in the building codes result in designs that are expected to fail more often than the dwelling fails.

The data developed in this report indicate that the loss cost for exterior structures (as a general category of structures) are much higher than the loss costs of the dwelling. Hence, actuarial principles dictate that higher insurance rates should apply to these types of structures. However, the data also suggests that aluminum structures are a significant part of the problem. Hence, it seems reasonable to treat these types of structures separately until more research is done to improve the classification of exterior structures and to make insurance coverage classes more consistent with building code requirements.

The results indicate that existing practice aluminum structures have an approximate loss cost factor (relative to the dwelling) of about 2.1 for site-built homes and 1.3 for mobile homes. These factors are estimates of the ratio of losses of exterior structures to the dwelling losses, normalized by mean valuations. These are preliminary estimates based on limited data. These estimates apply mostly to aluminum structures, although they were not developed exclusively for aluminum structures.

The data also indicates that coverage B losses (mostly detached structures) accrue at higher rates than the dwelling losses up to windspeeds of about 120 mph. Integration of the loss differential (B/A) again produces mean values greater than one for detached structures.

Example analyses for aluminum frame enclosures indicate that proper design of these structures to improved loads with an importance factor equal to one could potentially reduce the loss costs of these structures by a factor of 4 to 5. Benefit-cost analysis shows that the increased initial cost of building stronger aluminum structures is more than offset by the reductions in average annual loss. Benefit-cost ratios greater than 2 were obtained for these examples. These preliminary analyses need to be validated with further work.

Statewide estimates of loss were conservatively estimated to be $170 million per year for existing aluminum frame structures attached to site-built homes. Proven cost-effective mitigation approaches need to be developed and tested to address the long term insurability of these structures.

We estimated that more than 10,000 new aluminum frame enclosures per year are being added to the Florida site-built home building stock. With research to develop improved loads and design factors, the annual loss reduction savings potential was estimated at about $6 million per year and increasing each year thereafter. The net present value of benefits for improved designs was estimated at more than $400 million. With improved designs, the root causes of the insurability problem for new structures would be greatly alleviated.

6.2 Findings and Recommendations

Based on the data obtained and evaluated in this project, we present the following findings and recommendations.

6.2.1 Findings

The work described herein should be qualified as an initial research project on a complicated, large scope problem with many contributing data sources. The findings should be considered preliminary, as more research is needed to develop effective long term solutions to loss and insurability issues of exterior structures. All numerical quantifications should be treated as ‘ball park” estimates, as the sample sizes were relatively small and in some cases limited to one insurer.

The main findings of this research project on exterior structures include:

1. Exterior structures are common throughout Florida, averaging about one exterior structure per site-built home and almost three per manufactured home.
2. Exterior structures comprise a significant amount of the value of the average Florida home. Preliminary estimates from this study indicate that exterior structures average about 10.3% of the Coverage A insured value for site-built homes. For manufactured (mobile) homes, exterior structures average about 19% of the Coverage A insured

value. The distributions of these data are skewed due to the fraction of homes that do not have exterior structures.

3. Exterior structures have widely varying building characteristics, are highly vulnerable to hurricane damage, can damage the dwelling at attachment points when they fail, and also provide a source of wind-borne debris upon failure.
4. Aluminum structures (patio enclosures and carports) are an important contribution to the total losses experienced in Florida hurricanes for both site-built and mobile homes.
5. Initial empirical estimates of insurance loss cost factors (loss costs of exterior structures divided by loss cost of dwelling) are about 2.1 for site-built single family homes and about 1.3 for mobile homes. More work is needed to confirm these crude estimates.
6. Exterior structures are generally classified as Category I structures in the ASCE 7 national standard and are not designed to the same loads as the dwelling (Category II structure). The importance factor on the design loads for Category I structures is 0.77 *vs.* 1.0 for Category II structures. Hence, based on past design approaches, exterior structures should be expected to fail at lower windspeeds than the dwelling.
7. The engineering design approaches, building department review, and construction quality for aluminum exterior structures have not been adequate, regardless of the importance factor. The use of "master file engineering" has been the predominate approach in the industry.
8. Building departments need to do a better job of reviewing the designs and inspecting aluminum structures in the field.
9. Failure of aluminum structures (enclosures and carports) is generally catastrophic, requiring total replacement.
10. Consumer-owners of aluminum structures that have failed appear to be frustrated and have been economically impacted by the poor performance of these structures.
11. The aluminum industry has been working to address known deficiencies by developing an updated guide. Both training and certification of engineers and contractors are also needed.
12. New and complementary research is also needed to further improve industry design guidance and confirm design performance/survivability of aluminum structures.
13. Hurricane losses from exterior structures (aluminum structures, in particular) are a significant problem in Florida due to: the large number and relatively high value of exterior structures; high hurricane wind hazard in most regions of the state; the use of a reduced importance factor in design; inadequate engineering designs for many structures; and poor construction practices by some contractors.
14. The potential reduction in loss costs for exterior aluminum structures properly designed and built to newly developed standards (resulting from a research program) is estimated to more than a factor of 4 to 5. Achieving such reductions would tend to solve the major insurability issues with these structures in Florida.

15. Benefit-cost analysis shows that the benefits of loss reduction far outweigh the estimated increased costs of constructing these structures to improved standards. Preliminary benefit-cost ratios greater than two were computed, indicating that design/construction improvements are economically justified.
16. Preliminary statewide estimates of the net present value of savings (loss reduction benefits minus costs of improved designs for new structures) resulting from improved standards were calculated as $857 million for aluminum pool/patio enclosures alone. Additional savings would be expected for improved standards for attached aluminum carports and enclosures for mobile homes.
17. Long term solution to the insurability problem for aluminum structures requires further research to: improve the design loads; conduct full-scale testing to verify design performance; evaluate mitigation options for existing structures; update and verify design guides; and develop training programs/certification requirements for engineers and contractors.
18. An effort is also needed to address terminology issues and make structure classifications in homeowner insurance contracts more consistent with building code requirements.

In summary, the aluminum structure industry needs a verified set of guidelines and standards for design and construction, coupled with an educational requirement that facilitates the delivery of those standards to all those who work with these products, including the engineers providing the designs, the building departments reviewing the designs, contractors building the designs, and building departments inspecting the construction.

6.2.2 Recommendations.

Much work remains to be done to solve insurability issues of certain types of exterior structures. Without further investment to develop mitigation strategies for these vulnerable structures and to develop improved design requirements for new structures, insurability problems will continue to exist. In Florida, the hurricane losses for exterior structures will therefore remain high until we fix the basic problems. Following is a list of recommended short-term, mid-term, and long-term steps.

Phase I: Short-Term. Short-term recommendations include:

1. Allow insurers to exclude for hurricane hazards the following types of exterior structures for hurricanes in the standard homeowner policies:
    a. Site-Built Homes
        i. Attached carports
        ii. Attached pool/patio enclosures
    b. Manufactured (Mobile Homes)
        i. Attached Carports
        ii. Attached Sheds
        iii. Attached pool/patio enclosures

This recommendation recognizes the difference in both design requirements and loss costs for these structures.

2. Require the insurer to offer buy-back coverage for hurricane hazards for the above excluded structures:

   a. At a rate not to exceed about 1.5 times the loss costs of the dwelling for site-built homes and about 1.2 times the loss costs of the dwelling for mobile homes.[1]

   b. Coverage would not include damage to screens.

   c. No separate deductible needs to be applied to these structures. Failure is usually catastrophic and a small deductible would likely have little bearing on the loss costs.

   This recommendation is the necessary complement to the first recommendation. It provides risk transfer for consumers who have unwittingly purchased poorly designed/built structures.

3. Begin the Phase II research and training programs. This recommendation provides a long-term solution for designers, contractors, consumers, and insurers.

4. Improve the language of insurance contracts to better align with building code language and structure design requirements. This should be done in a "plain-language" manner so that the policy holder is able to understand what is covered and not covered.

The not to exceed rates in item 2 are believed to be consumer-oriented lower bound factors for use in the short term. These rates are less than the crude average factors estimated in this initial project and are likely much less than the true loss cost differentials between exterior structures and the dwelling. Additional work is needed to assess rate differentials for mitigated and new code attached structures. These future differentials would be based on the Phase II program.

Phase II: Mid-Term. Mid- term recommendations (12-18 months) includes research to complement the recent work of the aluminum industry and research to complete the insurability analysis.

1. Improve the loading requirements for screen enclosures and carport type structures by conducting new wind tunnel tests:

   a. Use model scales of the order of 1:10 to 1:20 to evaluate the lateral forces on compression members in order to determine the reduced buckling capacity of these slender members (both wall and roof members), due to lateral loads.

   b. Full scale tests on screen sections to measure drag forces on windward saturated/blocked screens.

