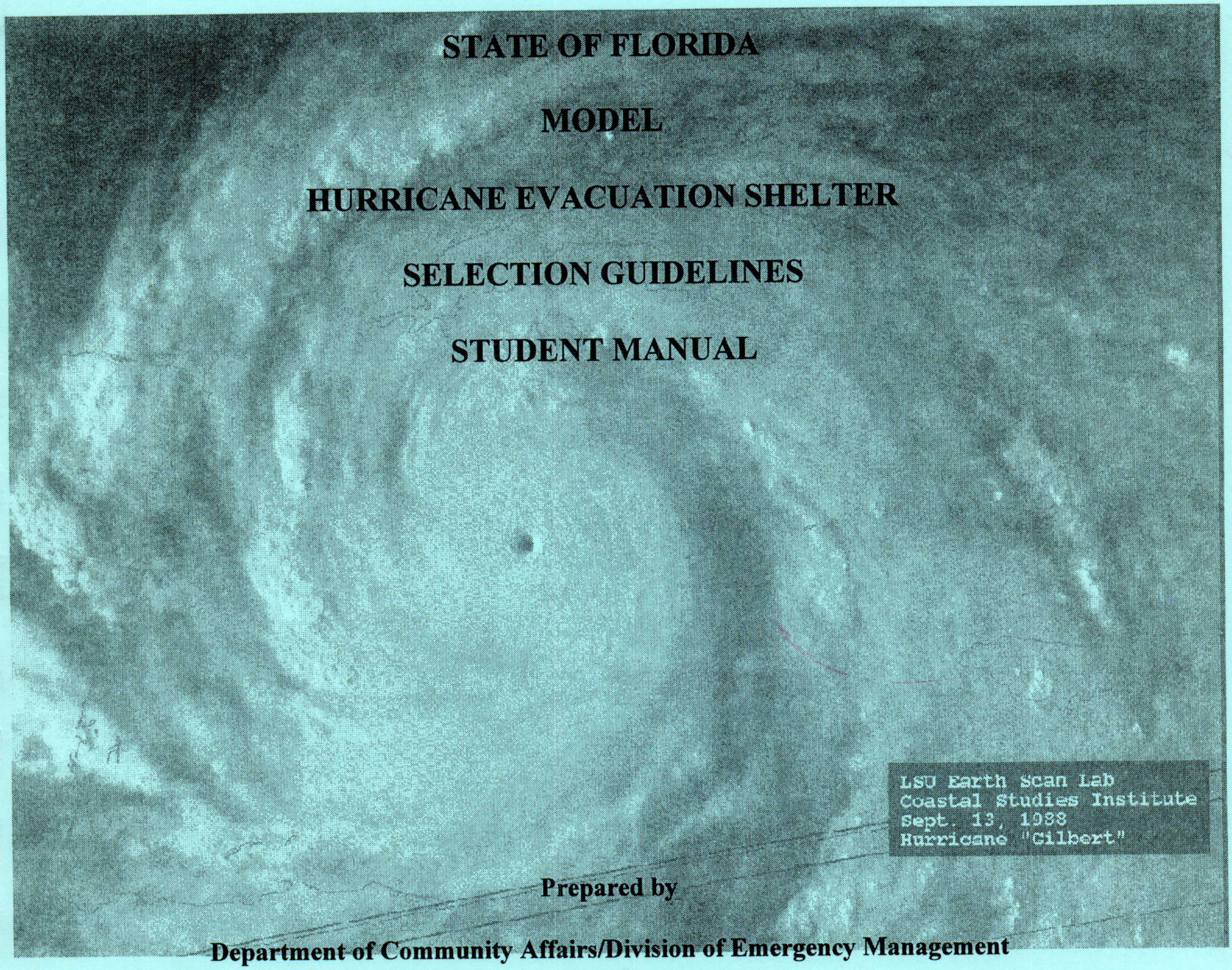
STATE OF FLORIDA

MODEL

HURRICANE EVACUATION SHELTER

SELECTION GUIDELINES

STUDENT MANUAL



Prepared by

Department of Community Affairs/Division of Emergency Management
and
University of Florida/School of Building Construction

October 1997

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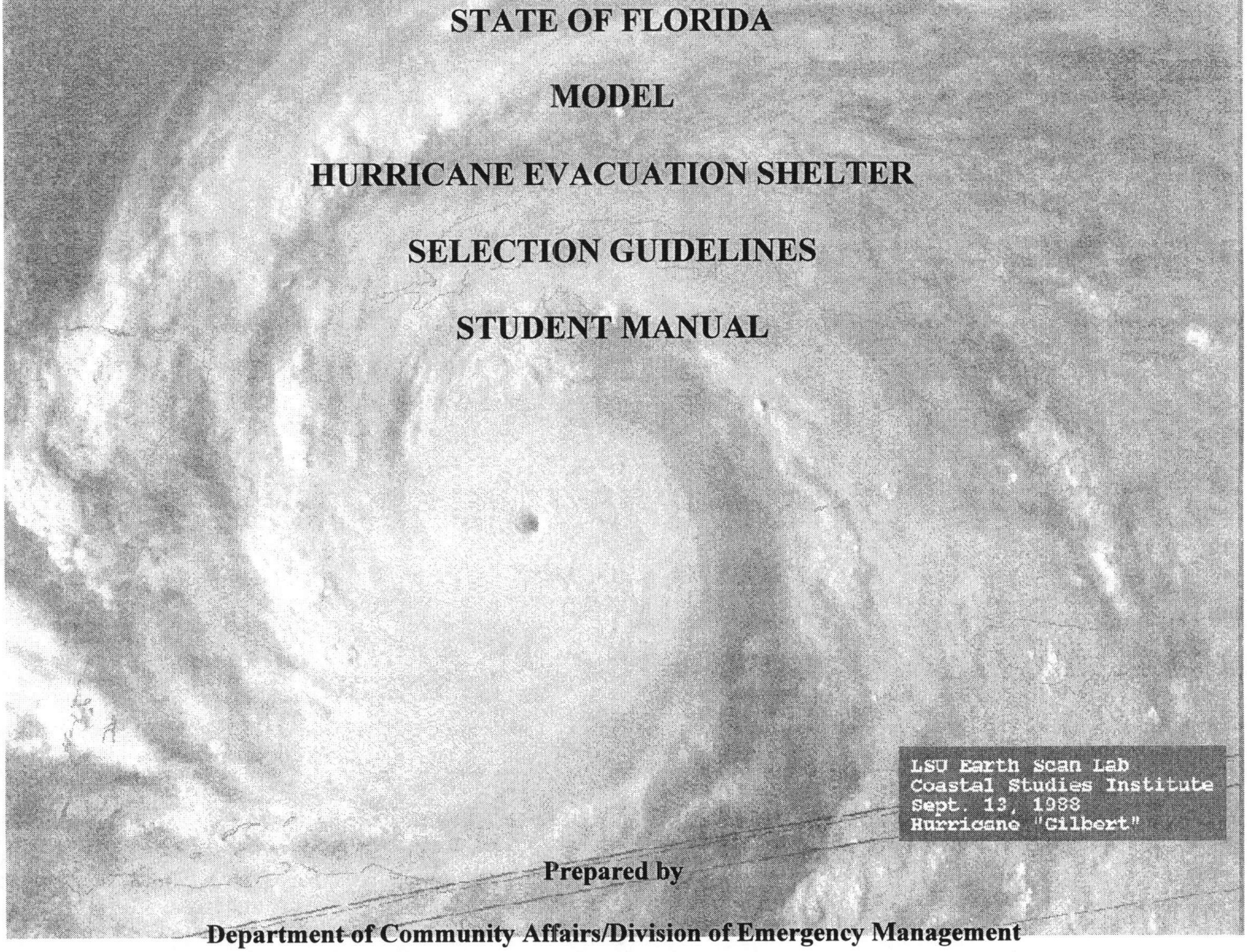

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PREFACE

Chapter 252, Florida Statutes, charges the Division of Emergency Management with the responsibility of maintaining a comprehensive statewide program of emergency management. A critical component of this program is the sheltering of Florida's vulnerable populations in the face of an impending hurricane. The Division is responsible for administering a shelter survey program with the goal of eliminating the deficit of "safe" public shelter space. As a component of this shelter survey program, the Division is responsible for establishing model shelter guidelines. The Division has adopted the guidelines established by the American Red Cross in *MASS CARE -- Preparedness and Operations* (ARC 3031, April 1987), and its supplement *Guidelines for Hurricane Evacuation Shelter Selection*, (ARC 4496, July 1992).

To meet the responsibilities defined in Florida Statutes, the Division has developed a multifaceted strategy to eliminate the statewide shelter deficit. This strategy includes promoting the use of public shelter design criteria when constructing new facilities; surveying existing buildings, both public and private, to identify additional shelter capacity; and recommending appropriate retrofitting and mitigation projects to increase available shelter space in existing buildings. An integral component of this strategy is to provide technical assistance and training to local and state officials in shelter selection and, where appropriate, retrofitting and mitigation techniques. The publication of this manual provides the basis for the Division's shelter selection and retrofitting technical assistance programs and a supplementary training program.

Though the focus of this manual is hurricane evacuation shelter selection, the hazards assessment procedures outlined are relevant to any structure critical to a community's ability to respond to, and recover from, a major hurricane. As such, the Division recommends use of the procedures established in this manual as the **minimum** level of hazard evaluation for other types of critical facilities; e.g., police departments, hospitals, communications centers, fire stations, etc.

During the preparation of this manual, an effort was made to maintain consistency with terms prescribed in both ARC 3031 and ARC 4496. To maintain consistency with ARC 4496, this document repeatedly uses the term Hurricane Evacuation Shelter. In the interest of succinctness, this term has been abbreviated to HES. The acronym HES is more commonly ascribed to Hurricane Evacuation Studies, which also are referenced in this text. Therefore, where used in this document, HES pertains only to Hurricane Evacuation Shelters and NOT to Hurricane Evacuation Studies.

DISCLAIMER

The use of the statements, recommendations, and procedures contained in this manual are limited to the matters expressly set forth herein, and no information or opinion is implied or may be inferred beyond the matters so stated. This guidance manual is intended solely for the use of public safety officials and other agencies, public and private, in connection with shelter and evacuation decisions, and may not be relied upon for any other purpose or by any other person for any purpose without the prior written consent of the Division of Emergency Management. The Division expressly disclaims any duty to update or revise this manual in the future for any changes of fact or law which may affect any of the material contained herein. **There are no expressed or implied warranties of any kind, in particular there are no warranties of fitness or merchantability, which apply to this manual or its contents. This manual is provided as is.**

This manual was developed to provide guidance in selecting hurricane evacuation shelters and to provide guidance in identifying and prioritizing mitigation efforts to improve/occupant safety of selected structures. The user must assume responsibility for adapting and/or supplementing the information contained herein to meet the particular requirements of a project.

For the purposes of this guidance manual, the terms "safe", "safer," and "safest" are relative terms and solely intended to indicate the degree of conformity with ARC 4496, *Guidelines for Hurricane Evacuation Shelter Selection*, and for no other purpose. The use of these terms is **not** intended, and should **not** be construed, to mean that a particular structure is free from hazard, affords complete protection, or is free from danger or harm.

TABLE OF CONTENTS

CHAPTER I

INTRODUCTION

1.0 General

- In the case of a major hurricane, the time required to evacuate vulnerable populations from coastal areas will increase dramatically as coastal populations grow. Forecast lead times have not significantly improved, making prediction of a specific landfall location more than 12 hours before its occurrence difficult. It is, therefore, important that vulnerable populations that are unable to evacuate in a timely manner be sheltered initially in or as close to their communities as possible.

- Emergency Management Agencies of both state and local jurisdictions generally are charged with safeguarding the lives and property of citizens. This responsibility also includes the task of selecting buildings that can serve as Hurricane Evacuation Shelters (HES). This manual explains a simple procedure for collecting data on and then evaluating potential HES buildings.

1.1 Purpose of Student Manual

Two technical documents establish the criteria for selecting buildings to serve as HESs:

(1) *MASS CARE -- Preparedness and Operations* (ARC 3031)
- Focuses on mass care considerations

(2) *Guidelines for Hurricane Evacuation Shelter Selection* (ARC 4496)
- Contains the requirements relating to storm surge, rainfall flooding, wind hazards, and hazardous materials considerations

- ARC 4496 lists the requirements in a generic form. This provides little help to an emergency management official who is responsible for applying the guidelines to a particular building.

- This student manual has been prepared to provide training in the application of the procedures established in the Model Hurricane Evacuation Shelter Selection Guidance Manual.

    - Information regarding principles of building construction, wind effects, storm surge, rainfall flooding, hazardous materials considerations, and a least-risk decision making procedure are included.

- A survey checklist and its relationship to the least-risk decision making table are explained.

- This manual can be used for formal training and self-help programs to assist local officials in selecting buildings that may be used as HESs.

- The guidelines provided in ARC 4496 were prepared by an interagency group and:

  - Reflect the application of technical data compiled in:

    - Hurricane Evacuation Studies,
    - research findings related to wind loads and structural problems,
    - and other hazard information that may affect the suitability of a building as an HES.

- The risk assessment procedure outlined in this manual:

  - Is based upon a qualitative evaluation procedure that does not include detailed structural analysis or destructive testing.

  - Does not guarantee that a specific building will survive the associated risks of a hurricane. The wind design and construction practices of many local communities are frequently inadequate to resist the effects of a major hurricane.

  - Only provides a mechanism for selecting the least vulnerable areas within suitable buildings.

- The planning assumptions used in preparation of this manual can be found below in Figure 1.1.

Planning Assumptions Used In Preparation Of This Manual

For the purposes of this manual, the following planning assumptions were used:

a. In the absence of known structural deficiencies, buildings are assumed to provide adequate protection for storm conditions up to the level they were designed to (e.g., 110 mph windloads). Safety procedures similar to those recommended for the general population should be followed in selecting shelter space (e.g., avoiding areas adjacent to glass, etc.), if storm conditions are not expected to exceed local code requirements.
b. The potential HES buildings will be selected from locally available building stocks that are unlikely to have received special hurricane resistance attention in design and construction.
c. The guidelines established in this manual assume that storm conditions (wind, flood, etc.) will exceed local code requirements, therefore extraordinary procedures must be followed to identify suitable shelter areas within existing buildings. This must be done to significantly reduce the risks to those seeking shelter in an HES.
d. Once designated as an HES, the building will be utilized by local emergency management officials and other sheltering agencies regardless of the projected intensity of a hurricane event.

Figure 1.1 Planning Assumptions

- The Student Manual:
  - Is intended for an audience including HES surveyors and public safety officials involved in the actual shelter selection process
  - Has been specifically designed in a low-tech format to meet the needs of an audience with a limited knowledge of hurricane effects and building wind design principals.
  - Focuses on the hazards and risks associated with the use of a building as an HES.
  - Uses procedures based upon currently available technical information (SLOSH, FIRM, etc.), historical wind performance data, and sound engineering judgement.
  - Is intended to enable HES surveyors and public safety officials to approach the selection process in an informed manner and to reach logical and consistent conclusions.

1.2 Development of a Comprehensive Shelter Strategy

- The development of a comprehensive shelter strategy is an essential component of disaster preparedness planning for a community. All communities should have a comprehensive long-range strategy and continuously strive to achieve these goals. The process of selecting HES buildings can help in developing such a comprehensive strategy.

This section provides a basic description of the strategic planning process and describes how to incorporate the data from hurricane evacuation shelter studies into a planning process.

- For effective hurricane evacuation planning, it is essential to create a survivable operations capability for immediate needs. This process is called Survivable Crisis Management (SCM). People, plans, facilities, and equipment are four essential components of the SCM infrastructure. The following steps are required to develop an effective SCM infrastructure.

Step 1-Assess hurricane hazards, risks, and vulnerabilities of a community
Step 2-Define requirements for the community
Step 3-Assess existing capabilities against requirements
Step 4-Identify shelter deficiencies
Step 5-Develop a comprehensive plan to correct deficiencies and meet requirements
Step 6-Develop contingency plans to work around deficiencies until they are corrected
Step 7-Develop and conduct exercises to evaluate capabilities

Figure 1.2, SCM Development Process Flowchart illustrates the activities necessary to develop SCM capability. The individual steps in this process also must focus on four principal components; people, plan, facilities, and equipment.

1.2.1 Steps for Developing a Comprehensive Shelter Strategy

Step 1: This step begins with an assessment of the hurricane hazards and risks facing a community. The specific hazards associated with hurricanes are well documented in this manual and can be generalized into four categories: storm surge, rainfall flooding, wind hazards, and hazardous materials considerations. Identifying the hazards must be accompanied by a determination of the risk each hazard poses for that community. For example, coastal communities are more vulnerable to storm surge compared to inland communities. The actual threat from hurricane-related hazards depends upon the location, topography, geography, and industry.

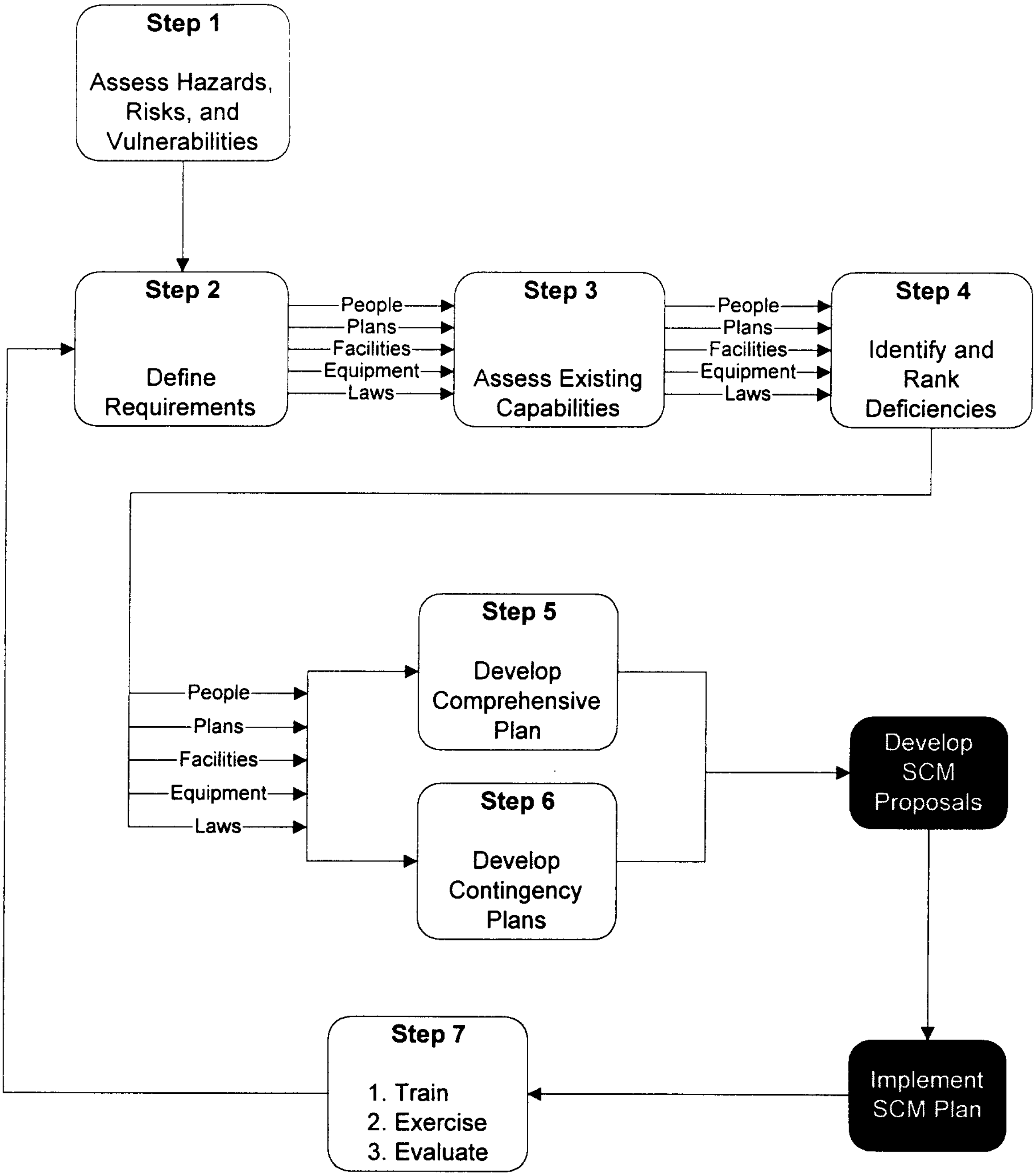


Figure 1.2 SCM Development Process Flowchart

The assessment of the vulnerability of a community must also include an analysis of the effects of simultaneous emergency events, such as flooding and windborne debris, which can lead to hazardous materials risks.

Step 2: The next step is to define what is required to manage these hazards and risks adequately, and to assess the shelter requirements of the community. For example, a complete evacuation plan may be required for a barrier island, whereas inland communities with few evacuation routes may simply need adequate shelter spaces within the community. With respect to hurricane shelter planning, the objective is to provide a suitable space for an evacuated population. This population is defined as a summation of residents from mobile homes and substandard housing, those evacuated from storm surge risk and flood-prone low-lying areas, nonresident tourists and visitors, and, in some cases, overflow evacuees from other jurisdictions.

Step 3: The next step focuses on the evaluation of existing shelter facility capabilities within the community, both current facilities and potential new facilities. The approach to be used is:

1) Evaluate existing shelter facilities to determine their status with respect to established guidelines;

2) Determine actual shelter space capacity in existing facilities and identify un-utilized space; and

3) Evaluate new facilities with respect to the established guidelines to provide options for increasing local shelter space capacity.

The evaluation process used for each individual facility includes a risk analysis with respect to the four major hazards, shelter space capacity evaluation, assessment of features conducive to mass care operations, and infrastructure and emergency power assessments. This information will provide emergency management officials with a snapshot of actual capabilities and associated risks of each facility with respect to the established guidelines.

The qualitative risk analysis performed during this study provides the following type(s) of information:

Storm Surge Inundation - Refer to Chapter III, Section 3.4.2
Rainfall Flooding/Dam Considerations - Refer to Chapter III, Section 3.4.3
HAZMAT & Nuclear Power Plant Considerations - Refer to Chapter III, Section 3.4.4
Wind and Debris Exposure - Refer to Chapter IV, Section 4.3.1.3

Based on shelter demand, existing capacity, and risks known for each facility, and a composite profile of the community-at-large available, emergency management officials and other agencies with mass care responsibilities can determine whether there is sufficient shelter capacity to meet its needs. When anticipated demand exceeds existing capacity, as established in the evaluation criteria, a least-risk decision making process needs to be developed and marginal facilities utilized.

Step 4: With the requirements and existing capabilities clearly understood, the community can identify its deficiencies and develop a comprehensive plan to remedy them. This shelter study has to be formatted specifically to provide a list of deficiencies and, where feasible, recommend mitigation/retrofit options to alleviate the deficiencies. In situations where a shelter deficit does exist, a comprehensive shelter strategic plan should be prepared to address all aspects of shelter deficit reduction. This plan should include, but not be limited to, shelter demand reduction (which should receive high priority), identification of nontraditional shelter facilities (shopping malls common areas, public hearing facilities, community or civic centers, fraternal organizations, funeral homes, etc.), and mutual aid agreements with neighboring jurisdictions that have shelter surplus.

The deficiencies also should be ranked, or prioritized, for retrofit. The ranking process should include considerations for both the impact the deficiencies have upon the use of the individual facility and the overall impact upon the community's shelter strategy. Some deficiencies, such as lack of feeding capabilities, may have an impact upon short term operations. Further, a weak long span roof over the shelter area or unreinforced masonry walls may pose a serious threat to occupant safety in a severe hurricane.

For retrofit actions that cannot be undertaken immediately, contingency plans must be prepared and implemented. Nature and probability are unlikely to wait until all deficiencies are corrected. The safety of vulnerable citizens of a community must receive priority. Options of space utilization that is not considered convenient (e.g., school classrooms, courtrooms, commercial and public conference centers, etc.) must be inventoried. As a final option, refuge-of-last-resort operational plans should be prepared.

Step 6: With the deficiencies identified, cost-effective corrective actions prepared, and projects ranked, then the SCM proposals should be prepared and potential funding sources identified. As with any proposal recommending capital investment, the project(s) must have a demonstrated role within the framework of comprehensive shelter strategy plan. The information obtained during the SCM process can be used to justify the necessity and effectiveness of the project(s).

Step 7: The final step of the SCM process is the actual implementation of the comprehensive shelter strategy and periodic evaluation of progress. Shelter planning and operational preparedness activities are a dynamic process. Changes in shelter demand, renovation activities at a key shelter facility (that temporarily removes it from the inventory), new construction projects at existing campuses, and a host of other factors must be updated constantly. Also periodic inspections of existing shelter facilities to verify the status, with respect to ARC 4496 conformance, and evaluation of new construction projects should be performed.

1.3 Contents and Organization

- For ease of referencing the information found in this manual, it has been organized into chapters, which are further subdivided into sections. As an example, the material you are currently reading is located in Chapter I, Section 1.3; the first digit of the section number indicates the chapter where the corresponding information is found and the "3" indicates the section.

- **Chapter I** provides introductory information on the purpose of this manual, contents and organization, and basic assumptions about the manual's target audience. The hurricane environment and its effects on buildings due to winds, storm surge, rainfall flooding, and hazardous materials considerations are described in **Chapter II**. Pre-site Visit procedures and checklist are discussed in **Chapter III**. Site Visit procedures and checklist are covered in **Chapter IV**. **Chapter V** explains the procedure for completing the Least-Risk Decision Making (LRDM) table and for classifying a building as preferred, marginal or non-compliant. **Chapter VI** provides recommendations for a sample report.

1.4 Overview of Hurricane Evacuation Shelter Selection Process

- Planning for an HES involves consideration of numerous factors that guide selection.

  - No individual agency is expected, or is likely, to possess all the skills and expertise necessary to implement fully a disaster shelter program. Instead, the implementation of the guidelines and procedures in this manual requires assistance and coordination with other public and private agencies that have the essential expertise and technical backgrounds.

  - As the focus of this manual is HES selection, it is important that individuals involved in this process have a basic understanding of shelter planning. This will assist individuals in seeing how they fit into this overall project. The HES Selection Process flowchart, shown in Figure 1.3, illustrates the activities necessary to identify sufficient HES capacity for a community.

- The first step in the hurricane evacuation shelter planning process is to identify, and quantify, the vulnerable population. This population consists of the following groups:

- Persons living in areas subject to storm surge inundation
- All mobile-home and manufactured-home residents
- Persons living in wind damage-prone housing
- Persons living in the 100-year floodplain, or other special hazard area
- Special needs populations
- Seasonal tourists and visitors and
- Other nonlocal evacuees/regional overflow

- With the vulnerable population identified, evacuation studies are conducted that take into account out-of-area evacuation, evacuation to a friend or relative's home outside of vulnerable areas, those who are likely to use a public shelter, etc. These studies provide information on shelter demand that is used as a planning assumption.

    - Sufficient public shelter space that will meet both long-term mass care criteria (72 hours or more), and short-term (+/- eight hours) sheltering during the gale-force wind period of a hurricane must be identified.

    - The shelter demand planning assumption and the per-capita square footage are used to determine the quantity of HES floor area needed.

- As an example, recently performed HES demand studies for "Hazard County," indicate that approximately 17 percent of the vulnerable population of 55,000 persons will seek public shelter. Consequently, local public safety officials must plan to provide HES space for 9,350 shelterees. On a short-term basis, ARC guidelines recommend 20 square feet of HES space per shelteree. Therefore, public safety officials must identify at least 187,000 square feet of usable space.

- Once the shelter demand and floor area requirements are known, a sufficient quantity of facilities must be identified that have an aggregate floor area equal to the HES demand.

    - Historically, public education facilities are the first buildings considered when identifying potential HESs.

    - Other types of facilities that may be included in the list of potential HES buildings are: churches, private schools, fraternal organizations, community centers, public buildings, and occasionally commercial/industrial facilities

    - The potential list of HES facilities may be influenced by demographic and area-specific hazard factors.
    - For example, public safety officials may place special emphasis on specific school campuses, even though they are in close proximity to each other, due to a large and concentrated mobile-home population neighboring the campuses.

- With the initial list of potential HES buildings prepared, each facility must be evaluated to meet any established mass care and hurricane vulnerability criteria. For the purposes of this manual, the criteria will be assumed to be ARC 3031 for mass care and ARC 4496 for hurricane vulnerability.

