HURRICANE LOSS REDUCTION FOR HOUSING IN FLORIDA

A Research Project of the
International Hurricane Research Center
at Florida International University

Funded by the Florida Department of Community Affairs
Under Contract 04-RC-11-13-00-05-001

FINAL REPORT

For the period July 1, 2003 to June 30, 2004

VOLUME 1

REPORTING REQUIREMENT NO. 6
Due July 30, 2004

PREPARED BY
THE INTERNATIONAL HURRICANE RESEARCH CENTER
FLORIDA INTERNATIONAL UNIVERSITY
Miami, FL 33199

July 30, 2004

Mr. Charles McCool
Department of Community Affairs
2555 Shumard Oak Boulevard
Tallahassee, FL 32399-2100

RE: Residential Construction Mitigation Program (RCMP)
Contract # 04-RC-11-13-00-05-001

Dear Mr. McCool:

I am pleased to herewith enclose the Final Report on research conducted by the International Hurricane Research Center (IHRC), at Florida International University (FIU), for the Residential Construction Mitigation Program (RCMP) under the contract of the reference. As required, this report is being submitted to you as one printed (paper) and one digital original.

This Final Report covering research activities carried-out during the period from July 1, 2003 to June 30, 2004, consists of three volumes complemented by relevant information, data and photographs on our ad hoc web site (ttp:// *mitigation.fiu.edu*). Submission of this Final Report fulfills our contractual obligations for the period indicated.

As in previous years our research team included a wealth of expertise in a range of scientific fields, involving colleagues from six universities in Florida, Texas and South Carolina and more than a dozen graduate students providing support as research assistants. On their behalf, as Principal Investigator for this project, I am pleased to report that we all worked with enthusiasm and dedication to meet the objectives of a program that can benefit so many in our vulnerable communities. I would like to express our gratitude to you and others at DCA for your support and guidance.

Our work this year continued building on a strong foundation from previous years while tackling new challenges and research topics. In line with this approach, it was rewarding to learn that in October 2003 the State Building Code Commission had approved a modification to the Florida Building Code based on two years of prior research conducted here at FIU. I believe the modification to the building code, involving something as small as a ring shank nail epitomizes the true value of the RCMP.

Please call me should you have any comments or questions about the Final Report.

Sincerely

Ricardo A. Alvarez
Principal Investigator & Project Director

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FOREWORD

In addition to fulfilling a contractual obligation with DCA, the writing of this Final Report also presents us with an opportunity for taking stock, for assessing what the Residential Construction Mitigation Program (RCMP) is all about and whether or not this program is meeting its main objectives. From our vantage point, the RCMP represents the following:

1. A farsighted program of our State government that has fostered the development of an “official” state research agenda focusing of the critical field of hurricane loss mitigation.

2. The opportunity for enhancing or developing in-state capabilities for conducting far-reaching, even cutting-edge, applied research for the benefit of Florida residents.

3. The realization that while the RCMP is funded on yearly cycles, often research efforts must continue from one year to the next and beyond before significant and practical findings are achieved.

4. Support for research, educational and outreach efforts, and also for the entrepreneurial spirit, that will allow us to push the envelope in search of new and innovative hurricane loss reduction devices and techniques.

5. Offering enough leeway to researchers with the understanding that while research may help us find the answer to a specific problem, at times it may only give us enough knowledge to know the right questions to ask in order to continue looking for a solution to the larger issue.

6. Recognizing that research findings must be converted into usable and practical knowledge for transferal to practitioners and stakeholders by way of efforts of education and outreach.

7. The fostering of collaborative efforts among institutions and agencies across the state in pursuit of common objectives.

8. The development of a program that could benefit millions in Florida, but also people in other states or countries that share a common vulnerability to the impact of hurricanes.

9. The implementation of a novel approach to mitigation that could become a model for a national program regardless of the type of hazard that may be prevalent in any given region of the country.

Under this environment created by the RCMP the IHRC research team reached significant milestones during the 2003-2004 research period including:

1) *The announcement by the State Building Code Commission in October 2003 that it had adopted a proposed modification to the Florida Building Code that had been submitted in April of 2003 on the basis of two years of research conducted here at FIU.* The modification makes the 8d ring-shank nail the new standard for attaching roof sheathing to its supporting structure in the High Velocity Hurricane Zone effective January 1, 2005. Research conducted by the IHRC team has shown that the ring-shank nail can improve the performance of roof sheathing under the impact of hurricanes by a factor of 130%. This result of RCMP sponsored research has the potential for protecting the lives and property of more than one million Floridians over the next ten years.

2) *The design and construction of a Wall-of-Wind (WOW) apparatus, a first of its kind at an academic research laboratory in Florida.* The WOW apparatus will allow FIU to continue its research into the development of a new impact test protocol involving roofing tiles as a major component of flying debris during hurricanes. The WOW equipment will also allow the continuation of work started in 2003-2004 regarding the role of “impact modifiers” based on design modifications, including such low-cost and seemingly unimportant building components as the drip-edge flashing.

3) Complementing research efforts with a range of educational and outreach activities, as a way of disseminating critical knowledge to promote the benefits of hurricane loss mitigation among residents of vulnerable communities throughout the state.

4) Participation of our research team in surveys and other research initiatives to continue assessing not only the human impact of hurricanes, but also

the effectiveness of various components of the RCMP in delivering or promoting hurricane loss mitigation in Florida. These surveys and focus groups constitute a critically important element of the RCMP.

In summary it is very important that we emphasize the need to continuously remind all contributors to the RCMP effort that this program must meet the critical test of answering the following questions:

- *Will this initiative result in hurricane loss mitigation?*
- *How will this research (or initiative) result in hurricane-loss mitigation?*
- *What is the cost-effectiveness of this proposed hurricane loss mitigation measure or initiative?*

By subjecting the research agenda proposed each year to these questions, DCA should be able to maximize the effectiveness of the RCMP by only including research proposals that meet these criteria for hurricane loss reduction, and by investing its resources on those areas of research or in educational and outreach activities that clearly and effectively contribute to hurricane loss mitigation.

We would like to close this foreword by recommending that DCA organize an annual one-day working meeting where all contributors to the RCMP come together to share their findings and recommendations. This will be an opportunity to assess the contributions made to meet the objectives of the RCMP during that specific research period. This working meeting will not only foster more collaboration among many of the players, but it will also provide healthy doses of peer review and constructive criticism as well as an opportunity for State congressional staffers and even legislators to also participate and become more familiar with the RCMP.

The IHRC Team

July 30, 2004

EXECUTIVE SUMMARY
FINDINGS AND RECOMMENDATIONS

This section highlights the main findings from work during the 2003-2004 period. The second part of this section provides additional and complementary information on the work conducted by the IHRC team on each of the research tracks included in the scope of work.

The main purpose of this section is to provide the reader with brief and clear information about the results of this work funded under the RCMP. If the reader wants detailed information regarding a particular research track or a specific finding, Volumes 2 and 3 provide an extended narrative describing the work completed under each of the research tracks.