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[1] We recognize that there are some well-designed, well-built "excluded" structures (Item 1) and that we are lumping "good" and "bad" excluded structures together. However, verifying which structures are "good" is difficult without further research. Further, the "good" structures were also designed with an importance factor of 0.77. Hence, we expect that the loss costs are still greater than the dwelling loss costs by more than recommended penalty factors even for "good" structures. This treatment of a single class of buy-back coverage will need to be revisited following the mid-term work.

c. Tests to determine bounding load conditions for quartering winds with and without blockage.

2. Aluminum structure connections need to be tested for connector pullout and a prescriptive design guide developed. Dynamic testing of connections should also be performed to validate the finite element models and the behavior of the screwed connections under dynamic loading situation.
3. Full-scale dynamic tests should be performed to verify performance and assess mitigation options. Perform impact test on individual members under combined loads.
4. Develop and implement training and certification programs for engineers and contractors. An aluminum structure is certified if both the engineer and contractor are certified when they perform the work.
5. Develop training programs for building department officials involved in reviewing plans and inspecting construction.
6. Evaluate the effectiveness of mitigation strategies for existing attached carports, patio enclosures and storage sheds for mobile homes. Develop mitigation/retrofit guides using cable bracing, foundation connection strengthening, fastener replacement, and joint reinforcement for existing structures.
7. Assess loopholes in building codes for exterior structures and building classifications. Develop long term standard language for insurance forms to make language consistent with building code classifications of structures. Suggest a coding system for insurers to use, based on consistent building code classifications.
8. Perform life-cycle benefit cost analysis to determine what the optimal importance factor should be for exterior structures in residential areas. This work would provide a basis for updating the FBC and national standards on importance factors for exterior structures that are near a residential occupancy. These analyses would produce the best long term solution for minimum life cycle costs (initial costs and damage/failure costs, including insured losses).
9. Complete the analysis of insurance data and claim data obtained during this project to ensure fair treatment for insurance coverage of exterior structures, including loss cost factors, deductibles, and mitigation incentives. Also determine if valuations of exterior structures are adequate in terms of insurance coverage.
10. Update the insurability analysis, exclusions, and buy-back provisions. Evaluate consumer notification options for aluminum structures that are built as Category I vs Category II structures.
11. Conduct damage surveys that focus on exterior structures to confirm the initial findings of this study and to proactively identify new problems.

Rough estimates of the research program to address the mid-term recommendations is about $1 million over about an 18 month period. Estimates of the benefits of the loss reduction of such a program over a 20 year period is $857 million (net present value) for new structures that will be added over that period.

The benefit-cost ratio of the research investment is expected to be greater than 500 to 1. Consumers would benefit greatly from the research through significantly reduced damage, losses, and out-of-pocket expenses.

Phase III: Long-Term. Long-Term recommendations (18+ months) include:

1. Continue to monitor performance through detailed damage surveys and analysis of insurance company data.
2. Update guides, training, and certification as required.
3. Update recommendations on exclusion and buy-back coverage, considering year built, certification of new structure, and certification of mitigation of existing structures.

Unless we solve the root causes of the problem and confirm the design performance of aluminum structures, excessive losses and the associated insurability problems of exterior structures will continue to plague the state.

7. REFERENCES

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APPENDIX A:

ARA EXTERIOR STRUCTURE SITE-BUILT HOMES SURVEY

Exterior Structure Survey

Applied Research Associates, Inc.
Project #17819

Request Number : ______________ **Owner Last Name:** ______________

A. Attached Structures (Not separated from main dwelling by clear space)

		Structure 1	Structure 2	Structure 3	Structure 4	
1 Photo Req'd	**Structure Type**	PE CP SR DK SS PH GA GH OP OT	PE CP SR DK SS PH GA GH OP OT	PE CP SR DK SS PH GA GH OP OT	PE CP SR DK SS PH GA GH OP OT	circle one
	If Structure Type is OT, Describe…					
1 Photo Req'd	**Where Attached on Main Dwelling**	Wall Roof Surface Eave/Fascia Soffit	Wall Roof Surface Eave/Fascia Soffit	Wall Roof Surface Eave/Fascia Soffit	Wall Roof Surface Eave/Fascia Soffit	circle all applicable
	Year Built	Known Estimated	Known Estimated	Known Estimated	Known Estimated	
	Wall or Column Structure Material	WD URM RM MT AL RC OT	WD URM RM MT AL RC OT	WD URM RM MT AL RC OT	WD URM RM MT AL RC OT	circle all applicable
	Wall Cover (skip if open structure)	SC VI BK ST PB GL WD AL EI OT	SC VI BK ST PB GL WD AL EI OT	SC VI BK ST PB GL WD AL EI OT	SC VI BK ST PB GL WD AL EI OT	circle all applicable
	Roof Cover	SC VI SH TI NO GL WD MT BU OT	SC VI SH TI NO GL WD MT BU OT	SC VI SH TI NO GL WD MT BU OT	SC VI SH TI NO GL WD MT BU OT	circle all applicable
	Length (ft) X Width (ft)	L: W:	L: W:	L: W:	L: W:	
	Number of Stories					
	Foundation	NO TD CO EE OT	NO TD CO EE OT	NO TD CO EE OT	NO TD CO EE OT	
	Cost Estimation Class	Economy Standard Custom Luxury	Economy Standard Custom Luxury	Economy Standard Custom Luxury	Economy Standard Custom Luxury	circle one
	Condition	Poor Average Good	Poor Average Good	Poor Average Good	Poor Average Good	circle one
PE Only	**Poor PE Condition Explained***	BC MBB MTS Other: ______	BC MBB MTS Other: ______	BC MBB MTS Other: ______	BC MBB MTS Other: ______	circle all applicable
PH, GH, GA Only	**PH, GH and GA Living Area %****					

B. Codes

Structure Type	**PE = Pool/Patio Enclosure** **PH = Pool House**	**CP = Carport** **GA = Garage**	**SR = Sunroom** **GH = Guest House**	**DK = Deck** **OP = Open Structure**	**SS = Storage Shed** **OT = Other**
Wall Column or Structure Material	**WD = Wood** **AL = Aluminum**	**URM = Unreinforced Masonry** **RC = Reinforced Concrete**		**RM = Reinforced Masonry**	**MT = Metal (not AL)** **OT = Other**
Wall Cover	**SC = Screen** **GL = Glass**	**VI = Vinyl** **WD = Wood**	**BK = Brick or Block** **AL = Aluminum**	**ST = Stucco** **EI = Ext. Insul. & Finish System**	**PB = Painted Block** **OT = Other**
Roof Cover	**SC = Screen** **GL = Glass**	**VI = Vinyl** **WD = Wood**	**SH = Shingle** **MT = Metal**	**TI = Tile** **BU = Built-up**	**NO = None** **OT = Other**
Foundation	**NO = None**	**TD = Tie Down/Anchored**	**CO = Attached to Concrete**	**EE = Earth Embedded**	**OT = Other**
Condition	**Poor = In need of repair**	**Good =Recently installed or very well maintaned**			**Average = Everything else**
Poor PE Condition	**BC = Broken Connections**		**MBB = Missing or Bent Bracing**		**MTS = Missing or Torn Screen**

C. Detached Structures (Separated from main dwelling by clear space)

		Structure 1	Structure 2	Structure 3	Structure 4	
2 Photos Req'd	**Structure Type**	PE CP SR DK SS PH GA GH OP OT	PE CP SR DK SS PH GA GH OP OT	PE CP SR DK SS PH GA GH OP OT	PE CP SR DK SS PH GA GH OP OT	circle one
	If Structure Type is OT, Describe…					
	Year Built	Known Estimated	Known Estimated	Known Estimated	Known Estimated	
	Wall or Column Structure Material	WD URM RM MT AL RC OT	WD URM RM MT AL RC OT	WD URM RM MT AL RC OT	WD URM RM MT AL RC OT	circle all applicable
	Wall Cover (skip if open structure)	SC VI BK ST PB GL WD AL EI OT	SC VI BK ST PB GL WD AL EI OT	SC VI BK ST PB GL WD AL EI OT	SC VI BK ST PB GL WD AL EI OT	circle all applicable
	Roof Cover	SC VI SH TI NO GL WD MT BU OT	SC VI SH TI NO GL WD MT BU OT	SC VI SH TI NO GL WD MT BU OT	SC VI SH TI NO GL WD MT BU OT	circle all applicable
	Length (ft) X Width (ft)	L: W:	L: W:	L: W:	L: W:	
	Number of Stories					
	Foundation	NO TD CO EE OT	NO TD CO EE OT	NO TD CO EE OT	NO TD CO EE OT	
	Cost Estimation Class	Economy Standard Custom Luxury	Economy Standard Custom Luxury	Economy Standard Custom Luxury	Economy Standard Custom Luxury	circle one
	Condition	Poor Average Good	Poor Average Good	Poor Average Good	Poor Average Good	circle one
PE Only	**Poor PE Condition Explained***	BC MBB MTS Other: ______	BC MBB MTS Other: ______	BC MBB MTS Other: ______	BC MBB MTS Other: ______	circle all applicable
PH, GH, GA Only	**PH, GH and GA Living Area %****					