  - The site-specific evaluation process can be broken down into four major components: mass care requirements, flood inundation hazards, structural integrity and wind resistance, and technological or hazardous materials considerations.

  - As each of these components requires expertise in differing fields, each component may be evaluated by a different individual and/or agency. Each, however, is equally important to the decision to designate a building as an HES.

  - All the information and recommendations from each of these components must be compiled into a useful format to assist local public safety officials, and other sheltering agencies, with the decision-making process.

- The final step in the selection process is to perform a detailed review of all information pertinent to designating a facility as an HES.

  - For buildings that meet or exceed the minimum established criteria, the decision to use the facility as an HES is a simple matter.

  - If the buildings that meet the minimum guidelines also provide sufficient usable space to meet the projected shelter demand, the shelter selection process is complete for the approaching hurricane season.

PRIMARY RESPONSIBILITIES
WHO DOES WHAT ?

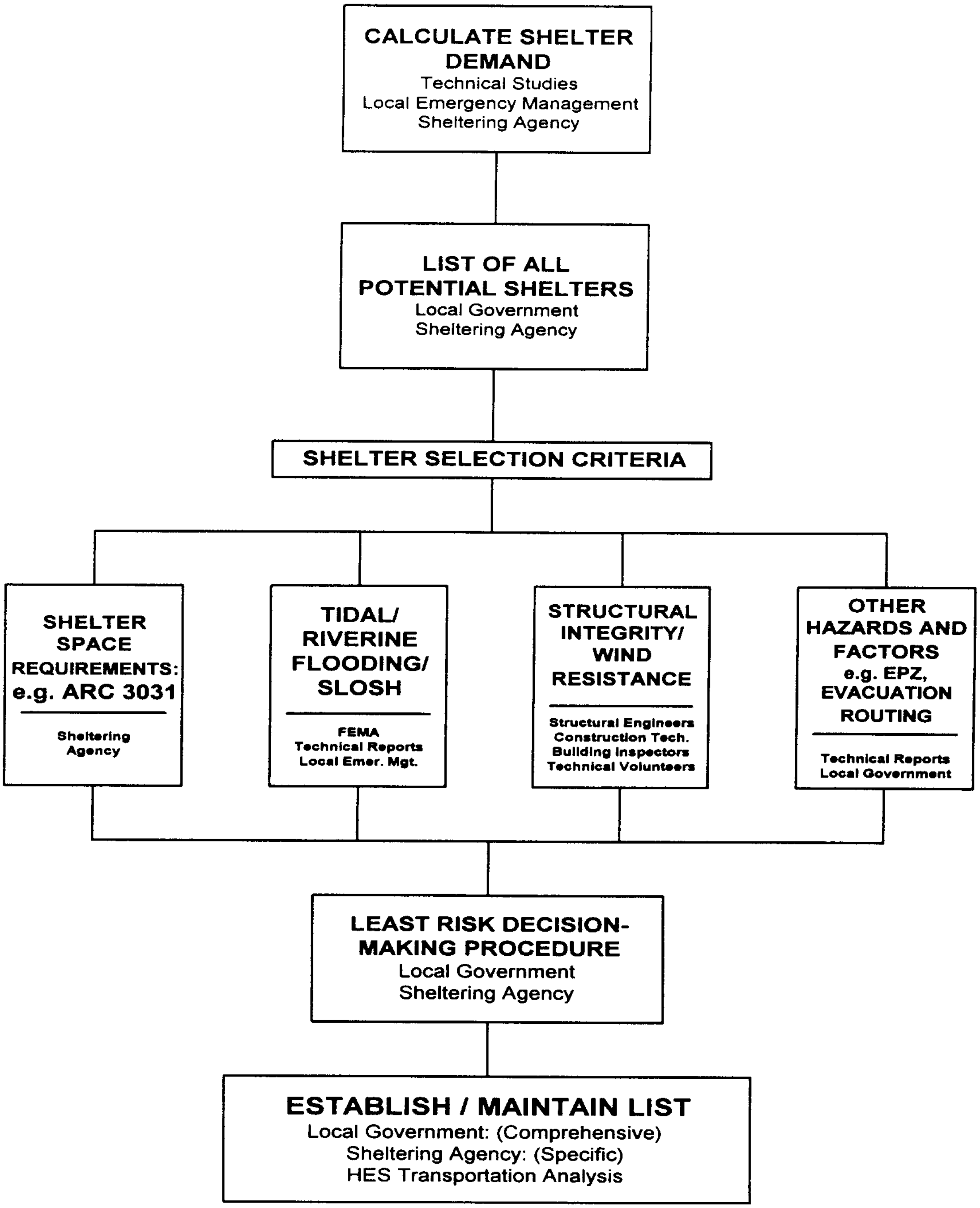


Figure 1.3 HES Shelter Selection Process Flowchart

- However, it is a rare luxury for the majority of communities to find adequate HES space that meets the minimum criteria. Public safety officials often must make a decision that balances the relative risks associated with the use of marginal, and in some cases noncompliant, buildings against the risks associated with other options (i.e., out-of-area evacuation).

  - Experts who assisted in the facility evaluation process should be consulted in situations where marginal or noncompliant facilities are considered.

  - Every effort should be made to identify a sufficient quantity of facilities that comply with the hazards assessment criteria, as mass care criteria deficiencies often can be overcome through adequate resource planning and management.

- Planning for HES operations is an ongoing activity. Once a facility is designated as an HES, it must be evaluated annually, prior to hurricane season, to reaffirm its status in the local shelter inventory.

  - Modifications or additions may enhance the safety and/or shelter capacity of an HES, or they may be a detriment. In situations where there is a question as to the impact of a modification, the facility should be re-evaluated by someone with the appropriate expertise.

  - Planned maintenance or remodeling projects undertaken during hurricane season also should be noted, particularly if it temporarily will reduce or eliminate the HES's shelter capacity from the local inventory.

1.5 Qualifications of Surveyors

- The shelter selection process involves proper understanding of hurricane effects on buildings, flood risk-assessment methods, common construction techniques, construction drawing and specification reading, and structural considerations for hurricane resistance. The process does not require a structural engineer's level of expertise. Anyone with appropriate technical knowledge and writing skills can survey and assist in the selection of HES buildings.

- The following professionals, with sufficient training, should be able to survey and select public buildings for shelter purposes:
  - Structural engineers,
  - Architects,
  - Construction professionals with four or two-year degrees in civil engineering technology,

- Certified building inspectors,
- Commercial/institutional building construction contractors, and
- Persons with extensive experience in the building construction industry.

- The hazardous materials evaluations, and the fire/life safety requirements require special expertise in evaluating the level of risks at particular buildings.

    - Usually this expertise is available from the local fire/life safety inspectors and the Local Emergency Planning Committee (LEPC); they should provide current evaluations for any potential HES buildings.

CHAPTER II

THE HURRICANE ENVIRONMENT AND EFFECTS ON BUILDINGS

2.0 General

- This chapter discusses the hurricane environment, wind-structure interaction, storm surge-structure interaction, and rainfall hazards associated with hurricanes.
    - Section 2.1 includes general characteristics of hurricanes, descriptions of hurricane categories, and damage potential.
    - Section 2.2 describes the effects of hurricanes on structures, such as windloads on building envelopes, wind-borne debris and internal pressurization, effects of terrain on wind speeds, shear forces impacting shear walls, and diaphragm action.
    - Section 2.3 explains storm surge, surge heights in various categories of hurricanes and the effects of storm surge.
    - Section 2.4 describes the rainfall hazards common under hurricane conditions.

2.1 The Hurricane Environment

- Hurricanes are cyclonic storms that develop tremendous strength and can become extremely destructive.
    - The word "hurricane" frequently is used for any wind that blows more than 74 miles per hour for a duration of six to eight hours.
    - Viewed from above, hurricanes resemble huge doughnuts, with a "circle of high winds and clouds and a quiet, relatively cloudless center (known as the "eye")". This doughnut shape can have a deceptively dangerous effect. After a hurricane roars ashore, it appears to have passed as the initial heavy winds and rain moves on and the quiet, clear eye area passes overhead. However, within an hour or so, the eye has passed and the strong winds and rains from the opposite side of the storm suddenly hit.
    - The storm itself may be from 60 to more than 1,200 miles in diameter, with the eye usually 12 to 62 miles across. The eye generally is well defined by a cylindrical wall of clouds.
- Hurricanes form over water and <u>generally</u> travel in a west-northwest direction.

Hurricanes are, however, known for their unpredictable patterns and numerous changes of direction.

- Hurricanes that impact the southeastern United States and the Caribbean Sea typically form over either the mid-Atlantic, the southern Caribbean Sea, or the Gulf of Mexico. As they move closer to the U.S. mainland, they usually begin to strengthen as they draw energy from the warm waters.

- Some hurricanes begin to weaken as they approach landfall, but others actually have intensified, depending on atmospheric conditions affecting the storm system. In both cases, once the hurricane passes over land it will begin to lose strength as it is separated from its energy source and friction with the passage over land drains energy from it.

- Often the worst damage occurs on the coastline where the storm makes landfall. This is because the storm is still relatively strong from its energy source and especially due to the presence of storm surge.

  - However, major hurricanes can maintain tremendous strength well inland if other atmospheric conditions remain favorable.

  - The distance inland that a hurricane maintains major status is directly related to its forward speed; faster forward speeds increase the damage potential further inland. The half life of an hurricane is approximately twelve hours once it makes landfall.

- Storm surge is another phenomenon associated with hurricanes.

  - It is a rapid rise in water level above normal, caused by hurricane winds and decreasing barometric pressure. As the hurricane approaches land and shallower water, the water level rises rapidly and waves develop well above the mean high tide.

  - Storm surge levels can range from four to five feet in a Category 1 storm to greater than 38 feet above normal tide levels in a Category 5 storm (where sustained winds exceed 155 mph).

  - The maximum storm surge usually occurs 10 to 20 miles to the right of the storm track. However, maximum surge may occur to the left of the storm if the winds pile water up against an obstruction, such as the land side of a coastal barrier island.

- For a hurricane, the surge typically has a duration of several hours.

- Whether a hurricane is approaching or exiting land can have a significant impact on the surge characteristics of the storm.

  - A landfalling hurricane generally will have more time and space across water to "push" a large volume of water in front of it.

  - A paralleling hurricane (one moving up or down the coast) may or may not have the general high surge levels depending on the angle of approach and the location.

  - An exiting hurricane will generally surge on its weak side and only has a relatively short distance to build up surge.

  - Of the three scenarios, the landfalling hurricane will have the greatest storm surge potential, all other factors being equal.

(1) Hurricane Categories and Damage Potential

- The intensity of a hurricane can be ranked by Categories 1 through 5 on the Saffir/Simpson Hurricane Scale.

  - A Category 1 hurricane is considered the weakest hurricane and has relatively limited damage potential.

  - A Category 5 hurricane is deemed the strongest and has extreme damage potential.

- The following table describes wind speeds and the damage potential of all five categories. The wind speeds in this table are sustained wind speeds, not gusts.

Saffir/Simpson Hurricane Scale		
Category	**Winds (mph)**	**Effects**
One	74-95	No real damage to building structures. Damage primarily to un-anchored mobile homes, shrubbery, and trees. Also, some coastal road flooding and minor pier damage.

Saffir/Simpson Hurricane Scale		
Category	**Winds (mph)**	**Effects**
Two	96-110	Some roofing material, door, and window damage to buildings. Considerable damage to vegetation, mobile homes, and piers. Small craft in unprotected anchorage break moorings. Coastal and low-lying escape routes flood 2-4 hours before arrival of center.
Three	111-130	Some structural damage to small residences. Utility buildings with a minor amount of curtainwall failures. Mobile homes are destroyed. Flooding near the coast destroys smaller structures, with larger structures damaged by floating debris. Terrain continuously lower than five feet above MSL (mean sea level) may be flooded inland eight miles or more.
Four	131-155	More extensive curtainwall failures with complete roof structure failure on small residences. Major erosion of beach. Major damage to lower floors of structures near the shore. Terrain continuously lower than 10 feet above MSL may be flooded, requiring massive evacuation of residential areas inland as far as six miles.
Five	> 155	Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Major damage to lower floors of all structures located less than 15 feet MSL and within 500 yards of the shoreline. Massive evacuation of residential areas on low ground within five to 10 miles of the shoreline may be required.

Below is a table showing deaths and property losses associated with some major hurricanes.

Name	Month/Year	Areas Affected	Number of Deaths	Property Losses
Camille	August 1969	Louisiana, Mississippi, Alabama	225	$1-2 Billion
Hugo	September 1989	Caribbean Islands, Carolinas	500	$7-8 Billion
Andrew	August 1992	Florida, Louisiana	40	$20-25 Billion

2.2 Wind-Structure Interaction

(1) Wind Loads on Building Envelopes

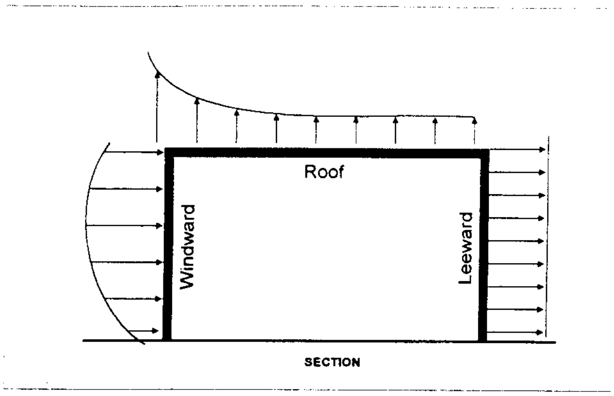
- When wind interacts with a building, a positive pressure is created on the windward wall and negative pressure is created on the windward roof, leeward roof, and leeward wall and side walls (see Figure 2.1). This pressure increases with height on the windward wall but remains constant on the leeward wall (see Figure 2.2). These diagrams show the wind loads on a building, provided the envelope stays intact. The same assumption is used in most building designs. When technical specifications indicate that a building is designed to a given wind speed and code, that design normally is based on the assumption of an intact building envelope. If the envelope is breached, then internal pressurization occurs and the wind load patterns on the building change dramatically (see subsection (2) below).

- When buildings are exposed to the wind loads higher than what they were designed to, systems failures can be expected.

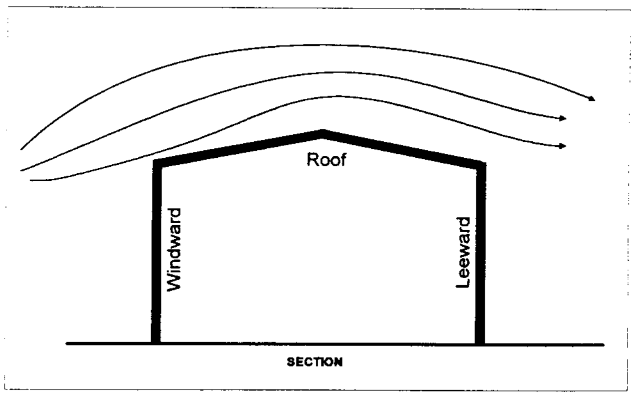
  - In particular, wind loads on the windward wall can cause the wall to flex and bend inward.

  - Without built-in tensile strength, unreinforced masonry walls often fail under hurricane conditions (see Figures 2.3 and 2.4).

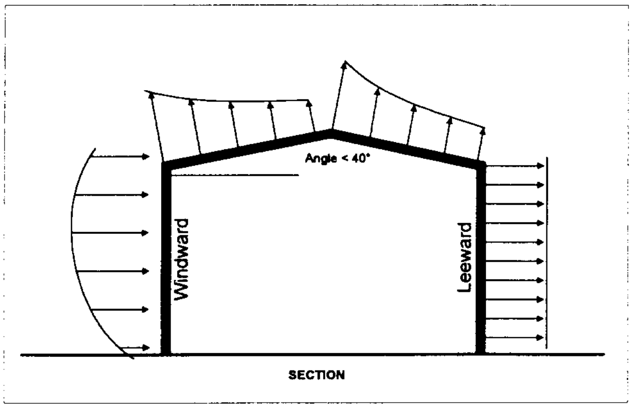
  - Exterior Insulation and Finish System (EIFS) systems also frequently fail under the high wind loads of hurricanes.



Wind pressures on flat roof



Wind flow over simple building with gable roof



Wind pressures on building envelope

Figure 2.1 Wind Effects on Buildings

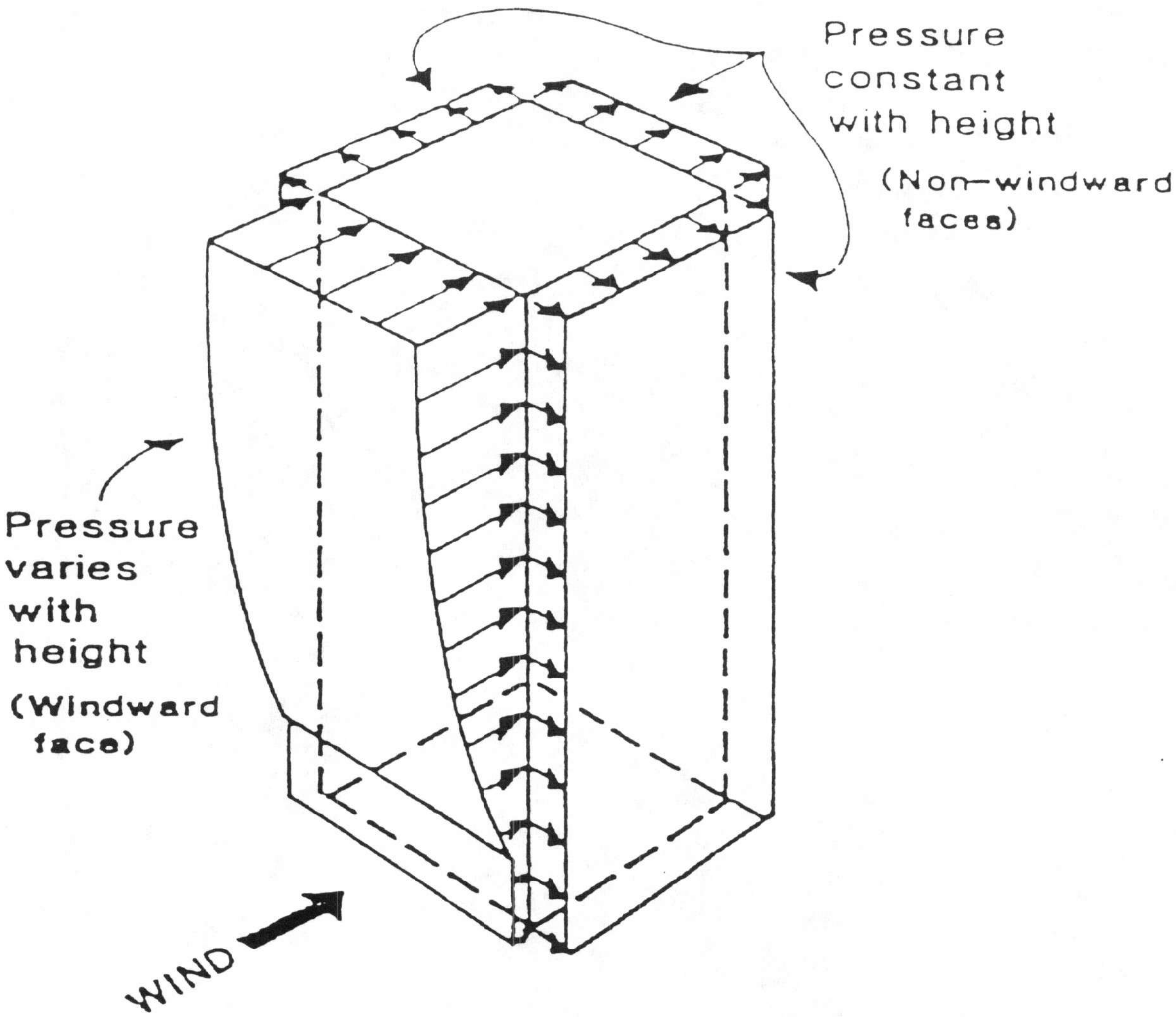


Figure 2.2 Wind Pressures on Tall Buildings

Figures 2.3, 2.4

Failures of Unreinforced Masonry under Hurricane Conditions

Figure 2.5 Lifting and rolling of precast double-T member due to inadequate connections (Hurricane Andrew)

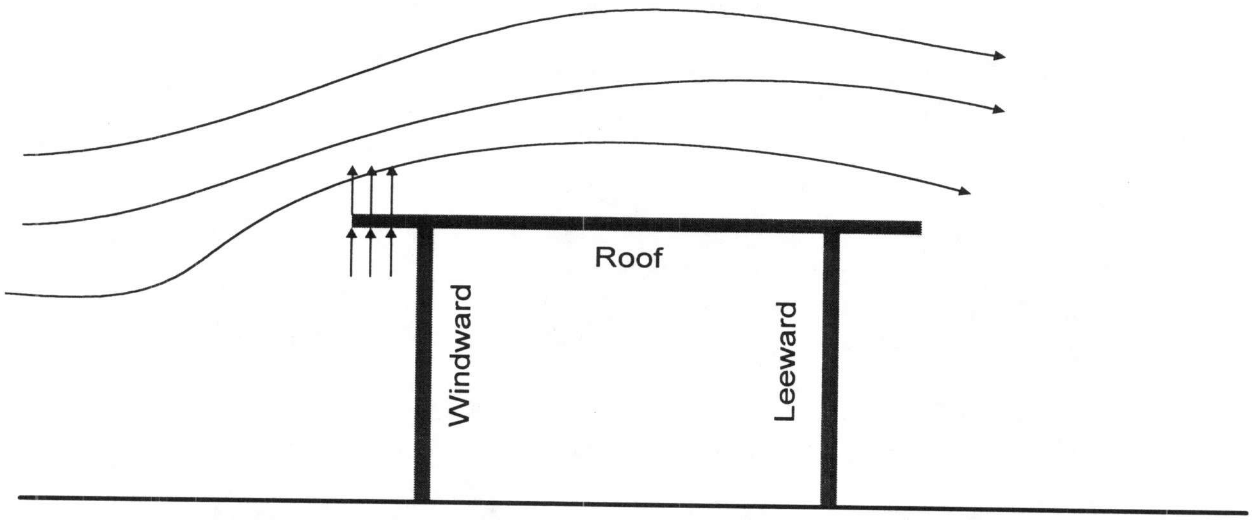


Figure 2.6 Wind Pressures associated with Roof Overhangs

- Another effect of windloads is uplift on the roof.

  - The shape and slope of the roof can have a significant impact. Winds crossing over a large flat roof create an uplift similar to that which provides the lift for aircraft wings. Many older lightweight, flat roofs are not designed to counter this uplift and, historically, have performed poorly under hurricane conditions.

  - Many older, heavy roofs rely solely on deadweight to counter uplift. Unfortunately, the stronger hurricanes often have proved to generate sufficient uplift to overcome the deadweight, resulting in sufficient movement of the roof systems to collapse the roofs (see Figure 2.5).

  - Conversely, roofs with steep slopes do not create as much uplift and generally perform better.

- A roof overhang also is subjected to uplift forces, both from above and below (see Figure 2.6).

  - Large overhangs can "catch the wind" like a sail and generate tremendous uplift forces. This can result in tearing of the connections between roof and walls and subsequent destruction of the roof system (structure and/or covering).

  - Even in cases where the overhang is anchored down thoroughly by posts, the tremendous uplift forces may tear away the decking and covering, exposing the interior roof system to hurricane-force winds and rain.

- Wind uplifts on roofs vary substantially within various zones of the roof, such as roof corners, roof edges, and ridge lines (see Figure 2.7).

  - In particular, roof corners are subjected to extreme uplift forces (see Figure 2.8).

  - Wind uplift on roofs changes substantially with respect to location and time along roof framing members (see Figure 2.9). This dynamic nature of uplift creates extreme cyclic pressures on connectors resulting in their failures (see Figure 2.10).

  - Smaller structural components, such as connectors, etc., are more likely to fail because of the dynamic nature of the wind loads.

  - Wind loads on roofs can roll rooftop equipment and pick up roof gravel and insulation boards (see Figure 2.11).

- Failure of almost all structures under hurricane conditions can be attributed to connections. Note the vulnerability of connectors for thin-gage metal decks that are subjected to uplift and cyclic loading (also see Figure 2.10).

- Traditionally, connections between various components of a building were not given enough attention, as buildings were designed to withstand gravity loads only, e.g., dead loads due to the weight of building material, live loads due to people, furniture, snow, and rain.

- Under hurricane conditions, the design and quality of connections become of vital importance as the various components (roof, walls, etc.) flex and move under the cyclic windloads.

- In general, a strong hurricane will quickly test all of a building's connections. If one fails, a cascade of subsequent component failures is likely to rapidly follow.

(2) Windborne Debris and Internal Pressurization

- Hurricane-force winds often will pick up objects and propel them through the air at great speeds (generally from 30 percent of the wind speed for heavy objects to approximately 100 percent of the wind speed for light objects). Roof tiles, framing lumber, tree limbs, and even small gravel traveling at high speeds can shatter windows (already under windload stresses), allowing hurricane-force winds and rains into a building's interior (see Figures 2.12 and 2.13).