RESEARCH TRACK 1: ELIMINATING STATE AND LOCAL BARRIERS TO UPGRADING EXISTING MOBILE HOMES AND COMMUNITIES

The Role of Rehabilitation in the Upgrading of Mobile Homes and Communities

The IHRC team, under the lead of USF researchers, explored the role of rehabilitation ("rehabbing") of mobile homes in upgrading of mobile home parks and to the strengthening of individual units. A turning point for manufactured housing was the new federal Manufactured Home Construction and Safety Standards enforced by the Department of Housing and Urban Development, which became effective in 1976. By some estimates, there are about a quarter million pre-HUD homes in use in Florida. It is mobile homes of this earlier vintage which were the focus of this project.

Researchers conducted an exhaustive literature search for private and public organizations that are involved in the renovation of mobile homes. Team members interviewed administrators of noteworthy programs in person, by phone and/or email. Researchers also visited some mobile home renovation projects**.**

Among the Key Findings and Recommendations:

- Some of the innovative programs, including those involving prisoners and vocational classes, have been shut down because the programs were not sustainable.
- The primary obstacles to renovation programs seem to be overarching prejudices against mobile homes in many communities and difficulties of committing public/private resources to a housing type that is often considered personal property (not real property).
- Communities in some states seem to have well developed approaches to encourage renovation of individual mobile homes and mobile home parks.
- Very few private sector companies are involved in extensive mobile home renovation or remanufacturing projects.

Case Studies: Closing of an Urban Mobile Home Park

IHRC investigators conducted a detailed case study of an urban mobile home park in the Miami-Dade area, during the few months immediately after the residents were given notice that the park was closing. The objective in this project was to interview mobile home park residents as well as other key stakeholders from the surrounding community and from participating organizations. As originally conceived, the research are focused on being present at selected committees' meetings and meetings that involved representative of the Mobile Home Park Councils, park owners, prospective new owners/ developers, and representatives of the mobile home park residents.

The goal was to gauge their knowledge about relevant statutes, programs and resources, to learn their attitudes about the park closing and relocation processes, and the relocation plans of the residents. An additional aim was to compare this specific park closing with newspaper accounts of recent local mobile home park closings to provide a county-level context. Another goal was to obtain a statewide context (e.g., to explore the implications of this closing for other Florida urban mobile home parks and residents, using data and the work of other groups). The intent was to learn as much as possible that might inform and improve local governments' and State of Florida relocation and alternative affordable housing policies and programs.

In addition the IHRC team developed case studies of mobile home parks that are closing in Tampa Bay. Objectives included: (a) development of a chronology of

events related to these external factors acting upon the park, (b) description of the current status of this process, (c) analysis of the actions taken by the various parties involved in this process. Two parks were studied in detail. Researchers interviewed former residents of both parks, consulted with public officials who were involving in both closings, and interviewed other interested parties. For those residents who confirmed that they had lived at one of the mobile home parks, the team asked permission to conduct short interviews, regarding current living arrangements, financial and emotional status. Team members also reviewed the numerous news articles about each park and interviewed reporters who wrote articles.

Among the Key Findings:

- Notice to the residents of impending park closing did not occur when it was anticipated by the Village Council and, by extension, the project investigators.
- Reasons for the delay in notice to the residents followed an apparently common pattern of continuations, evasions, and delaying tactics employed by park operators and developers, according to reviewed code enforcement documents.
- A year-long effort by a large local governmental task force yielded a wealth of relevant findings and recommendations that are incorporated into this report.
- Analysis of mobile home occupancy data from the U.S. Census, mobile home park data from the Florida Department of Health, and estimates of mobile home vulnerability (by generation of manufacture) by exposure (Florida counties with Gulf and Atlantic shorelines) provides useful county-level context and scoping.
- Interpretation of larger, seemingly ineluctable urban economic and demographic growth patterns, suggest that urban mobile home parks will continue to be characterized by aging stock, not being replaced with newer safer units.
- Increasing value of land occupied by urban mobile home parks, costs of upgrading their infrastructure, local governments' need for increased tax revenues, and nearby businesses' and residents' desire to have the parks converted to other uses make the continuation of park closures very likely.
- Park closures is indisputably being re-framed as a public policy issue (i.e. the need for a compassionate and socially equitable affordable housing policy for the benefit of elderly retirees on limited fixed incomes and low-income working families who cannot afford to move their mobile homes away from

neighborhoods where they have jobs and social supports and cannot find affordable fixed-site housing either for rent or purchase).
- There are wide discrepancies in compensation packages for displaced residents.
- Tampa is in the very early stages of supporting a private effort to develop new manufactured housing, as affordable housing.

Key recommendations include:

- Consider commissioning IHRC researchers to conduct the resident interviews in the coming fiscal year when it is almost certain that residents will be given notice of the Little Farm Trailer Park closure.
- Conduct follow-up studies (five years after the Task Force Report) to document which recommendations have been implemented.
- Use the 20 generalizable recommendations from the Miami-Dade mobile home park task force report as the basis for providing county-level guidance to local governments throughout Florida.
- Create and maintain a web-accessible master database of mobile home park property information (zoning, tax, resident demographics, enforcement actions), accessible by all enforcement and housing assistance agencies.
- Implement the recommendations of the Affordable Housing Study Commission, particularly those which attempt to assist mobile home park residents to transition from older generation units in parks with health and safety hazards to affordable and hurricane-resistant site-built housing.

RESEARCH TRACK 2: RESEARCH AND DEVELOP A PROGRAM FOR THE RECYCLING OF EXISTING OLDER MOBILE HOMES

Regulatory and Financial Issues

Florida has a large stock of mobile homes, which are very vulnerable to hurricane damage. The Florida Department of Motor Vehicles (DMV), which registers mobile home titles, has recorded approximately 1.14 million mobile home units in Florida. It is estimated that over 338,000 of those units were built before 1976 (Generation 1) and more than 648,000 between mid-1976 and mid-1994 (Generation 2). Combined, this sector accounts for 12.8% of the total housing stock and 85.5% of the total mobile home units. The years 1976 and 1994 are important in mobile home construction due to the establishment of national HUD standards for the manufacturing of mobile homes and the implementation of higher standards during the respective years.

Mobile homes built before 1976 and between 1976-1994 are more vulnerable to hurricanes. Various research activities have been performed by the IHRC to examine damage loss reduction to these mobile homes. Past research focused on different approaches to develop a replacement program for Generation 1 and 2 mobile homes with less vulnerable housing. The primary objective for this year's research was to identify various available financial resource options for the replacement of old mobile homes and/or construction of new mobile homes and to assess the feasibility of those options.

Among the Key Findings and Recommendations:

- The total estimated cost of recycling all pre-1976 mobile homes currently in use in Florida would amount to $1.71 billion 2003 dollars. The theoretical cost estimate from the 2001-2002 period was $1.34 billion. If such a program were undertaken over a period of ten years, the annual cost would be $171 million in current dollars.
- Given the estimated cost of a replacement program for pre-1976 mobile homes in Florida, it is critical to carry out a benefit-cost analysis of such a program to determine its cost-effectiveness. No responsible decision could be made by policy-makers and public officials without first knowing the benefit-cost ratio of such a program.
- From the initial research, it is clear that many alternatives for financing mobile homes exist, including a number of lending institutions that provide

conventional and government-insured financing plans for prospective owners. The most common method of financing a manufactured home is through a retail installment contract, available through a retailer. Some lending institutions that offer conventional, long-term real estate mortgages may require the homes to be placed on approved foundations. Manufactured homes are eligible for government-insured loans offered by:

- HUD-Federal Housing Administration (FHA)
- Veterans Administration (VA)
- Rural Housing Services (RHS) under the U.S. Department of Agriculture (USDA)

Survey of Pre-1976 Mobile Home Owners in Florida

In the first year of the FIU project, the research team did a telephone survey of mobile home owners; which included 200 randomly selected households using random digit telephone dialing. While this effort offered information and insight into how people perceived their risk and other information, the methodology itself also had significant limitations. The major limitation was that it did not focus on the owners of mobile homes, but rather, those that lived in them.

