



A Resource of the State of Florida

**HURRICANE LOSS REDUCTION
FOR
HOUSING IN FLORIDA**

**A Research Project Funded by
The State of Florida Department of Community Affairs
Through Contract 02-RC-11-13-00-05-001**

QUARTERLY REPORT No. 3
For Quarter Ended March 31, 2002

DELIVERABLE # 5
DUE BY APRIL 15, 2002

PREPARED BY
THE INTERNATIONAL HURRICANE CENTER
FLORIDA INTERNATIONAL UNIVERSITY

HURRICANE LOSS REDUCTION FOR HOUSING IN FLORIDA
A RESEARCH PROJECT UNDERTAKEN BY
THE INTERNATIONAL HURRICANE CENTER
At Florida International University

QUARTERLY REPORT FOR THE PERIOD ENDED MARCH 31, 2002

SUMMARY

This report summarizes the activities of the International Hurricane Center (IHC), at Florida International University (FIU), and its research team related to the project designated as *Hurricane Loss Reduction for Housing in Florida* (hereinafter Project) being funded by the Florida Department of Community Affairs (DCA) under contract # 02-RC-11-13-00-05-001 executed on August 6, 2001.

This quarterly report summarizes activities of the IHC research team from January 1, 2002 through March 31, 2002. This quarterly report is submitted in compliance with Deliverable #5 of above referenced contract.

Ricardo A. Alvarez, Deputy Director at the IHC, is Principal Investigator (PI) and Project Director. Nicole Dash, Research Associate at the IHC, is responsible for project coordination.

This report summarizes the status of the three specific areas of research required under above indicated contract, these are:

1. Eliminating State and Local Barriers to Upgrading Existing Mobile Homes and Communities.
2. Programs of Research and Development Relating to Hurricane Loss Reduction Devices and Techniques for Site-Built Residences.
3. Research and Develop a Program for the Recycling of Existing Older Mobile Homes.

Work under these three areas of research is currently on schedule save two exceptions listed below:

1. The first exception, a minor one, relates to the testing of roof assemblies using full-scale test samples under hurricane wind conditions. These tests will be conducted outdoors using airboats to create the necessary hurricane wind field to interact with test samples anchored to a concrete slab. At this time the necessary airboats have been located, but the IHC Project Team has encountered some delays in the process of selecting and securing an appropriate location for conducting these tests where the resulting noise [from the airboat engines] will not cause unacceptable impact on the neighboring community. The site has been identified and a request has been submitted to the Florida International University [FIU] Space Utilization Committee for authorization to use the site these tests. A response to this request to the FIU committee is expected shortly. Due to the short duration of this specific research activity it is expected that the tests will be completed within the timelines of the overall project.
2. The second exception relates to research into the feasibility of a recycling program to replace older existing mobile homes. The proposed work plan included four phases for this research track. Although no specific hard timelines were assigned to the completion of these four phases the concept was that they would be implemented in sequence, initiating a new phase once the previous one had been completed. Significant research has been completed for Phase I and work has started on Phase II – development of a *prototype* program. However both these phases have proven far more complex and involved than initially anticipated and have required a much larger investment of time and resources. As a result, Phase III which proposed implementing *pilot projects* to test the sensibility and feasibility of various program alternatives has not been started pending completion of the prior phase. However, important information and knowledge has been acquired that will contribute to Phase IV – development of *policy alternatives*. The conclusion here is that the initially proposed work plan was too optimistic and did not foresee the complexity of issues that were to emerge from the research effort. In summary, Phases I and II will be completed within the timelines of the present project, Phase III will be developed in theory, but the actual pilot projects involving the *recycling* of actual units will have to be postponed until the 2002/2003 project year. The IHC project team should be able to develop Phase IV to the point where it provides a sound conceptual menu of policy alternatives that DCA may consider for possible legislative analysis.