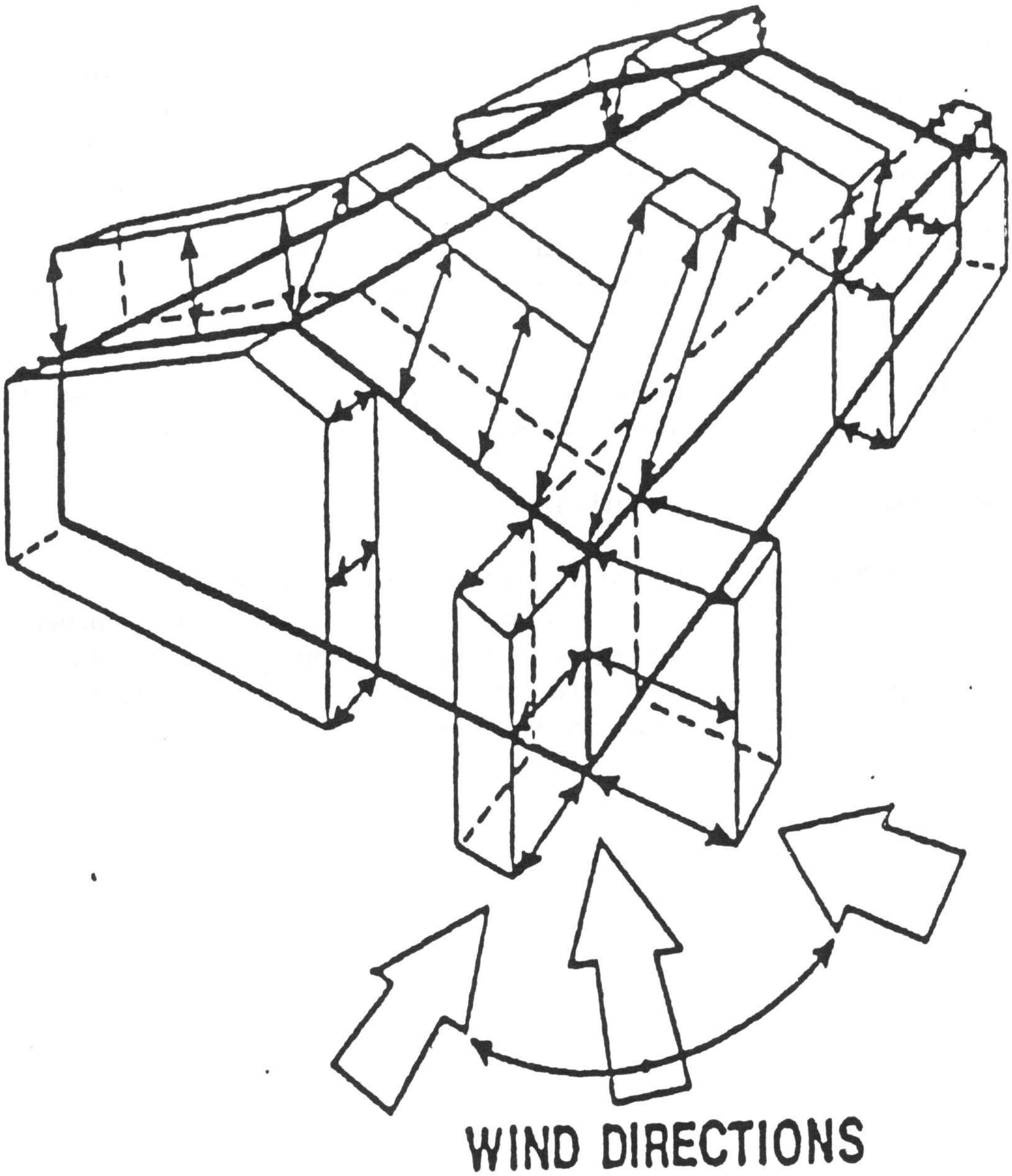
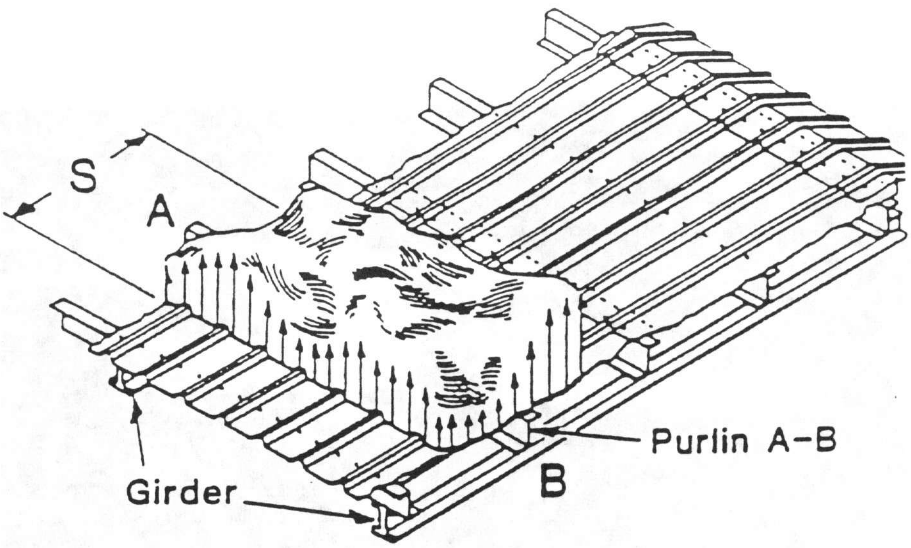
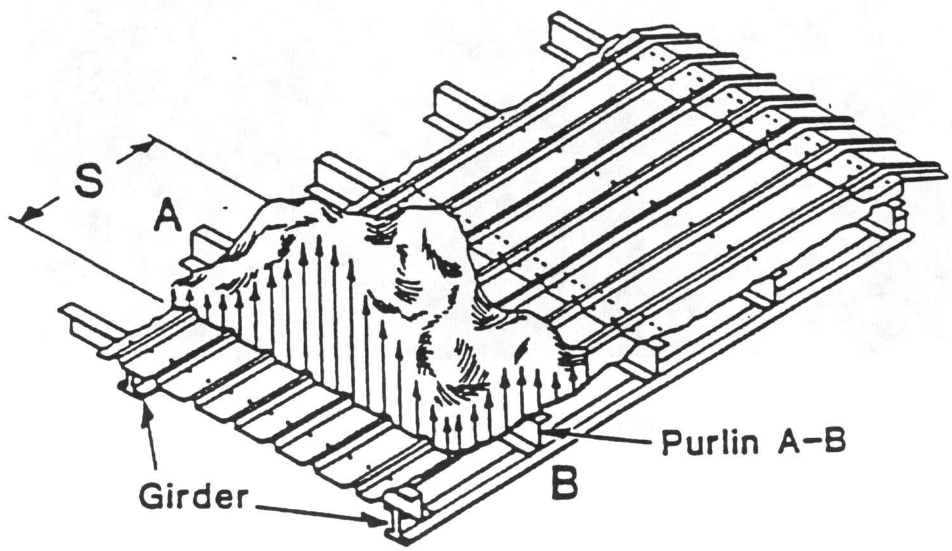


Figure 2.7 Wind Pressures on different Roof Zones

Figure 2.8 Wind Uplift on Roof Edges



Wind-induced pressures on purlin A-B at time t_0



Wind-induced pressures on purlin A-B at time t_1

Figure 2.9 Dynamic Nature of Wind Uplift Over Time

Figure 2.10 Complete Failure of Metal Deck at a Metal Building under Hurricane Conditions

Figure 2.11 Loss of roof gravel and insulation boards under hurricane conditions

Figure 2.12 Window breakages by roof gravel (Hurricane Alicia)

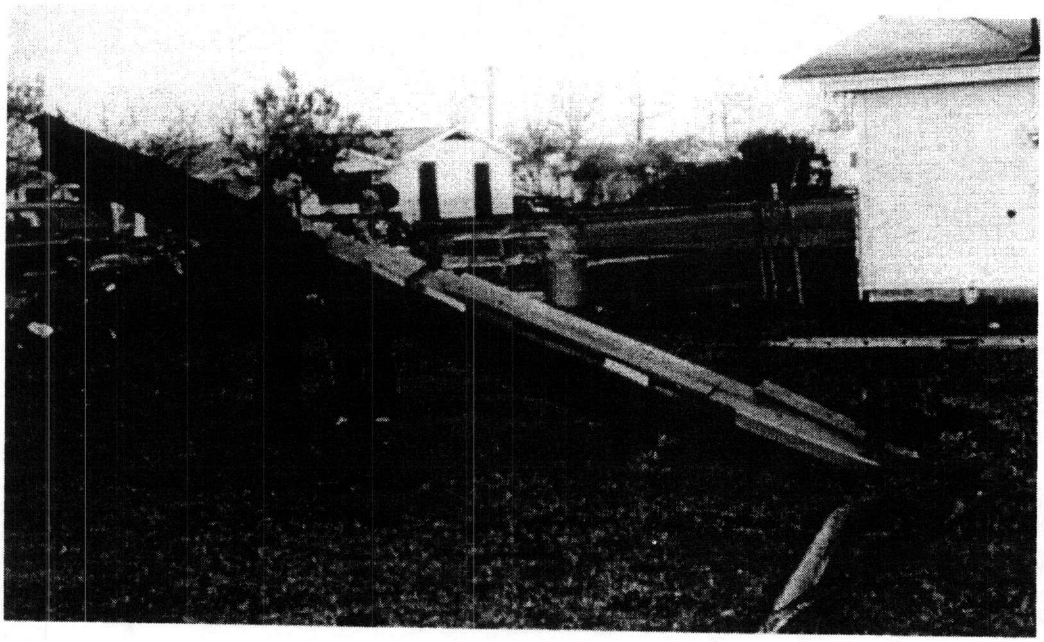


Figure 2.13 Heavy Lofted Debris

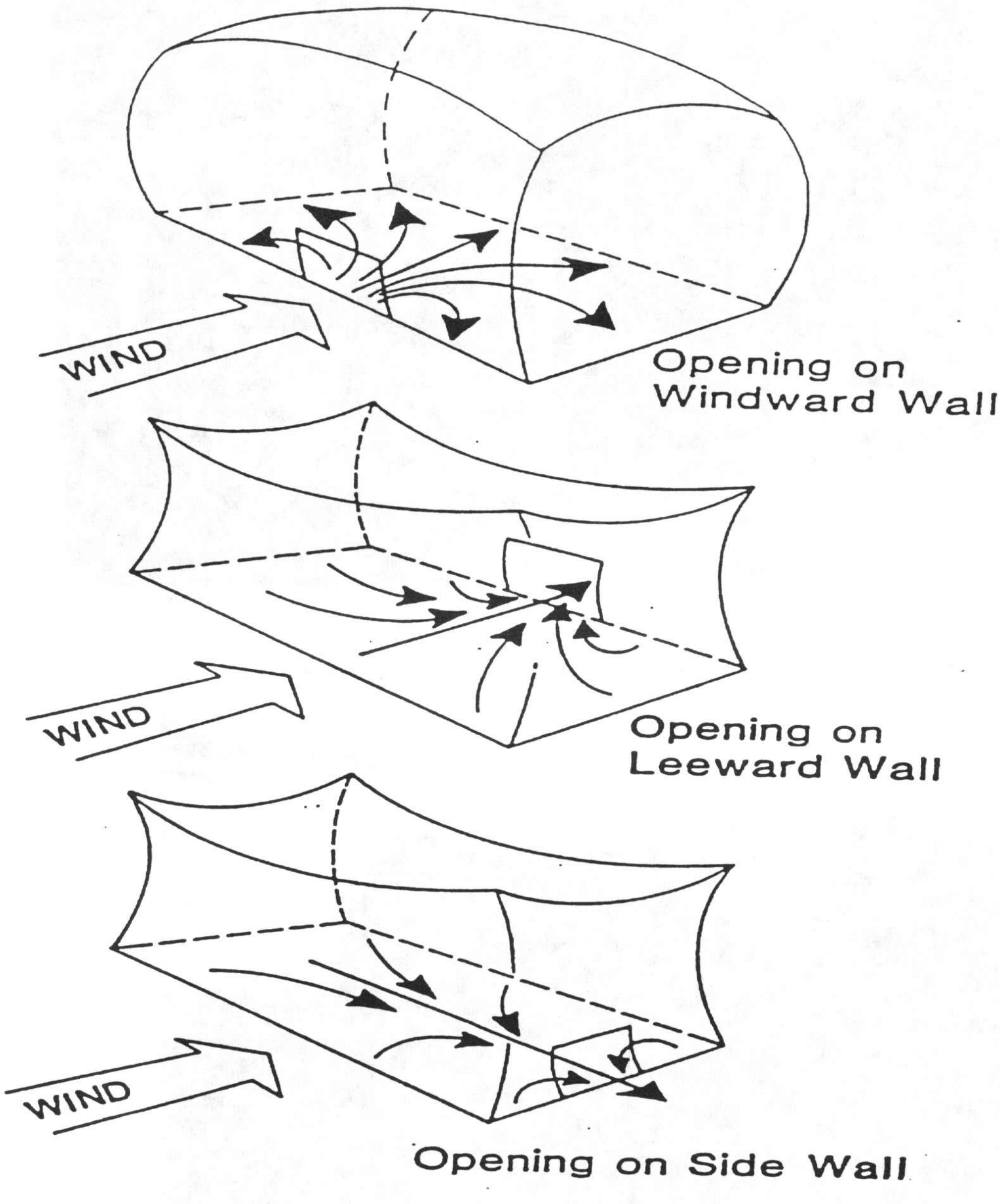


Figure 2.14 Internal Pressurization and Suction Due to Wall Openings

- Once the building's envelope is breached, the building is subjected to rapid internal pressurization that can push out walls and roofs (see Figure 2.14). Openings in the windward wall can create internal pressurization, whereas openings in the leeward wall and side walls can create internal suction.

- Building codes categorize buildings as (1) enclosed, (2) partially enclosed, and (3) open buildings. Most designers design buildings as enclosed buildings.

    - Transformation of buildings from enclosed to partially enclosed buildings, prior to ASCE 7-95 revision, was not addressed in building codes.

    - ASCE 7-95, for the first time in the history of windload standards, recognizes windborne debris as a problem for fenestrations. This standard requires that building envelopes either be protected from debris or the building be able to withstand internal pressurization.

    - Most buildings are not designed to handle the rapid internal pressurization that occurs with an envelope breach under hurricane conditions.

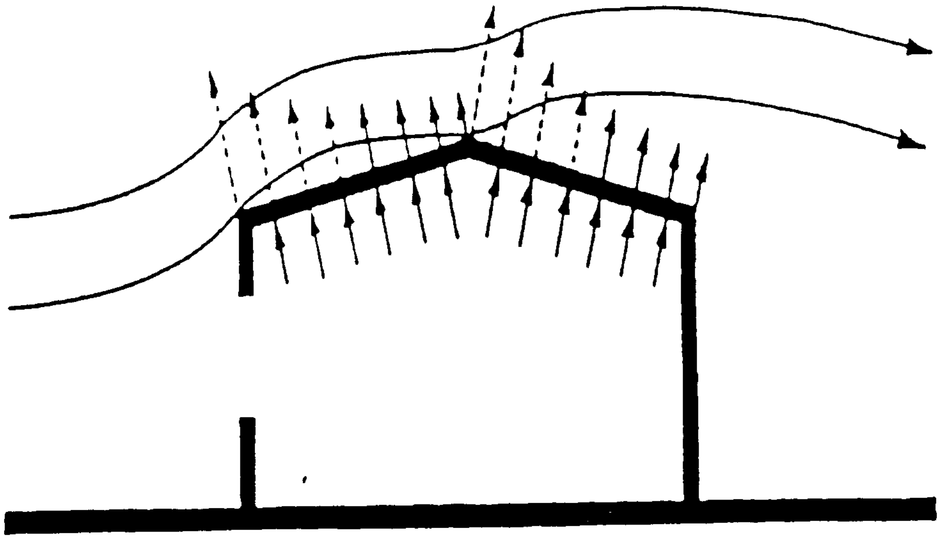
    - Openings equal to only one percent of the area of the windward wall can create full internal pressurization that almost doubles the pressures on the walls and roof assemblies (see Figure 2.15).

    - Typically, with the stronger hurricanes, once the envelope is breached, a cascade of subsequent roof and structural system failures occur, resulting in considerable damage or destruction of the building. Therefore, unless openings are protected, buildings are susceptible to internal pressurization and damage.

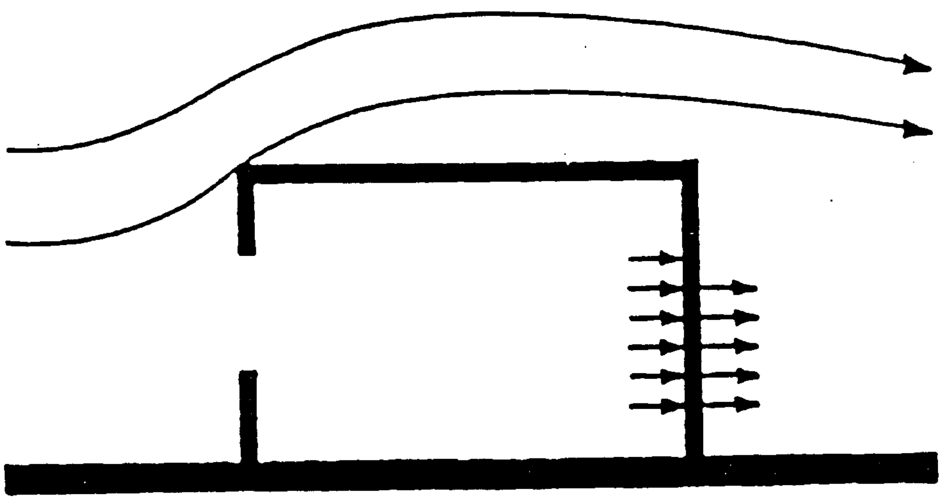
(3) Effects of Exposure on Wind Speeds

- Terrain features, such as large city centers, urban and semi-urban areas, open county, grassland, or proximity to large bodies of water, significantly affect wind loads on structures (see Figure 2.16). For this reason, selection of an HES in a sheltered area is preferred over one in an exposed location.

    - For example, at 33 feet above the ground, the same wind would be traveling at 106 mph off a large water surface, 90 mph over flat, open terrain, 64 mph through suburban terrain, and 40 mph in urban terrain. Note that this is a generalization and a peculiar alignment and spacing of buildings in a particular location (e.g., creating a wind tunnel effect) may change the windspeeds and relationships between graphs for that location.

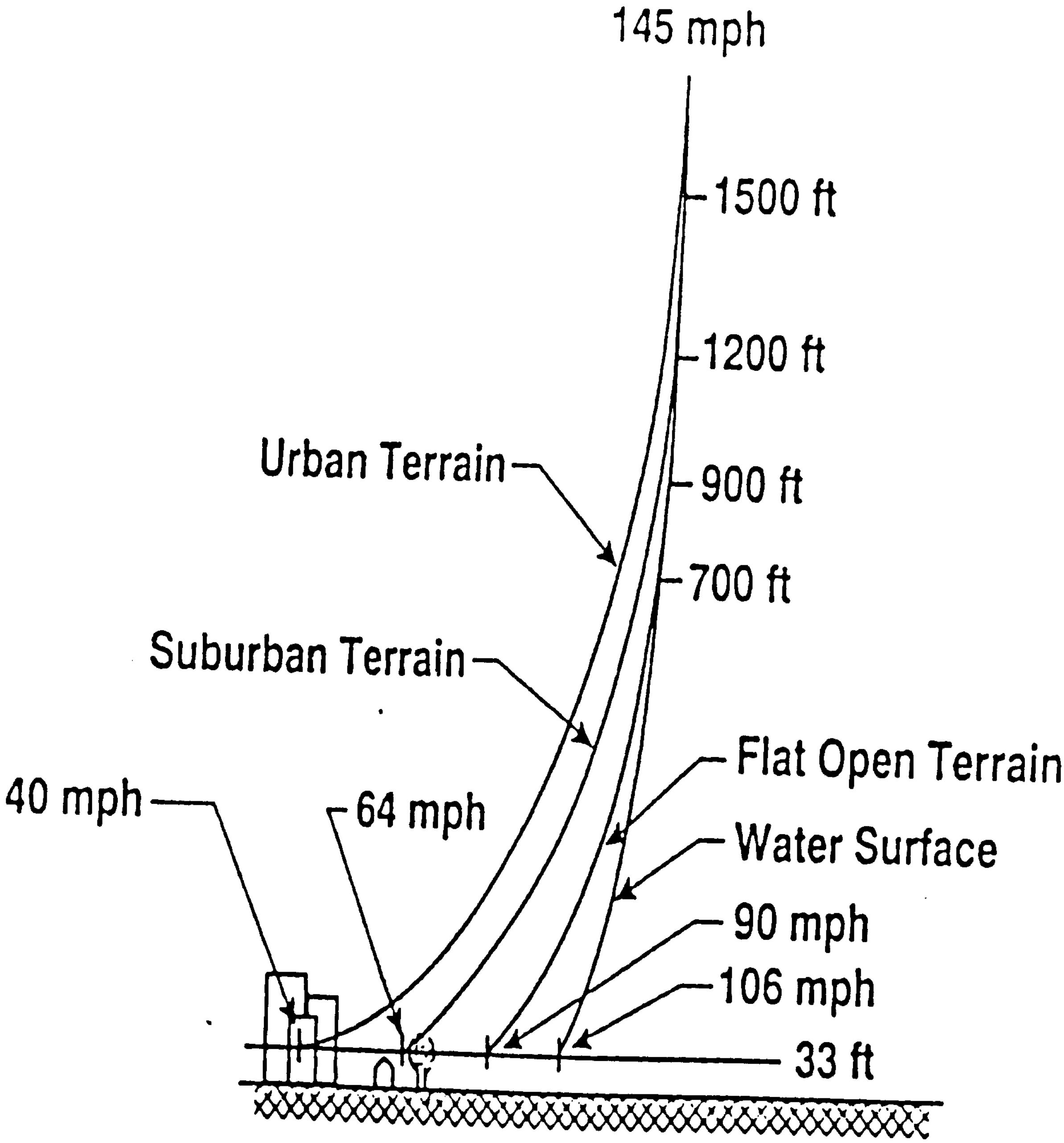


a) Internal Pressure Combines with External Pressure on Roof



b) Internal Pressure Combines with External Pressure on Leeward Wall

Figure 2.15 Increase in wind loads on walls and roofs due to internal pressurization



Figures 2.16 Effect on terrain features on wind speed

(4) Wind Shear Forces, Shear Walls, and Diaphragms

- When wind strikes a building it exerts lateral forces on the building by pushing in windward walls and pulling out leeward walls (see Figure 2.15).
  - These lateral forces of the windward walls are transferred to the top of side walls by the diaphragm action of roof and/or floor systems.
  - The roof and/or floor systems act as long deep beams (a diaphragm) to transmit lateral forces as shear forces onto the top of the side walls. The side walls then transfer these shear forces to the ground by their shear capacity.
  - The shear capacity of a shear wall can be reduced substantially by the amount of fenestrations in the wall.
  - Continuous vertical reinforcement from the foundation to the top of the walls provides resistance to overturning of shear walls.

2.3 Storm Surge-Structure Interaction

- As a hurricane moves across the open ocean, the storm accumulates vast amounts of energy. As it makes landfall and moves inland, this vast energy is dissipated by the land areas as the storm interacts with the land features and loses its ocean energy source. When a building becomes a barrier to the free movement of the wind or water, forces will be transmitted from the wind or water to the building. A building designed and constructed to be hurricane resistant must be designed to withstand these forces.
- Water will interact with a building in three ways: surge, waves and scouring.
  - Storm surge will interact with a building similar to a river flood. It may cause the building to float off its foundation and floating debris to collide against the building. If the building is left intact, surge water entering the building may destroy or damage the contents, walls, flooring, insulation, wiring, etc. Surge forces on the building are primarily the momentum of water striking the building and the drag force in the direction of the water flow, and/or flotation which tends to lift the pilings or produce upward forces on the first floor of a building.
  - Scour is the erosion of sand and soils caused by wave action, that may penetrate landward tens to hundreds of yards in the course of a storm. On low-lying, sandy coastal barriers, scour depths of four to six feet are common, sometimes leaving well-delineated scarps, causing sand buildups from overwash several hundred yards landward. Houses or buildings in the scour zone (typically in the first row

or tier from the shoreline) often have several feet of supporting soils removed from around their pilings. This increases the lateral forces acting on the pilings. Grade platforms in the scour zone typically are undercut. They then often collapse because of inadequate reinforcement and the uplift forces of the waves under them.

- •• While scour generally will not erode below sea level when it confronts no steep or vertical obstructions, it may undermine protective seawalls or bulkheads, eroding well below sea level. Waves striking the Holiday Inn at Gulf Shores, Alabama during Hurricane Frederic scoured a hole about 20 feet deep on the vertical face of the inn's Gulf-front.

- •• Almost all of the houses that collapsed on the Gulf shoreline on the west end of Galveston Island during Hurricane Alicia collapsed due to scour and inadequate piling penetration into supporting soils. Piling penetration ranged from three feet nine inches to six feet below the pre-storm ground surface in areas that experienced six feet of scour. The buildings had to collapse, they could not resist the uplift and horizontal forces of the storm once the supporting soil was scoured away.

- Hurricane waves increase the effective height of the storm surge as much as 50 percent higher than the storm surge level at the coast.

  - •• Although surge typically has forward motion, the force of the wave is much more destructive because the velocity of the wave may be several times faster than the surge.

  - •• The energy from one 5½ foot wave breaking (at 10 mph) along 40 miles of beach is equivalent to the maximum power generated at Hoover Dam. Thus the amount of kinetic energy released by even a modest wave breaking is tremendous.

  - •• Because of these potential forces, most codes and standards require all structures to be elevated above the wave crest elevation.

  - •• Elevation above the wave crest eliminates all lateral water loads against the building itself, leaving the loads to pilings for design considerations.

  - •• The pilings must be designed to resist the impact forces of the waves and the drag forces of the water in the direction of the water's velocity.

- ARC 4496 recommends using only HES buildings above the Category 4 storm surge zone to avoid such storm surge effects.

- An additional issue is the height of water entering the HES under storm conditions. Sufficient height of water can threaten the lives of HES occupants, as well as damage the building's walls and floors.

- A differentiation should be made between a landfalling and exiting hurricane. Much of the information above and in the chart below is based on landfalling hurricanes.

    - Typically, the effects of an exiting hurricane will be significantly less than a landfalling hurricane of the same category.

    - Shelter compliance with the storm surge criterion in the LRDM table should allow for the different storm surge zones predicated for a landfalling versus an exiting storm.

    - For example, a particular shelter may be in a Category 3 storm surge for a landfalling storm, but in a Category 4/5 for an exiting storm.

    - Be sure to evaluate the expected height of water in the potential HES building in each case.

The following chart indicates the storm surge levels for Categories 1 through 5 storms:

Saffir-Simpson Hurricane Scale			
Category	Windspeed (mph)	Possible Storm Surge (feet)	Potential for Damage by the Storm Surge
1	74-95	4-5	minimal
2	96-110	6-8	moderate
3	111-130	9-12	extensive
4	131-155	13-18	extreme
5	>155	>18	catastrophic

- HES buildings should have site elevations above Category 4 storm surge levels.

    - If this criterion cannot be met, the building's lowest floor level should be no more that two feet below the Category 5 storm surge levels.

- Bear in mind, that HES buildings with the bottom floor level with up to two feet of surge in them, will most likely be isolated by the surge.

- The storm surge level can further increase due to an elevation in windspeeds, as well as the presence of construction (wind piling water up on obstructions) around the facility.

  - It is important, therefore, to assume storm surge levels for one category of hurricane higher than indicated. When selecting an HES, a safety factor against storm surge amplification should be added to the above-calculated storm surge levels.

2.4 Rainfall Hazards

- The onslaught of a hurricane usually is associated with intense rainfall, in some cases as much as two inches of rain in one hour. Rarely are stormwater drainage systems designed to handle this much this fast. Thus, rainfall-generated flooding is a recurring problem before, during, and after hurricanes.

  - Typically, landfalling hurricanes are preceded by heavy rains. This results in ground saturation and usually some flooding. When the high winds of the hurricane arrive, the combination of saturated grounds and winds usually results in massive and widespread falling trees. These in turn disrupt power distribution systems (tearing down power lines), underground pipelines (roots tearing up pipes when the tree falls over), and damage nearby buildings (trees falling on them).

  - The rising floodwaters also can isolate buildings by flooding all access roads, thus disrupting transportation systems. They also can pose a direct threat to life by flooding areas and buildings. In some cases they may cause dam or reservoir failures due to excessive amounts of floodwater, resulting in a threat to life and property downstream.

  - Another problem with the rainfall is the structural and property damage resulting from the entrance of the heavy rains into breached or damaged structures.

  - Finally, there can be buildings with flat roofs and parapet walls, but insufficient scuppers to drain the roofs. Such buildings will accumulate considerable water on the roof (i.e., ponding). Up to a point the water can serve to help hold down the roof system. However, as the amount of water accumulates, the weight may become dangerously high and collapse some lightweight roof systems.

- For the above reasons, ARC 4496 guidelines require checking to ensure that the potential HES is above the 100-year floodplain (preferably above the 500-year floodplain) and that at least one access road is above the 100-year floodplain.

- For the purposes of HES facilities, an access road consists of the route from the HES to a major highway (Interstate or US road) or a point of supply (airfield, train station, etc.).

CHAPTER III
PRE-SURVEY SCREENING

3.0 General

The Pre-Survey Screening is the time the Emergency Manager plans the shelter survey. This includes a meeting with all agencies and individuals that will assist with the survey. The meeting should address all preliminary preparations and administrative issues that are required prior to the site visit. During this portion of the survey, all participants, under the direction of the local emergency manager, will review all potential HES stocks. They will establish a "Short List" of facilities to survey. This section will outline the steps and procedures of this portion of the survey.

3.1 Introductory Notices

This step is fairly straightforward. The Emergency Manager, or their authorized representative should notify the appropriate agents to:

- Collect documents (construction drawings, specifications, etc.) required for the survey.
- Make arrangements with the building owners or facility managers to assist with the survey.
- Set up meeting with Pertinent Agencies/Individuals.

3.2 Meeting with Pertinent Agencies/Individuals

This meeting is the time to make preliminary preparations, address administrative issues, plan and organize the survey. When this step is complete, everyone should understand their role and responsibilities. The steps are as follows:

- Establish a tentative schedule for field surveying the various targeted buildings.
- Identify the areas of the facility that will be used for a HES.
- Identify the roles for all pertinent agencies/individuals (i.e., local Building Official, School Board Personnel, ARC Personnel, etc.). Who collects:
    - Surge data.
    - Flood data.
    - Hazmat data.
- Verify that all documents required for the survey are available.

- SLOSH (Sea Lake and Overland Surges from Hurricanes) maps.
- FIRM (Flood Insurance Rate Map) maps.
- USGS (United States Geological Survey) topographic maps.
- FISH (Florida Inventory of School Houses) drawings and data.
- Appropriate street maps.

● Answer questions and/or concerns relative to the survey.

3.3 Plans & Specifications Acquisition

An accurate survey can not be accomplished without detailed drawings and specifications. This step is critical in the survey process.

● Request drawings and specifications from appropriate Agencies/Individuals.

- Verify that the plans are the most recent, preferably "As Built".

- Verify that the plans are for the building surveyed. (Some Schools are built from "Cookie-cutter/re-used" plans; The building architectural design is approved for the entire state by DOE, but local School Boards often make changes to these plans, which may affect structural components.)

● The Drawings which are most important are as follows:

- Site Plan
- Foundation Plan
- Typical Wall Elevations
- Roof Framing Plan
- Structural Plan
- Floor Plan.