A small follow-up survey during Year 2 attempted to illicit more information from those who lived in first generation mobile homes regarding their willingness to participate in a replacement program. Respondents were asked their willingness to participate in a variety of potential programs. Surprisingly, overall, it appeared that most were not interested. Further follow-up during the survey showed that the most common motivation for moving out of one's mobile home was "death." Considering the State of Florida remains exposed to significant hurricane losses with the pre-1976 mobile home stock, we found ourselves at a crossroads trying to find a way to reduce the vulnerability of a significant population of Florida residents.

To help assess options, a mail survey based on a random sample of pre-1976 Florida Mobile Home Registration was undertaken. The purpose of this survey was to find out what owners think of mitigation for their units, particularly those owners who rent their units out. Also this survey allowed us to get a better idea of where mobile homes are located. The DMV database does not ask where the unit is located; it merely has a registration address. The goal was to obtain a better idea of the relationship between registration, zip code, and actual location zip code.

The mail survey was started in February 2004. The sample was selected, and the survey was developed. The first mailing in late March 2004 to 3,404 mobile home owners was followed-up with a second mailing in early April 2004. As of the writing of this report, 509 surveys were completed. Unfortunately, 1,333 surveys were returned with bad addresses. Considering bad addresses, the survey resulted in an approximate response rate of 25%. While this response rate appears low, considering the population and the little we know, the response rate appears acceptable.

Among the Key Findings and Recommendations:

- About 40% of respondents reported that their mobile home is in a zip code that is different from the mailing address in the DMV database. Considering the DMV data include addresses from all over the United States, this suggests that a consider portion of the people in the sample do not use their mobile homes as permanent residence.
- About 40% of owners report little if any concern about hurricanes.
- About 23% of owners believe their mobile home is as safe or safer than a site built home, while 13% believe they would have little or no damage to their mobile home as the result of a hurricane.
- It appears that education may be the best mitigation. Surprisingly, a considerable percentage of respondents do not recognize the hurricane threat or the increased vulnerability of their mobile home (as compared to a traditional site-built home).
- While the majority report having insurance to cover damage to their mobile homes, written comments on returned surveys suggest that the cost of insurance has skyrocketed during the last year. One respondent reported that insurance costs have doubled during the last year. Future research should explore the changing landscape for mobile home insurance. Despite research that was done during the first year of the RCMP project, additional research should be conducted to better understand the insurance market for mobile home owners. Are the anecdotal stories about skyrocketing insurance costs supported by empirical evidence? Considering the limited insurance market for mobile home owners, what potential impact could a major hurricane have on the mobile home insurance market?
- While the majority of respondents indicate that they do not believe anything can be done to strengthen their mobile home, over 60% of owners are interested in the development of such a product. However, survey results indicate that such a product would have to be “affordable” – less then $1,000.

- Only about 30% of respondents are very interested in a program to replace their current mobile home in exchange for a credit for a newer mobile home. Even fewer report interest in a program for a down payment for a site built home.
- On a positive note, about 70% of respondents support the State of Florida developing a program to remove deteriorated and abandoned mobile homes. However, this is probably seen more as an aesthetic issue than a mitigation issue.

RESEARCH TRACK 3: HURRICANE LOSS REDUCTION DEVICES AND TECHNIQUES

The Effects of Residential Neighborhood Configurations on Hurricane Winds.

Architectural design features play an important a role in modifying the impact of hurricanes on housing. Other elements such as neighborhood layout and landscaping also play a role in modifying the impact of hurricanes on a site- or neighborhood. Modifications may be positive or negative, meaning that in some cases the specific feature may contribute to increased damage, while in other cases the design or external feature may reduce the potential for damage from hurricane impact.

Understanding the role of design components would be useful for architects, city planners, developers and home builders as well as public officials responsible for building, design and construction or comprehensive planning. Researchers at the IHRC from the building design and construction professions intuitively believe the shape of houses, and especially the shape of the roofs of houses, may act as *impact* or *performance modifiers* when the house is subjected to hurricane winds.

To address this issue and related questions the IHRC undertook tests using reduced-scale models in a Boundary Layer Wind Tunnel (BLWT) located at Clemson University. A total of three 1:50 scale models built by students at FIU School of Architecture were tested in three different types of neighborhoods typically found throughout Florida. The house model included a variety of house shapes and several architectural features including the base-model, breezeway model, and zero-lot line model. The three types of neighborhood settings included the zero-lot line, Coral Gables, and Cul-de Sac.

Among the Key Findings and Recommendations:

- For all three houses tested, the zero-lot-line neighborhood context significantly lowered uplift roof pressures. The zero-lot-line house prevented the wind from creating high suction pressures at its edge.
- The Coral Gables neighborhood also helped reduce extreme uplift pressures. The one-story house and the breezeway house were both a scale that fit into this context. As a result, they seemed to be protected. The surrounding houses produced an irregular context, which broke up the wind flow. The

larger zero-lot-line house did not benefit from this lower context. Only when trees were introduced did the uplift pressures for this house go down.

- Context played a significant role in reducing uplift pressures. The houses tested were protected from high uplift pressures while situated in densely built-up areas and/or dense vegetation. Left in the open, these houses were exposed to high uplift pressures.
- This type of work, using reduced-scale models in the BLWT, needs to be combined with testing of full-size roof assemblies. The main purpose of this research would be to demonstrate how the extreme pressures at the roof edges could be modified in order to reduce the potential for damage.
- Additional tests should be conducted using models with more complex roof shapes, including larger overhangs and combinations of various shapes.
- Computer animation of the pressure distribution of the house models would be an excellent compliment to the research program.

Role of Vegetation as an Impact Modifier

Various design features can play as important a role as structural design criteria in modifying the impact of hurricanes on housing. Neighborhood layout and landscaping modify the impact of hurricanes on a site- or neighborhood-specific basis. The IHRC team began research regarding the role of vegetation as an impact modifier for individual dwellings within a neighborhood. The team initiated studies of the effectiveness of various tree and shrub species as impact modifiers in Florida.

The team primarily conducted literature searches --books, articles, reports, papers-- regarding the effectiveness of trees and landscaping as impact modifiers. Using the literature as a starting point, matrices were developed of Florida trees that are resistant and vulnerable to high winds. The team also developed a summary of best practices in hurricane-resistant landscaping and a bibliography of the most pertinent materials.

Among the Key Findings and Recommendations:

- There is a lack of research and consensus regarding the greatest and least wind-resistant trees. Red cedar, elms, sweetgum, hickory, mango, pecan, and pines all appear on some authors' "most wind resistant" lists, and others' "least wind resistant".