* If screened pool or patio enclosure condition is Poor, circle the appropriate code(s): BC, MBB, MTS
** Living area percentage is only required for pool houses, guest houses and garages

Request Number : ____________ Owner Last Name: ____________

D. Other Exterior Structures (Fences/Walls, Docks, Swimming Pools, and Spas/Hot tubs)

Photos Not Req'd **1. Fence/Wall** **Length (ft):** ________ **Height (ft):** ________ **Number of Gates:** ________ **Gate Material:** ________

Cost Estimation Class: *Economy* *Standard* *Custom* *Luxury*

Material: *Wood* *Masonry* *Vinyl* *EIFS (Ext. Insl. Fin. Sys.)* *Metal* *Chain-Link*

Photos Not Req'd **2. Dock** **Type:** *Stationary* *Floating* **Length (ft):** ________ **Width (ft):** ________

Cost Estimation Class: *Economy* *Standard* *Custom* *Luxury* **Boat Lift:** *Y* *N*

Photos Not Req'd **3. Swimming Pool** **Length (ft):** ________ **Width (ft):** ________ **Below Ground?** *Y* *N*

Construction: *Concrete/Marcite* *Fiberglass* *Vinyl Liner*

Cost Estimation Class: *Economy* *Standard* *Custom* *Luxury*

Photos Not Req'd **4. Spa/Hot Tub** **Length (ft):** ________ **Width (ft):** ________ **Below Ground?** *Y* *N*

Construction: *Concrete/Marcite* *Fiberglass* *Vinyl Liner* *Wood*

Cost Estimation Class: *Economy* *Standard* *Custom* *Luxury*

Photos Not Req'd **5. Playset/Jungle Gym** **Dimensions of Footprint:-** **Length (ft):** ________ **Width (ft):** ________

Material: *Wood* *Metal* *Plastic*

Cost Estimation Class: *Economy* *Standard* *Custom* *Luxury*

E. Information for the Homeowner

This survey of attached and detached exterior structures is being collected as part of a reseach project funded by the State of Florida. The information collected will be kept anonymous. It will not be provided to your insurance company or your local building department.

F. Survey and Photograph Notes

Notes:

1. **If in doubt, complete the form and take required photos.**
2. Driveways, sidewalks, and uncovered patios are not of interest in this survey.
3. Vehicles, boats, RVs, camper trailers, or any other items on wheels are not of interest in this survey.
4. Structures attached to house by only a fence or utility line should be considered "Detached", since such connection is not "Structural".
5. Checklists received without request number will not be paid.
6. When completing invoice and cover page, please put the $15 charge on a separate invoice.

Photographs

1. Two photos are required for each exterior structure noted in Sections A and C only.
   a. Attached Structures -- One photo of structure and one photo of attachement to main dwelling.
   b. Detached Structures -- One photo of structure and one photo of clear space between main dwelling and detached structure.
2. Take a close-up photograph of any existing damage to an exterior structure.
3. Electronic photographs are preferred, but hard copies will be accepted.
4. File name must start with the full request number followed by the section of the checklist and structure number.
5. Example: The file name for photograph #2 of structure #3 in Section C should be "MSFH123456-C-3-2.jpg"
6. Digital photographs should be uploaded to ftp://ftp-intrarisk.ara.com/

☐ Check this box if there are no Exterior Structures on this property. Please take a photo of the house if no exterior structures.

Inspector Signature: ______________________ Date: ____________

APPENDIX B:

TRENDS IN EXTERIOR STRUCTURE VALUE AND INSURED VALUE

APPENDIX B:

TRENDS IN EXTERIOR STRUCTURE VALUE AND INSURED VALUE

Field survey data on the dimensions and characteristics of exterior structures associated with both site-built and manufactured homes was used to estimate the replacement value of these exterior structures. Where available, these value data were compared with insured value data. This appendix contains additional information not included in Chapter 2 of this report that presents additional detail with respect to the relationship between exterior structure value and insured (coverage A) value.

Relationships are presented as scatter plots of exterior structure value versus insured values. Additional analysis is underway.

Exterior Structures for Site-Built Homes

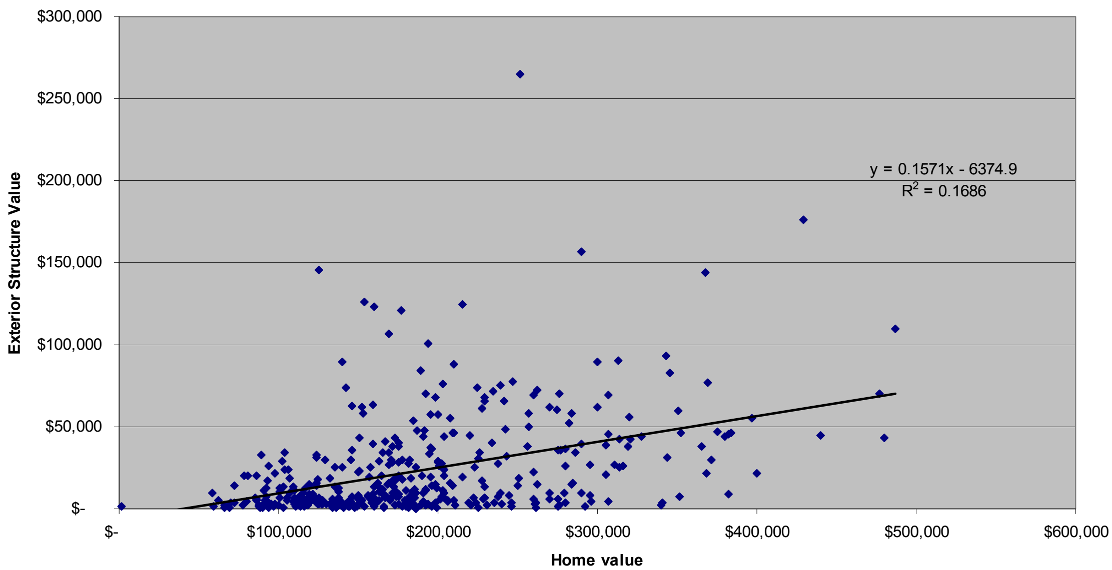

Figure B-1. Replacement Value of All Exterior Structures on Site-Built Homes versus Coverage A Insured Value.

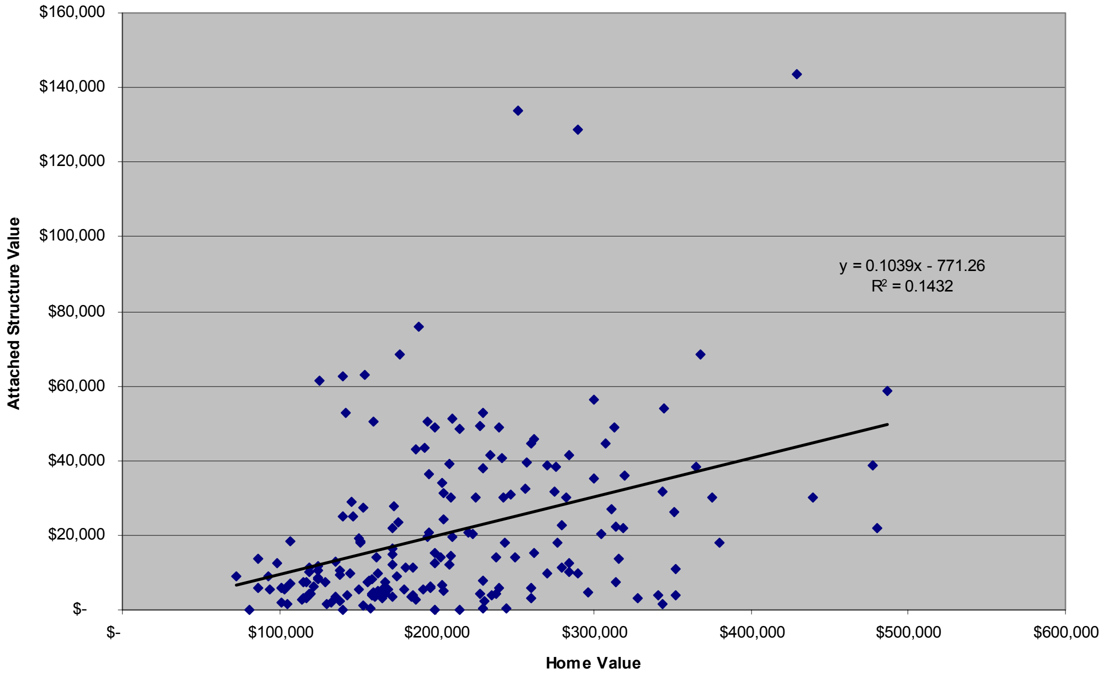

Figure B-2. Replacement Value of All Attached Exterior Structures on Site-Built Homes versus Coverage A Insured Value.