3.4 Pre-Survey Check List

The pre-survey check list consists of Part One and Part Three of the Survey Checklist. The Survey Checklist was divided into three parts to facilitate different agencies/individuals completing the different portions. For example, Part One could often be more readily completed by local emergency management personnel than by the surveyor. Part Two requires the surveyors' on-site review of the facility. Part Three is optional and covers mass care issues. To facilitate tracking of the data when the different parts are completed by various agencies/individuals, identification sections are provided in each part.

Use the technical drawings/specifications and information from the authority-having-jurisdiction/facility manager to answer as many of the Part One checklist items as feasible. Once this is done the next step is an on-site review of the specified facility to confirm the data, as well as collect data which was not provided on the drawings (See Chapter IV).

- Complete as many items on the checklist as possible from the technical drawings.
- Use the checklist to ensure that you gather all the information you need the first time you visit the site.
- Note that certain "YES" and "NO" answer boxes are shaded on the survey checklist. This was done as a convenience for the surveyors. Any check in a shaded box indicates that a potential problem exists in this area and that further investigation may be warranted. A scan of a completed checklist for "checked" shaded boxes should quickly identify the key problem areas of a building.

Part One:

3.4.1 Section 0 - Identification

- Item 0.1 - Facility Name:
  - Clearly identify the specific building being surveyed (i.e., Cherry Elementary School, Bldg 02/Kindergarten, etc.).
- Item 0.2 - Latitude / Longitude:
  - Use a Global Positioning System (GPS) or, measurements from a USGS map to determine the latitude-longitude of the building.
  - Often after a major hurricane has passed most if not all local road signs are destroyed, making it difficult for emergency responders from out-of-area to locate specific buildings.
  - An accurate latitude-longitude will enable emergency units equipped with GPSs to quickly locate the shelter after a hurricane.
  - Accurate latitude-longitude will also enable the generation of GIS (Geographic Information System) products such as maps of critical facilities.
  - Latitude-Longitude collected previously by other parties may or may not be accurate, be sure to verify them.

- Item 0.3 - County, 0.4 - Owner, and 0.5 - Facility Type:
    - These are self-explanatory.
- Item 0.6 - Contact, Alternate 1 and Alternate 2:
    - Attempt to use at least one custodian/building manager who works at the building as a contact. - preferably one with an extensive knowledge of the building's history.
- Item 0.7 - Areas to be used as HES
    - Identify the areas of the facility that will be used for a HES. At times this may be driven primarily by local policies.
- Item 0.8 - Alternate Communications:
    - Check to see if the facility has alternate communications with the EM office, and if so what type. If landline phones are disabled by power loss, what other communications methods are available?" (i.e., Ham Radio, local emergency radios, cellular phone systems, etc.) This may need to be verified at the site.
- Item 0.9 - Power Company:
    - Identify the Power Co. which provides electrical power to the facility. This is to determine whom to ask for scheduled times for power restoration, as well as other reasons for coordination.

SECTION 0 - IDENTIFICATION [SAMPLE]	
0.1 Facility Name: ______ Building ID #: ______ Street Address: ______ City: ______ State, Zip+4: ______ 0.2 Latitude: ______ Longitude: ______ 0.3 County: ______ 0.4 Owner: ______ Public ❑ Private ❑ 0.5 Facility Type: O vital - O shelter - O utility O other ______	0.6 Contact: ______ Title: ______ Phone: ______ Alt. Phone: ______ Alternate 1: ______ Title: ______ Phone: ______ Alt. Phone: ______ Alternate 2: ______ Title: ______ Phone: ______ Alt. Phone: ______
0.7 Indicate Area/s of Facility that are planned to be used as shelter; ❑ Cafeteria; ❑ Gymnasium; ❑ Auditorium; ❑ Classroom; ❑ Corridor; ❑ Kitchen; ❑ Clinic; ❑ Other: ______	
0.8 Does the building have Alternate Communications with local Emergency Management? ❑ YES ❑ NO If yes, indicate type: ______	
0.9 Under normal conditions, which Power Company provides electrical power? ______	

3.4.2 Section 1 - Storm Surge Inundation

This section identifies areas which increase the vulnerability of the building/site to storm surge.

- Item 1.1 - Is the Facility located on a coastal barrier island?:
  - ARC 4496 states "Do not locate hurricane evacuation shelters on barrier islands."
  - Shelters should not be located on barrier islands due to isolation potential and potential for direct damage from winds/surges.
- Items 1.2-1.3 - Determining Storm Surge Vulnerabilities:
  - Storm surge is a rapid rise in water level above normal levels, caused by hurricane winds and decreasing barometric pressure. As the hurricane approaches land and shallow water, the water level rises rapidly in waves, well above the mean high tide.
    - Storm surge levels can range from four to five feet in a Category 1 storm

to greater than 18 feet above normal tide in a Category 5 storm (where sustained winds exceed 155 mph).

- •• The maximum storm surge usually occurs 10 to 20 miles to the right of the storm track's forward motion. However, maximum surge may occur to the left of the storm if the winds pile water against an obstruction, such as the landward side of a coastal barrier island.

- •• For a hurricane, the surge typically has a duration of several hours and affects about 100 miles of coastline.

- Storm surge levels due to hurricanes can be a potential hazard for an HES. Storm surge heights can be significantly higher than the ground level of the HES. Therefore, it is very important to determine the storm surge hazards and the risks associated with using a building as an HES.

    - •• The National Weather Service (NWS) has developed a mathematical model known as SLOSH (Sea, Lakes and Overland Surges from Hurricanes) that is critical in determining the potential level of surge inundation in a given area.

- To obtain information on storm surge for a particular site/building, refer to the "Hurricane Storm Tide Atlas" prepared for each county. The maps in this atlas identify the maximum level of surge inundation, by hurricane category, that could occur for that county.

● <u>Item 1.2</u> - Is the Facility Outside of the Category 4 Storm Surge Zone:

- ARC 4496 states: "....locate all hurricane evacuation shelters outside Category 4 storm surge inundation zones."

- If it is necessary to use a facility inside a Category 4 storm surge zone, the Hurricane Evacuation Shelter should have a site elevation **above** the maximum expected Category 4 storm surge height.

    - •• If this criteria cannot be complied with then the next possible option is that the <u>lowest floor level of the building should not be inundated greater than two feet in a Category 5 surge.</u>

    - •• Similarly, at least one access route from the potential HES building to a supply point or major highway should not be inundated in a Category 5 surge.

● <u>Item 1.2.1</u> - Elevation Above MSL of Facility:

- The elevation of the building's floor/or site elevation above the Mean Sea Level (MSL), can be obtained from the USGS survey maps or, sometimes, from the building's technical drawings.

- **Be careful in using the elevations provided on technical drawings.** Sometimes a presumed base elevation is used. For example, a site is presumed to have a base elevation of 100 feet (even though the actual elevation is around 30 feet), and the building elevations are calculated from that presumed base elevation.

- Item 1.2.2 - Predicted Storm Surge Height at Facility:

  - The maximum expected storm surge height can be obtained from the pertinent Storm Tide Atlas.

  - To determine the depth of surge flooding at a particular location, the ground elevation at that location must be known. At the inland extent of depicted surge inundation, water depths may be shallow, even for Category 5 storms.

  - Time/History points have been included on each map page in the atlases to define surge elevations for the tropical storm, Category 1 through 5 hurricanes in selected locations. In some instances, where Category 4 and 5 storm surge predictions are within the same general elevation contour, the categories are combined into a Category 4/5. In this situation, consider the Category 4/5 zone to be equivalent to a Category 5 level.

  - The height above mean sea level, by number, of each time/history point is shown on the last page of the atlas (i.e., Point Elevation column).

    - In most atlases each surge height will be based on total height above mean sea level.

      - However, in the case of the example chart (see Figure 3.1.5), the height of each Time/History Point is broken out in the Point Elevation column. Thus <u>for this example</u> it is necessary to add the point elevation to the surge elevation to determine the total surge height above mean sea level.

    - Be sure to ascertain from the instructions in the front of any atlas used, whether the surge heights in the atlas are total heights above mean sea level or whether a point elevation must be added in first.

    - The Category 4/5 zone represents the extent of flooding for either Category 4 or 5, whichever is greater.

  - The depth of surge, for a given hurricane category, at the Time/History points can be determined by deducting the known ground elevation (using local survey data, referenced to the National Geodetic Vertical Datum-NGVD) from the respective hurricane category surge elevation (total height above mean sea level).

- - United States Geological Survey (USGS) Quadrangle Sheets, or other appropriate topographic references which are based on the same datum, can also be used to determine ground elevation at a specific location, but the accuracy of these elevations will be limited to the precision and tolerances associated with that map, typically within five feet for coastal areas.

- Item 1.2.3 - Maximum Storm Surge Height in Building
  - The storm surge height above MSL along with the site elevation, can be used to estimate the height of storm surge that would actually enter the building, depending on the Category of Storm.
  - For example, a building with an elevation of 12 feet above MSL lies in a Category 2 storm surge zone. The expected maximum storm surge height is 14 feet above MSL. This indicates a maximum of two feet of water in the building in a Category 2 storm.

- Item 1.3 - Is the Facility subject to isolation from Storm Surge:
  - ARC 4496 states: "Avoid buildings subject to isolation by surge inundation in favor of equally suitable buildings not subject to isolation."
  - Review the appropriate Storm Tide Atlas and determine if the site could be isolated (all access roads will be inundated by the storm surge).

- On the following pages are several maps to help in understanding the atlas.
  - The following example will illustrate how to use SLOSH Maps and determine surge inundation for a shelter. Consider the Royal Palm Exceptional Center located in Lee County. Refer to the Lee County Storm Tide Atlas.
    - **Determine the Specific Location of Building:** The location of the shelter can be determined from street maps or the National Geodetic Survey Maps (see Figure 3.1.1). The arrow points out the location of the building.
    - **Determine the Location of the Shelter on the Index Map:** After determining the location of the shelter on the Geodetic Survey Maps, locate the approximate location of the building on the Index Map of the SLOSH Maps (see Figure 3.1.2 and Figure 3.1.3), which gives a general view of the county and the storm inundation zones.
    - **Determine the Plate Number:** The Index Map is divided into several plates that are studied separately. Identify the plate on which the shelter is

located and then refer to that plate map. In this case, the building is located in Plate 4 (see Figure 3.1.4).

- **Refer to the Plate Map and Determine the Storm Surge Height of Location:**

  - The Plate Maps follow the Index Map. Go to the Plate Map in which the shelter is located (in this case Plate Map 4). The different category storms are shown with various colors and the table on the left-hand side of the map identifies which color represents each category storm.

  - Identify in which hurricane surge category the shelter is located. In this example, it is Category 4/5. Here, Category 4 and 5 hurricanes are not shown separately. Since the shelter lies in Category 4/5, this indicates there is a potential hazard of surge inundation of the shelter.

  - The next step is to determine the amount of inundation (in feet) that will be present in the shelter in a Category 4/5 storm.

    - Refer to the Time History Points on the left-hand corner of the Storm Surge Maps (see Figure 3.1.5), which are defined surge elevations for the various category storms.

    - Locate the time history point closest to the shelter (shown as a white triangle with a number in it). Here, it is 19.

    - Then refer back to the table and find out the amount of water at this time history point for the category storm (in this case, Category 4/5). In this example it is 14' 0", which is above the point elevation mentioned in the Time/History Points table. In this example the point elevation is eight feet. Therefore, the total amount of water at the shelter would be 22 feet (14'+8') above MSL.

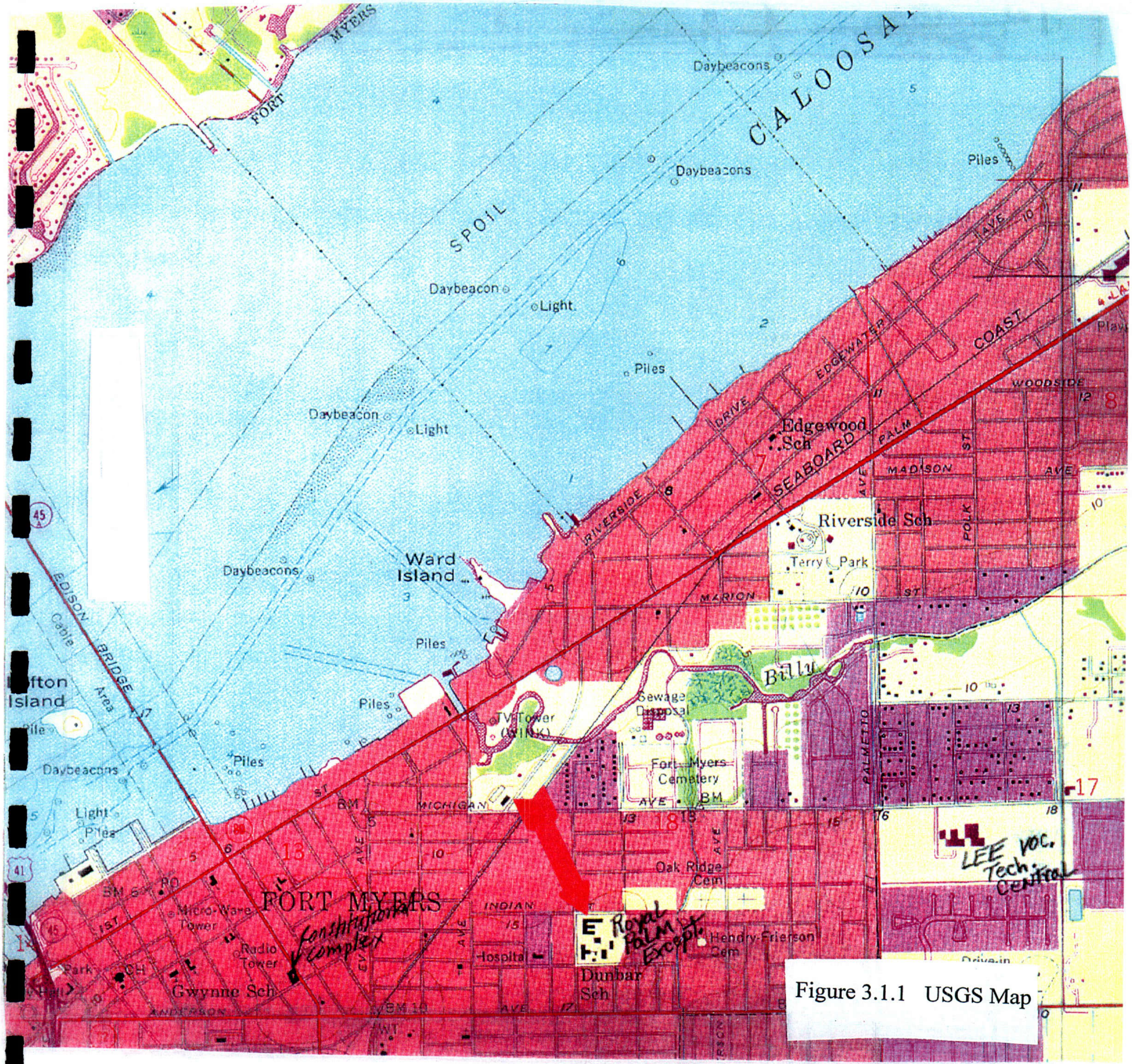


Figure 3.1.1 USGS Map

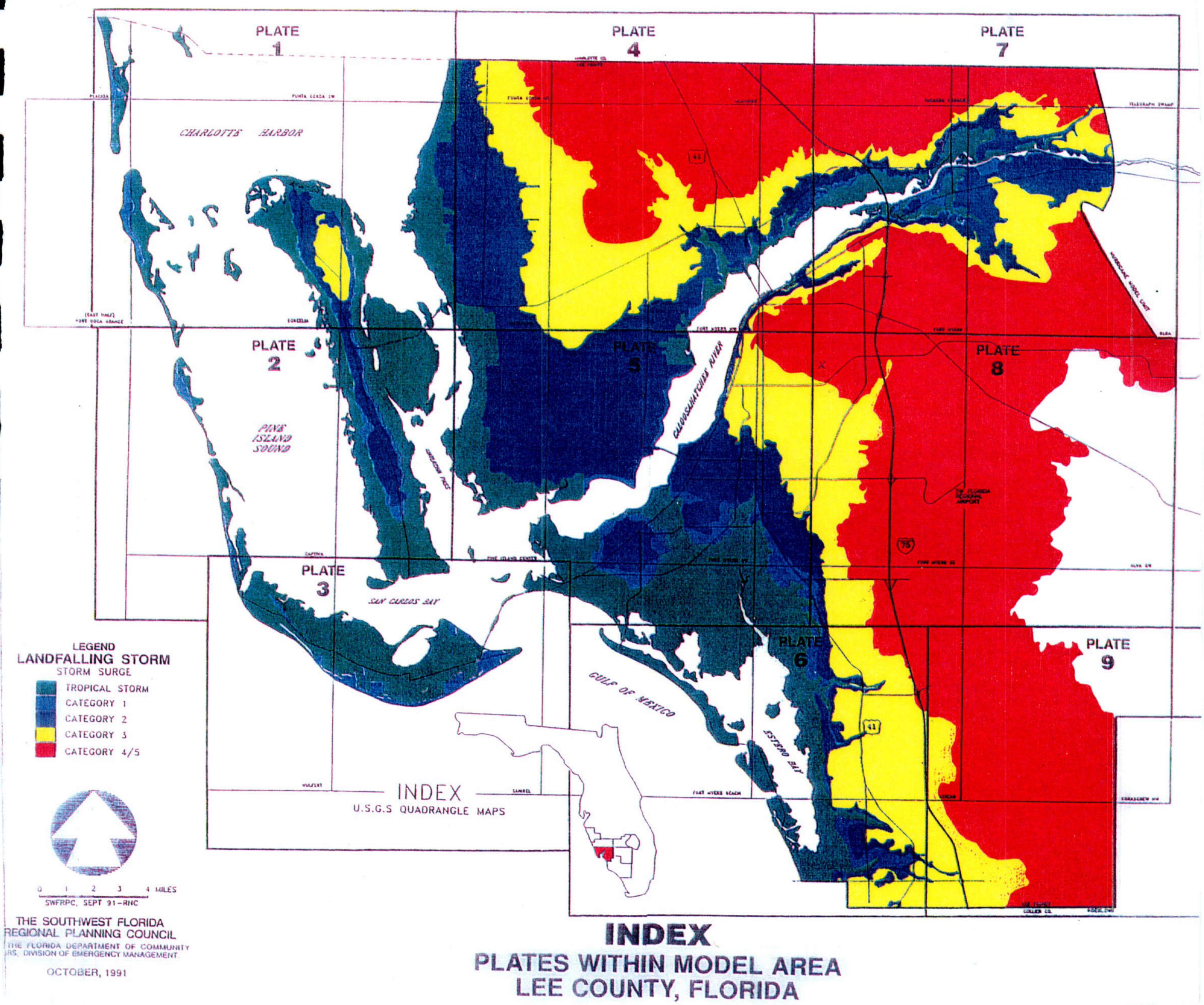


Figure 3.1.2 Lee County Storm Atlas Index

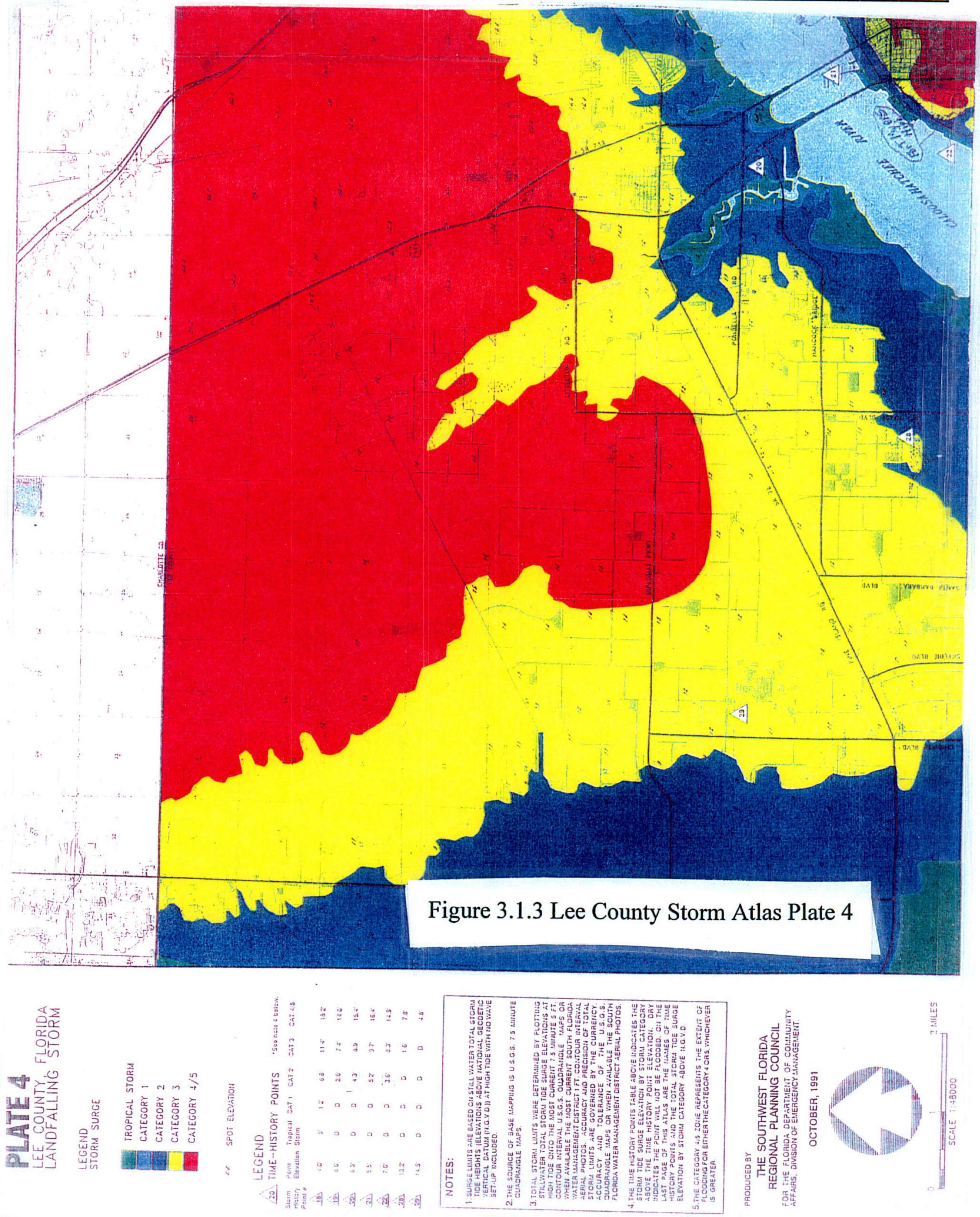


Figure 3.1.3 Lee County Storm Atlas Plate 4

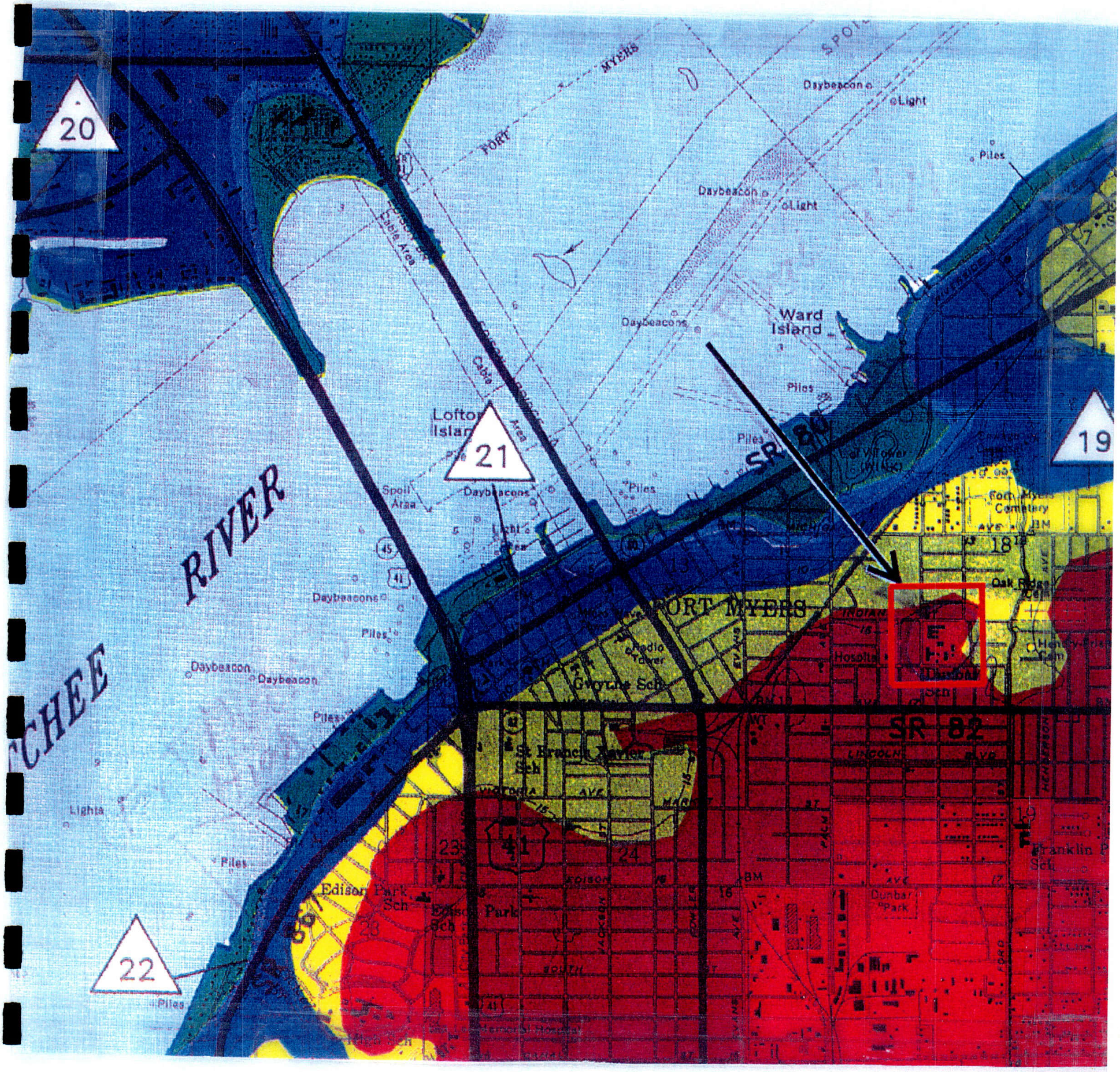


Figure 3.1.4 Closeup of Site Location & Time History Points

PLATE 4

LEE COUNTY, FLORIDA LANDFALLING STORM

LEGEND
STORM SURGE

- TROPICAL STORM
- CATEGORY 1
- CATEGORY 2
- CATEGORY 3
- CATEGORY 4/5

SPOT ELEVATION

LEGEND
20 TIME–HISTORY POINTS *See note 4 below.

Storm History Point #	Point Elevation	Tropical Storm	CAT 1	CAT 2	CAT 3	CAT 4/5
18	4.0'	.5'	1.2'	6.8'	11.4'	18.2'
19	8.0'	D	D	2.6'	7.4'	14.0'
20	6.3'	D	D	4.3'	8.9'	15.4'
21	5.5'	D	D	5.2'	9.7'	16.4'
22	7.0'	D	D	3.6'	8.3'	14.9'
28	13.2'	D	D	D	1.6'	7.8'
29	14.5'	D	D	D	D	4.8'

Figure 3.1.5 Plate 4 Time History Points Table

- **Determine the ground elevation of the shelter:** The 22 feet of water determined above basically is obtained from the base elevation. But it is necessary to calculate the height of water from the ground elevation of the shelter. Therefore, the ground elevation of the shelter must be determined.
  - The ground elevation can be determined from the National Geodetic Survey or USGS Maps. They are marked as contours on the maps. In this case the shelter lies between the 15 and 20 feet contour lines.
  - It can be assumed that the shelter has a ground elevation of 16 feet and the height of water in the shelter would be six feet (22'-16') above the floor. This is the actual maximum estimated height of water that would be present in the shelter during a Category 4/5 storm in a worst-case hurricane track.
  - It should be noted that if as-built drawings are available, then actual floor elevations may be drawn from them.
    - Beware that technical drawings often are used, without corrections, at more than one site.
    - Also beware that on some technical drawings an assumed base elevation is used. For example, all elevations at a given site are based on an assumed 100 foot elevation, even though the actual elevation above MSL may be only 30 foot.
    - Confirm any floor elevations used from a technical drawing.