- Context is important. A cluster of pines may serve as an outstanding windbreak, with superb wind resistant qualities. A pine standing by itself is a victim tree.
- While a fairly large body of research exists on the effects of hurricanes on natural forests and ecosystems such as the patterns of wind damage, recovery, mortality, and even replanting, very few studies have investigated the effects of hurricanes on urban forests.

Performance Modifiers in the Mitigation of Roof Damage

Work under this critical area was highlighted by the approval by the State Building Code Commission in October 2003, of the proposed modification to the Florida Building Code resulting from work conducted by the IHRC team. This modification makes the 8d ring-shank nail the required fastener for roof sheathing within the High Velocity Hurricane Zone. This new required fastener improves the performance of roof sheathing by a factor of up to 130%, considerably reducing the potential for damage to houses from hurricane impact.

The IHRC team worked on the design of a “Wall-of-Wind” [WOW] apparatus, both in reduced scale and in full scale. The design for the full size wall of wind was completed after a comprehensive search for the optimum type of equipment, manufacturer. The WOW equipment have been ordered and will be delivered during the 2004-2005 research period. FIU was granted a no-cost extension to allow for the fabrication of this WOW prototype using funding from the 2003-2004 grant period.

The WOW apparatus will allow the IHRC team to continue researching various roofing components that could be modified to become impact modifiers capable of reducing the potential for damage to the roof during a hurricane.

In parallel with the full size WOW, the IHRC team also designed a reduced-scale WOW using model-airplane engines and propellers. The prototype has been completed and is ready to be used in research during the 2004-2005 grant period. The main use of the reduced-scale WOW will be to continue our studies of the interaction of wind fields with houses and how such interaction may be modified by various design or construction means in order to reduce the potential for damage during hurricanes. Studies with the reduced-scale WOW will allow the IHRC team to design the parameters for tests to be conducted using the full-size WOW.

The IHRC team also initiated work toward the objective of defining a new impact testing protocol for roofing tiles--a common type of flying debris during hurricanes. Specific work completed during 2003-2004 include: (a) development of a mathematical model to define the flight path and other flight characteristics for clay roofing tiles that may become dislodged and converted into flying debris under the impact of extreme winds.

To complement work in this critical area, the IHRC team supported by the FAU Center for Electronic Communication developed a brief animated video showing what happens to a tile roof under the impact of hurricane winds. The video was useful in sharing research findings and knowledge with various professionals, and it was shown at the 2004 Governor's Hurricane Conference and the 10th Annual Broward County South Florida Hurricane Conference.

Research continued on the role of the ring-shank nail in improving the performance of roof sheathing under hurricane-force winds. Specific work focused on the possibility of retrofitting existing roofs that may have been built to lesser standards in the region now known as the High Velocity Hurricane Zone. Initial results show improvements in performance, ranging from 70% to 80% under various retrofitting configurations. Another question involves use of the ring-shank nail in Florida counties that are outside the High Velocity Hurricane Zone where standards for roof sheathing prescribe thinner plywood and less dense nailing schedules. Initial results indicate improvements ranging between 30% and 40% are possible when keeping the currently prescribed nailing schedule, but this improvement could easily double when the nailing schedule goes to 6" o.c. throughout the roof (both on the field and at the edges). However, when the ring-shank nail is used with ½" plywood sheathing, the incidence of "nail-head pull through" failures increases by a factor of 10% to 20% when compared to the 8d common bright nail.

It is obvious that much work remains to be done regarding roof sheathing. DCA should continue funding this specific area of work that holds so much potential for the protection of life, property and housing throughout Florida.

Developing New Protocols for Impact Testing

The main objective of this research topic is to define flight and impact characteristics of roofing tiles converted into flying debris during hurricanes. Empirical information shows that roof covering materials are one of the main components of flying debris during hurricanes. With roofing tiles being so prevalent in South Florida, this type of

research could provide critically important findings that may lead both to improved methods of installation for roofing tiles, and also to a new impact testing protocol. Roofing tiles could be used as flying debris to test the resistance of various building envelope components and other building materials to the impact of such projectiles.

The goal of the IHRC team through this research is to contribute to hurricane loss mitigation in vulnerable communities throughout Florida, but especially in the High Velocity Hurricane Zone. Research was conducted through the use of air cannons and "full-scale" testing mock-ups using an airboat as a wind source. Three digital-video cameras recorded the flight path and flight characteristics of individual clay roofing tiles.

Among the Key Findings and Recommendations:

- Preliminary analysis of data collected from air cannon tests has shown that a barrel-shaped clay tile can go through a sheet of 5/8" plywood when it reaches speeds in excess of 55 mph, or at somewhat lower speeds if the plywood has sustained previous damage from the impact of flying debris.
- IHRC team was able to record the speed of flying tiles as a percentage of the speed of the wind generated by the airboat propeller used as the source of wind. Based on the preliminary analysis of these data, the IHRC team was able to determine that the speed of the flying tile is proportional to the maximum sustained speed of the propelling winds. Preliminary data analysis would appear to indicate the ratio of flying tile speed to the speed of the propelling winds is in the order of 35% to 40% for minimal hurricane winds.
- Research is complemented by the animated video created by the Center for Electronic Communication at FAU that is being attached to this report.

Improvement of Atmospheric Instruments and Data Collection System

The IHRC team continues to focus on the roof as a critical component of the building envelope, both in housing and in larger commercial or institutional buildings. A key objective of our research is to gain a better understanding of how variations in pressure are distributed over the surface of a roof under hurricane conditions. One method is to install instruments on the roof to read the variations in wind pressures as a function of wind speeds. During previous years the IHRC team designed a prototype instrument to acquire the desired data, which can be installed on the flat roof without having to be attached to it and without being invaded by rising water.

The field instrumentation method provides reliable empirical data to assess the vulnerability of a given building, its performance under hazard conditions, and it also identifies structural and building-envelope weaknesses and strengths.
Researchers during the 2003/2004 period were given a task of improving the flat-roof instrumentation system located on the roof of the FIU Engineering Center (EC) building. Researchers performed the following tasks:

- Sensors were re-calibrated and re-installed into the system.
- Sensor dwellings were secured and waterproofed more tightly by making perforations with bolts.
- New barometric sensors and other flat-roof instruments including rain gauge, thermocouple, and an anemometer were installed.
- New sensors were connected to a wireless data acquisition system.
- Data were collected continuously from the sensor network system for future analysis.

Though the objective of this program is to collect the data during extreme wind and hurricane conditions, such conditions have not been encountered during the project period. However, efforts will be made to collect and monitor the data during the coming hurricane season.

Roof to Wall Connections Subjected to Combined Loads

Work related to the performance of roof-to-wall connections continued during 2003-2004 using the dual-load test frame. Research during this period focused on the connection between a roof assembly and masonry walls.

Among the Key Findings and Recommendations:

- Tests of retrofit connections using conventional hurricane strapping attached to the masonry with double helix masonry screws provided capacities in line with the manufacturer's published values.

- Combined uplift and shear tests produced results indicating that the capacities can be combined for these cases using the same type of vector combination found for cast-in-place masonry straps and the hurricane straps for light frame wood structures.

- Application of several cycles of loading up to the design allowable values produced load deflection curves that did not exhibit hysteresis beyond removal of the initial slack in the system. Failures for most anchors occurred in the metal strapping.