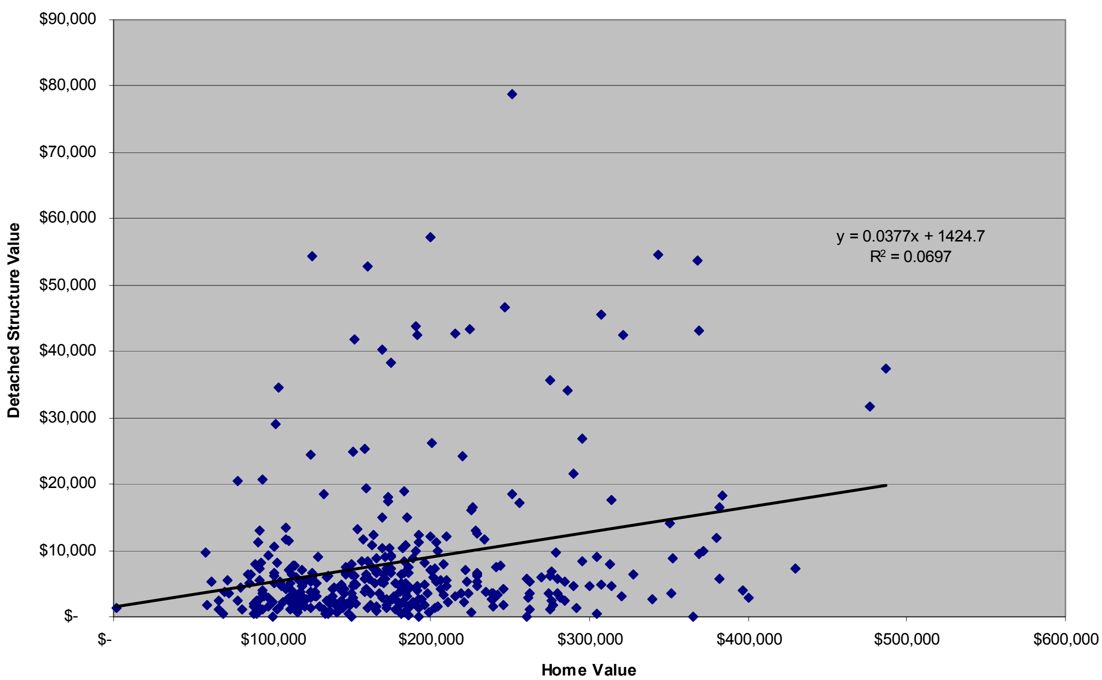

Figure B-3. Replacement Value of All Detached Exterior Structures on Site-Built Homes versus Coverage A Insured Value.

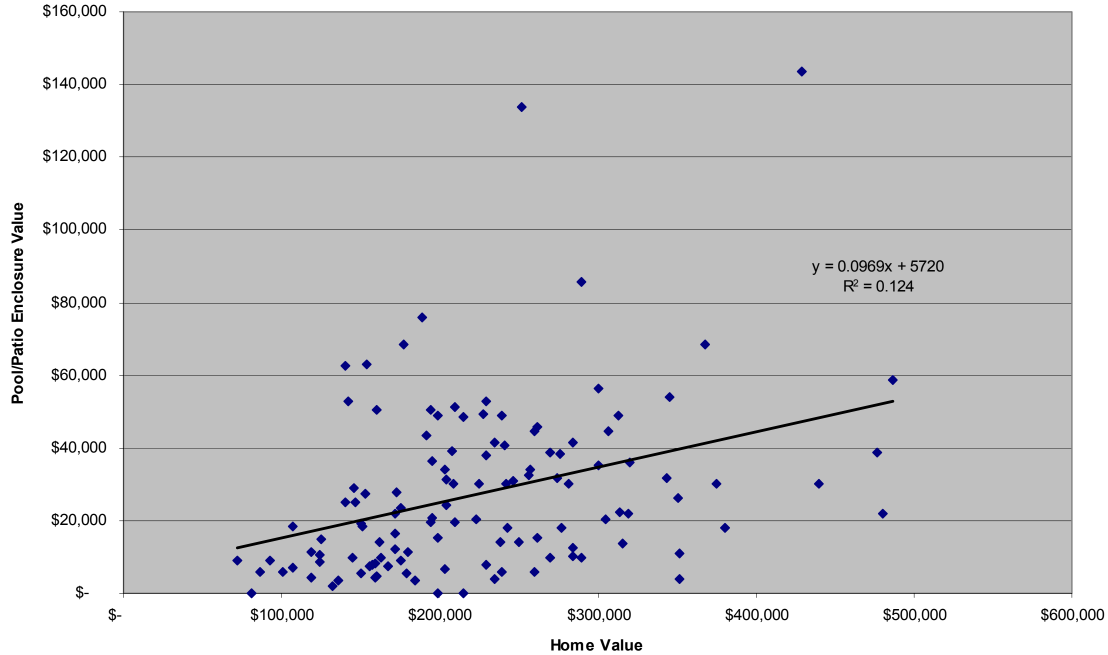

Figure B-4. Replacement Value of All Pool/Patio Enclosures on Site-Built Homes versus Coverage A Insured Value.

Exterior Structures for Manufactured Homes

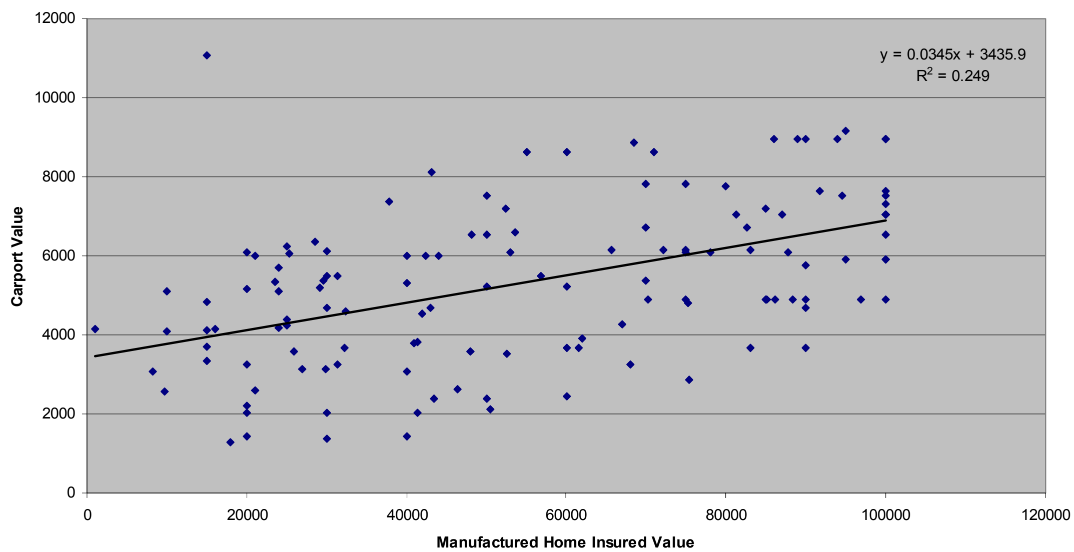

Figure B-5. Replacement Value of Carports on Manufactured Homes versus Coverage A Insured Value.