SECTION 1 - STORM SURGE INUNDATION		
YES		**1.1 Is the Facility located on a coastal barrier island?**
NO		
YES		**1.2 According to the appropriate Storm Tide Atlas, is the Facility's site located above any Category 4 storm surge zone?** *(If not applicable, answer YES)*
NO		
1.2.1 What is the site elevation above MSL? ________ feet above MSL What is the building's ground floor elevation above MSL? ________ feet above MSL		
1.2.2 What is the maximum predicted storm surge height at the Facility's site? Cat. 2 ________ feet MSL Cat. 3 ________ feet MSL Cat. 4/5 ________ feet MSL		

SECTION 1 - STORM SURGE INUNDATION		
1.2.3 What is the maximum height of surge expected in the building? Cat. 2 _______ feet MSL Cat. 3 _______ feet MSL Cat. 4/5 _______ feet MSL		
YES		**1.3 According to the appropriate Storm Tide Atlas, is the Facility's site subject to isolation due to storm surge activity?**
NO		

3.4.3 Section 2 - Rainfall Flooding/Dam Considerations

This section identifies areas which increase the vulnerability of the building/site to rainfall/dam flooding.

- Item 2.1 - Is the Building's First Floor Elevation Equal To Or Higher Than Base Flood Elevation (BFE) For The Site:
  - The purpose here is to determine whether or not the first floor will be above the estimated maximum flood elevation (from riverine or rainfall flooding)
  - The building's first floor elevation may be obtainable from building blueprints. If not, then use the site elevation as an approximation.
- Item 2.1.1 - What Is BFE At The Building:
  - If the building is not in a flood zone, put "N/A" for not applicable. If the building is in a flood zone, but the BFE is undetermined, put "Unknown".
  - The BFE is obtainable from the Flood Insurance Rate Map for the site.
- Item 2.1.2 - What Is BFE At The Building IF Multi-Story:
  - This item addresses whether or not a multi-story building has a floor above the expected flood elevation.
  - Identify the lowest floor above the elevation and what its elevation is.
  - If the building is single storied, mark "Not Applicable".
- Items 2.2-2.4 - Using the Flood Insurance Rate Map (FIRM)
  Information and guidelines on FIRMs can be obtained from "Your Guide to Flood Maps from FEMA " published by FEMA. The following steps should be used in getting specific information from Flood Insurance Rate Maps (FIRMs):

  Step 1: Find the correct panel.

- Most cities and counties are members of the National Flood Insurance Program and have FIRM maps.

  - In some cases though, FIRMs have never been developed and the community has in place a Flood Hazard Boundary Map (FHBM), which only details the boundaries of the floodplain. Though a community may only have FHBMs, many of these have been adopted by letter from the Administrator of the Federal Insurance Administration to be used as FIRMs though no physical FIRM exists.

- To find the panel that covers the area of study, refer to the Map Index for the particular area.

  - Reviewing the index shows that it is prepared in one of two basic formats and is composed of several panels.

    - Flat Flood Maps: One or more 11" x 17" pages and a cover sheet that includes an index and a legend.

    - Z-fold Maps: Similar to a highway map and consisting of one or more panels, each of which has a legend printed on it. Z-fold Flood Maps with more than one panel also have an index.

  - The index title box indicates the number of panels printed.

  - Identify the shelter location on the Index Map, then check on which panel it is located.

  - Check the title boxes on individual panels to find the needed panel.

<u>Step 2:</u> **Find the general location of the area.**

- Because the individual panel shows more physical features than the index lists, use the landmarks (roads, key lakes, etc.) to locate the area.

<u>Step 3:</u> **Find the specific location of the area** (see Figure 3.2.1).

- To find the specific location:

  - Look at the Flood Map scale and also refer to a plat map of the property.

  - Knowing where the property lies, find the dimensions of the property on a tax assessor's map, on a plat map, or in a legal description.

- Convert the known dimensions to inches using the Flood Map scale and measurements on the Flood Map panel and thereby find the specific location of the area.

- The USGS maps can also be used to determine the elevation of the shelter.

<u>Step 4:</u> **Identify the Flood Zones** (see Figures 3.2.1 and 3.2.2).

- After locating the area, identify the zone in which the area lies. The table below gives the zone definitions, which indicate the magnitude of flood hazard in specific areas of a community.

- Occasionally, when an area or building is close to the edge of the Special Flood Hazard Area (SFHA), it may be difficult to assess whether FEMA will consider the building to be in the Special Flood Hazard Area.

- The deciding factor in such cases is the elevation of the property or, in the case of a building, the land directly adjacent to the building compared to the base flood elevation (found in step 5).

    - In the case of an area, when the lowest ground elevation is below the base flood elevation, FEMA determines the area to be in the Special Flood Hazard Area (SFHA).

    - When the elevations of the lower floors (including the basement) of a building and/or the lowest grade adjacent to the building are below the base flood elevation, FEMA establishes the building is in the SFHA.

    - If the property or building is shown to be within the SFHA on the Flood Map, **only** FEMA may determine it is not in the Special Flood Hazard Area by comparison of these elevations.

<u>Step 5:</u> **Identify the Base Flood Elevation at the area** (see Figure 3.2.1).

- To identify the base flood elevation, locate the base flood elevation lines (labels) shown near the property on the Flood Map.

    - When an area is between two base flood elevations, estimate the base flood elevation at the area by interpolating between the two base flood elevations.

    - For an accurate elevation number, refer to the flood profiles for the flooding source that appear in the Flood Insurance Study Report for that community.

- **Flood profiles:** Flood profiles are presented on 22-inch x 8 ½ -inch, 10 x 10 to the inch, co-ordinate paper at the back of the FIS booklet (see Figure 3.2.3).

  - The water-surface profiles of the 10-, 50-, 100-, and 500-year floods and the channel bottom (stream bed) or hydraulic base line are shown in most booklets (sometimes only the "100-year" is shown).

  - All hydraulic structures such as bridges, culverts, or dams, points of confluence, corporate limits, and other pertinent information are shown on the profiles.

  - The elevation scales of "1 inch equals 1,2,5,10, or 20 feet" generally are used.

  - Elevation figures are displayed on the left side of the grid at one-inch intervals within the profile elevation range. Occasionally, they may be shown on the right side as well.

  - There are 10 sectional squares for every inch of elevation range. Therefore, each square represents 1/10 of the elevation increment per inch.

  - The stream distance scale, the horizontal scale along the bottom length of the grid, is labeled at one-inch intervals, which represent 200, 400, 500, 1,000, or 2,000 feet in horizontal distance.

  - Cross sections are plotted on the profile at distances consistent with the tabularized data and map locations.

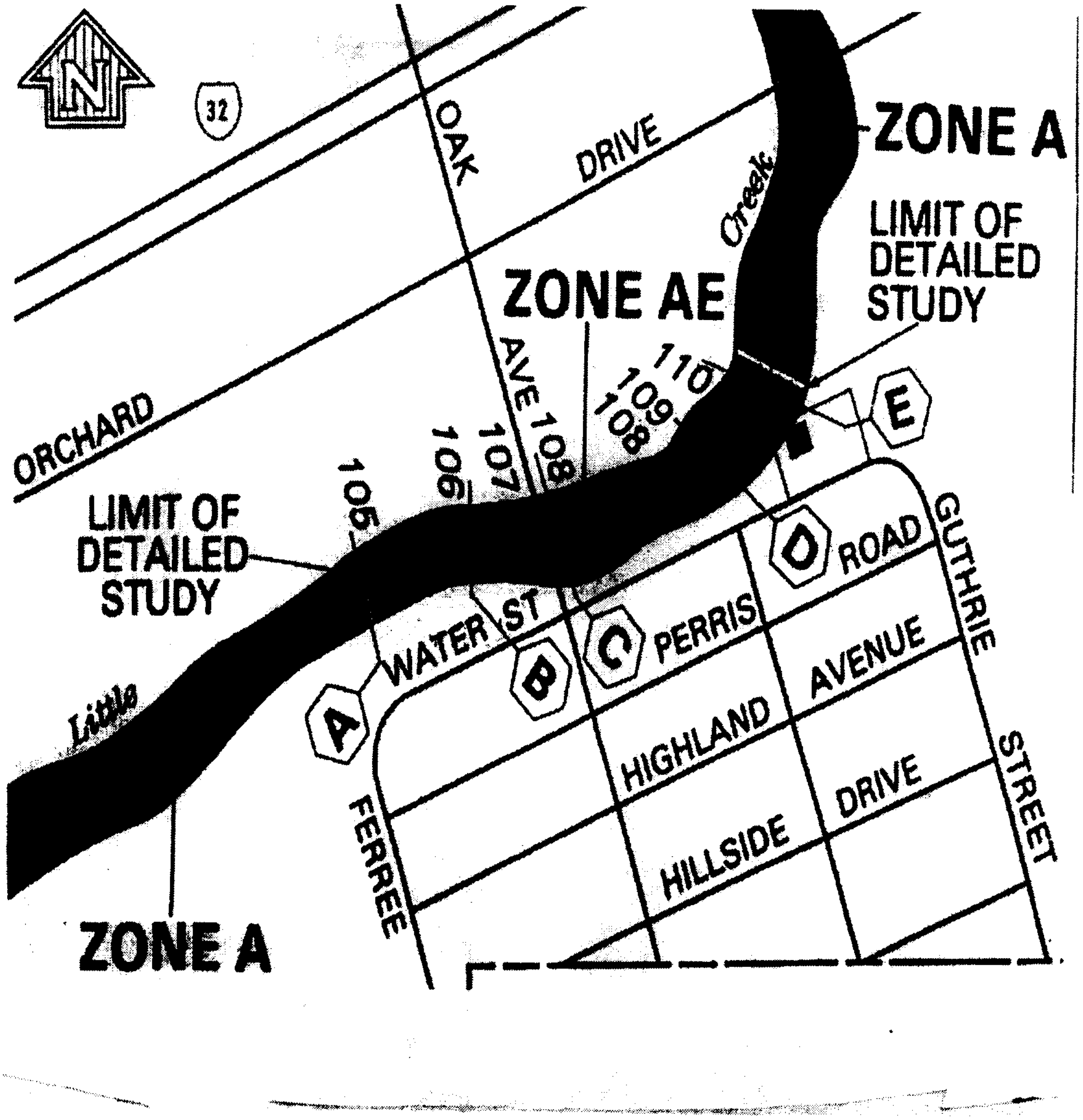


Figure 3.2.1 Flood Insurance Rate Map Example

Found on All Flood Maps

Flood Insurance Risk Zone Designations
The zone designations indicate the magnitude of the flood hazard in specific areas of a community. A list of zone definitions follows:

Zone A: Special Flood Hazard Areas inundated by the 100-year flood; Base Flood Elevations are not determined.

Zone A1-30 and Zone AE: Special Flood Hazard Areas inundated by the 100-year flood; Base Fiood Elevations are determined.

Zone AO: Special Hazard Areas inundated by the 100-year flood; with flood depths of one to three feet (usually sheet flow on sloping terrain); average depths are determined. Fore areas of alluvial fan flooding, velocities are also determined.

Zone AH: Special Flood Hazard Areas inundated by the 100-year flood; flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations are determined.

Zone AR: Special Flood Hazard Areas that result from the decertification of a previously accredited flood protection system that is in the process of being restored to provide a 100-year or greater level of flood protection.

Zones AR/A1-30, AR/AE, AR/AH, AR/AO, and AR/A: Special Flood Hazard Areas that result from the decertification of a previously accredited flood protection system that is in the process of being restored to provide 100-year or greater level of flood protection. After restoration is complete, these areas will still experience residual flooding from other flooding sources.

Zone A99: Special Flood Hazard Areas inundated by the 100-year flood to be protected from the 100-year flood by a Federal protection system under construction; no BFEs are determined.

Zone B: Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one foot or where the contributing drainage area isles than one square mile; or areas protected by levees from the base flood.

Zone C: Areas of minimal flooding.

Zone D: Areas of undetermined, but possible, flood hazards.

Zone V: Special Flood Hazard Areas inundated by the 100-year flood; coastal floods with velocity hazards; BFEs and flood hazard factors not determined.

Zone V1-30 and Zone VE: Areas of 100-year coastal flood with velocity (wave action); BFEs and flood hazards factors determined.

Figure 3.2.2 List of Flood Insurance Risk Zone Designations

- **<u>Use of Profile:</u>** The profile information is the primary tool for determining a BFE. The manner in which the profile is presented allows users to identify the BFE for any location along the flood profile. To determine the BFE for use in regulating floodplain development:

    - Find the location of the proposed site based on the distance scale at the bottom of the grid.

    - Follow this point vertically to where this line intersects the 100-year flood profile.

    - Read the elevation scale on the left side of the grid where the horizontal line from this point connects to ht elevation scale.

<u>Step 6:</u> Determine the potential level of flooding in the building

- Once elevation of the flood water in the zone where the building is located is determined, the elevation of the building must then be ascertained to find out which portions of the building will be flooded. It is possible that no level in the building will be flooded.

- Even if located in a generalized flood zone, localized areas of higher ground are not necessarily indicated on the FIRM, and a building's lowest floor level may be several feet above the elevation of the surrounding ground. As explained in Step 3, the National Geodetic Maps or surrounding terrain can be used to determine the elevation of the building, and these can be shown verified with the blueprints.

- From the blueprints find out the elevation of the lowest floor. Comparing the flood elevation with the lowest floor level will determine the depth of water expected in the building during flooding.

<u>Step 7:</u> Determine if access routes are flooded.

- Streets are shown on the FIRM and, thus, it is possible in most cases to determine quickly if at least one access road will be outside of flood hazard areas on the map.

- This access route must lead to the general surrounding area. For example, if the road on which the building is located is above the flood elevation, but only a few blocks in any direction, all routes will be flooded and then the access is flooded. This means the building is subject to isolation.

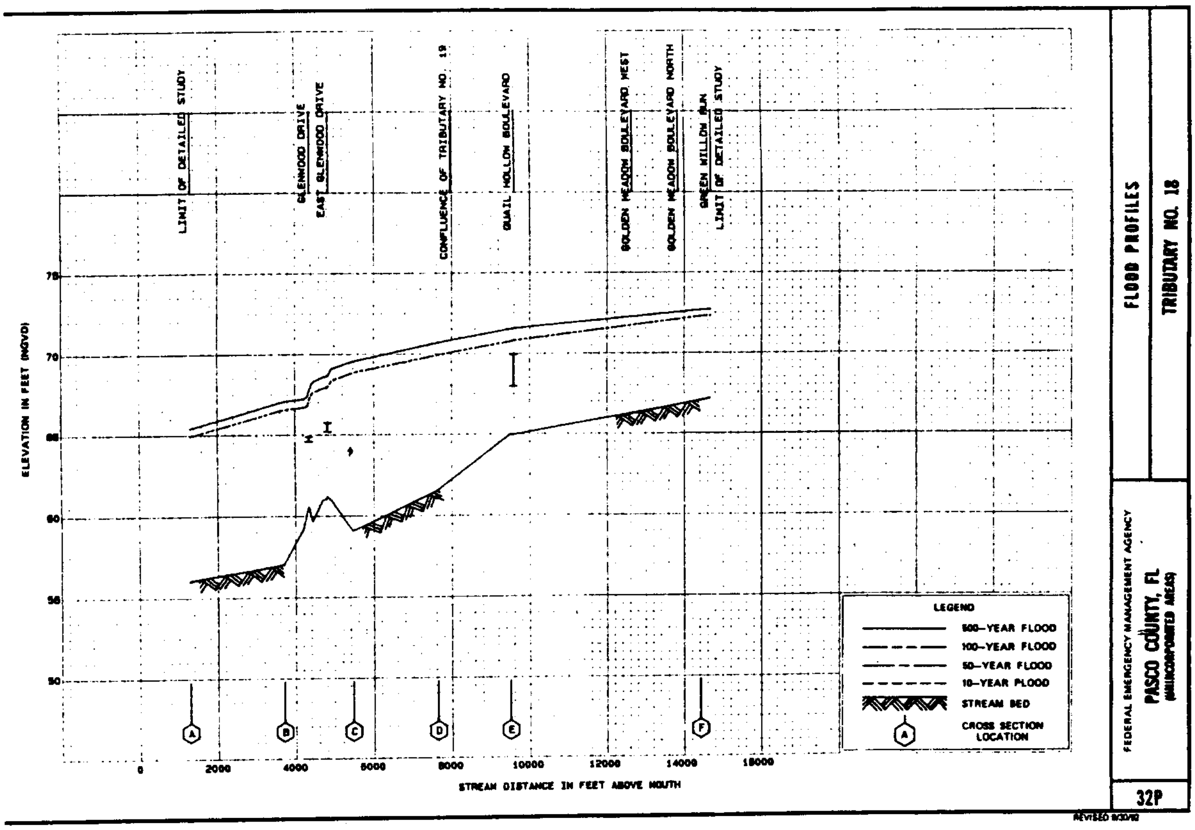


Figure 3.2.3 Profile Chart

(8) Selection Criteria Based Upon Rainfall Flooding

The ARC 4496 guidelines for rainfall flooding are:

> **Rainfall Flooding**
> Rainfall Flooding must be considered in the hurricane evacuation shelter selection process. Riverine inundation areas shown on Flood Insurance Rate Maps (FIRM), as prepared by the National Flood Insurance Program, should be reviewed. FIRMs should also be reviewed in locating shelters in inland counties.
> - Locate hurricane evacuation shelters outside the 100-year floodplain
> - Avoid selecting hurricane evacuation shelters in areas likely to be isolated due to riverine inundation of roadways.
> - Make sure a hurricane evacuation shelter's first floor elevation is on an equal or higher elevation than that of the base flood elevation level for the FIRM areas.

Figure 3.2.6 ARC 4496 Rainfall Guidance

- Item 2.2 - Is Facility's Site Above The 100-Year Flood Plain:
  - The idea is to avoid locating shelters in areas vulnerable to the floods to be expected from the usually heavy rainfall associated with hurricanes.
  - ARC 4496 states: "Locate hurricane evacuation shelters outside the 100-year floodplain."
- Item 2.2.1 - What Flood Zone is the facility's site in:
  - Identify the zone from the FIRM map for the site location.
- Item 2.3 - Is Facility's Site Above The 500-Year Flood Plain:
  - Determine this from the FIRM map for the site location.
- Item 2.4 - Is Facility's Site Subject To Isolation From Riverine Flooding:
  - Determine this from the FIRM map for the site location.
- Item 2.5 - Is Facility's Site Subject To Inundation Due To Failure Of Dams/Levees:
  - The question is whether or not failures of dams/reservoir containment systems could result in flooding into the surveyed building.
  - Determine this from local information about dams and reservoirs.

- Item 2.6 - Is Facility's Site Subject To Isolation From Failure of Dam/Reservoirs:
    - The question, in this case, is whether or not failures of dams/reservoir containment systems could result in flooding of the access roads to/from the surveyed building.
    - Determine this from local information about dams and reservoirs.
- Item 2.7 - Is There A Engineered Stormwater Drainage System At Facility
    - Determine this from on-site observation and from site drawings.
- Item 2.8 - Is There A History Of Flooding/Ponding At The Facility Site.
    - Determine from questioning personnel at the site.
- Item 2.9 - Comments:
    - Self-explanatory. Note here which FIRM and USGS maps, and Storm Tide Atlas were used. Include plate, panel and page numbers, as well as dates.

SECTION 2 - RAINFALL FLOODING/ DAM CONSIDERATIONS		
YES		**2.1 Is the building's first floor elevation on an equal or higher elevation than that of the base flood elevation level for site?**
NO		
2.1.1 What is the base flood elevation at the building? ________________ feet above MSL		
2.1.2 If multi-storied, does the building have a floor level above the base flood elevation? ❑ YES ❑ NO The (____) floor elevation is ____________________ feet above MSL ❑ Not Applicable		
YES		**2.2 According to the appropriate Flood Insurance Rate Map, is the Facility's site above the 100-year flood plain?**
NO		
2.2.1 What flood zone is the Facility's site located within? ❑ A____ ; ❑ B; ❑ C; ❑ D; ❑ X; ❑ V; ❑ Panel Not Printed; ❑ Area Not Surveyed ;		
YES		**2.3 According to the appropriate Flood Insurance Rate Map, is the Facility's site above the 500-year flood plain?**
NO		
YES		**2.4 According to the appropriate Flood Insurance Rate Map(s), is the Facility's site subject to isolation due to riverine and/or ponding inundation of roadways?**
NO		
YES		**2.5 Is the Facility's site subject to inundation due to failure of containment of levees, dams and reservoirs following hurricane-related flooding?**
NO		

SECTION 2 - RAINFALL FLOODING/ DAM CONSIDERATIONS		
YES		2.6 Is the Facility's site subject to isolation due to failure of containment of dams and reservoirs following hurricane-related flooding?
NO		
YES		2.7 Is there an engineered stormwater drainage system at the Facility's site?
NO		Condition: ❑ Clean and functional ❑ Marginally functional ❑ Non-functional
YES		2.8 Is there a history of minor flooding/ponding at the Facility's site under normal rainfall conditions?
NO		(minor flooding is the water level where water actually enters buildings)
2.9 Comments:		

3.4.4 Section 3 - Hazmat & Nuclear Power Plant Considerations

The section addresses the proximity of hazardous materials plants, facilities, and nuclear power plants, to the surveyed building. ARC 4496 states: " Hurricane evacuation shelters should not be located within the ten-mile emergency planning zone (EPZ) of a nuclear power plant."

(1) Sources of Potential Hazardous Materials Exposure

- ARC 4496 is primarily concerned with a spill or release of hazardous materials from a nearby Nuclear Power Plant (NPP), from within the HES facility itself and from an hazardous materials facility nearby.

- The risk of release from a NPP generally is regarded low due to the numerous safety precautions built in to U.S. NPPs.

  - ARC 4496 recommends against use of an HES located with the ten-mile emergency planning zone (EPZ) of a nuclear power plant.
  - Do not use an HES within the two-mile evacuation zone of a NPP (see Figure 3.4.1).

- Another risk is the release of toxic materials from within the HES facility. Using a manufacturing or storage facility that contains highly toxic materials is inappropriate. The onslaught of a hurricane will induce numerous stresses throughout a facility and may cause the release of such materials, if present.

  - Hazardous materials, in this case, does not mean the presence of secured and limited quantities, such as would be found in a high school laboratory or the fuel tanks of generators.

  - Generally, the intent is sufficient quantity and toxicity to require reporting under Section 302 and/or Section 312 of the Emergency Planning and Community

Right-to-Know Act (EPCRA).

- Since passed in 1986, the EPCRA, which is Title III of the Superfund Amendments and Reauthorization Act, requires facilities to report hazardous chemical quantities to State and local governments for community right-to-know as well as to benefit emergency planning for toxic chemicals stored at these facilities.

  - Under EPCRA, the U.S. Environmental Protection Agency developed a list of over 360 chemicals deemed as Extremely Hazardous Substances (EHSs).

  - Chemicals included on this list include those substances which are, in an accident, most likely to inflict serious injury or death upon persons in a single short-term exposure.

  - Though facilities must report these hazardous materials on an annual basis, the transport of hazardous materials via railway, highway or pipeline is not required to be reported under this act.

  - In addition, certain flammable chemicals which are not categorized as toxic also are not required to be reported under EPCRA.

- Section 312 of EPCRA states that a facility must annually submit a "Tier II Emergency and Hazardous Chemical Inventory Form" to the State Emergency Response Commission, Local Emergency Planning Committee (LEPC) and local fire department.

  - Any hazardous chemical (all of which OSHA requires a Material Safety Data Sheet) present at any one time in the preceding calendar year that equaled or exceeded 500 pounds or the Threshold Planning Quantity (TPQ), (which ever is less) must be reported.

  - In essence, if facilities are reporting correctly within the law, information on 1) large quantities of OSHA regulated hazardous chemicals; and 2) TPQs of EHS chemicals should be available at the local level of the fire department or the LEPC.

  - LEPC files are routinely maintained at the local emergency management office.

(2) How to Determine the Hazardous Materials Risks

<u>Step 1:</u> Contact the local fire department and/or the LEPC and, if possible, obtain the help of personnel knowledgeable in hazardous materials handling to evaluate the risks to each particular HES building.

<u>Step 2:</u> Determine if there are any NPP's in the area of the HES building.

- This should be common knowledge available at the local emergency management office.

- Determine if the potential HES building is within the 10-mile EPZ of the NPP. ARC 4496 recommends against use of buildings within this zone.

- However, circumstances may force local officials to consider buildings within this 10-mile radius. This is a local judgement call.

- **Do not use buildings within the two-mile EPZ of a NPP.**

Step 3: Contact the facility manager/owners of the potential HES building and determine from them what, if any, hazardous materials are stored/used on-site.

- The local fire department or LEPC officials should be able to help in determining what the risk is, if there are reportable quantities of toxic materials on-site.

- This does not apply to generator fuel tanks (properly secured and protected) or properly secured school laboratory supplies.

Step 4: After reviewing Tier II information submitted by facilities, determine whether these facilities are in the proximity of a potential shelter.

- If these facilities are in a general area of a potential shelter, further information on the chemical should be researched.

- In some cases, the LEPC and emergency management coordinator have developed vulnerability zones for chemical releases, which have shown the potential plume paths of hazardous chemicals released. This information might be available in digital format in such software as the EPA's CAMEO program.

- In other cases, the local government might not have performed these calculations toward developing vulnerability zones (VZ).

- In 1998, under Section 112(r) of the Clean Air Act (CAA) Amendments, chemical facilities must submit Risk Management Plans to the LEPCs and the EPA concerning potential releases of hazardous materials. This will include vulnerability zones for hazardous chemicals found on the CAA list of chemicals. Though this list is not identical to the EHS list of chemicals, it is another way of gathering information for potential releases and VZ determination.

Four Nuclear Plant Sites: 10 &50 mile radius

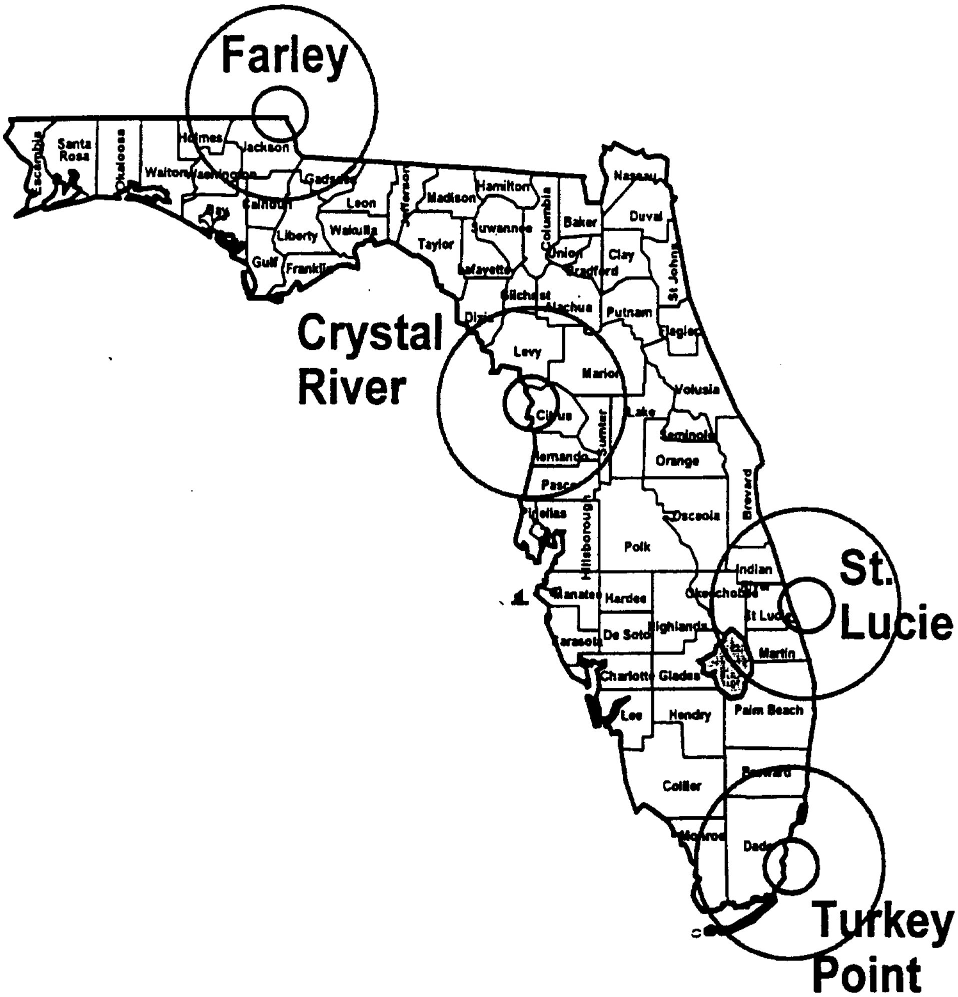


Figure 3.4.1 NPP EPZ Zones

- A useful way of determining the potential HES building's vulnerability is to use a Hazard Analysis Questionnaire as presented below to provide a systematic approach toward determining the risk.