- The H-10 style straps which included some screws near the face of the concrete did exhibit some localized failures of the concrete at load levels near the ultimate capacity of the metal strapping.

RCMP Evaluation Project: Focused Survey of the Florida Coastal Monitoring Program

Each year as part of the evaluation of the effectiveness of the Hurricane Loss Reduction Program (RCMP), the IHRC team conducts a focused evaluation survey of a specific RCMP contracted project that is selected by DCA staff. In 2002-2003, an IPOR evaluation survey measured satisfaction with and effectiveness of newly required courses on the Florida Building Code for building professionals. In 2001-2002, the focused survey evaluated the statewide effectiveness of RCMP-funded programs that use public service announcements and training to increase public awareness and willingness of citizens to make their homes and communities safer from hurricanes. Earlier focused IPOR surveys for DCA looked at mobile home vulnerability, mitigation incentives, and windstorm insurance.

For 2003-2004, the contract selected by DCA for focused survey-based evaluation is the Florida Coastal Monitoring Program (FCMP). The FCMP designs and deploys instruments and models to understand how hurricane winds affect homes and other buildings on the ground.

Among the key findings:

1. The DCA-initiated research will potentially have a great benefit in mitigating the dangers of hurricanes and minimizing the costs. The research apparatus can be used to strengthen building codes and help determine cost-effective windstorm insurance coverage.

2. No hurricane has made landfall in Florida since Irene in 1999, before FCMP data collection towers and instrumented houses were deployed. This was good for Florida residents, but meant most necessary data collection could not be completed. As a result data collection needs to continue.

3. FCMP has worked to get additional funding to augment DCA's investment. Now that the FCMP research operation has proven by the Isabel tower deployment to be able to generate significant data for NOAA, more Federal funding should be available.

4. DCA and FCMP have not collaborated on a research development plan to direct and facilitate the overall State funded research effort, but they should do so.

Workshop to Review, Update and Extend Prior Mitigation Incentives Research and Planning Efforts

This project is intended to investigate the "Feasibility of Implementing Programs of Incentives to Include Hurricane Loss Mitigation Devices and Techniques in the Design/Construction of New Houses or in the Retrofit of Existing Houses". It is within the Hurricane Loss Reduction Devices and Techniques research track.

As originally proposed by the IHRC, the Laboratory for Social Science Research agreed to assess the feasibility of developing and implementing a program of incentives for home-buyers who purchase new homes that include one or more hurricane loss mitigation devices or techniques.' In addition, an aim of this research was to look at programs intended to provide incentives to existing homeowners to retrofit their houses with cost-effective hurricane loss mitigation devices or techniques. Further study proposed to look into potential sources and methods of funding such incentive programs. The IHRC team focused on completing the following tasks:

- Conducting electronic and library searches to determine which types of incentive programs are already in place or nearing implementation in Florida.
- Reviewing mitigation incentive work completed earlier by and/or including IHRC.
- Organizing and conducting a workshop on prospective incentives for homebuyers and homeowners.

Among the Key Findings**:**

- The Florida Department of Community Affairs website for mitigation information http://www.floridacommunitydevelopment.org/mitdb/, continues to be the best and most authoritative source of mitigation incentive information for Florida homebuyers, homebuilders, homeowners and related organizations

- Four recommendations from the 1999 Homeowner Incentive Team report have been partially or completely implemented:
    - Discounted or waived building permits, plan check or inspection fees for retrofits in accordance with guidelines
    - Low interest loans for retrofitting
    - Recognition for structures built in accordance with higher standards
    - Insurance premium incentives

- Reanalysis of 1999 and 2003 statewide homeowner surveys revealed:
    - Improvement statewide in 100% covered homes using code compliant materials
    - Significant reductions in homes with no protection in highest risk areas
    - Yet 48% have at best partial protection and 35% have no window protection
    - Significant decrease in those that feel that they do not need window protection
    - Significant increase in reporting of cost as main reason for not having window protection
    - Additional frequent excuses are procrastination and appearance
    - Minority households more likely to say cost is main reason for not having shutters
    - Lower income households were also more likely to report cost as a factor
    - Low interest loans were not of interest to vast majority of surveyed homeowners
    - Low interest loans significantly decreased in popularity as a mitigation incentive
    - Forgivable loans were very attractive to 45% of those in each of the surveys
    - Lower insurance premiums were of interest to 38% and 41%
    - 22% reported getting insurance discounts for mitigation features
    - Approximately 46% had no idea if their insurance company offered discounts

        - Property tax reductions increased in popularity as incentive to mitigate (a modal response of somewhat likely (37%) in 1999 but very likely (44%) in 2003
- Hurricane risk perceptions of Florida's single family homeowners and Expert Risk Analysis (ASCE 7-98) show significant but far from perfect correspondence
- New home buyers responses indicate:
        - Greater awareness and concern about hurricane safety
        - Lack of knowledge and information about what is important
        - Often do not have adequate resources to act on their awareness, concern, and knowledge
- Homeowners in multi-family units were much more likely (48% in 6+ units and 44% in 2-5 unit buildings) than single family homes (26%) to have nothing as shuttering or opening coverage
- A majority of residents of rental housing (51% in single family, 69% for families in 2-5 unit buildings, and 75% for families in 6+ unit buildings) reported having nothing as shuttering or opening coverage

Key recommendations include:

- The Florida Department of Community Affairs website for mitigation information http://www.floridacommunitydevelopment.org/mitdb/ can be much more cogent for all consumers by:
        - Facilitating mitigation incentive comparisons among insurance carriers
        - Including specific insurance premium mitigation incentive information for condominium owners/associations, landlords and renters
        - Providing links to websites of other organizations that provide goods and services that facilitate and/or provide incentives for mitigation

- Develop mitigation incentive programs that feature forgivable loans. Property taxes and insurance premium discounts, while favored by homeowners, are probably unacceptably expensive and therefore not reasonable as incentive options.
- Improve the availability and accessibility of information, both on existing insurance mitigation incentives and any new incentives, because no single incentive or combination will be effective if unknown to consumers.

- A hurricane safety inspection program should be cautiously explored.
- Mitigation incentive education programs should target potential home buyers and realtors, perhaps as an extension of general population programs.
- Mortgage programs that allow buyers to finance wind hazard mitigation improvements as part of the original purchase should be considered.
- Reduced fees and similar incentives for purchasing a home with wind hazard protection features should be considered.
- Research should be conducted to identify issues of knowledge, attitude, willingness and ability to respond to hurricane mitigation incentive programs and the nature of incentive programs most likely to be effective for:
    - Homeowners in multi-family buildings
    - Owners of commercial residential (rental) property
    - Renters in both single and multi-family buildings

Program of Education and Outreach to Convey Benefits of Hurricane Loss Mitigation Devices and Techniques

The IHRC team complemented its research work during 2003-2004 with a series of educational activities with the objective of sharing important research findings with stakeholders and the public at large.

This effort also had the objective of publicizing the objectives of the RCMP by allowing Florida residents to witness specific research tests and also by participating in various tours of the IHRC's Laboratory for Structural Mitigation. All of these activities were complemented by exhibits of various kinds designed by the IHRC team and displayed at various conferences in Florida, and at other special events including the Hurricane Awareness week event at the Miami Children's Museum.