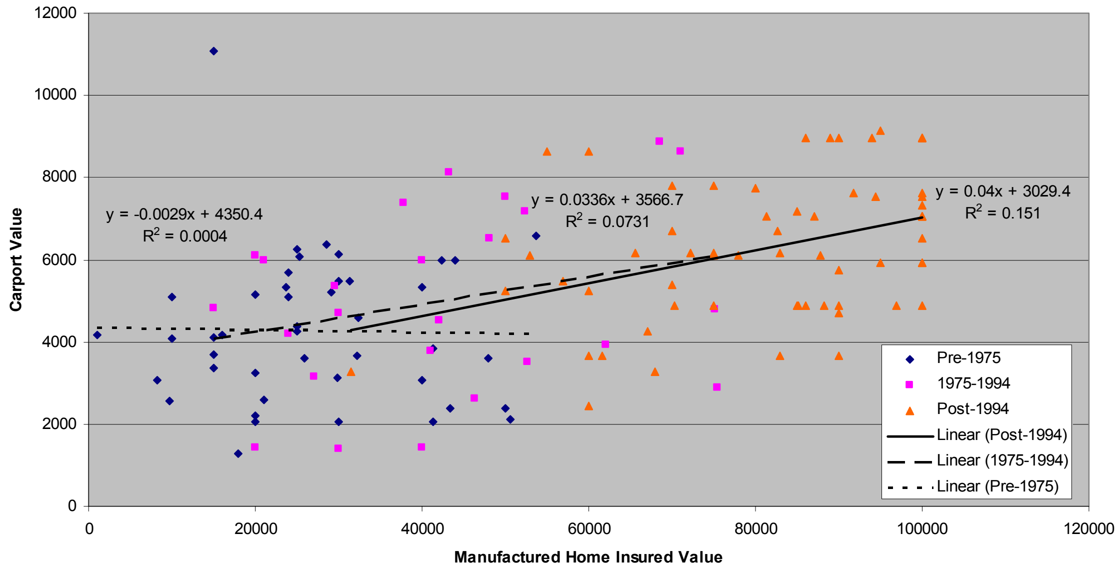

Figure B-6. Replacement Value of Carports on Manufactured Homes versus Coverage A Insured Value by Age Range.

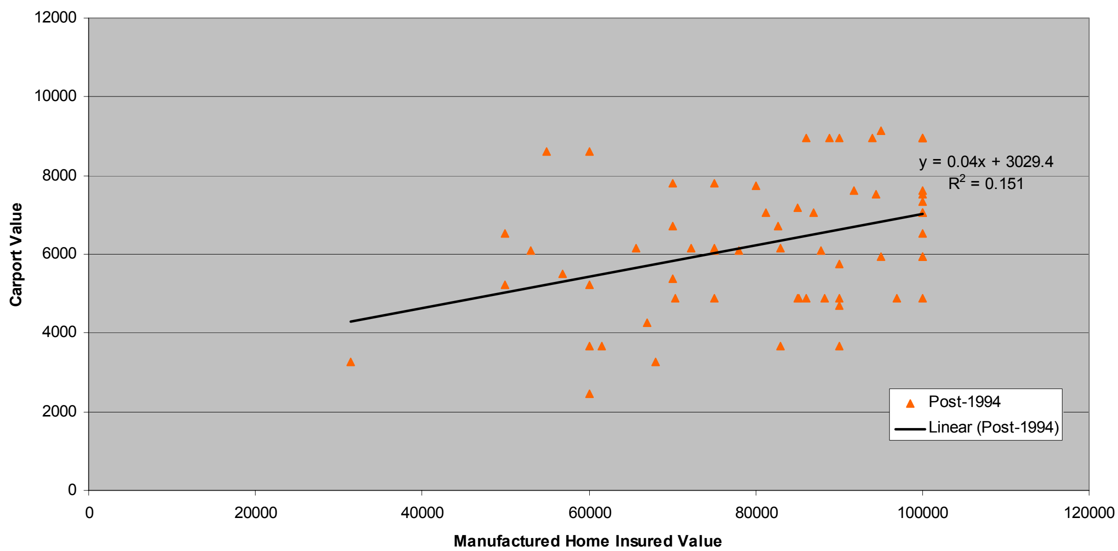

Figure B-7. Replacement Value of Carports on Manufactured Homes versus Coverage A Insured Value – Post 1994 Homes Only.

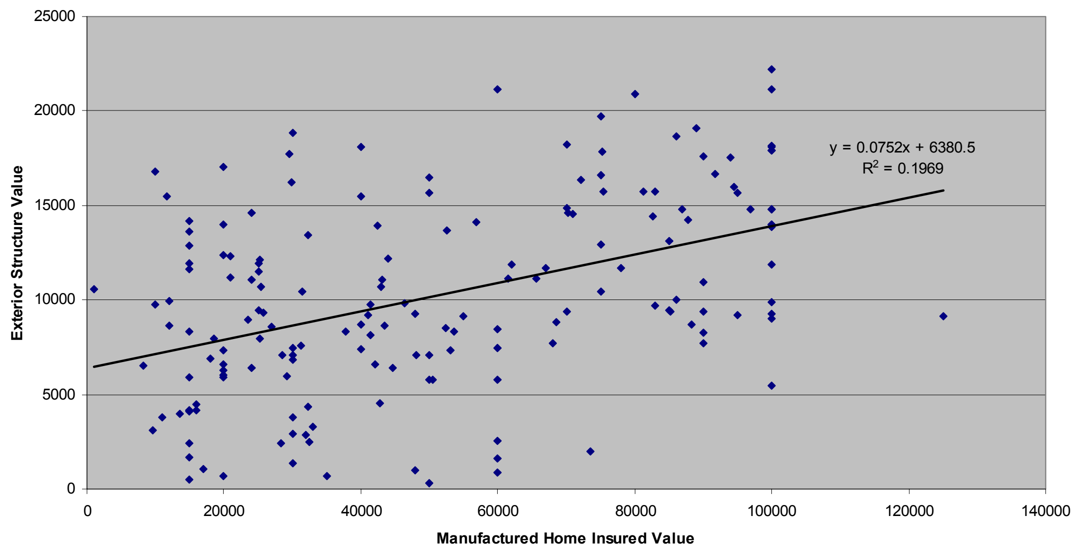

Figure B-8. Replacement Value of All Exterior Structures on Manufactured Homes versus Coverage A Insured Value.

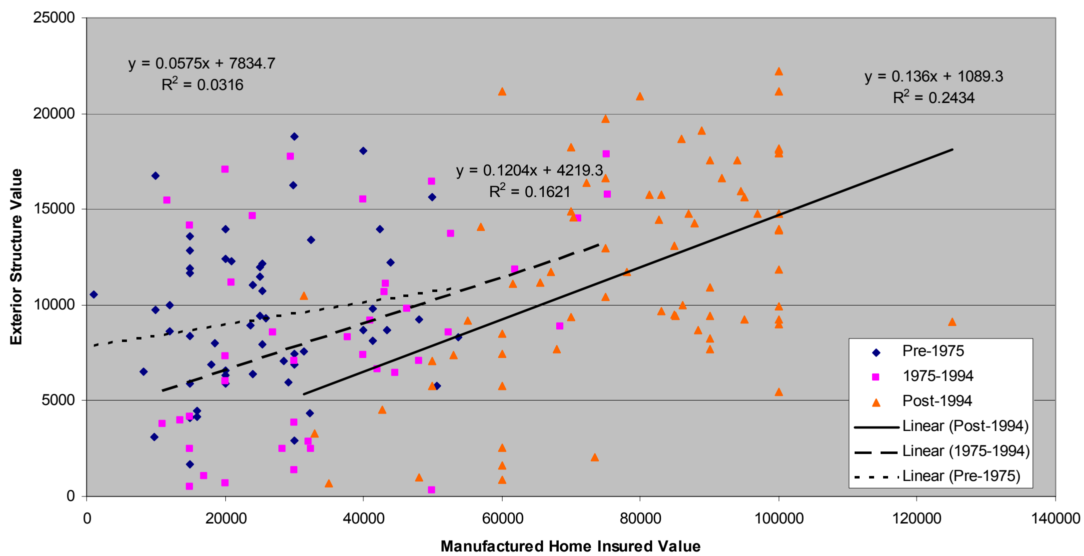

Figure B-9. Replacement Value of All Exterior Structures on Manufactured Homes versus Coverage A Insured Value by Age Range.

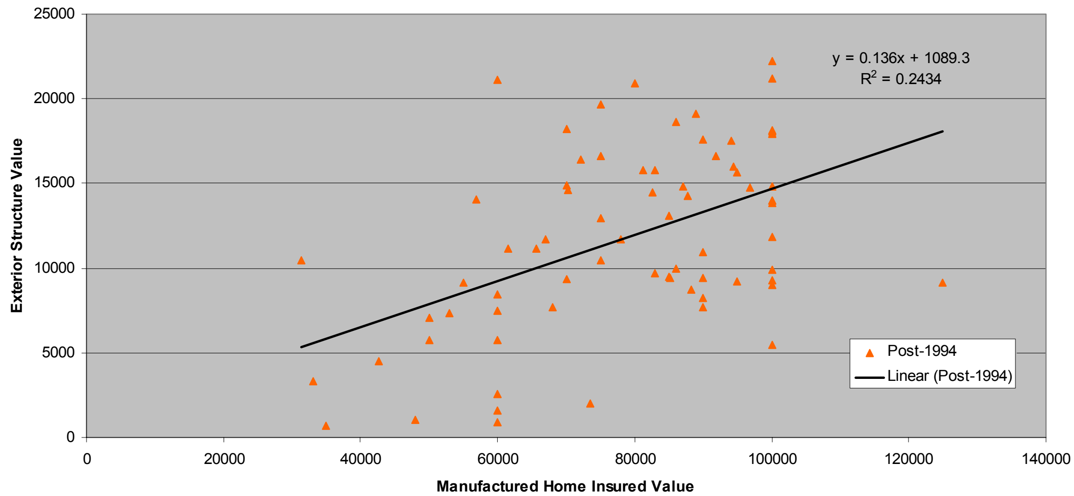

Figure B-10. Replacement Value of All Exterior Structures on Manufactured Homes versus Coverage A Insured Value – Post 1994 Homes Only.