HAZARD ANALYSIS QUESTIONNAIRE		
Questions	**HAZARD A**	**HAZARD B**
What is the chemical?	Chlorine	Ammonia
What type of facility?	Water Treatment Facility	Manufacturing Plant
What is the quantity?	2,000 lbs.	5,000 lbs.
What are the harmful chemical properties if the populations is exposed?	Poisonous, may be fatal if inhaled. Respiratory conditions aggravated by exposure.	Poisonous, may be fatal if inhaled. Vapors cause irritation of eyes and respiratory tract. Liquid will burn skin.
Potential Vulnerable Zones	A spill of 2,000 lbs of chlorine from a storage tank could result in an area of radius of over 0.3 miles being at or above the level of concern.	A spill of 5,000 lbs. of ammonia could result in an area of radius of 0.35 miles being at or above the level of concern.
Is Shelter within this zone?	Yes	Yes
Probability of occurrence?	Low - Chlorine is stored in an area with leak detection equipment. Building construction is at or above hurricane wind strength and containers are adequately secured.	High - Facility has no leak containment equipment. Building construction is below par and hurricane strength winds could damage facility and containment.
Probability of simultaneous emergency release?	Low	High

Adapted from the Example Hazards Analysis For a Hypothetical Community, *Hazardous Materials Emergency Planning Guide (NRT-1),* March 1987.

- As can be seen from above, though a potential shelter is being considered in both areas, the shelter in HAZARD A is a much safer alternative than a shelter in HAZARD B.

- Depending on the wind speed, direction, terrain, amount and speed of release, hazardous chemical plumes can travel great distances. With the information gathered from the above Hazard Analysis Questionnaire, both the level of hazard (high, medium or low) and the level of risk or vulnerability (low, medium or high) can be determined using the Hazard-Risk Matrix Table below.

HAZARD - RISK MATRIX TABLE			
	Low Hazard	Medium Hazard	High Hazard
Low Risk			
Medium Risk			
High Risk			

- As examined, the matrix table above must be viewed as a tool.

  •• For example, if a hazardous chemical such as chlorine is housed at the city water system in the amount of 2,000 lbs., a release could present a high hazard to the community.

    ••• However, if the potential shelter is located outside the VZ of approximately 0.3 miles, the risk to this shelter would be significantly lower.

  •• Though hazardous chemical storage does present a risk, it is important to know both the distance a potential HES would be from a chemical storage facility and the risk if a release were to occur.

  •• Ideally, shelters should be located outside hazardous chemical vulnerability zones but unfortunately, this might not be an option.

  •• In these cases, the Hazard-Risk Matrix Table will provide an approach to determining both the level of hazard and risk to a potential shelter.

- Finally, when assessing risk, meet with representatives of the hazardous chemical facility as well as the hazardous materials response coordinator of the local fire department.

  •• Discuss with them the planning assumptions for shelter surveys and seek advice on potential structure damage to the facility by high winds, heavy rains and wind-lofted debris which might cause a release.

  •• Obtain copies of Hazards Analyses conducted for Section 302 facilities from local emergency management or LEPC and review the reports for those hazardous materials facilities that have vulnerability zones (VZs) that impact the potential HES building.

- •• Each hazards analysis report will contain various data on the type of materials, dangers, evacuation routes, risk of release, a list of critical facilities within the VZs, etc.

- •• Typically, the report also will contain a hazardous materials site map (see Figure 3.4.2), which will show VZs based on different windspeeds.

  - ••• Each VZ will appear as a circle drawn for a radius from the hazardous material site. Any building within the circle is at risk if there is a release of that particular hazardous material at that site.

  - ••• For each VZ impacting the potential HES note the type of hazardous material(s), name and location of the facility, and the risk of release.

  - ••• In some cases there may be more than one hazardous material at a facility, and each will have its own VZ.

  - ••• Take note of each hazardous material whose VZ impacts the HES, and make a note on the LRDM table.

  - ••• In Figure 3.4.2 below, the hazardous material site is a water treatment plant with a VZ for chlorine of 5.6 mile radius and a VZ for sulfur dioxide for a 1.2 mile radius. If the potential HES building is within either/or both radii, it should be noted, and the risk, under hurricane conditions, evaluated.

- If the risk of release under hurricane conditions is deemed low, the decision to use a building in a particular VZ as an HES is a local judgement call.

  - However, the risks should be evaluated by local hazardous materials experts (LEPC or equivalent).

  - If the risk of release, under hurricane conditions, is deemed moderate to high the potential HES building is considered noncompliant and should not be used.

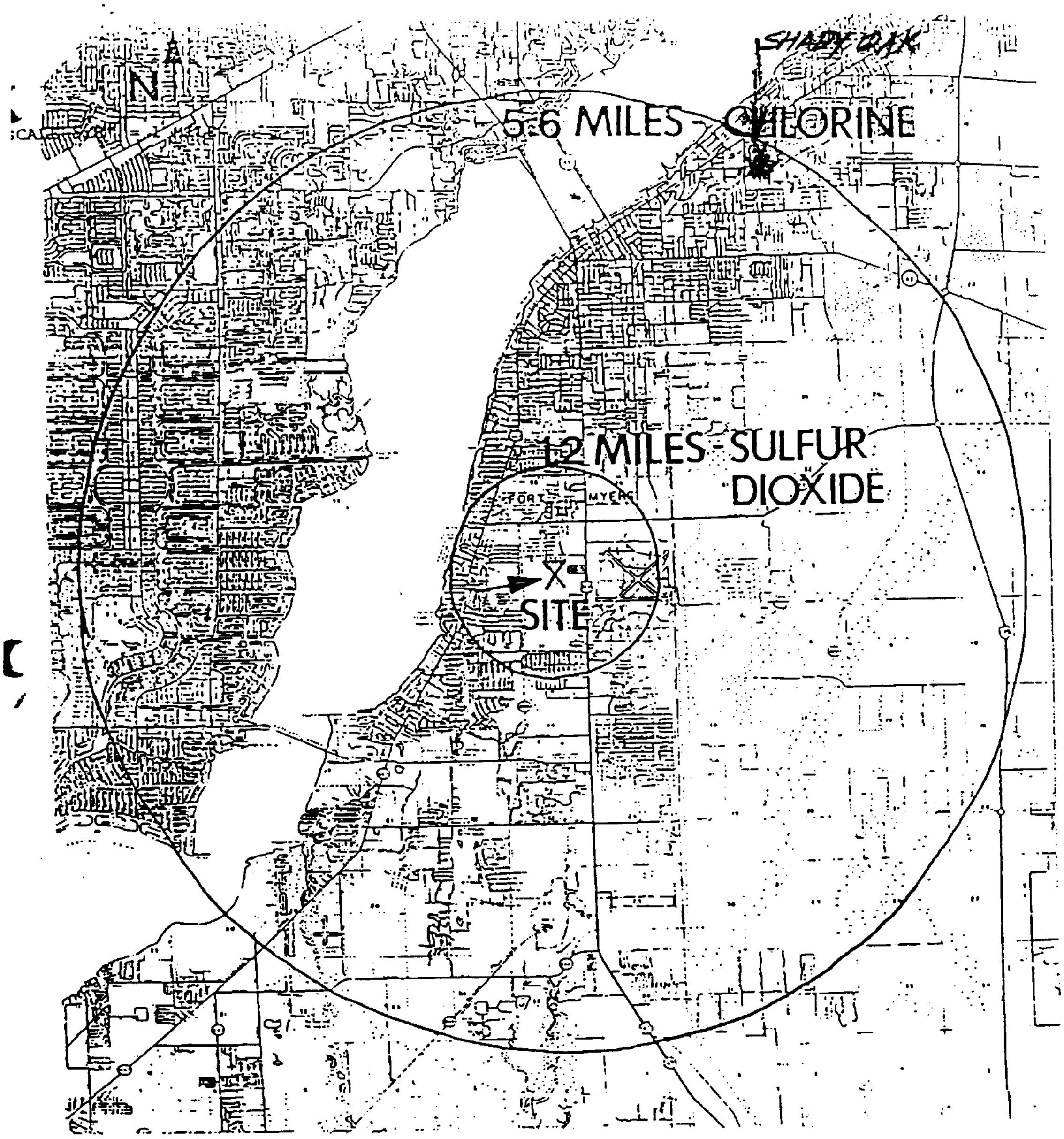
- Item 3.1 - Are Hazardous Materials In Close Proximity To The Facility's Site:

  - This item is not looking for school chemistry lab supplies, or the typical flammable storage supplies at a school. This is looking for facilities like propane gas distributors across the street from the building, an ammonia plant one block away, and so forth. Such a facility could pose a threat to shelterees if damaged during a hurricane.

- Item 3.2 - Is The Facility's Site In The Vulnerability Zone Of Extremely Hazardous Materials:
    - The Local Emergency Planning Committee and fire department should have Material Safety Data Sheets on all facilities manufacturing, using, or storing hazardous materials (in reportable quantities). Use these to determine if the surveyed building is too close to these facilities.

- Item 3.3, 3.4 and 3.5 - Is The Facility's Site In a two, or ten-mile Emergency Planning Zone (EPZ) of a nuclear power plant, and comments:
    - Self-explanatory.

SECTION 3 - HAZMAT AND NUCLEAR POWER PLANT CONSIDERATIONS		
YES		**3.1 Are hazardous materials manufactured, used, or stored (in reportable quantities) at, or in close proximity to the Facility's site?**
NO		❑ Data on the hazardous material facilities in the area was not available at the time of the survey.
YES		**3.2 Is the Facility's site located within the Vulnerability Zone of a facility that manufactures, uses, or stores materials that are considered extremely hazardous (Section 302)?**
NO		❑ Data on the hazardous material facilities in the area was not available at the time of the survey.
YES		**3.3 Is the Facility's site located within the two-mile Emergency Planning Zone (EPZ) of a nuclear power plant?**
NO		❑ Data on the hazardous material facilities in the area was not available at the time of the survey.
YES		**3.4 Is the Facility's site located within the ten-mile Emergency Planning Zone (EPZ) of a nuclear power plant, but outside the two-mile EPZ?**
NO		❑ Data on the hazardous material facilities in the area was not available at the time of the survey.
3.5 Comments:		



City of Fort Myers South Wastewater Treatment Plant
1618 South Drive

Vulnerable zones for chlorine and sulfur dioxide.

Figure 3.4.2 Hazardous Materials Facility VZ Map

Part Three: (Mass Care Provider Supplied)

- This portion of the Survey Checklist is optional and is provided for collecting mass care data. In many cases the local mass care provider will choose to use their own data collection forms (i.e., ARC Form 6564). If not, this portion should collect the pertinent data.

3.4.5 Section 0 - Identification

- Item 0.1 - Facility Name:
    - Clearly identify the specific building being surveyed.
- Item 0.2 - Latitude / Longitude:
    - Use a Global Positioning System (GPS) or, measurements from a USGS map to determine the latitude-longitude of the building
    - Often after a major hurricane has passed most if not all local road signs are destroyed, making it difficult for emergency responders from out-of-area to locate specific buildings.
    - An accurate latitude-longitude will enable emergency units equipped with GPSs to quickly locate the shelter after a hurricane.
    - Latitude-Longitude collected previously by other parties may or may not be accurate, be sure to verify them.
- Item 0.3 - County, 0.4 - Owner, and 0.5 - Facility Type:
    - These are self-explanatory.

0.1 Facility Name:____________	0.6 Contact: ____________
Building ID #: ____________	Title: ____________
Street Address:____________	Phone: ____________
City:____________	Alt. Phone: ____________
State, Zip+4:____________	Alternate 1: ____________
0.2 Latitude:____________	Title: ____________
Longitude:____________	Phone: ____________
0.3 County:____________	Alt. Phone: ____________
0.4 Owner:____________ Public ❑ Private ❑	Alternate 2: ____________
0.5 Facility Type:	Title: ____________
O vital - O shelter - O utility	Phone: ____________
O other ____________	Alt. Phone: ____________

3.4.6 Section 16 - Site Infrastructure (Optional)

This section identifies potential sources of potable water and sewer which could be used as an alternate should the public systems be destroyed/damaged.

- Item 16.1 (16.1.1 - 16.1.3) - Is there a survivable potable water supply at the facility:
    - These items address potential sources of potable water at the site. Public water systems are often disrupted during hurricanes, some times for extended periods.
    - Even non-potable water sources may be convertible into potable water sources.
- Item 16.2 (16.2.1 - 16.2.3) - Is there a survivable on-site septic/sanitary sewage system at the facility:
    - These items address potential sanitary sewage systems at the site. Public sanitary sewage systems are often disrupted during hurricanes, sometimes for extended periods.

SECTION 16 - SITE INFRASTRUCTURE (OPTIONAL)		
YES		16.1 Is there a survivable on-site potable (i.e., bottled or drinkable) water supply?
NO		

SECTION 16 - SITE INFRASTRUCTURE (OPTIONAL)		
16.1.1 What is the primary on-site **potable** water source? ❑ Public Utility ❑ On-site Well ❑ Other ______		
16.1.2 What are the secondary on-site **potable** water sources? ❑ None ❑ On-site Water Tank (______ Gals.) ❑ Other ______		
16.1.3 What are the on-site <u>**non**</u>**-potable** water sources? ❑ None ❑ Irrigation Well ❑ Swimming Pool ❑ Other ______		
YES		**16.2 Is there a survivable on-site septic/sanitary sewage system?**
NO		
16.2.1 What is the on-site sanitary sewage system? ❑ Public Utility ❑ Wastewater Treatment Plant ❑ Septic Tank ❑ Other ______		
16.2.2 What are the potential secondary sanitary sewage systems on-site? ❑ None ❑ Abandoned Septic Tank ❑ Portable Units ❑ Other ______		
16.3 Comments: ______		

3.4.7 Section 17 - Mass Care Characteristics (Optional)

This section identifies food preparation capabilities at the potential HES building. Much of this information is covered in ARC form 6564 and other mass care survey forms. This form is provided as an alternative form, if desired or needed.

- <u>Item 17.1</u> What type of food preparation does the building have:
  - Self explanatory.
- <u>Item 17.2</u> What type of equipment is available in the kitchen:
  - This item lists the equipment in use in the kitchen. This data allows calculation of the food handling capacity of the building and, potentially, the electrical load needed for the kitchen. For buildings without kitchens mark "Not Applicable".
  - It is important to consider the power source for the equipment.
    - Electrically powered will be rendered inoperable if power is disrupted (common under hurricane conditions).

- •• Even gas powered devices may rely upon electric ignition systems.

- •• Natural gas systems will also normally become inoperable under hurricane conditions. Natural gas is typically cut off some time prior to the onset of a hurricane and may not be restored for some time later. This is due to the need to check for leaks and other damage to pipelines prior to restoring the flow of gas.

- Items 17.3 -17.6

  - Self explanatory.

- Item 17.7 (17.7.1, 17.7.2, and 17.7.3) - Number of toilets, wash basins, and showers available in the building:

  - Type of Fixture.
  - Accessible/Non-Accessible (Handicapped)
  - A special note should be made to whether or not the toilets are accessible from inside the building or only from the outside. This is important as toilets accessible only from outside the building would force shelterees to expose themselves to the elements (e.g., hurricane) to use the toilets during the hurricane.

- Item 17.7.4 - 17.10

  - Self explanatory.

SECTION 17 - MASS CARE CHARACTERISTICS (OPTIONAL)
17.1 What type of food preparation capability does the building have? ❑ None ❑ Full Kitchen ❑ Warming Oven Kitchen ❑ Other: ______

SECTION 17 - MASS CARE CHARACTERISTICS (OPTIONAL)

17.2 What types of equipment are available in the kitchen?

- ❑ Refrigerator(s) #_____ Size(s): ____________
- ❑ Walk-in Refrigerator(s) #_____ Size(s): ____________
- ❑ Freezer(s) #_______ Size(s): ____________
- ❑ Walk-in Freezers(s) #______ Size(s): ____________
- ❑ Burner(s) #_____ Fuel Type(s): ○ Electric; ○ Nat. Gas; ○ LP Gas; ○ Other: ____________
- ❑ Griddle(s) #_____ Fuel Type(s): ○ Electric; ○ Nat. Gas; ○ LP Gas; ○ Other: ____________
- ❑ Oven(s) #_____ Fuel Type(s): ○ Electric; ○ Nat. Gas; ○ LP Gas; ○ Other: ____________
- ❑ Convection Oven(s) #_____ Fuel Type(s): ○ Electric; ○ Nat. Gas; ○ LP Gas; ○ Other: ____________
- ❑ Microwave Oven(s) #______ Size(s): ____________
- ❑ Tilting Fryer(s) #_____ Fuel Type(s): ○ Electric; ○ Nat. Gas; ○ LP Gas; ○ Other: ____________
- ❑ Icemaker #_________ Size(s): ____________
- ❑ Steamer Oven(s) #_____ Fuel Type(s): ○ Electric; ○ Nat. Gas; ○ LP Gas; ○ Other: ____________
- ❑ Vertical Warmer(s) #_____ Fuel Type(s): ○ Electric; ○ Nat. Gas; ○ LP Gas; ○ Other: ____________
- ❑ Other: ____________

17.3 How many servings can the kitchen handle per meal? #____________

17.4 Is there a cafeteria in the building? ❑ YES ❑ NO (If yes, shelter usable square footage : ____________

17.5 Is there a Snack Bar in the building? ❑ YES ❑ NO (If yes, shelter usable square footage: ________)

17.6 Comments: ____________

17.7 What are the total number of toilets available inside the building? #____________

17.7.1 Toilets: # **Male**____ (# handicap:____); # **Female**____ (# handicap:____); # **Unisex**____ (# handicap:____)

17.7.2 Wash Basins: # **Male** _____ ; # **Female** _____; # **Unisex** _____ ;

17.7.3 Showers: # Male _______ # Female _______

17.7.4 Comments: ____________

____

17.8 Health Care: #____________ rooms Total square footage: ____________ #_________ beds

17.9 What are the size(s) and number of paved/unpaved parking lots on-site?

❑ Paved #_______ lots, # cars: _______; ❑ Unpaved #_____ lots, # cars: _______;

SECTION 17 - MASS CARE CHARACTERISTICS (OPTIONAL)
17.10 Comments: ______

3.4.8 Section 18 - Communications (Optional)

This section identifies and describes any emergency communications equipment at the facility.

- Item 18.1 (18.1.1 - 18.1.6) - Does The Building Have Emergency Communications Capability?
  - Address the emergency communications capabilities at the building. Landline telephones are often disrupted during hurricanes.

SECTION 18 - COMMUNICATIONS (OPTIONAL)		
YES		18.1 Does the building have an emergency communications capability?
NO		
18.1.1	Does the building have land line telephone(s)? ❑ YES ❑ NO	
18.1.2	Does the building have any land line telephone(s) that will continue to function even after electrical power is lost (i.e., an emergency telephone line)? ❑ YES ❑ NO	
18.1.3	What weather warning communications capabilities are available to the building? ❑ NOAA weather alert warning radio; ❑ Weather Channel(s) - Cable; ❑ Commercial Radio Broadcasts; ❑ Short-Wave Radio; ❑ Local Emergency Management Radio Broadcasts; ❑ Other: ______	
18.1.4	Does the building have an intercom system? ❑ YES (O One-Way; O Two-Way); ❑ NO	
18.1.5	If yes, does the intercom work when electric power is lost? ❑ YES ❑ NO	
18.1.6	Comments: ______	

Chapter IV
Site Visit

4.0 General

With the completion of Part One of the survey checklist, the Emergency Manager can now decide which of the potential HES buildings to concentrate on with the surveyors. The following procedures include a preliminary "drive-by", analysis of technical drawings for structural details, and collection of the key structural details on Part Two of the survey checklist.

4.1 Windshield Drive-By

This step consists of a simple drive-by of the potential HES buildings, preferably with a local emergency manager representative along:

- Why? To get a quick view of the potential HES buildings and their surroundings.
- In some cases this survey will reveal major flaws that push a particular building to a lower priority or even eliminate it from selection.
  - For example, a drive-by may reveal that the building's condition is so deteriorated that further efforts would not be cost-effective.
  - Another example is the presence of tall trees all around and immediately next to the potential HES buildings, presenting a major lay down threat.
- Another advantage is that the surveyor gets a good mental picture of the specified buildings.
  - It is not uncommon that modifications to buildings may not be shown in available technical drawings - the drive-by allows an accurate observation of what has actually been built.
  - In some cases the technical drawings available indicated a wooden building, yet the drive-by showed a masonry building was actually built.

4.2 Plans & Specifications Review

At this point the surveyor should be concentrating on the technical/structural details of the building - in particular those details answering the Part Two questions.

- Use AS-BUILT technical drawings if available - Preliminary drawings may or may not be accurate.

- Locate the pertinent specifications as well as technical drawings - details such as the reinforcement in the walls are often only stated in the specifications, especially in older buildings.

- Recommend for documentation the photocopying of the page(s)/or parts of pages with the following technical details:
  - Site Plan
  - Foundation Plan/Sections
  - Typical Wall Details
  - Roof Framing Plan
  - Structural Plans showing load-bearing frames/walls
  - Details showing typical roof-wall connections
  - Details showing typical roof system construction
  - Floor Plans

4.3 Facility Visit

Use the technical drawings/specifications to answer as many of the Part Two checklist items as feasible. Once this is done the next step is an on-site review of the specified facility.

4.3.1 Complete Survey Checklist During On-Site Review

- Next complete those items on the survey checklist that you could not complete from the technical drawings.

- Also verify the information from the survey checklist (as much as feasible with non-destructive evaluation procedures).

- Use the survey checklist to ensure that you gather all the information you need the first time you visit the site.

- Note that certain "YES" and "NO" answer boxes are shaded on the survey checklist. This was done as a convenience for the surveyors. Any check in a shaded box indicates that a potential problem exists in this area and that further investigation may be warranted. A scan of a completed checklist for "checked" shaded boxes should quickly identify the key problem areas of a building.

- Blank samples of the pertinent sections from the survey checklist are provided in each section for reference.

Part Two:

4.3.1.1 Section 0 - Identification

- Item 0.1 - Clearly identify the specific building being surveyed.

  In many cases, the building being surveyed may consist of multiple sections with significantly different structural characteristics. For example, a building may have an original section built in 1969, with additions built in 1986 and 1994. The original could have been unreinforced masonry construction, with partially reinforced masonry construction in one addition (1986), and with fully reinforced masonry construction in the other (1994). It is important to examine how these additions are attached to the other sections. If they can be isolated or "compartmentalized", then that particular section should be evaluated as a separate building. For example, if the 1994 addition is separated by an expansion joint, roof and walls systems, and is thus, structurally, a separate building, it should be identified individually, and evaluated on its own characteristics. If the 1969 section is identified as Building 01a, then the additions could be identified as Buildings 01b and 01c. The key point is that the section is structurally separated from the other sections (i.e., it can stand on its own if the others should collapse).

- Item 0.2 - Use a Global Positioning System (GPS) or, if one is unavailable, measurements from a USGS map to determine the latitude-longitude of the building

  - Often after a major hurricane has passed most if not all local road signs are gone or destroyed - making it difficult for emergency responders from out-of-area to locate specific buildings.
  - An accurate latitude-longitude will enable emergency units equipped with GPSs to quickly locate the shelter after a hurricane has passed through.
  - Latitude-Longitude collected previously by other parties may or may not be accurate, be sure to verify them.

- Items 0.3-0.5 Self-explanatory.

- Item 0.6 - Attempt to use at least one custodian/building manager who works at the building as a contact - preferably one with an extensive knowledge of the building's history.

- Item 0.7 - Identify the surveyor and date of survey - for future contact if necessary.

SECTION 0 - IDENTIFICATION	
0.1 Facility Name:__________ Building ID #:__________ Street Address:__________ City:__________ State, Zip+4:__________ 0.2 Latitude:__________ Longitude:__________ 0.3 County:__________ 0.4 Owner:__________ Public ❑ Private ❑ 0.5 Facility Type: O vital - O shelter - O utility O other __________	0.6 Contact: __________ Title: __________ Phone: __________ Alt. Phone: __________ Alternate 1: __________ Title: __________ Phone: __________ Alt. Phone: __________ Alternate 2: __________ Title: __________ Phone: __________ Alt. Phone: __________
0.7 Surveyor's Name:__________	Survey Date:__________
0.8 Comments: __________	

4.3.1.2 Section 4 - Lay Down Hazard Exposure

This section specifically identifies any nearby trees or structures that could fall down on the HES building.

- Items 4.1-4.1.2 - Lay-Down range is defined as close enough that a tree or structure falling flat to the ground at a right angle to its base would strike the HES building with sufficient force to breach the building's envelope. The danger is that a falling tree or structure would damage the building/or its envelope enough to allow access into the interior by hurricane force winds, windborne debris and rain, resulting in subsequent interior damage and roof system failures.

- Item 4.1.3 - Identify any potential roll-over threats to the building. Look for portable buildings that could be rolled over into the building, for nearby parking lots, where cars could be parked (and rolled into the building under hurricane conditions), and nearby HVAC units not anchored down. Look for roll-over threats within 100 feet of the building.

- Item 4.1.4 - Also note whether there is at least one access route to the site that is not tree-lined. Tree-lined routes are likely to be blocked by fallen trees during and immediately after hurricanes.

- Item 4.1.5 - Comments: In some cases smaller trees/structures may not threaten the building with sufficient force in a single strike, but because of a close proximity would repeatedly batter against the building - these should also be noted as threats.

  - Consider also the damage that may be done to a building by the root system of a tree immediately next to a building if it is blown over during a hurricane.

  - Note the locations and general numbers of lay-down threats for consideration for mitigation actions -- if only one or two trees, removal may be feasible, however, if numerous trees present threats, then it may be more cost-effective to look elsewhere.

SECTION 4 - LAY DOWN HAZARD EXPOSURE		
YES		**4.1 Is there a lay-down hazard in close proximity to the Facility?**
NO		
4.1.1	Are there large/tall trees within lay-down range of the Facility? ❑ Yes ❑ No	
4.1.2	Are there tall structures (e.g., towers, chimneys, steeples, etc.) within lay-down range of the Facility? ❑ Yes ❑ No	
4.1.3	Are there potential roll-over hazards within 100 feet of the HES building? For example, unanchored relocatable buildings, vehicle parking lot, and unanchored HVAC units. ❑ Yes ❑ No	
Describe:		
4.1.4	Is there at least one access road not tree-lined? ❑ Yes ❑ No	

SECTION 4 - LAY DOWN HAZARD EXPOSURE	
4.1.5	Comments: *(Specify quantity and distribution of lay-down hazards in relation to building)*

4.3.1.3 - Section 5 - Wind and Debris Exposure

This section captures the building's vulnerability to wind and debris.

- Item 5.1 - How exposed is the building to the full force of hurricane winds?
  - Walk around the building and observe on each of the sides the type of terrain surrounding it.
  - USGS quadrangle maps and recent aerial photographs (that are to scale) can be used to assess wind exposure.
    - •• USGS quadrangle (topographic) maps will provide an estimate of the elevation and the terrain's relative profile.
    - •• The aerial photographs can be used to estimate the shielding capability of the building's surroundings.
      - ••• With photographs on table, use a scale or measuring tape to estimate the perimeter of a circle one-mile distant from the potential HES site.
      - ••• Observe the type and relative density of obstructions in all directions from the site.
      - ••• Based on the wind exposure categories below, identify the worst-case exposure for the building.
      - ••• Repeat these steps for the topographic (USGS) maps.
      - ••• The worst case condition of the terrain and topographic categories is the wind exposure category for the surveyed building.
      - ••• In borderline situations, provide a degree of additional

weighting to the direction of the open ocean.

- •• If the maps/photographs are not available, a field evaluation of assessable areas will provide limited information.

- Item 5.1.1 - Sheltered Exposure: The building is located in surroundings that offer protection from all directions. The surroundings can be characterized as urban, suburban, or wooded setting, or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger for a mile or greater in all directions. The building cannot be within one mile of the ocean or other large body of water, nor within a quartermile of an open area.

  - Limited Exposure: A building located in an open area that extends less than a quartermile in any direction with sheltered exposure beyond the open area.