Major activities during the period covered by this report include:

1. Quarterly Report No. 2 covering activities of the IHC Project Team from October 1, 2001 through December 31, 2002 was delivered as scheduled to DCA, as deliverable No. 4, on January 15, 2002.
2. A working meeting of the IHC Project Team including the PI and project director and all principal researchers was held at FIU on Wednesday, April 10, 2002. The status of work timelines under the three required research areas was reviewed during the meeting. During this meeting the IHC Project Team also reviewed preliminary findings from current work and began to identify areas where additional work may be necessary in the future.
3. Each municipality in Miami-Dade and Broward counties was contacted either by telephone or personal visit, or by both methods, with the purpose of: (a) defining if the specific municipality allows or not the installation of mobile homes within its boundaries, (b) if mobile home installation is allowed both in parks and on private lots or only in parks, (c) what is the legal basis for not allowing mobile homes within its boundaries, (d) what are the requirements to be complied with for installation, (e) what information is provided to residents who want to install a mobile home, and (f) how is that information provided to the public. The main objective of this particular research activity is to assess the level of knowledge of both the local public bureaucracy and the public with respect to requirements for mobile home installation, and if such knowledge or lack thereof may result in increased vulnerability to mobile homes.
4. GIS maps of Polk County were developed using census data, maps and state records. All mobile home parks have been located on these maps, which also show the various flood plains and other features that may contribute to the vulnerability of mobile homes. The IHC Project Team is also in the process of analyzing zoning codes from Polk County. An important objective of this research is to assess if mobile homes have an equal or higher propensity, than site-built homes, of being located in vulnerable locations within a municipality or county.
5. Building upon research initiated during 2000/2001 in Miami-Dade and Broward County the IHC team is documenting instances of site-built additions to mobile homes in order to: (a) ascertain if these have been built in conformance with existing regulations, and (b) assess if these contribute to the increased vulnerability of mobile homes in case of hurricane impact.

6. An initial battery of test has been completed on roof sheathing panels using a total of 44 test samples of several types of fasteners. These tests will provide important data on the *pullout capacity* [this is the capacity to resist withdrawal from the structural member when subjected to dynamic loads such as those created by hurricane winds] of specific type of fasteners. In addition these tests will provide statistical data to determine the uplift capacity of roofing panels against uplift loads caused by hurricane winds. A specially designed testing apparatus has been constructed to carry out these and future tests at FIU. An important objective of this specific research area is to identify more effective combinations of roofing materials and design criteria that may lead to improved construction methodology, and to a reduction in the potential for damage to roofing and to site-built homes from the impact of hurricane winds.
7. The design of test specimens for evaluating roof-to-wall connections has been completed and is currently undergoing evaluation for compliance with specific provisions of the Florida Building Code. Actual testing will commence toward the end of April focusing on wood frame construction. The testing schedule calls for 30 to 40 wood frame walls to be tested using two different types of hurricane straps. A combined load test apparatus, specifically designed and constructed, will be used for this battery of tests. The IHC Project Team expects to conduct similar tests using masonry walls during the year 2002/2003. A key objective of this activity is to learn more about the performance of complete assemblies, by combining roofing structures and walls, than has been possible in the past by testing single components.
8. Work is continuing on the design of test specimens, and the test specimen conditioning area, for the testing of performance of various roof cover materials. These tests will be conducted on a specially designed wind tunnel, currently under construction, that will be capable of subjecting test samples to continuously varying wind speeds ranging from approx. 10 mph to 200 mph. This research will complement the work of the IHC Project Team with roofing panels and various fasteners, and also the testing of roof structure to wall connections. The combination of these three research activities will contribute to improving our understanding of the performance of a critical component of the building envelope in housing under hurricane conditions. This improved knowledge base will assist the IHC Project Team in identifying future areas of research that may lead to improved housing design criteria and construction techniques with a potential for reducing damages in the event of impact by a hurricane.

9. Design of test specimens and the concrete slab that will serve as a testing platform for the outdoor roofing tests has been completed. A suitable outdoor area for conducting these tests has been identified in the FIU CEAS [Center for Engineering and Advanced Science] campus. Proper justification has been provided with a request for authorization to use this specific space to the FIU Space Utilization Committee. At the request of the committee, issues of environmental contamination, safety and noise were addressed by the IHC Project Team. A source for the airboats that will be used in these tests was located and a reasonable cost has been obtained. As soon as the FIU Committee issues its authorization to precede the concrete slab will be constructed. An important benefit of these tests results from the fact that full scale specimens will be used. This will provide empirical test data that can be transferred directly to practical solutions.
10. The IHC Project Team completed the literature review regarding information on (a) load combinations for roof-to-wall connections, (b) load modeling, and (c) roof cover testing.
11. Work relative to the feasibility of implementing a mobile home recycling program in Florida is continuing to progress on schedule. Several areas of research relative to the regulatory, technical, social and financial issues pertinent to such a proposed program have been tackled by the IHC Project Team. One important initial finding with respect to this research track is the need to speak of a mobile home “replacement” program rather than a “recycling” program. This is true even if there are recyclable materials that could be salvaged from older mobile homes and sold for a profit. Addressing this as a replacement program places the whole issue within the context of its objectives of addressing the issue of the vulnerability of a particular housing stock in Florida. This subtle, but significant change in project designation will also help focus on the legislative alternatives that may be needed to make such a program viable. Another important early finding is the need to find a way to measure the *benefit-cost* of such a program in terms of its potential for effective hurricane loss reduction.
12. The following activities relating to regulatory and technical issues of a mobile home “replacement” program were conducted during the quarter:
 - (a) An inventory of licensed contractors with capability for demolishing mobile homes, either for salvage or for dumping, was developed on a county by