THE BILL WILLIAMS ACT

Work by the IHRC for the *Hurricane Loss Reduction for the Residences and Mobile Homes in Florida* research project is being funded through a legislative earmark under Florida Statutes section 215.559 – Hurricane Loss Reduction Program also known as the *Bill Williams Residential Safety and Preparedness Act*.

The text of this statute follows:

The 2001 Florida Statutes; Title XIV; Taxation and Finance Chapter 215; Financial Matters: General Provisions View Entire Chapter

215.559 Residential Construction Mitigation Program.--

(1) There is created a Residential Construction Mitigation Program. The Legislature shall annually appropriate $10 million of the moneys authorized for appropriation under section 215.555(7)(c) from the Florida Hurricane Catastrophe Fund to the Department of Community Affairs for the purposes set forth in this section.

(2)(a) Seven million dollars in funds provided in subsection (1) shall be used for programs to improve the wind resistance of residences and mobile homes, including loans, subsidies, grants, demonstration projects, and direct assistance; cooperative programs with local governments and the Federal Government; and other efforts to prevent or reduce losses or reduce the cost of rebuilding after a disaster.

(b) Three million dollars in funds provided in subsection (1) shall be used to retrofit existing facilities used as public hurricane shelters. The department must prioritize the use of these funds for projects included in the September 1, 2000, version of the Shelter Retrofit Report prepared in accordance with s. 252.385(3), and each annual report thereafter. The department must give funding priority to projects in regional planning council regions that have shelter deficits and to projects that maximize use of state funds.

(3) Forty percent of the total appropriation in paragraph (2)(a) shall be used to inspect and improve tie-downs for mobile homes. Within 30 days after the effective date of that appropriation, the department shall contract with a public higher educational institution in this state which has previous experience in administering the programs set forth in this subsection to serve as the administrative entity and fiscal agent pursuant to s. 216.346 for the purpose of administering the programs set

forth in this subsection in accordance with established policy and procedures. The administrative entity working with the advisory council set up under subsection (5) shall develop a list of mobile home parks and counties that may be eligible to participate in the tie-down program.

(4) Of moneys provided to the Department of Community Affairs in paragraph (2)(a), 10 percent shall be allocated to a Type I Center within the State University System dedicated to hurricane research. The Type I Center shall develop a preliminary work plan approved by the advisory council set forth in subsection (5) to eliminate the state and local barriers to upgrading existing mobile homes and communities, research and develop a program for the recycling of existing older mobile homes, and support programs of research and development relating to hurricane loss reduction devices and techniques for site-built residences. The State University System also shall consult with the Department of Community Affairs and assist the department with the report required under subsection (7).

(5) Except for the program set forth in subsection (3), the Department of Community Affairs shall develop the programs set forth in this section in consultation with an advisory council consisting of a representative designated by the Department of Insurance, a representative designated by the Florida Home Builders Association, a representative designated by the Florida Insurance Council, a representative designated by the Federation of Manufactured Home Owners, a representative designated by the Florida Association of Counties, and a representative designated by the Florida Manufactured Housing Association.

(6) Moneys provided to the Department of Community Affairs under this section are intended to supplement other funding sources of the Department of Community Affairs and may not supplant other funding sources of the Department of Community Affairs.

(7) On January 1st of each year, the Department of Community Affairs shall provide a full report and accounting of activities under this section and an evaluation of such activities to the Speaker of the House of Representatives, the President of the Senate, and the Majority and Minority Leaders of the House of Representatives and the Senate.

(8) This section is repealed June 30, 2006.

History.--s. 2, ch. 99-305; s. 1, ch. 2000-140; s. 1, ch. 2001-227.

THE IHRC PROJECT RESEARCH TEAM

In keeping with the comprehensive agenda of the research topics for this project, the IHRC organized a multidisciplinary team of researchers, assistants and support staff from within the IHRC and six academic institutions.

All together a total of fifty individuals were involved in this project representing such disciplines as architecture, construction management, city planning, civil engineering, computer animation, mathematics, fine arts, sociology and anthropology, structural engineering, public opinion surveying, wind engineering among others.

In addition to their specific disciplines, members of the IHRC research team possessed a wealth of practical expertise in the fields of emergency management, vulnerability assessment, hazard mitigation, hurricane damage assessment, structural testing, construction management, analytical survey methodology, statistical analysis, project management, mathematical modeling among others.

The 50 members of the research team are listed below:

Principal Investigator: Ricardo Alvarez FIU/IHRC

Project Coordinator: Carolyn Anderson FIU/IHRC

Principal Researchers:

Ronald Baier	FIU	Construction Management
Jason Chandler	FIU	Architecture
Nicole Dash	UNT	Sociology
Hugh Gladwin	FIU	IPOR
Francis McAfee	FAU	Center for Electronic Communication
Betty Morrow	FIU	Sociology/Anthropology
Dianne Newman	FAU	Center for Electronics Communication
Walter G. Peacock	TA&MU	Landscape Architecture & Urban Planning
Vivek Patel	FAU	Center for Electronic Communication
Edgar Polo	FIU	HCET
Alfredo Ravinet	FIU	HCET
Timothy Reinhold	Clemson	Civil Engineering

James Rivers	FIU	IHRC
Stephen Schreiber	USF	Architecture
Edmund Skellings	FAU	Center for Electronic Communication

Research Assistants:

Lilia Cunningham	FIU	Sociology/Anthropology
Josue Cruz	FIU	Architecture
Michael DeLoach	Clemson	Civil Engineering
Carlos Escuti	FIU	Architecture
Michael Figueredo	FIU	Architecture
Sarah Goodridge	FIU	Construction Management
Diedra Hazeley	FIU	Sociology/Anthropology
Zuzana Hlavacova	FIU	International Relations
Emily Hogue	FIU	Sociology/Anthropology
Laura Lake	USF	Architecture
Juanita Mainster	FIU	Sociology/Anthropology
Kevin Nickorick	USF	Architecture
Michael Olivero	FIU	Computer Science
Anthony Peguero	FIU	Sociology/Anthropology
Robert Perez	FIU	Architecture
Amy Reid	FIU	Sociology/Anthropology
Goldia Robinson Taylor	FIU	Education
Swapnali Salunkhe	USF	Architecture
Brian Saponaro	FIU	Architecture
Myron Strong	UNT	Sociology/Anthropology
George Torrente	FIU	Architecture
Hsin Ju Yang	FAU	Center for Electronic Communication

Undergraduate Students:

Victor Camps	FIU	Architecture
Brian Dick	Clemson	Civil Engineering
Cos Gardner	Clemson	Civil Engineering
Kyle Hardee	Clemson	Civil Engineering
Jon Lamb	Clemson	Civil Engineering
Brie Losego	FIU	Architecture

Support Staff:

Kyle Campbell	USF	FCCDR
Scott Caput	FIU	IHRC
Ann Gorazcko	FIU	IPOR
Regnier Jurado	FIU	IHRC
Eddy Rodriguez	FIU	Vehicle Services
Patricia Ruiz	FIU	Facilities Management
Jennifer Sandford	USF	FCCDR

THE SCOPE OF WORK

To address the purpose of this research project, as stated in the language of the Bill Williams Residential Safety and preparedness Act, the IHRC and DCA, after consultation with the Hurricane Loss Mitigation Advisory Council, agreed on a set of three research tracks. Included below is the text of a document submitted by the IHRC to DCA containing the work plan and timelines. The Work Plan guided all research work during the 2003/2004 year covered under the Final Report.