  - Unsheltered Exposure: All other terrain that is flatter, more open, or less sheltered than sheltered or limited exposures, including flat, open country, grasslands, or with scattered obstructions with heights of 30 feet or less. This exposure includes topography that can be characterized as open hill (elevated 15 feet or more above surrounding terrain) or promontory. Buildings in areas located within one mile of the ocean or other large body of water will be considered unsheltered exposure.

- Item 5.1.1.1 - Provides four choices for the type of topography at the site;

  - •• Flat - For a building set in a flat terrain;

  - •• Sheltered - For a building set in a valley, sheltered by surrounding hills; a building sheltered by surrounding buildings, obstructions, etc.; see definition Item 5.1.1 above.

  - •• Hill - For a building set on top of or on the side of a hill (more exposed than those above).

  - •• Promontory - For a building set out on a promontory and thus fully exposed to hurricane winds.

- Item 5.1.1.2 - Asks for the type of surrounding terrain on each of four sides. Some choices are self-explanatory. Others are explained below:

  - Water - Building set close (within 1,500 feet) to water, where there is an open expanse of at least one mile of water.
  - Open - Building is set in an area with scattered trees/house/etc. Basically, little or no resistance to the wind.
  - Wooded - Heavy, dense woods around the building, providing some wind resistance.
  - Residential - The building is surrounded by low-rise buildings and houses.

- Items 5.1.1.3 - 5.1.1.4 - Nearby open areas/large bodies of water can allow stronger/faster winds to assail the building.

- Items 5.2- 5.2.5 - Under hurricane conditions, windborne debris often impacts nearby buildings resulting in subsequent damage. If the windborne debris breaches windows or doors, then hurricane force winds and rains can enter into the building's interior. This could result in overpressurization and subsequent roof system failures.

Definitions for Types of Debris Generated in a Hurricane

Small Debris: Objects that weigh less than five pounds and have the potential of becoming windborne. The debris is small, but under hurricane conditions able to travel a great distance and do serious damage to windows or lightweight wall systems. Small debris materials may include small tree branches, gravel, and pieces of asphalt shingles.

Large Debris: Building materials (wall framing studs, plywood sheets, roof tiles, etc.), potted plants, tree branches, patio furniture, garbage containers, etc., with a weight range of six-20 pounds.

Roll-over Debris: Unanchored (or inadequately anchored) objects that may become partially airborne, pushed, or rolled along the ground surface by hurricane force winds. Potential "roll-over" debris sources include trailers, portable structures, vehicles, unanchored HVAC units, and empty fuel tanks.

Lofted Heavy Debris: Lofted heavy debris means massive objects that become windborne as nearby structures fail catastrophically. As the structure(s) disintegrates, large pieces of heavy debris in excess of 20 pounds are generated that loft, or arc, for a short distance. This type of debris can be extremely hazardous to other more wind-resistant buildings located in close proximity. Potential "lofted heavy" debris materials include large portions of roof, bond beams, porticos, and walkways. Also included under this definition are debris materials generated from tall buildings, such as wall and roof materials, HVAC units, and ventilators.

- Item 5.2 - Address the level of exposure for the building to potential windborne debris.

  - Minimal Exposure: Surroundings with negligible quantities of small and/or large debris. No concentrated debris sources near to large areas of unprotected fenestrations or softspots. Only debris materials located with 300 feet of the building should be considered. There must not be any significant roll-over, lay-down, or lofted heavy debris sources with 100 feet of the building.

  - Limited Exposure: Surroundings with scattered small and/or large debris materials. The terrain can be generalized as having less than 20 percent ground area coverage of potential debris sources within 300 feet, such as roofing materials, gravel or shell driveways, trees, fencing, and construction materials. There is no concentrated source of debris in close proximity to large areas of unprotected fenestrations or softspots of the building. There also must not be any significant roll-over, lay-down, or lofted heavy debris sources within 100 feet of the building.

- - High Exposure: Surroundings with significant quantities of small and/or large debris materials. The terrain can be generalized as having greater than 20 percent ground area of debris in close proximity to large areas of unprotected fenestrations or softspots of the building. There also may be significant roll-over, lay-down, or lofted heavy debris sources within 100 feet of the building.

- Item 5.2.1 - Identify the presence of potential sources of windborne gravel near to the building.

- Item 5.2.2 - Identify the presence of nearby buildings with loose cladding or materials which could supply windborne debris.

- Item 5.2.3 - Identify the presence of nearby debris sources, such as lumberyards, nurseries, trees, etc.

- Item 5.2.4 - Relocatables are trailers or moveable structures. Such structures have historically performed poorly under hurricane conditions, often being destroyed and generating windborne debris. Such lightweight structures should be securely anchored.

SECTION 5 - WIND AND DEBRIS EXPOSURE		
YES		**5.1 Will the Facility site be exposed to the full force of hurricane winds?**
NO		
5.1.1		What is the degree of wind exposure for the Facility? ❑ Sheltered Exposure ❑ Limited Exposure ❑ Unsheltered Exposure
5.1.1.1		What is the type of topography? ❑ Flat ❑ Sheltered ❑ Hill ❑ Promontory
5.1.1.2		What is the surrounding terrain?
North:		❑ Flat ❑ Hilly ❑ Low Lying (O marsh) ❑ Open ❑ Wooded (O heavily - O lightly) ❑ Rural ❑ Residential ❑ Lake/Pond ❑ Commercial Dist. (O shopping - O manufacturing) ❑ Many tall trees ❑ Other: ____
South:		❑ Flat ❑ Hilly ❑ Low Lying (O marsh) ❑ Open ❑ Wooded (O heavily - O lightly) ❑ Rural ❑ Residential ❑ Lake/Pond ❑ Commercial Dist. (O shopping - O manufacturing) ❑ Many tall trees ❑ Other: ____
East:		❑ Flat ❑ Hilly ❑ Low Lying (O marsh) ❑ Open ❑ Wooded (O heavily - O lightly) ❑ Rural ❑ Residential ❑ Lake/Pond ❑ Commercial Dist. (O shopping - O manufacturing) ❑ Many tall trees ❑ Other: ____

SECTION 5 - WIND AND DEBRIS EXPOSURE	
West:	❑ Flat ❑ Hilly ❑ Low Lying (O marsh) ❑ Open ❑ Wooded (O heavily - O lightly) ❑ Rural ❑ Residential ❑ Lake/Pond ❑ Commercial Dist. (O shopping - O manufacturing) ❑ Many tall trees ❑ Other: ______
5.1.1.3	Is the Facility within one mile of the ocean or other large body of water? ❑ Yes ❑ No
5.1.1.4	Is the Facility within a quarter mile of an open area? ❑ Yes ❑ No
5.2	What is the degree of debris hazard exposure for the Facility? ❑ Minimal Exposure ❑ Limited Exposure ❑ High Exposure
5.2.1	Do the structures within a 300-foot radius have roof gravel? ❑ Yes ❑ No
5.2.2	Is there potential of debris from metal, wood frame, and masonry buildings, loose material or roofing within a 100 foot radius? ❑ Yes ❑ No Within a 300 foot radius? ❑ Yes ❑ No
5.2.3	Are there other debris generating sources within a 100 foot radius (e.g., lumber yard, junk yard, plant nursery, tree branches, etc.)? ❑ Yes ❑ No Within a 300 foot radius? ❑ Yes ❑ No
5.2.4	Are there relocatable/portable buildings located on-site? ❑ Yes ❑ No
5.2.4.1	Are the relocatable/portable building(s) securely anchored? ❑ Yes ❑ No ❑ Not Applicable
5.2.4.2	Are the relocatable/portable building(s) within 100 feet of the HES? ❑ Yes ❑ No ❑ Not Applicable
5.2.5	Comments: _(Specify quantity, types, and distribution of debris sources)_

4.3.1.4 Section 6 - Wind Design Verification

- Item 6.1 - The first guideline described in ARC 4496's structural considerations is a requirement for a certification by a structural engineer indicating that a building conforms to ASCE 7-88 or ANSI A58 (1982). ASCE 7-88 or ANSI A58 (1982), *Minimum Design Loads for Buildings and other Structures*, have some of the most stringent wind load requirements available, especially with respect to wind effects on components and cladding.

    - Certification by a professional engineer that a building meets this standard indicates the building is in compliance with the best wind design standard currently available.

    - A building complying with either of these standards generally should perform well under hurricane conditions. However, it must be noted that such a building may still need retrofitting with respect to protection of fenestrations or other softspots.

- Buildings built in 1996, or thereafter, may comply with ASCE 7-95, which is the latest revision of the ASCE 7-88 Standard.

- With the exception of tall buildings that are greater than 60-feet in height, the vast majority of buildings that will be evaluated as a potential HES will not conform to ASCE 7.

- Instead, low- and mid-rise structures will conform to a locally adopted wind code, such as the SBC. Post-1986 model codes use wind design procedures based upon ASCE 7 but permit the use of reduced pressure coefficients at the high pressure zones of buildings.

- It is unlikely that any building built prior to 1982 will meet the preferred design criteria of ARC 4496. Therefore, a structural engineer will often only provide a "certification" or other statement as to the degree of compliance of the building with current wind codes and standards.

- Consequently, the HES evaluation procedure in this guidance manual focuses on an alternative to ASCE 7-88 or ANSI A58 (1982) certification, ranking the proposed HES based upon historical wind performance data and sound engineering judgement.

- <u>Items 6.1.1-6.1.2.2</u> - Buildings built higher (mean height) than 60 feet must be in compliance with ASCE 7-88. Generally buildings built 60 feet or lower will not comply with ASCE 7-88.

- <u>Items 6.2-6.2.6</u> - Help to rank the building, assuming that the building was not built to ASCE 7-88 or ANSI A58.

  - <u>Item 6.2</u> - This should be indicated on the technical drawings. The attention of a professional architect or structural engineer should, generally, result in a better designed building.

  - <u>Item 6.2.1</u> - Identify the availability of technical drawings. If it is not certain whether the drawings are Preliminary or As-Built, then assume Preliminary.

  - <u>Item 6.2.2</u> - Buildings constructed prior to 1987 probably have only limited or no vertical reinforcements in the walls (rebar). More recently designed buildings are generally designed to higher wind standards than pre-1987 buildings.

- Item 6.2.3 - Major additions to buildings are generally designed to higher wind standards than older buildings. Such additions may provide "core" areas that potentially could serve as shelter areas.

- Item 6.2.4 - Addresses what wind resistance code was probably used at the time of design of the surveyed building.

  - Determine the year(s) of design and construction; the years of design and construction are not always the same. The wind codes used by the structural engineer or architect for design purposes often will be noted on construction drawings in "general notes." The date the drawings were prepared also will be provided on every page, typically in a "revision log," title block, or similar information entry. If construction drawings are not available, and site inspection is the only available option, a monument or dedication plate may be attached to the building that provides the construction date.

  - Based upon information provided locally, determine which wind code(s) were in effect during the relevant time frame.

  - The dates of design and construction will significantly affect the wind resistance of the building; earlier codes are less stringent than more modern codes.

  - The following table will provide a procedure for ranking a potential HES building. This table reflects the historical milestones at which major changes in wind design and construction standards were adopted by the listed model codes. For example, all other factors being equal, a structure built using the SBC in 1992 is designed to a more stringent wind standard than one built in 1979.

Model Building Code Ranking					
Model Code(s)	Ranking				
	Promulgation Period				
	Pre-1960	1960-1976	1977-1986	1987-1989	1990 +
SBC	0	1	2	3	4
SFBC	0	2	2	2	2*
UBC	0	1	2	3	4
NBC	0	1	N/A	N/A	N/A
MBMA	0	0	0	3	3

* - Buildings constructed to SFBC after 1994 are required to comply with ASCE 7. Therefore, they are not considered built to a model code.

- •• The construction drawings should be reviewed, specifically looking for design features that are relevant to good wind-resistant construction practice.
- •• If possible, the building should be certified to meet, or substantially meet, current codes and standards.
- •• If certification is not possible, the evaluator should take note of systems, components, and connections utilized by the building's designer to resist wind loads for comparison to current code requirements.
- •• All wind-resistant construction details derived from the construction drawings must be field verified.

- Item 6.2.5 - This can often be gotten from technical drawings or the specifications. ARC 4496 assumes that buildings generally resist wind forces up to the wind speed that they are designed to handle.

SECTION 6 - WIND DESIGN VERIFICATION		
YES		**6.1 Has a structural engineer certified this building as being capable of withstanding wind loads according to ASCE 7-88 or ANSI A58 (1982) structural design criteria?**
NO		(Give preference, in selecting shelters, to buildings designed to ASCE-7 or ANSI A58, in lieu of model codes)
6.1.1 If yes, Specify actual wind design parameters (e.g., ASCE-7, 110 mph)__________		

SECTION 6 - WIND DESIGN VERIFICATION		
YES		**6.1.2 Does the building have more than one story?**
NO		
6.1.2.1 How many stories does the building have? ❑ One ❑ Two ❑ Three ❑ Four-Five ❑ Six +		
6.1.2.2 What is the overall height of the building? ❑ 0-30 feet ❑ 31-59 feet ❑ 60+ feet		
YES		6.2 Was this building designed by a professional architect or structural engineer?
NO		❑ Unknown
6.2.1 What type(s) of technical design drawings were available for the survey? □ Architectural ❍ Full ❍ Preliminary ❍ Partial ❍ As-Built ❍ None □ Structural ❍ Full ❍ Preliminary ❍ Partial ❍ As-Built ❍ None ❍ Drawings do NOT furnish a high level of detail; ❍ Drawings are more representative of residential drawings. ❍ Truss anchors and/or reinforcement in masonry was not addressed.		
6.2.2 The building was designed in what year? ____________ □ Actual □ Estimated		
6.2.3 In what year(s) were major addition(s) built? ______________________________		
6.2.4 What type of wind resistance code was utilized (or prevalent) at the time of design? □ Model Building Code (❍ SBC - ❍ SFBC - ❍ Other: __________) □ Custom Code □ MBMA □ Unknown □ None		
6.2.5 To what wind speed was the building designed? ____ mph ______ importance factor ❑ Unknown		
6.2.6 Comments: ______________________________		

4.3.1.5 Section 7 - Construction Type/Loadpath Verification

- <u>Item 7.1</u> - The most important aspect of the HES evaluation process is the identification of a definable and continuous load path for resistance to wind-induced loads.

    - The primary focus is on the building's "Main Wind Force Resisting System" (MWFRS) and exterior envelope and their ability to transfer effectively all wind loads to the foundation. A single break, or discontinuity, in the system may be capable of initiating progressive and possibly catastrophic failure. The primary source of information will be in construction drawings.

- Using the construction drawings, the HES evaluator should identify all vertical structural components that are designed and/or capable of transferring tensile (uplift) forces to the foundation. This may include columns of structural frames, reinforced pilasters in bearing walls, vertical reinforcement in grouted masonry wall cells, metal rods, and cables or straps.

- Identify the major structural components or systems that transfer floor and roof loads to the vertical structural components. There must be a clearly defined path between these components and the foundation. In many buildings, there is a combination of these systems, especially if there are changes in construction type due to differing floor functions, renovations, or later additions to a building.

- There cannot be a "connection" that relies on gravity, grout/friction, or withdrawal reactions to resist uplift or tensile loads. These fastening methods do not provide a substantial connection and, therefore, do not provide a continuous loadpath.

- The weakest link in the loadpath is likely to be the building's limiting factor when subjected to extreme windloading.

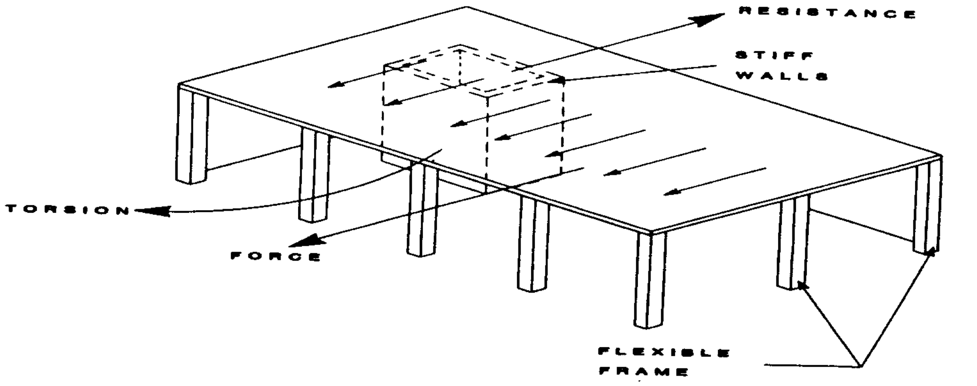
- With the vertical load path established, the components or systems that produce lateral stability must be identified. The MWFRS must be capable of resisting racking, overturning, and translational (sliding) effects.

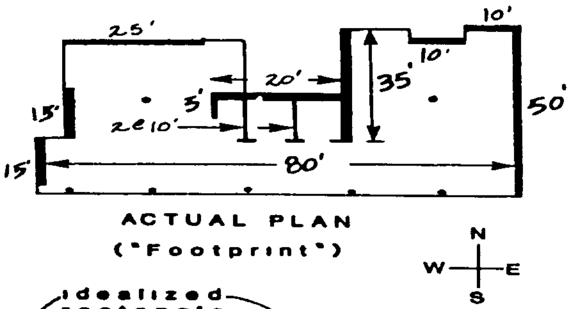
- The most common lateral stabilizing system found in potential HES buildings include shear wall/diaphragm systems, though semi-rigid or rigid framing and bracing systems are less commonly used.

  - As in the vertical load-resisting system, there cannot be a "connection" that relies on gravity, grout/friction, or withdrawal reactions.

  - The apparent lack of a significant lateral stabilizing system is sufficient to deem a building noncompliant.

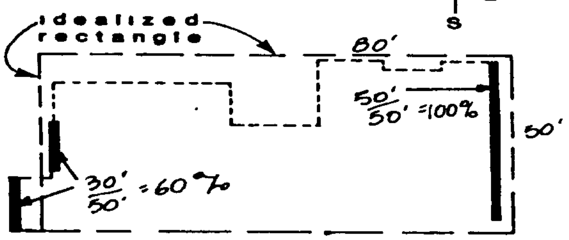
- The configuration of the Main Wind Force Resisting System (MWFRS) is also important. If the structural capacity of the MWFRS is not uniformly distributed throughout the building, a torsional imbalance or open side may exist. A torsional imbalance or open side may significantly increase the wind vulnerability of a building.





ACTUAL PLAN
("Footprint")

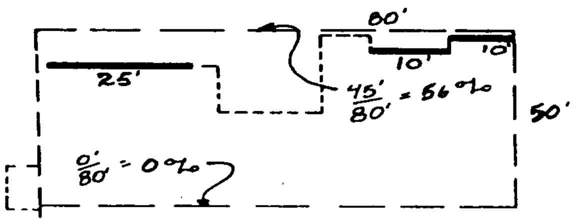
Torsional Imbalance



IDEALIZED PLAN
Shear walls of east–west sides

<u>Shear Wall Footage</u>:
North-South = 140 feet
East-West = 65 feet

<u>Open sided</u>? Yes, less than 50 percent of one side's footage is composed of shear wall (south side).



IDEALIZED PLAN
Shear walls of north–south sides

<u>Torsional Imbalance</u>? (Difference of at least 50 percent between parallel side's wall percentages.)

West vs. East: 100% vs 60% = 40%
No torsional imbalance.
North vs. South: 56% vs 0% = 56%
Yes.

- Similarly, all exterior envelope components must be connected/fastened via primary (beams, columns, and loadbearing walls) or secondary (light wood or metal framing) elements to the MWFRS to resist both positive and negative pressures. The presence of lightweight claddings and softspot materials (e.g., EIFS, light-gauge metal, and glazed panels) which typically perform poorly under high wind conditions may be sufficient to deem a building non-compliant with ARC 4496.

- The building construction type of a potential HES can have a significant impact upon its wind resistance.

  - A building that is constructed to impart an inherent surplus structural capacity, or a high factor-of-safety, generally will perform better under conditions that exceed the building's design wind code requirements.

  - Multistory buildings typically possess redundant structural capacity, as do monolithically poured reinforced concrete frame and heavy steel frame buildings.

  - If the exterior envelope is not weak, and all other factors being equal, these types of structures should be given preference over single-story buildings.

  - Low- and mid-rise buildings with a fully reinforced masonry MWFRS also perform well.

  - Single-story structures that are "fine tuned" to reduce surplus structural capacity should be avoided.

  - The table provided below can be used to rank the MWFRS of a building.

Building Construction Type Ranking Table	
Relative Strength	**Main Wind Force Resisting System (MWFRS)**
Strongest	high-rise heavy concrete or steel frame multistory braced heavy steel frame multistory heavy concrete* or steel frame with fully reinforced shear walls multistory heavy concrete* or steel frame with partially reinforced shear walls multistory fully reinforced masonry wall bearing single-story heavy concrete* frame with fully reinforced shear walls single-story fully reinforced masonry wallbearing single-story tilt-up or precast concrete wallbearing panels multistory partially reinforced masonry wallbearing multistory unreinforced masonry wall bearing with pilaster-bond beam single-story heavy concrete* frame with partially reinforced shear walls single-story pinned steel frame with partially reinforced masonry shear walls single-story partially reinforced masonry wall bearing single-story unreinforced masonry wall bearing with pilaster-bond beam light-wood or metal stud wall framing with plywood sheathing (SSTD 10-93) Preengineered Metal Buildings with light-gauge metal cladding (MBMA 1986 or more recent) light wood or metal stud wall framing with non-plywood sheathing (SSTD 10-93) pinned steel frame with light stud or unreinforced masonry shear walls (NONCOMPLIANT) pinned/precast concrete frame with light stud or unreinforced masonry shear walls (NONCOMPLIANT) unreinforced masonry wall bearing (NONCOMPLIANT)
Weakest	

* - For purposes of this table, Heavy Concrete Frame means a monolithically poured reinforced concrete frame capable of resisting overturning moments.

- Item 7.1.1 - This is the roof system that directly supports the roof deck.
- Item 7.1.2 - This is the system that supports the roof system and connects it to the foundation.
- Item 7.1.3 - Historically, many of the failures in building structures began at connection points. This has been especially true between the roof and supporting walls.
- Item 7.1.4 - It is also important to determine how the loadbearing systems are connected to the foundation. Since destructive investigation is not within the scope of this survey, you often will be forced to rely on foundation/structural plans to ascertain this information.

- Item 7.2 - ARC 4496 recommends avoiding pre-engineered (steel pre-fabricated) buildings built before the mid-1980s.

  - PEMBs are considered "fine-tuned" structures, and as such have a limited surplus structural capacity. This fine-tuned design process makes PEMBs susceptible to wind damage whenever wind speeds exceed their design requirements. Many catastrophic failures of PEMBs have been documented in hurricanes.

  - PEMBs should be avoided unless extraordinary wind design and construction criteria are included in the design specifications.

  - If this type of building must be used as an HES, it should be evaluated by a structural engineer to verify conformance with high wind zone design and construction criteria. At a minimum, the PEMB should have the characteristics described below:

Hurricane Evacuation Shelter Selection Criteria for Preengineered Metal Buildings

Due to their fine-tuned design procedures, Preengineered Metal Buildings (PEMB) should be avoided when selecting potential HES facilities. If other local building-stock options are limited, PEMBs should be evaluated using the guidelines described in this manual and the criteria provided below:

1. PEMB shall be designed and constructed to high wind zone requirements as established in MBMA (1986) or a more recent edition.

2. Exterior wall and roof cladding must be 22-gauge or greater thickness galvanized steel (recommend reinforced masonry exterior wall or frame infill envelope).

3. The condition of the building must be considered good; loadpath connections and cladding fasteners are surveyed for deterioration or construction irregularities.

4. Cross-bracing must be installed in every third bay and at the wall and roof on both sides of structure.

5. All fenestrations must be protected; no combination of large apertures (greater than eight feet in width) can exceed one percent of the exterior wall surface area.

6. There cannot be a roof overhang.

SECTION 7 - CONSTRUCTION TYPE/LOAD PATH VERIFICATION		
YES		**7.1 Is there a definable and continuous load path from the building's roof to its foundations?**
NO		

7.1.1 What is the primary roof support system? ❑ Reinforced Concrete ❑ Steel Beam

❑ Steel Truss ❑ Open Web Steel Joist ❑ Tapered Steel Beam ❑ Wood Truss ❑ Unknown

❑ Glue Laminated Wood Beam ❑ Other: ____________________

7.1.2 What is the primary load-bearing structure of the building? ❑ Wood Frame

❑ Unreinforced Masonry Walls ❑ Reinforced Concrete Frame ❑ Heavy Steel Frame

❑ Tapered Steel Frame ❑ Reinforced Masonry Walls ❑ Heavy Timber Frame

❑ Laminated Beam Frame ❑ Unknown ❑ Other: ____________

7.1.3 How is the primary roof support system connected to the primary load-bearing system?

Description: ____

____

____

____

7.1.4 How is the primary load-bearing system connected to the foundation?

Description: ____

____

____

YES		**7.2 Is the building a Pre-engineered (steel pre-fabricated) building built <u>or</u> designed prior to the mid 1980's?**
NO		*(Specify year built/designed: ____________)*

4.3.1.6 Section 8 - Building Condition/Wind Damage History

- This section captures the observed overall condition of the building. The condition of a building's MWFRS and exterior envelope can play a significant role in determining the wind vulnerability of a potential HES. A building with major deterioration of critical loadpath components, or exterior envelope walls or cladding, will have lost any excess structural capacity that may have been present in the original structure.

    - The building's owner or facility manager should be able to provide information on wind damage history, which may offer valuable information concerning the vulnerability of a building.

- Wind damage initiated by a weak storm, relative to a major hurricane, may indicate construction workmanship problems, or other possible design and construction flaws. Special attention should be given to the previous failure mode(s) when performing the building's field survey.

- The building's condition and the effectiveness of wind damage repairs can only be verified during the field survey. Based upon findings from the field survey, determine if the potential HES's condition is suitable for use.

- Use the following guidelines for defining the condition of the building:

Good Condition:

- •• A building has no apparent signs of deterioration. The building is approximately as sound as it was when new, and the structure shows none of the signs of deterioration indicated in the minor or major deterioration categories.

- •• The building generally looks as if it is well maintained in other nonstructural respects; it is not in obvious need of painting, does not have broken windows, weeds are not growing in roof gutters, etc.

Minor Deterioration:

- •• A field survey indicates there are some cracks in walls and other signs of slight deterioration that do not appear to significantly impact on wind resistance.

- •• One or more of the following signs may be present:

  <u>Cracks in Concrete or Masonry</u> - Cracks in walls, columns, beams, or slabs that are not slabs-on-grade. The cracks are less than a 1/16 inch in width and do not extend for more than a few feet in a continuous line. Cracks in slabs-on-grade are considered only insofar as they indicate foundation settlement, which is separately described below.

  <u>Deterioration</u> - Masonry mortar joints may be somewhat soft or eroded, but mortar cannot be removed easily with a key or similar metal object. The building has hairline crack(s) in masonry walls that run diagonally up the wall without cracking CMUs and

without any indication of significant yielding of joint reinforcement.

Corrosion - There is rusting of steel members but not to the point that a cross section of a metal member is reduced significantly. Rust stains on the concrete indicate rusting reinforcing bars may be present but only in occasional places and only to a slight degree.

Spalling - There are pebble-size pieces of concrete, smaller than a golf ball, broken away. Reinforcing bars are not significantly exposed or the cross sections of members are not significantly compromised.

Rot - There is some rotting or degradation of wooden members, but not to the extent that a key or similar metal object can penetrate easily.

Foundation Settlement - Signs of about an inch or less of foundation settlement.

Major Deterioration:

- A field survey indicates there is observable deterioration of the facility's superstructure that may impact on wind resistance.

- One or more of the following types of deterioration is observable and there are at least two instances noted (two cracks, two areas of a brick wall with mortar deterioration, one major crack and one case of major post rotting, etc.).

  Cracks in Concrete or Masonry - There are cracks in walls, columns, beams, or slabs that are not slabs-on-grade. The cracks are more than a 1/16 inch in width or extend for several feet in a continuous line. There are diagonal cracks at the ends of beams or extending through the story height of a wall.

  Deterioration - Masonry mortar joints are soft or eroded. The mortar can be removed easily with a key or similar metal object. There are hairline crack(s) in masonry walls that run diagonally up the wall. Cracking of CMUs may also be present, indicating significant yielding of joint reinforcement.