county basis. The inventory groups these contractors by region based on the seven regions in which the state has been divided for emergency management purposes. This inventory is a key step in assessing current and future state-wide capabilities for replacing the older mobile homes [pre 1976] under a state sponsored program.

- (b) A second inventory developed during the quarter identifies the various landfill and solid waste management sites by county and region in the state. This inventory includes information on current/projected capacities and projected life of the various landfills throughout the state.
- (c) A study was initiated to determine the amounts of municipal solid waste and construction/demolition debris processed annually at existing facilities throughout the state. This information was compared to a hypothetical amount of annual solid waste resulting from a mobile home replacement program running for five years. The initial finding from this analysis is that the incremental annual amount of solid waste resulting from such a program will not adversely impact existing capabilities.
- (d) As an extension of the analysis mentioned above a specific study was conducted focusing on Region 4 [West Center], which includes Pinellas, Polk, Hillsborough and other counties] as this area has been identified as the location for the vast majority of mobile homes.
- (e) Conducted an analysis of content by type of material used in the manufacturing of these older mobile homes quantifying these by recyclable and non-recyclable. This analysis resulted in asbestos and lead paint being identified as part of the mix in some cases. This analysis was then extended to a study of the abatement procedures that would be needed for the removal of such hazardous materials prior to the demolition of the unit. This included not only the regulatory issues and pertinent permits, but also the abatement procedure itself and estimated costs including permitting.
- (f) Created an inventory of companies throughout the state specializing in the removal and transportation of mobile homes. This inventory provided a foundation to begin analyzing the cost elements involved in these operations.

13. Other research activities during the quarter focused on important social issues related to such proposed mobile home replacement program, and on how these help frame some of the financial issues that are critical to such a program. These included the following:

- (a) Data were collected via telephone interview focusing on the willingness or desire of people to move from pre-1976 mobile homes into what would be considered “safer” housing – either a post-1994 mobile home unit or site-built housing. This survey included individuals residing in mobile home parks as well as those living in mobile homes, but on their own private lots. This data provides an important foundation when analyzing the feasibility of a mobile home replacement program.
- (b) The survey was also used to collect data to assess the interest of pre-1976 mobile home residents in acquiring a “more wind-resistant” unit. This information also provides an important knowledge base when analyzing the feasibility of proposed mobile home replacement programs.
- (c) Data were also collected to assess the degree of interest among pre-1976 mobile home residents in participating in a mobile home replacement program. Although this specific question was asked in the abstract without providing any additional information on how such a replacement program might work, the IHC Project Team believes it offers an important benchmark when trying to measure potential interest on an eventually proposed mobile home replacement program.
- (d) Another important data collection effort undertaken by the IHC Project Team focused on the percentage of mobile home owners who have mortgages. This data is relevant to the financial issues that must be addressed when designing a proposed mobile home replacement program. The importance of this data stems from the fact that any proposed program involves costs that must be paid and critical questions associated with this, such as: *who pays? How much?*
- (e) Based on initial analysis of the social issues as well as the technical and regulatory issues identified before, work was initiated on defining the components of a mobile home replacement program with the objective of arriving at prototype designs that could become alternatives for eventual adoption by the state. This effort, initiated during this quarter and currently

continuing, is addressing the objectives of Phase II as proposed in the work plan.

- (f) During the quarter work was also initiated with the objective of identifying critical issues that would need to be resolved administratively or via legislation by the state, related to this type of program.