APPENDIX C:

ARA EXTERIOR STRUCTURE MANUFACTURED HOMES SURVEY

Exterior Structure Survey (Manufactured Housing)

Applied Research Associates, Inc.
Project #17819

Address:		**MHP/# :**	
Date/Memory Stick:		**Photos:** TO	**Inspected By:**
Manufacturer:		**Year MH Built:**	K E

A/C. Attached and Detached Structures

		Structure 1	Structure 2	Structure 3	Structure 4	
	Attached	Attached Detached	Attached Detached	Attached Detached	Attached Detached	
1 Photo Req'd	**Structure Type**	PE CP SR DK SS PH GA GH OP OT	PE CP SR DK SS PH GA GH OP OT	PE CP SR DK SS PH GA GH OP OT	PE CP SR DK SS PH GA GH OP OT	circle one
	If Structure Type is OT, Describe…					
1 Photo Req'd	**Where Attached on Main Dwelling**	Wall Roof Surface Eave/Fascia Soffit	Wall Roof Surface Eave/Fascia Soffit	Wall Roof Surface Eave/Fascia Soffit	Wall Roof Surface Eave/Fascia Soffit	circle all applicable
	Year Built	Known Estimated	Known Estimated	Known Estimated	Known Estimated	
	Wall or Column Structure Material	WD URM RM MT AL RC OT	WD URM RM MT AL RC OT	WD URM RM MT AL RC OT	WD URM RM MT AL RC OT	circle all applicable
	Wall Cover (skip if open structure)	SC VI BK ST PB GL WD AL EI OT	SC VI BK ST PB GL WD AL EI OT	SC VI BK ST PB GL WD AL EI OT	SC VI BK ST PB GL WD AL EI OT	circle all applicable
	Roof Cover	SC VI SH TI NO GL WD MT BU OT	SC VI SH TI NO GL WD MT BU OT	SC VI SH TI NO GL WD MT BU OT	SC VI SH TI NO GL WD MT BU OT	circle all applicable
	Length (ft) X Width (ft)	L: W:	L: W:	L: W:	L: W:	
	Number of Stories					
	Foundation	NO TD CO EE OT	NO TD CO EE OT	NO TD CO EE OT	NO TD CO EE OT	
	Cost Estimation Class	Economy Standard Custom Luxury	Economy Standard Custom Luxury	Economy Standard Custom Luxury	Economy Standard Custom Luxury	circle one
	Condition	Poor Average Good	Poor Average Good	Poor Average Good	Poor Average Good	circle one
PE Only	**Poor PE Condition Explained***	BC MBB MTS Other: ___	BC MBB MTS Other: ___	BC MBB MTS Other: ___	BC MBB MTS Other: ___	circle all applicable
PH, GH, GA Only	**PH, GH and GA Living Area %****					

B. Codes

Structure Type	**PE = Pool/Patio Enclosure** **PH = Pool House**	**CP = Carport** **GA = Garage**	**SR = Sunroom** **GH = Guest House**	**DK = Deck** **OP = Open Structure**	**SS = Storage Shed** **OT = Other**
Wall Column or Structure Material	**WD = Wood** **AL = Aluminum**	**URM = Unreinforced Masonry** **RC = Reinforced Concrete**	**RM = Reinforced Masonry**		**MT = Metal (not AL)** **OT = Other**
Wall Cover	**SC = Screen** **GL = Glass**	**VI = Vinyl** **WD = Wood**	**BK = Brick or Block** **AL = Aluminum**	**ST = Stucco** **EI = Ext. Insul. & Finish System**	**PB = Painted Block** **OT = Other**
Roof Cover	**SC = Screen** **GL = Glass**	**VI = Vinyl** **WD = Wood**	**SH = Shingle** **MT = Metal**	**TI = Tile** **BU = Built-up**	**NO = None** **OT = Other**
Foundation	**NO = None**	**TD = Tie Down/Anchored**	**CO = Attached to Concrete**	**EE = Earth Embedded**	**OT = Other**
Condition	**Poor = In need of repair**	**Good =Recently installed or very well maintaned**			**Average = Everything else**
Poor PE Condition	**BC = Broken Connections**	**MBB = Missing or Bent Bracing**		**MTS = Missing or Torn Screen**	

* If screened pool or patio enclosure condition is Poor, circle the appropriate code(s): BC, MBB, MTS
** Living area percentage is only required for pool houses, guest houses and garages

D. Other Exterior Structures (Fences/Walls, Docks, Swimming Pools, and Spas/Hot tubs)

Photos Not Req'd **1. Fence/Wall** **Length (ft):** ______ **Height (ft):** ______ **Number of Gates:** ______ **Gate Material:** ______

Cost Estimation Class: *Economy* *Standard* *Custom* *Luxury*

Material: *Wood* *Masonry* *Vinyl* *EIFS (Ext. Insl. Fin. Sys.)* *Metal* *Chain-Link*

Photos Not Req'd **2. Dock** **Type:** *Stationary* *Floating* **Length (ft):** ______ **Width (ft):** ______

Cost Estimation Class: *Economy* *Standard* *Custom* *Luxury* **Boat Lift:** *Y* *N*

Photos Not Req'd **3. Swimming Pool** **Length (ft):** ______ **Width (ft):** ______ **Below Ground?** *Y* *N*

Construction: *Concrete/Marcite* *Fiberglass* *Vinyl Liner*

Cost Estimation Class: *Economy* *Standard* *Custom* *Luxury*

Photos Not Req'd **4. Spa/Hot Tub** **Length (ft):** ______ **Width (ft):** ______ **Below Ground?** *Y* *N*

Construction: *Concrete/Marcite* *Fiberglass* *Vinyl Liner* *Wood*

Cost Estimation Class: *Economy* *Standard* *Custom* *Luxury*

Photos Not Req'd **5. Playset/Jungle Gym** **Dimensions of Footprint:-** **Length (ft):** ______ **Width (ft):** ______

Material: *Wood* *Metal* *Plastic*

APPENDIX D:

INFORMATION REQUEST TO INSURANCE COMPANIES

APPENDIX D:

INFORMATION REQUEST TO INSURANCE COMPANIES

Florida Office of Insurance Regulation
Freestanding and Attached Structures

Research Project
Applied Research Associates, Inc.

Insurance data are needed to help evaluate insurability issues, loss experience, and mitigation issues regarding exterior structures. Exterior structures include structures that can be either attached or detached with respect to the main dwelling. Examples may include: screen enclosures, carports, garages, storage sheds, gazebos, fences, and other such structures. The types of insurance data that are needed include policy level exposure and loss data as well as detailed claim information for recent Florida Hurricanes. The hurricanes of particular interest include Wilma, Charley, Frances, Jeanne, and Ivan. This information will be used in an anonymous statistical form as part of this research project. The scope of the project includes both single family homes and manufactured housing (mobile homes).

Applied Research Associates, Inc. was awarded a project to help evaluate these structures. As part of this project, we request the following types of information for the above named Florida hurricanes. This information is needed by no later than February 9, 2007.

1. **Policy Level Exposure and Losses**. The needed data file for policy level information would include:

   a. For each Florida hurricane

      i. For each house policy
         (1) House Zip Code, street address, and/or latitude-longitude
         (2) Year built
         (3) Number of stories
         (4) Roof cover type (shingles, tiles, …)
         (5) Square Feet (living area, heated/cooled)
         (6) Coverage A, B, C, D policy limits for house
         (7) Coverage A, B, C, D losses for house
         (8) This data grouped together so that we know the limits and losses for each property location. For example, for a given hurricane, each line of data could contain items 1-7 above for a house, the next line of data would repeat this information for the next house, and so forth.

      ii. For each mobile home policy
         (1) Mobile home Zip Code street address, and/or latitude-longitude
         (2) Year built
         (3) Single, double, or triple wide, or alternatively square feet (living area, heated/cooled)
         (4) Coverage A, B, C, D policy limits for mobile home

(5) Coverage A, B, C, D losses for mobile home
(6) This data grouped together so that we know the limits and losses for each property and the zip code or lat-long location.

iii. The data should be inclusive of all insured policies affected by the storm; i.e., we don't just want the policies with damage and loss. We need all the policy limits and losses in an affected zip code so we can determine the exposure as well as losses. The best way to do this is to include the above data for each zip code in which there are one or more claims.

iv. Please contact us with any questions or further suggestions on data fields.