MEMORANDUM

TO : Charles McCool– RCMP
FROM: Ricardo A. Alvarez – IHC/FIU
REF : Research Agenda
DATE : September 2, 2004

Attached herewith please find the research agenda the IHRC proposes to complete during the year starting on July 1, 2003 and ending on June 30, 2004 under the Hurricane Loss Reduction Project. This research work includes three main tasks as described in the attached document.

Please contact me [305/348-1865, *alvarez@fiu.edu*] should you have any questions or comments regarding our proposed scope of work for the current fiscal year.

Attachment A: Budget and Scope of Work
Florida International University/International Hurricane Research Center
Agreement #04 RC-11-13-00-05-001

International Hurricane Research Center/Florida International University

TASK #1

Areas of Research for the Period July 1, 2003 through June 30, 2004

Hurricane Loss Mitigation Program
(Residential Construction Mitigation Program – RCMP)

NOTE: *Research tracks to be undertaken by the International Hurricane Research Center (IHRC) at Florida International University (FIU) have been identified and designated by legislative action under the Bill Williams Residential Safety and Preparedness Act" (F.S. 215.559)*

1. **Barriers to the Upgrading of Existing Mobile Homes and Communities**

1.1 The Role of Rehabilitation in the Upgrading of Mobile Home and Communities

A host of factors may contribute to the degradation and, in some cases, the demise of mobile home parks. In older parks lot size and the inability of re-platting make it impossible for some parks to upgrade to newer, safer units. Often when these conditions combine with lack of maintenance of individual mobile homes or of the park itself deterioration and blight ensue in a downward spiral that is often unstoppable. Soon other factors come into play, including an exodus from the park that may take the park from physical deterioration to economic degradation. In the end, market or economic and regulatory pressure may combine with these other factors leading to the shutting down of the park, sale of the land and displacement of the resident population.

During 2003/2004 the IHRC will explore the role rehabilitation ("rehabbing") of mobile homes may contribute to an upgrading of the mobile home park itself and to the strengthening of individual units. The IHRC will also explore rehabbing as an opportunity to introduce structural enhancements as a method for promoting hurricane loss mitigation. This research will include an assessment of the economic aspects of rehabbing and the feasibility of implementing government programs to facilitate rehabbing.

1.2 Case-study: Mobile Home Park/Village of el Portal, Miami-Dade County

Our research has identified a range of factors, from regulatory and political to socio-economic, that may doom mobile home parks in urban areas to disappear or at the very least to be displaced. This in turn may cause displacement of residents and hardship. While we have studied historical cases of parks that have closed down there is an opportunity to research the case of a park that is still occupied and functioning, but which is going through the process of being subjected to a range of external pressures that may lead to its closure.

During 2003/2004 the IHRC will develop a case study of this current process at the Village of El Portal Mobile Home Park. The objective will be to: (a) Develop a chronology of events related to these external factors acting upon the park, (b) Describe the current status of this process, (c) record and analyze the actions taken by the various parties involved in this process such as: i) Residents of the park, ii) Mobile Home Park owner/management, iii) Village of El Portal public authorities/elected officials, iv) the public at large within the Village or the larger vicinity (Miami-Dade County), v) Others, (d) Assess the potential future outcome of this process based on knowledge acquired through this research.

2. **Replacement Program for Existing Mobile Homes**

2.1 Regulatory and Financial Issues Related to a Wide Scale Replacement Program

The IHC proposes to assess the total estimated cost and timelines associated with replacing all pre-1976 units currently located in mobile home parks in Florida. This research will also include identification of potential sources of funding for such a program, as well as policy alternatives that could be enacted through legislative action to make such a replacement program feasible and affordable.

3. **Hurricane Loss Reduction Devices and Techniques**

3.1 The Role of Impact Modifiers in Neighborhood Design

Architectural design features play as important a role as structural design criteria in modifying the impact of hurricanes on housing. Other elements such as neighborhood layout and landscaping also play a role in modifying the impact of hurricanes on a site- or neighborhood-specific basis. Such impact modification may be positive or negative, meaning that in some cases the specific feature may contribute to increased damage, while in other cases the design or external feature may reduce the potential for damage from hurricane impact. Understanding the role of each of such design components could contribute to the development of knowledge that would be useful for architect, city planners, developers and home builders as well as public officials responsible for building design and construction or comprehensive planning.
Proposed work for the 2003/2004 will build upon wind tunnel testing of various house shapes, including a variety of architectural features, conducted by the IHC during the 2002/2003 period. Specific research components may include:

(a) Wind tunnel testing of groups of houses, composed of an array of house shapes, types and design, to assess how the group itself may become an impact modifier.
(b) Research into the role of vegetation as an impact modifier for individual dwelling within a neighborhood.
(c) Research into the role of individual house orientation, as a function o neighborhood design, in modifying the impact of hurricanes on individual dwellings.
(d) Research into the effectiveness of various tree and shrub species as impact modifiers in Florida.

3.2 Performance Modifiers in the Mitigation of Roof Damage

The performance of roofs under hurricane impacts may be modified or improved by the use of design or construction methods or materials that go beyond the minimum prescriptions of the building code. Research, including that conducted by the IHC research team, has shown the improvement of performance could be significant. When such improvement in performance is achieved at low cost or at a high benefit-cost ratio, one that is acceptable to home-builders or home buyers, then a strong case can be made in favor of adopting such performance modifiers as standard house design or construction methods.

A good example of a performance enhancer [modifier] is the use of a different type of nail, while keeping the nail size and spacing the same as before, for fastening the roof sheathing to the supporting structure. Research work by the IHC team during the 2001/2002 and 2002/2003 periods has shown substituting 8d ring shank nails, for the 8d common nails prescribed by the Florida building Code for fastening roof sheathing in high velocity hurricane zones, can improve the performance of the roof by a factor of 80% to 130%.

Proposed work for the 2003/2004 period will build upon findings from current work and will include some of the following components:

(a) Research and development for a "wall of wind" study. This involves using difference sources to generate hurricane strength winds that closely replicate the wind shear and

other elements found in natural winds. The main objective of this is to allow the testing of full scale housing components and assemblies in order to develop new effective applications for hurricane loss mitigation methods and techniques applicable to site-built housing.

(b) Continued testing of a variety of fasteners, such as screw-shank nails, screws, clip-head ring shank nails and others. The objective of these tests is to increase the database of performance levels for a variety of fasteners that would be useful to builders and designers in Florida and other hurricane-vulnerable regions.

(c) Cost-analysis for the various fasteners tested to compare with the cost of using fasteners prescribed by pertinent building codes. This will be helpful in identifying cost-effective loss reduction alternatives.

(d) Research and development of modified-design for drip edge roof flashing that may contribute to reducing potential damage to shingle roofs under hurricane impacts.

(e) Research and development into the effectiveness of edge spoilers, installed on the gable end roof edge, in reducing the sequence of events that results in damage to the roof covering under hurricane impacts.