ORGANIZATIONAL/ADMINISTRATIVE ACTIVITIES

During this quarter, the research team was augmented by the incorporation of additional researchers and research assistants. The IHC Project Team active during the quarter subject of this report includes the following 32 individuals from 3 institutions:

Principal Investigator:	Ricardo Alvarez	FIU/IHC
Project Manager:	Nicole Dash	FIU/IHC

Principal Researchers:

Marshall Allen	FIU	HCET
Amaury Caballero	FIU	Construction Management
M. Ali Ebadian	FIU	HCET
George Epolito	USF	Architecture
Trent Green	USF	Architecture
Martha Gutierrez	FIU	High Performance Database Center
Jose Mitrani	FIU	Construction Management
Timothy Reinhold	Clemson	Civil Engineering
Stephen Schreiber	USF	Architecture
Gary Thye-shue	FIU	High Performance Database Center
Cindy Zhang	FIU	HCET

Research Assistants:

Luis Arencibia	FIU	Construction Management
Elpidio Dominguez	FIU	Construction Management
Jorge Remedios	FIU	Construction Management

Graduate Students:

Deepu Bhattacharjee	USF	Architecture
Mike Dailey	USF	Architecture
Kurt Dyer	FIU	Construction Management
Janaina Monteiro	FIU	Construction Management
Mary Phillips	Clemson	Civil Engineering Graduate
Scott Robinett	Clemson	Civil Engineering Graduate
Swapnali Salunkhe	USF	Architecture
Roger Williams	FIU	Environmental Engineering

Undergraduate Students:

Brian Dick	Clemson	Civil Engineering
Cos Gardner	Clemson	Civil Engineering
Jon Lamb	Clemson	Civil Engineering

Support Staff:

Kyle Campbell	USF	Director of Florida Center
Maria Cano	FIU	IHC
Scott Caput	FIU	IHC
Regnier Jurado	FIU	IHC
Jennifer Sanford	USF	Program assistant

PRELIMINARY FINDINGS BY RESEARCH TOPIC

Eliminating State and Local Barriers to Upgrading Existing Mobile Homes and Communities

The focus of this research track has been on regulatory, administrative or public information factors that may contribute to the vulnerability of existing units, either because these eliminate or significantly reduce any alternatives for upgrading existing mobile homes by way of replacement or retrofitting, or because these do not provide adequate information to the public thus limiting their ability for making informed decisions. This effort is also looking into issues of land use and zoning to see if any bias exists that may result in mobile home parks being located in vulnerable areas with higher frequency than conventional [site-built] developments.

Initial findings include the following:

- (a) In Miami-Dade county 17 of 31 municipalities do not allow mobile homes at all within their boundaries. Of the 14 municipalities that permit mobile homes 50% allow them only in mobile home parks, while the other 50% allows them both in parks and in private lots. This information is important because (i) it illustrates the limited or non-existing options available for the development of new parks where units would be of post-1994 manufactures, thus more resistant to extreme wind conditions, (ii) it also points to the lack of incentives for park or unit owners to upgrade to the newer stronger units.
- (b) In Broward County, although the data collection has not been completed yet, the situation is that 18 municipalities allow the installation of mobile homes, but only in parks [not in private lots]. Only 1 municipality has been identified so far that does not allow mobile homes within its boundaries. Due to the fact that Broward County is totally built-up, there is little or no land available for additional housing developments, it offers little or no options for the development of new parks.
- (c) One common finding in Miami-Dade and Broward the low level of quality, or even lack of, information available to the public who might be interested in installing or retrofitting mobile homes. A survey of municipal and county building and zoning departments, conducted both by way of personal visits and by telephone, shows that in a majority of cases the information is not readily available from one source and may, in some cases, even be incomplete. Members of the IHC Project Team who conducted this survey often had to communicate with several individuals within one department to obtain what often was only partial information. The picture that is emerging is one that indicates there is a critical need for educational programs that target both public employees and the general public focusing on issues of installation and retrofitting of mobile homes.

Programs of Research and Development Relating to Hurricane Loss reduction Devices and Techniques for Site-built Residences

Actual physical testing of housing components, assemblies or subsystems, under simulated hurricane conditions can be a cost-effective way of identifying alternatives for building design and construction that can contribute to effective hurricane loss reduction in housing.