2. Sample of Claim Folders

a. Detailed claim folder data will help us classify and estimate exterior structure losses for a sample of claims. In some cases, the exterior structure losses may be part of Coverage A, many times part of Coverage B, and in other cases the exterior structure may be excluded from coverage. By reviewing a sample of claim folders, we hope to determine what types of exterior structures are experiencing the most damage and how these losses relate to the total Coverage losses.

b. The sample of claim folders must be a scientific sample, drawn in an unbiased manner from all claims in a particular hurricane.

c. For each hurricane with single family policy level information extracted for data item 1, above, randomly draw a sample of 400 claim folders.

i. For single family homes, stratify the sample to draw 100 claims from each of four strata
(1) Strata 1: Coverage A Limit ≤ $100,000.
(2) Strata 2: $100,000 < Coverage A Limit ≤ $200,000
(3) Strata 3: $200,000 < Coverage A Limit ≤ $400,000
(4) Strata 4: Coverage A Limit >$400,000

ii. Hence, for single family homes, there will be 100 randomly drawn claims from Strata 1, 100 from Strata 2, 100 from Strata 3, and 100 from Strata 4. If there are insufficient claims in a stratum, please include all you have and indicate that there were not 100 claims total.

iii. These claims would be randomly drawn over all affected zip codes.

d. For each hurricane with mobile home policy level information extracted from data item 1 above, randomly draw a sample of 300 claim folders according to a stratification of year built:

i. Stratify the sample to draw 100 claim folders from each stratum, according to;
(1) Strata 1: Year built ≤ 1976
(2) Strata 2: 1976 < Year Built ≤ 1994
(3) Strata 3: Year Built > 1994

ii. These claims would be randomly drawn over all affected zip codes.

iii. Hence, for mobile homes, there will be 100 randomly drawn claims from Strata 1, 100 from Strata 2, and 00 from Strata 3. If there are insufficient claims in a stratum, please include all you have and indicate that there were not 100 claims total

e. Please contact us if you have any questions on how to set up the sample or to draw a random stratified sample.

f. For each sampled claim, we need to review the claim for the following information:

   i. Main dwelling and exterior structure damage
      (1) What was damaged; that is, roof, walls, windows, doors, etc.
      (2) What types of exterior structures were damaged and what were the apparent failure modes; i.e. screen enclosure frame failure, detached carport overturned, etc.
      (3) Any information or guidance on treatment of each exterior structure as falling under Coverage A, Coverage B, Coverage C, Rider, or Uncovered.
      (4) Hence, photos and descriptive information in the claim will be needed to make these assessments.

   ii. There are several ways to achieve this review and extraction of anonymous data:
      (1) Insurer draws sample of claims and ARA visits the insurer with a team of several engineers to extract what information can be gleaned from the claims in an anonymous format. This process could take up to one week at the insurer's location.
      (2) Alternately, the insurer provides an electronic or hard copy, complete with photos, notes, etc for ARA to review and extract the information in anonymous form.

3. Questions/Additional Information

a. Please provide copies of the language in your Standard HO-3 and MH policies that describe what is included or excluded under Coverages A, B, and C and how your company classifies exterior structures with respect to these coverages.

b. Does your company currently offer any discounts or apply any surcharges to your base windstorm premium with respect to the presence or absence of exterior structures? If so, please provide a table of those structures affected by a surcharge or discount.

APPENDIX E:

HURRICANE WINDSPEEDS FOR ANALYSIS OF INSURANCE LOSSES

APPENDIX E:

HURRICANE WINDSPEEDS FOR ANALYSIS OF INSURANCE LOSSES

This appendix contains background information on the use of the ARA hurricane wind field model to estimate the peak gust wind speed in unobstructed open terrain at the zip code level for Hurricanes Charley, Frances, Ivan, Jeanne, and Wilma. The wind speeds developed were used as an integral part of the insurance data analysis discussed in Section 3 of this report.

Note that in the development of the modeled wind speeds sited in this report, significant effort has been put forth into validating the modeled wind speeds through comparisons with full scale records of wind speeds, wind directions and pressures measured both over water and on land for all of the hurricanes examined here.

The following paragraphs present examples of wind speed validation analyses conducted for Hurricanes Ivan, Jeanne, and Frances.

Hurricane Ivan: The observed wind speeds in Hurrican Ivan cover a region all the way from New Orleans to the west of the landfall point, through to Tallahassee, well to the east of the point of landfall. As indicated in Figure E-1, there is excellent agreement between the maximum modeled and observed wind speeds. Each data point given in Figure E-1 represents the observed (x-axis) and modeled wind speed at an individual measurement location. The model and the observations indicate that the Pensacola area experienced peak gust wind speeds (in open unobstructed terrain) of about 110 mph, reducing to less than about 50 mph in the Tallahassee area. The good agreement between the modeled and observed wind speeds provides us with the confidence that the modeled peak gust wind speeds represent a reliable estimate of the actual maximum wind speeds experienced by the homes in Hurricane Ivan.

Hurricane Jeanne: Figure E-2 presents a summary comparison plot of the observed and modeled peak gust wind speeds produced by Hurricane Jeanne in Florida. The observed wind speeds cover a region from Fort Lauderdale to the south of the landfall point, through to Jacksonville, to the north of the point of landfall, in addition to points on the west coast near Tampa, and inland around the Orlando area. As indicated in Figure E-2, there is good agreement between the modeled and observed wind speeds, with both the model and the observations indicating that the area just to the north of the landfall point experienced peak gust wind speeds (in open unobstructed terrain) of about 110 mph, reducing to about than 80-90 mph in the Orlando area, 70-80 mph in the Tampa area and about 70 mph in the Gainesville area. The good agreement between the modeled and observed wind speeds provides us with the confidence that the modeled peak gust wind speeds represent a reliable estimate of the actual maximum wind speeds experienced by the homes in most of the areas affected Hurricane Jeanne, although the model appears to overestimate wind speeds in the Fort Lauderdale area.

Hurricane Frances: Figure E-3 presents a summary comparison plot of the observed and modeled peak gust wind speeds produced by Hurricane Frances in Florida. The observed wind speeds cover a region from Fort Lauderdale to the south of the landfall point, through to

Jacksonville, to the north of the point of landfall, in addition to points on the west coast near Tampa, and inland around the Orlando area. As indicated in Figure E-3, the agreement between the modeled and observed wind speeds is not as good as in the case of Hurricanes Ivan and Jeanne. The model tends to underestimate wind speeds well to the north of the point of landfall, and overestimate wind speeds near the point of landfall.

The model results and observation indicate that the area just to the north of the landfall point experienced peak gust wind speeds (in open unobstructed terrain) of about 110 mph, reducing to about than 70-80 mph in the Orlando area, 60-70 mph in the Tampa about 70 mph in the Gainesville area. Wind speeds in the Daytona Beach through to Jacksonville ranged from about 80 mph at Daytona Beach, reducing to about 70 mph near Jacksonville. Wind speeds in this area of Florida are underestimated using the wind model.