(f) Assess the performance of various types of roof coverings, such as clay tiles or shingles, under various intensities of wind to determine the feasibility of improving such performance by developing improved methods for installation.

(g) Research of performance improvement of existing roof built prior to the current applicable building code through various retrofit measures. The main objective of this specific track is to explore the viability of improving the existing housing stock as a way of achieving more comprehensive hurricane loss reduction for housing.

(h) Benefit-cost analysis of the various performance modifiers.

3.3 Developing New testing Protocols for Impact Testing

Empirical data from actual hurricane events in South Florida and others areas appear to indicate one of the most common types of flying debris consists of roofing tiles or shingles. Both these types of roofing materials have the potential for causing considerable damage as they impact houses and other structures.

Currently prescribed test protocols adopted within the Florida Building Code apply to: (a) Large debris in the form of 9 lb. 2x4 traveling at 50 pfs, or (b) Small debris in the form of 30 pieces of roof gravel 9 or steel balls). There is no test protocol for roof tiles or shingles that may become airborne during hurricanes.

The IHRC will undertake a series of tests to: (a) Determine the hurricane wind speed at which roof tiles or roof shingles may become airborne as flying debris, (b) Assess the relationship of such threshold wind speed to specific methods of attachment for tiles or shingles, (c) Assess the actual force of impact by roof shingles or roof tiles when hitting a house, (d) Assess the actual damage caused by such impacts.

This research will be most useful in Florida coastal areas and specifically in the High velocity Hurricane Wind Zone as defined by the Florida Building Code.

3.4 Using Field Instrumentation to Assess Hurricane Impact on Housing

Field instrumentation, using a variety on sensors and data collection equipment, provides a method for assessing the performance of a building as it interacts with extreme winds and hurricanes. This method also allows the assessment of such interaction at full scale, in real time and under real natural conditions, which in some cases is preferable to using reduced scale models under simulated hurricane conditions. The field instrumentation method provides reliable empirical data to assess the vulnerability of a given building, its performance under hazard conditions, and it also identifies structural and building-envelope weaknesses and strengths. This methodology is useful in identifying mitigation alternatives that may contribute to hurricane loss reduction.

Work during the 2003/2004 period will use current 2002/2003 work as a foundation and will include without limitation the following research components:

(a) Continued data collection and analysis using the flat roof sensors installed on a building at the FIU CEAS campus.
(b) Installation of additional sensors on at least one additional building.
(c) Addition of an open-field surface wind measuring instrumented tower to improve the reliability in data collection and analysis.
(d) Research and development of improved flat roof sensor design.
(e) Research on the adaptability of existing flat-roof sensor for sloped roof installation.
(f) Identification of potential mitigation alternatives to improve flat-roof performance under hurricane impacts.

3.5 State-wide and Focused Surveys to Assess Effectiveness of RCMP Program

Statewide surveys previously conducted by the IHRC, in 2002/2003, have helped establish a baseline from which we can assess the effectiveness of the RCMP program in contributing to hurricane loss reduction in Florida. A separate survey in 2002/2003 focused on the Florida Building Code education/outreach effort as one of the individual component of the RCMP program as a way of assessing the return-on-investment of such individual component of he program. This information is valuable to state agencies and policy-makers in understanding the benefits derived from the RCMP, and it will also help in modifying and fine-tuning of the program to maximize the benefits for the resident of Florida.

Work during the 2003/2004 period will include a new focused survey to assess the effectiveness of a different component of the program to be selected by the funding agency.

An additional focused mail survey, based on ownership registration, will also be implemented to gather information from those currently owning pre-1976 mobile homes. This survey will provide a better sample of those who live in pre-1976 mobile homes and will help focus the direction of a possible "replacement" program.

3.6 Feasibility of Implementing Programs of Incentives to Include Hurricane Loss Mitigation Devices and Techniques in the Design/Construction of New Houses or in the retrofit of Existing Houses

During 2003/2004 the IHC will assess the feasibility of developing and implementing a program of incentives for home-buyers who purchase new homes that include one or more hurricane loss mitigation devices or techniques. This research will also look at programs to provide incentives for existing homeowners to retrofit their houses by implementing cost-effective hurricane loss mitigation devices or techniques. The IHC will also look into potential sources and methods of funding such programs of incentives.

3.7 Programs of Education and Outreach to Convey the benefits of various Hurricane Loss Mitigation devices and Techniques

The IHC will explore ways and methods to educate various sectors of the public on the benefits of hurricane loss mitigation devices and techniques analyzed or developed through this program. One specific focus will be the homebuilding industry and ways to encourage homebuilders to offer hurricane loss mitigation measures to prospective home-buyers the same way they offer other options.

TASK # 2

The Recipient will report formally in writing to the Department on a quarterly basis regarding the activities that have been conducted under this Agreement. The report shall comprise three quarterly project progress reports and a final report. Each quarterly report is to be received by the Department no later than the 15th day of the month following the end of each calendar quarter. The quarterly report will briefly describe the activities undertaken, work plan milestones reached, difficulties incurred, and describe corrective action and/or steps planned-to-be taken/already-taken to overcome them. The final (quarterly project progress) report shall be due to the Department no later than July 31, 2004. The final report shall be a comprehensive report of research activities completed during State Fiscal Year 2004. The final report will include findings and comprehensive analysis on all areas of research activity funded under this grant.

TASK # 3: Assist the FL DCA with Annual Report to Legislative Leadership

The Recipient will consult with the Department and assist the Department as necessary to prepare a full annual report and accounting of activities under Section 215.559, Florida Statutes, Hurricane Loss Mitigation Program (HLMP), and an evaluation of such activities. The report will be submitted by the Department to the Speaker of the House of Representatives, the President of the Senate, and the Majority and Minority Leaders of the House of Representatives and the Senate by January 1, 2004. The Department will provide the Recipient with access to all pertinent sources of information related to and necessary to facilitate preparation of the report.

Reporting Requirements:

The due dates for reporting not withstanding, all work under this Agreement must be completed by June 30, 2004.

Within 30 days from the execution of this Agreement, the Recipient shall submit to the Department in both hard copy and electronic format a Work Plan and milestones chart detailing all tasks to be undertaken, milestones, meetings, and other critical dates. The Work Plan shall serve as the primary management tool for on-time performance between the Department and the Recipient.

By October 15, 2003 or within 15 days after execution of this Agreement, the Recipient shall submit to the Department (in hard copy and electronic format) a quarterly project progress report documenting the acceptable progress and completion of the tasks described in the Scope of Work during the calendar quarter ended September 30, 2003.

By December 1, 2003 the Recipient shall submit to the Department in both hard copy and electronic form the HLMP Annual Report to the Legislature as described under Task 3, above.

By January 15, 2004 the Recipient shall submit to the Department (in hard copy and electronic format) a quarterly project progress report documenting the acceptable progress and completion of the tasks described in the Scope of Work during the calendar quarter ended December 31, 2003.

By April 15, 2004, the Recipient shall submit to the Department (in hard copy and electronic format) a quarterly project progress report documenting the acceptable progress and completion of the tasks described in the Scope of Work during the calendar quarter ended March 31, 2004.

By July 31, 2004, the Recipient shall submit to the Department a final report as described in the Scope of Work, in both hard copy and electronic format.