Simple test conducted by the IHC Project Team using prescribed nailing schedules for roof sheathing, but different types of nails have already resulted in important findings as described below:

- (a) Tests of Roof Panel Uplift using 5/8" x 4' x 8' sheathing panels and the same prescribed nailing scheduled have shown the following results: (i) usage of 8D Common Bright nails resulted in panel failure [*the point where the panel begins to separate from the supporting structural member*] at a mean pressure of 127 psf [pounds per square foot] and nail pullout at a mean force of 175 lbs; (ii) the same test using 8D Galvanized nails resulted respectively in panel failure at 116 psf and nail pullout at 225 lbs, (iii) the same test using 8D Ring Shank nails resulted in panel failure at 231 psf and nail pullout at 373 lbs. These findings provide a strong foundation for analyzing the benefit-cost of utilizing one type of nail versus another, with benefits being measured as the reduction in potential damage from hurricane winds.
- (b) The same type of test can be repeated using alternate nailing schedules that go beyond what codes require, with results subsequently used to determine the cost-effectiveness of various alternatives.
- (c) One critical finding from this work is its value in arriving at empirical information that may result in improved design criteria as well as improved construction methodology that also provide sound cost-effectiveness data. These type of results go to the core issue of *credible data* on hurricane loss reduction that is required by the "Bill Williams Act" under which this work is being funded.
- (d) Another important finding is that more of this type of work is needed to create an empirical knowledge base that has application throughout vulnerable communities in Florida, and even other states. Continuation of this work would benefit greatly from tests involving existing [already built] homes that could provide performance data via the use of appropriate instrumentation. The IHC Project Team would recommend that this type of research be made part of future efforts under the Hurricane Loss Reduction project.

Research and Develop a Program for the Recycling of Existing Older Mobile Homes

- (a) An initial important finding from this research track is the need to identify this as a "mobile home replacement" program with the objective of substituting the pre-

1976 units with either post-1994 units or various alternate site-built housing options. This needs to be viewed as a housing issue rather than just a mobile home issue.

- (b) A second, an equally important, finding goes to the complexity of the issue where regulatory, technical, social and financial issues, including benefit-cost issues, interact in such a way that proposed solutions must deal with each and all of them in order to be feasible.
- (c) Another finding combines the demographics of mobile home park residents with the percentage that currently have mortgages on their units. A total of 93.1% of those residing in pre-1976 units DO NOT have a mortgage having paid off the unit long time ago. The mean age of this group is 69 years. This combination of elderly individuals and the absence of a mortgage illustrate a critical difficulty that will need to be addressed when exploring how a proposed mobile home replacement program might be financed. Intuitive answers at this time suggest that these individuals will not want to incur in any new debt in order to move to less vulnerable housing.
- (d) The same type of data gathering applied to individual who own pre-1976 mobile homes installed in private lots show that the median age of these is 51 years and 80.6% do not have a mortgage. This suggests a different type of population and a combination of other reasons for owning the unit. A valid question for this group would be *would you incur a mortgage in order to move to less vulnerable housing?*
- (e) Another critical finding is on the annual household income of these two groups. In the group living in mobile home parks, in pre-1976 UNITS, 53% had an annual income of \$20,000 or less. In the group residing in private lots 28% had annual incomes of \$20,000 or less. These findings also go to the critical issue of just how such a proposed replacement program might be financed and by whom? From these findings that relate to the financial aspects of this program, it appears there is a crucial need for working with all parties that may benefit in one way or another from the implementation of such a program. Work with these various parties should focus on what each one is willing to contribute to facilitate the massive replacement of these vulnerable units. Interested parties include federal, State and local authorities responsible for housing issues, housing manufacturers and builders, insurers, mobile home park owners, mobile home residents, mortgage companies and others.

- (f) On the technical aspects of an eventual mobile home replacement program an important finding from work this quarter is that there appears to be plenty of installed capacity in the state, to tackle the incremental volume that would result from such a program. Also, the IHC Project Team finds that the cost of demolition of these units may actually come down once contractors increase capacity in response to increased demand and new contractors begin to enter the market.

- (g) A final key finding emerging this quarter goes to the need to assess the interest and capability of the various parties with regard to the various methods that may be used to finance the program. Due to the complexity of the interaction between all of these parties additional work will be required to create a matrix for the assessment of such complex interactivity in order to begin to identify possible solutions that would be acceptable to the majority of the parties involved. The IHC Project Team would recommend such additional work be undertaken in 2002/2003.