ASOS	Description	Peak Gust Speed (mph)	
		Obs	Model
42003	*Data Buoy*	*85*	*83*
42007	*Data Buoy*	*96*	*95*
BURL1	*Southwest Pass, LA C-MAN Station*	*91*	*88*
DPIA1	*Dauphin Island C-MAN*	*102*	*112*
GDIL1	*Grand Isle C-MAN*	*69*	*63*
SGOF1	*Tyndall AFB C-MAN Station*	*65*	*56*
KBHM	Birmingham Int Airport, AL ASOS		58
KDHN	Dothan, AL ASOS	58	55
KDTS	Destin, FL ASOS		83
KGPT	Gulfport, MS ASOS		71
KMGM	Montgomery Regional Airport, AL ASOS	67	70
KBIX	Biloxi-Keesler AFB	73	78
KNEW	New Orleans Lakefront Airport	54	52
KMSY	New Orleans International Airport	48	47
KTLH	Tallahassee Regional Airport	49	46
KMOB	Mobile, AL ASOS	82	93
KMXF	Maxwell AFB, AL ASOS	68	69
KPFN	Panama City Airport ASOS	65	63
KNPA	Pensacola Naval Station ASOS	110	110
KPNS	Pensacola Regional Airport ASOS		106
KVPS	Eglin AFB ASOS	95	83
T1	FCMP Tower T1	107	106
T2	FCMP Tower T2	90	105

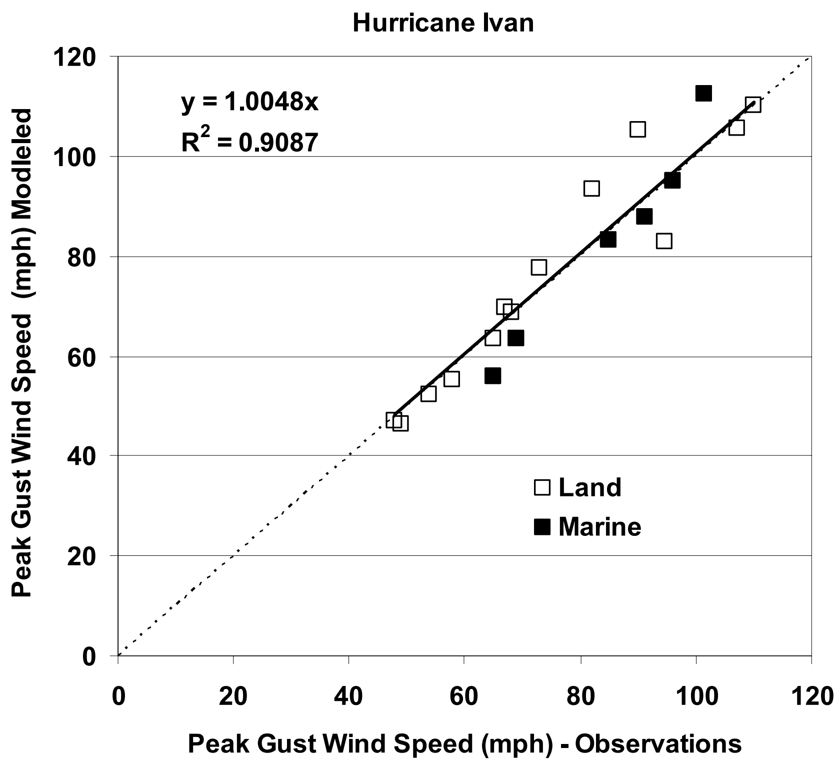

Figure E-1. Comparisons of Modeled and Observed Peak Gust Wind Speeds for Hurricane Ivan.

ASOS	Description	Peak Gust Speed (mph)	
		Observed	Modeled
KDAB	Daytona Beach ASOS	70	62
KFLL	Fort Lauderdale ASOS	58	68
KFPR	Fort Pierce ASOS		108
KGNV	Gainesville ASOS	69	68
KJAX	Jacksonville ASOS	62	52
KLEE	Leesburg ASOS	77	76
KMCO	Orlando International Airport ASOS	85	84
KMLB	Melbourne ASOS		97
KPBI	Palm Beach Airport ASOS		95
KSFB	Orlando-Sanford International Airport ASOS	76	72
KTPA	Tampa International Airport ASOS	64	70
KVDF	Tampa Vandenburg ASOS	81	74
LKWF1	Lake Worth C-MAN Station	93	98
T0	FCMP Tower T0	93	90
T1	FCMP Tower T1	103	106
T2	FCMP Tower T2	73	76
T3	FCMP Tower T3	106	109
T3	FCMP Tower T3 - Gainsville	69	67

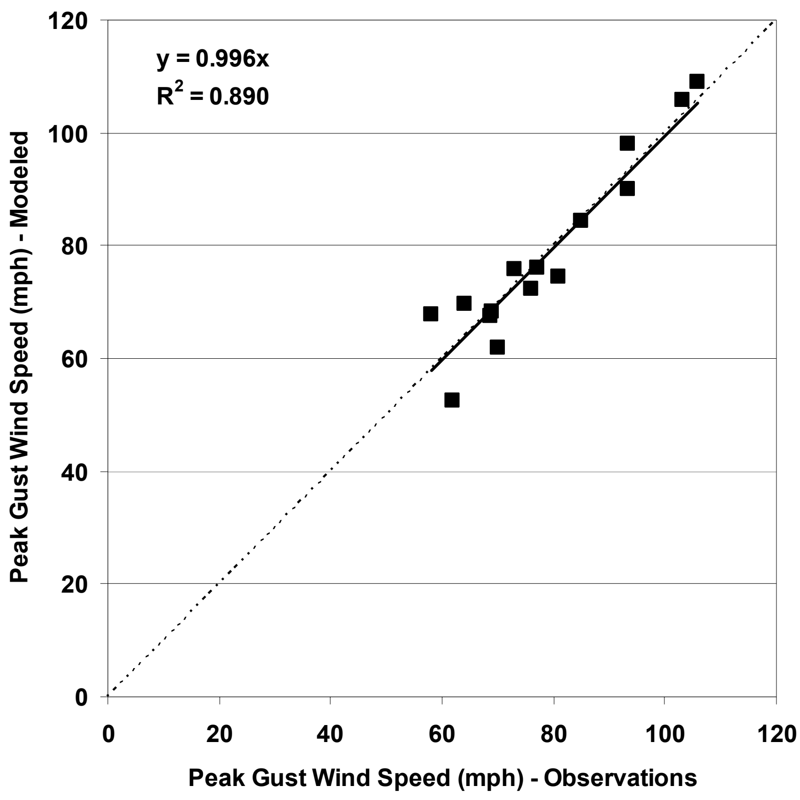

Figure E-2. Comparisons of Modeled and Observed Peak Gust Wind Speeds for Hurricane Jeanne.

ASOS	Description	Peak Gust Speed (mph)	
		Observed	Modeled
KDAB	Daytona Beach ASOS	84	62
KFLL	Fort Lauderdale ASOS	63	76
KGIF	Fort Pierce ASOS		80
KJAX	Jacksonville Airport ASOS	70	49
KGNV	Gainesville ASOS	72	60
KLEE	Leesburg ASOS	71	73
KMCO	Orlando International Airport ASOS	72	80
KPBI	Palm Beach Airport ASOS	91	99
KSPG	St Petersburg	63	66
KTPA	Tampa International Airport ASOS	60	69
LKWF1	Lake Worth C-MAN Station		103
T0	FCMP Tower T0	92	105
T1	FCMP Tower T1	83	88
T2	FCMP Tower T2	90	105
T3	FCMP Tower T3	112	106

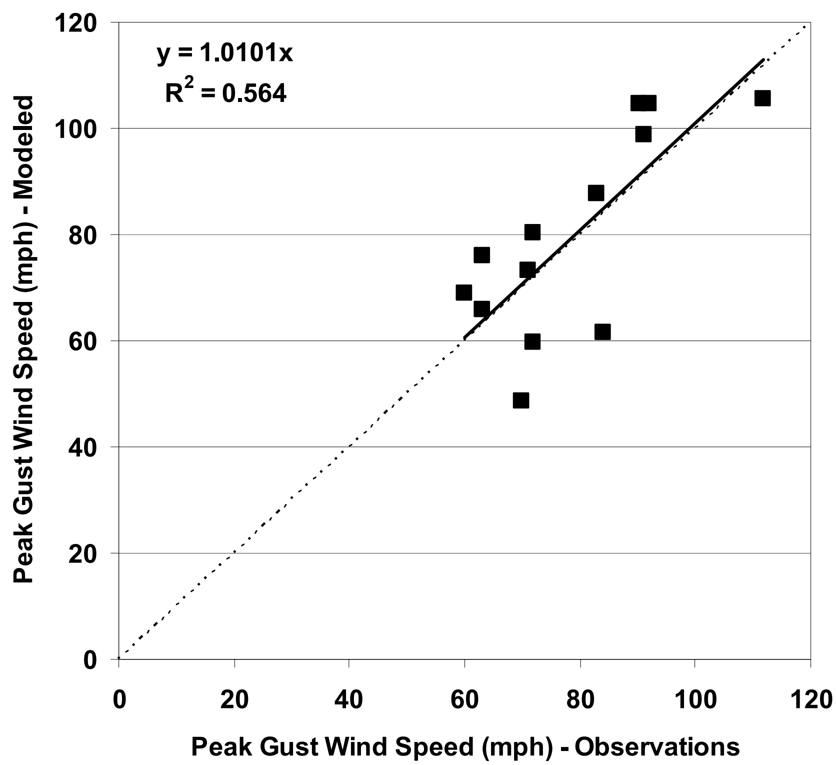

Figure E-3. Comparisons of Modeled and Observed Peak Gust Wind Speeds for Hurricane Frances.