Corrosion - There is rusting of structural steel members to the point where the cross section is reduced significantly. Rust stains on the concrete indicate rusting reinforcing bars may be present in numerous places and to a substantial degree.

Spalling - Golf ball- or larger-size chunks of concrete have broken away. Reinforcing bars are exposed significantly, or the member's cross section has been compromised significantly.

Rot - There is significant rotting or degradation of wooden members, such as sills, post bases, and wall framing, to the extent that a key or similar metal object can penetrate the wood easily.

Foundation Settlement - Signs of about an inch or more of foundation settlement; walls or columns are out of plumb more than one inch in a story height.

SECTION 8 - BUILDING CONDITION/ WIND DAMAGE HISTORY
8.1 From observation, what is the overall condition of the building? ❑ Good Condition ❑ Minor Deterioration ❑ Major Deterioration
8.2 Is there any history of damage from high winds, or storms at this building? ❑ YES ❑ NO
8.3 Comments: *(Specify damage history):* ______

4.3.1.7 Section 9 - Exterior Wall Construction

Items 9.1-9.1.3 address the ability of the exterior walls to resist wind loads and windborne debris impact.

- Item 9.1.1 -**Unreinforced Masonry Buildings:** Under hurricane conditions, wind uplift and/or flexural bending can create tensile forces in un-reinforced masonry. Though strong in compression, unreinforced masonry is incapable of resisting tensile forces, often leading to catastrophic failure. Loadbearing unreinforced masonry walls are particularly vulnerable to catastrophic failures. Unreinforced masonry also may be susceptible to perforations caused by large windborne debris impact.

- The term "unreinforced masonry," as referred to in ARC 4496, is commonly defined as masonry (CMU, clay tile, clay or concrete brick, etc.) without vertical steel reinforcement (rebar), or with vertical reinforcement spaced at distances greater than eight feet on-center.

- As a rule of thumb, if the building was designed and constructed prior to 1987, assume the masonry is unreinforced unless there is definitive evidence from construction drawings and specifications that contradict this assumption.

- For loadbearing masonry walls with reinforced pilaster and bond-beam flexural systems, the unreinforced masonry panel dimensions shall not exceed 12 feet vertically or horizontally (13'-3" on-center pilaster spacing).

- Buildings with loadbearing solid unreinforced clay brick walls (eight inches or greater in thickness) will be considered unreinforced, regardless of wall thickness.

- To determine the spacing of reinforcement in a masonry wall, review the construction drawings at both the foundation plan, first-floor plan, and typical upper-floor plan (if applicable).

  - The CMU cells the designer intends to have reinforced will be darkened or shaded.

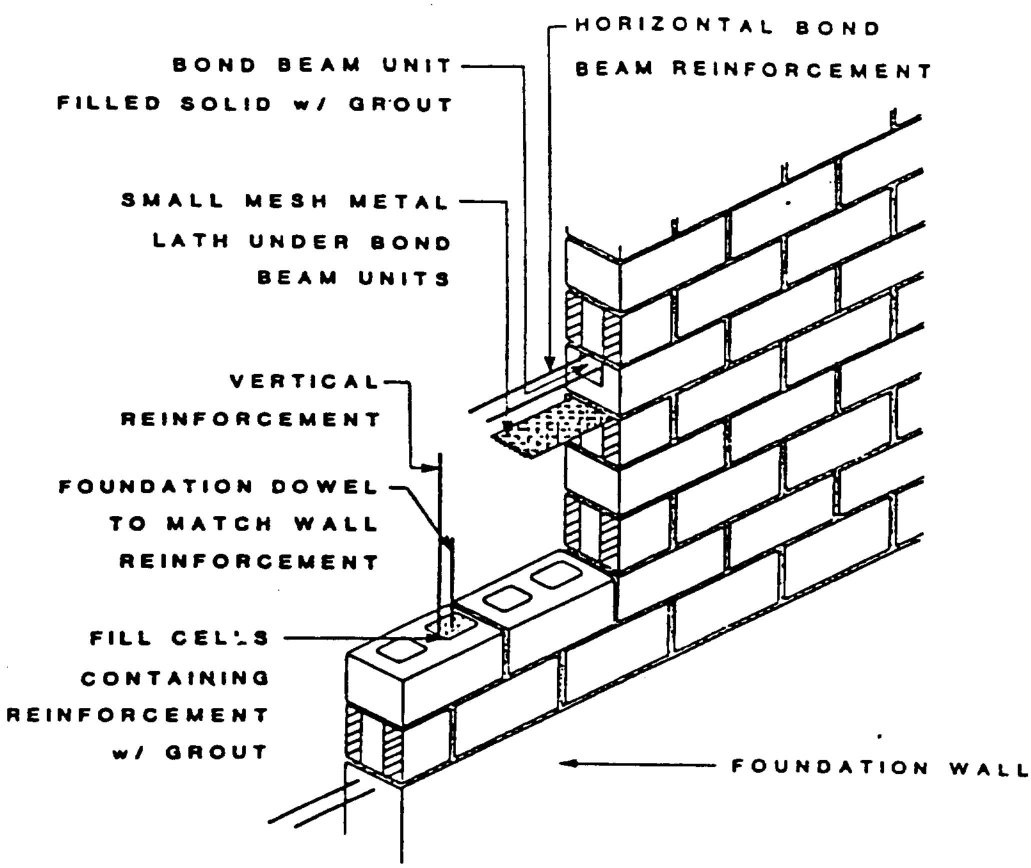
  - If there are no cells shaded, and the building was constructed prior to 1987, assume the walls are unreinforced.

  - If the wall was designed and constructed after 1987, or the reinforced cells are spaced eight feet on center or closer, the masonry wall will be considered fully or partially reinforced (as appropriate).

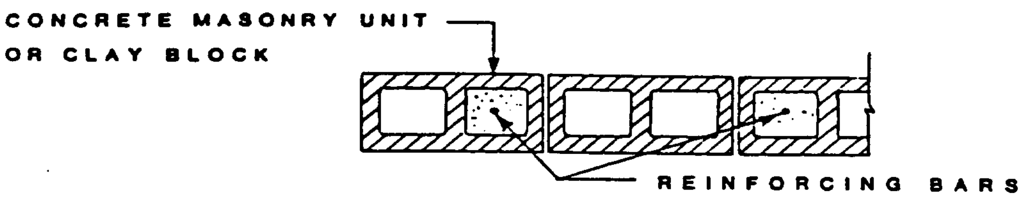
- <u>Item 9.1.1.1</u> - Various wall types have different levels of wind load and impact resistance.

  - Fully reinforced masonry (which is a preferred exterior wall system) is defined in ACI 530.

    - Generally, if a masonry wall has #5 rebar or larger at four feet on center or closer vertically, with rebar at the corners and around windows and doors it will meet the ACI 530 definition.



REINFORCED HOLLOW MASONRY



PLAN

- Partially reinforced concrete masonry is defined in NCMA TEK 63-1975.

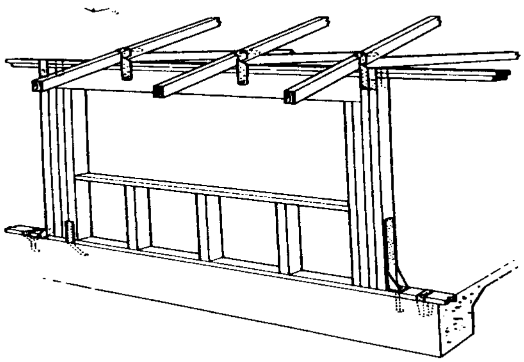
  - Generally, it is masonry wall construction designed as unreinforced masonry, except that vertical reinforcement is provided in some portions spaced no more than eight feet apart, with vertical bars at wall corners, wall intersections, and on each side of window and door openings. Horizontal reinforcing must be present at roof and floor levels and above and below window or door openings.

- If pilasters are present that contain a minimum of four #5 or greater diameter rebar, arranged in a rectangular or square pattern, check the spacing of the pilasters.

  - If the pilaster spacing is no greater than 13'-3" on center, check an appropriate wall cross-section to determine if the bond-beam vertical spacing(s) are less than 13'-3" on-center. If the pilaster wall system conforms to this requirement, and the nominal thickness of the masonry is greater than or equal to eight inches, the masonry's wind resistance will be similar to that of partially reinforced masonry (generally a marginal wall system).

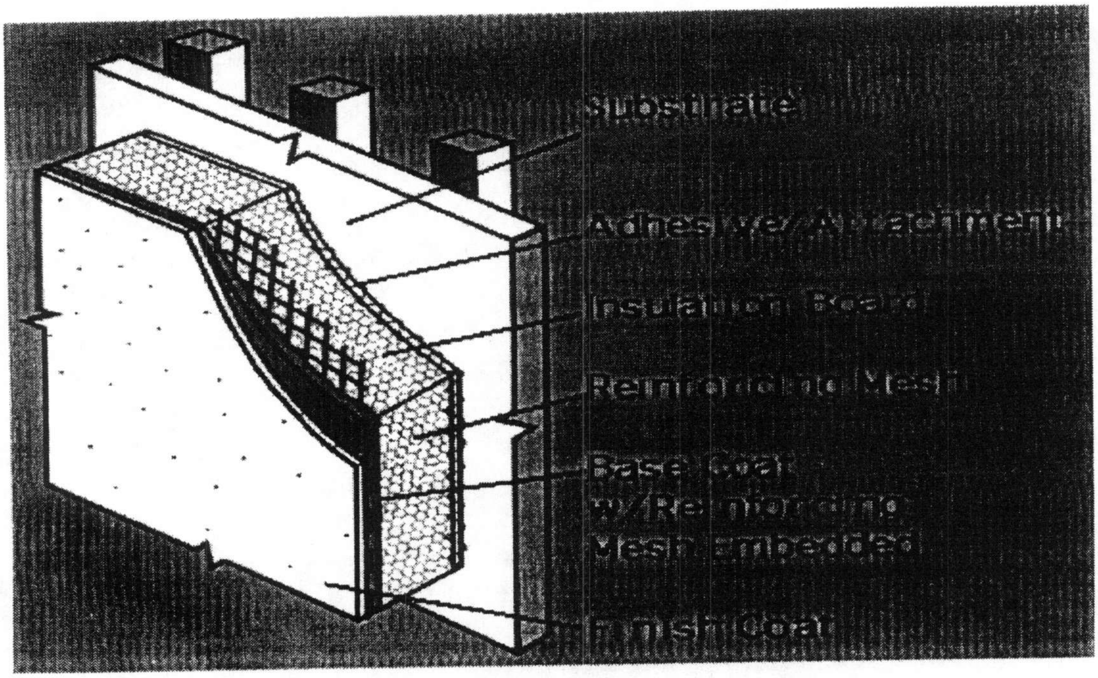
- Wood and metal stud wall systems should comply with SBC SSTD 10-93 (or a more recent version).

Example of wood stud connections from roof to foundation.



- Item 9.1.1.2 - Past performance indicates that metal panels/sheets thinner than 22 gage may have insufficient impact and cyclical fatigue resistance under hurricane conditions.

- Item 9.1.2 - A brick or stone veneer will provide an exterior wall with additional debris impact resistance.



Typical EIFS Components

- Item 9.1.3 - EIFS system have historically proved vulnerable to hurricane force winds and windborne debris impact.
- Item 9.1.4 - A cantilevered wall is a wall that is supported/connected only at the base. Such walls are vulnerable to windload forces and present softspots in the building exterior.
- Item 9.1.5 - Here look for areas such as bricked up windows, tall window systems that have been replaced with stucco or vinyl coverings, etc.

SECTION 9 - EXTERIOR WALL CONSTRUCTION		
YES		**9.1 Are the exterior walls relatively wind and debris impact resistant?**
NO		
YES		**9.1.1 Does the building have unreinforced masonry walls on its exterior?** ❑ Unreinforced Masonry or ❑ Rebar Spacings Unknown
NO		

9.1.1.1 If no, what is the Exterior Wall Construction type? *(Check only one)*

- ❑ Reinforced Masonry (Rebar @ 4 ft. centers or closer)
- ❑ Light Wood or Metal Stud w/ ½ inch or thicker plywood
- ❑ Partial Reinforced Masonry (Rebar @ 8 ft. centers to 4 ft. centers)
- ❑ Light Wood or Metal Stud w/ light non-plywood sheathing
- ❑ Partial Reinforced Masonry (Four-bar Pilasters 13 feet on center or less)
- ❑ Large Panel Glass or other Glazed Panel or Block System
- ❑ Reinforced Concrete or Precast Concrete Panels
- ❑ Metal Sheets or Panels or other Light Architectural Panel Systems
- ❑ Other: ____________________

9.1.1.2 If Metal Sheets or Panels (e.g. PEMB structures), what is the gage of the metal sheets or panels?

❑ Thinner than 22 gage (26 gage, etc.) ❑ 22 gage or thicker (18 gage, 16 gage, etc.) ❑ Not Applicable

9.1.2 Do the exterior walls have a brick or stone veneer (3 to 4 inches thick)? ❑ YES ❑ NO

9.1.3 Do the exterior walls have an Exterior Insulating and Finish System (EIFS)? ❑ YES ❑ NO

9.1.4 Are there cantilevered walls (walls connected/supported at the base/foundation, but not at the roof) on the exterior of the building?

❑ YES ❑ NO

Describe: ____________________

9.1.5 Are there any other softspots noted in the building's exterior wall/roof? ❑ YES ❑ NO

Describe: ____________________

4.3.1.8 Section 10 - Fenestrations/Window Protection

- <u>Item 10.1</u> - Unshuttered/Unprotected windows can be softspots in a building's envelope. Once breached by wind loads or wind borne debris impact, the window opening will allow access by hurricane force winds and rain into the building interior. This can result in overpressurization, interior damage, and subsequent roof system failures.

- <u>Item 10.1.1</u> - Generally, more than five percent of the exterior walls is considered excessive glazing, if unprotected.

- Item 10.1.2 - These are large softspots in the exterior walls that are very vulnerable to windborne debris.

- Item 10.1.3 - Different types of glass have different degrees of wind load and debris impact resistance.

- Item 10.1.4 - If only some of the windows are protected, then the unprotected windows still present softspots for the building. If only part of the building is to be used as a shelter, and that part is sealed off from the rest of the building, and all the windows in that part are shuttered/protected, then answer yes and explain in Item 10.4 below.

- Item 10.1.5 - There are numerous shutter/protective system products available. These two standards (or subsequent versions) are the ones available at this time.

- Items 10.1.6 - 10.1.6.3 - There may be many shutter/protective systems already installed that might meet the standards listed above but have not been tested. These items are intended to help estimate the general adequacy of such systems. Use documents provided by the manufacturer to answer these items, if possible.

- Item 10.2 - Overhead doors or other large doors (i.e., eight feet or wider) have historically performed poorly under hurricane conditions and present large softspots in the building's envelope.

- Item 10.2.1 - In some cases the overhead/large doors may have been modified to resist high wind loads. Be sure that the frame was also modified.

- Item 10.3 - Skylights and overhead glass or plastic windows have performed poorly under hurricane conditions. Once breached they allow access by hurricane force winds and rain into the building's interior, leading to subsequent and probably catastrophic roof system failures.

- Item 10.4 - Are there areas that have been walled in with unreinforced masonry, plywood, drywall, etc.? If yes, specify.

- Item 10.5- This a sketch page for a quick sketching of the building floorplan and locations of windows/doors and other points of interest.

SECTION 10 - FENESTRATIONS/WINDOW PROTECTION

YES		**10.1 Are all the windows in the building adequately protected by shutters/protective systems?**
NO		

10.1.1 What is the percentage of Glass in the exterior walls ? ❑ 0% to 1% ❑ 2% to 5% ❑ 6%+

(________ sq. ft. of glazings ÷ ________ sq. ft. of exterior walls x 100 = ____)

10.1.2 Are there "store-front", atrium, or clerestory sections of glazing in the exterior walls? ❑ YES ❑ NO

10.1.3 What type of glass is utilized in the exterior walls? ❑ Unknown

❑ Fully Tempered ❑ Laminated Glass ❑ Other________________________

10.1.4 Are all the windows in the exterior walls of the building shuttered/protected against windborne debris?

❑ YES ❑ NO ❑ Not Applicable

10.1.5 Has the shuttering/protective system used to protect the windows been certified to meet the windload and impact resistance standards in the Dade County version of the South Florida Building Code (Sections 2314.1, 2314.5, and 2315.1-2315.4), or SBC Standard SSTD 12-94?

❑ YES ❑ NO ❑ Not Applicable ❑ Unknown

10.1.6 If there is a shuttering/protective system in use but it is not certified to the standards in 10.1.5 above, is there documentation indicating the system was designed to transfer impact and wind loads to the building walls?

❑ YES ❑ NO ❑ Not Applicable ❑ Unknown

10.1.6.1 Does it appear that the system was installed per the manufacturers' design documentation?

❑ YES ❑ NO ❑ Not Applicable ❑ Unknown

10.1.6.2 Is the shuttering/protective system frame directly anchored into the wall around the window?

❑ YES ❑ NO ❑ Not Applicable ❑ Unknown

10.1.6.3 If a film protective system is used, does the film cover the entire glazing (exposed glass and portions embedded in the frame)?

❑ YES ❑ NO ❑ Not Applicable ❑ Unknown

10.2 Are there overhead/large door(s) in the building? ❑ YES ❑ NO

10.2.1 Have the overhead/large door(s) and framing been modified with additional bracing to resist high wind loads?

❑ YES ❑ NO ❑ Not Applicable ❑ Unknown

10.3 Are there skylights or overhead atrium glass or plastic? ❑ YES ❑ NO

Describe: ____

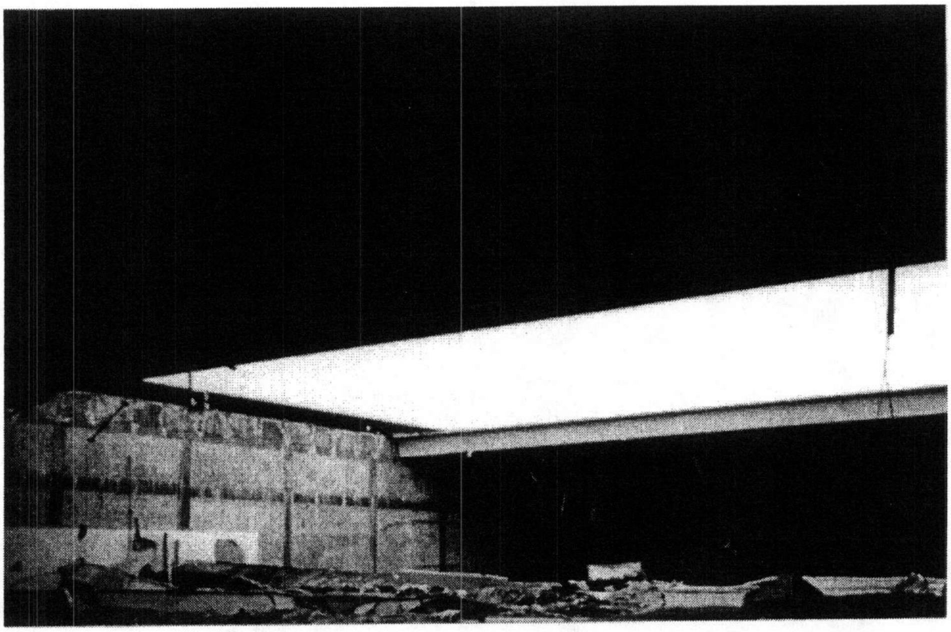
10.4 Comments: ____

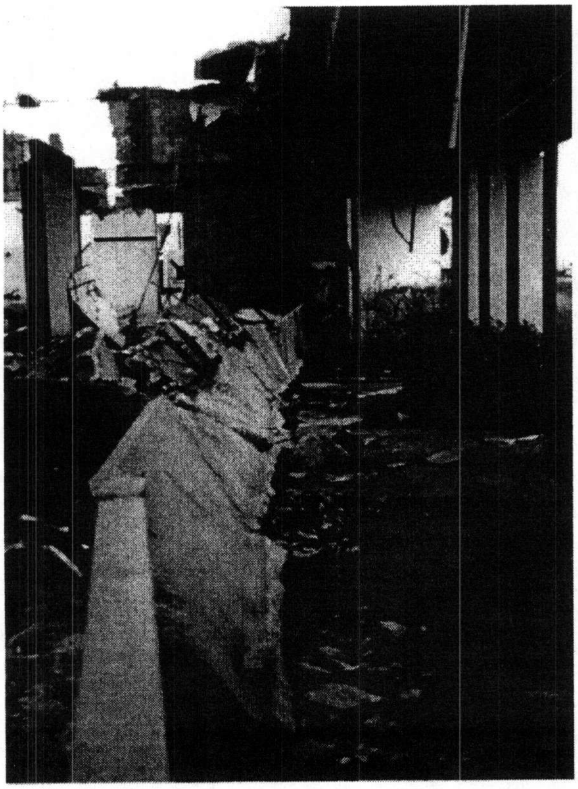
SECTION 10 - FENESTRATIONS/WINDOW PROTECTION
10.5 Draw "footprint" sketch of building showing overall dimensions & window location.
Window/Door Types and sizes:
A Size ____ x ____ - Type __________: e Size ____ x ____ - Type ______________________:
B Size ____ x ____ - Type __________: f Size ____ x ____ - Type ______________________:
C Size ____ x ____ - Type __________: g Size ____ x ____ - Type ______________________:
D Size ____ x ____ - Type __________: h Size ____ x ____ - Type ______________________:

4.3.1.9 Section 11 - Roof Construction/ Slope

- Item 11.1 - A heavy reinforced concrete roof deck can provide substantial resistance to the uplift forces present under hurricane conditions.

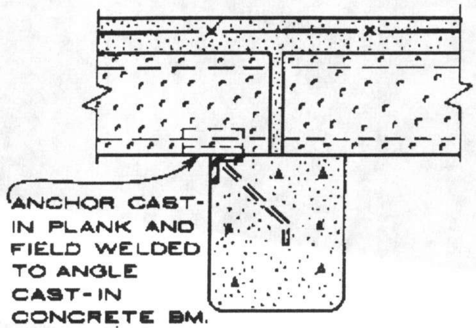
  - Precast Concrete Panels can provide relatively wind-resistant roofs, if they are securely anchored into the support system (walls, frame, etc.). Often, in older buildings, they are gravity loaded with grouting only, or welded to embedded metal plates for shear. Historically, such unanchored or inadequately anchored roofs have performed poorly under hurricane conditions.





Examples of precast concrete roof tees moved and dropped inside of buildings by hurricane effects.

TYPICAL TEE BEARING DETAIL



- Item 11.1.1 - Past performance indicates that metal panels/sheets thinner than 22 gage may have insufficient impact and cyclical fatigue resistance under hurricane conditions.

- Item 11.2 -The definition of "lightweight roof" is not provided in ARC 4496 but generally can be defined as the roof deck, and integral support elements, that have a combined weight less than the basic building code uplift pressure requirements. This uplift pressure varies with the building's height and the basic wind speed zone of the local jurisdiction; therefore, for the purposes of this procedure, a weight of 25 pounds per square foot (psf) or less will be assumed to mean lightweight.

  - Typical roof materials that are classified as lightweight include wood boards, plywood, precast cement-fiber planks, fiberboard, gypsum board, metal decking, wire-fabric, or other similar material, with or without poured gypsum or insulating (lightweight) concrete.

  - Historical data from previous hurricanes indicates that lightweight roof decks often fail at their connections with supporting roof trusses or joists.

  - The roof covering also is damaged and removed by clean-off, or erosion, effects of the wind; therefore, roof covering materials should generally not be included in the dead weight estimate.

  - Only the dead-weight of the roof's structural plate-like layer should be used to compare the potential HES's roof weight to the 25 psf lightweight roof criteria.

- •• If the HES evaluator has a high degree of confidence that the roof deck, covering, and support members will remain intact during an extreme wind event, the weight of these elements can be added to the roof deck when determining total dead weight.

- •• The weight of clay or concrete roof tiles can be included in the calculations if they have been fastened to a roof deck with a nail and full mortar bed, as prescribed by the product manufacturer for high-wind areas.

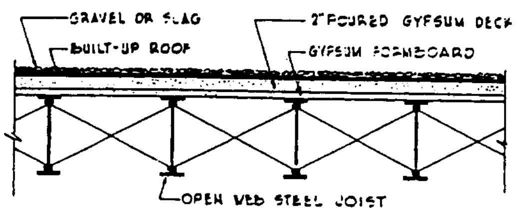
- •• Poured gypsum or insulating concrete may be included in the dead-weight calculations if applied directly to the structural deck (i.e., not on top of rigid insulation boards).

- To determine if a roof system is lightweight, review the construction drawings and take note of typical roof cross-sections. A sample procedure for estimating the dead weight of a lightweight roof system is provided below:

Procedure to Estimate the Dead Weight of a Lightweight Roof System

To determine the dead weight of a lightweight roof system, identify the materials that combine to create the structural plate-like layer of a roof deck. As an example, the roof cross-section shown below includes open-web steel joist (OWSJ) support members, a ½-inch gypsum formboard, two inches of poured gypsum, and a built-up roof covering with gravel. The weight of the OWSJ should not be included, as the connections between the gypsum formboard and joist are likely to fail with this type of system in a high-wind event. The gravel is likely to be cleaned off by high winds, as is the roof covering; therefore, they also should not be included in the dead-weight calculation.

This leaves the gypsum formboard and two-inch poured gypsum deck to contribute to the dead weight that will be resisting wind uplift forces. To determine their combined dead weight, turn to **Appendix E** of this manual. Locate the entries for each respective material, and note the weight given in psf. Note that the weights given in Appendix E are in psf per inch of depth unless otherwise indicated. The poured gypsum deck has a weight of four psf per inch of depth, therefore a dead weight of eight psf. Sum this weight with the two psf given for the formboard, and the total deck weight is 10 psf. As 10 psf is less than the 25 psf lightweight roof criteria, the roof is considered lightweight.

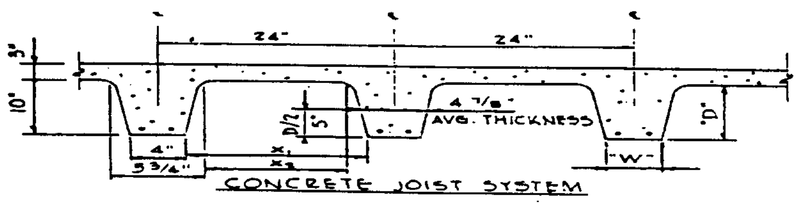


Built-up Roofing	N/A
Poured Gypsum Deck	8.0 psf
½" Gypsum Board	2.0 psf
Steel Joist	N/A
Total Dead Weight Used	**10.0 psf**

- To calculate the dead weight of a concrete roof system use the procedure below:

Procedure to Estimate the Dead Weight of a Concrete Roof System

To determine the dead weight of a concrete roof system, identify the materials that combine to create the structural plate-like layer of a roof deck and any monolithically connected roof support. As an example, the roof cross-section shown below includes tapered concrete joist support members, monolithically poured with a three inch reinforced concrete deck. A built-up roof covering with gravel is not shown for clarity, because it is likely to be cleaned-off by high winds; therefore, the covering should not be included in the dead-weight calculation. This leaves the poured concrete joists and 3-inch poured deck to contribute to the dead weight that will be resisting wind uplift forces. To determine their combined dead weight, turn to **Appendix E** of this manual and locate the entry for medium weight structural concrete. Note the weight given is in psf; in this case, approximately 11 psf. Note the weights given in Appendix E are in psf per inch of depth unless otherwise indicated. The poured concrete deck has a weight of 11 psf per inch of depth and, therefore, a dead weight of 33 psf. Calculate the adjusted weight of the joist by following the procedure given below. Sum this adjusted joist weight with the 33 psf weight given the deck, and the total roof weight is 55 psf. As 55 psf is greater than the 50 psf heavyweight roof criteria, the roof is considered heavyweight.



To adjust the weight of the joists to account for spacing, take the average thickness of the joists and multiply by their depth (excluding deck thickness). This gives the cross-sectional area of the joist itself. Divide the area by the center spacing distance of the joists to average the area over the full span; this gives the adjusted depth of concrete for the joists. Multiply the adjusted depth of joist concrete by the weight per inch to calculate the added weight for the roof due to the presence of the joists.

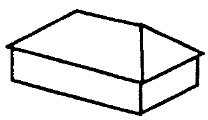
To calculate adjusted weight of concrete joist, use the following formula:

$$\frac{\textbf{Depth x (Avg. Width)}}{\textbf{on-center Joist Spacing}} \textbf{ x weight/inch = Adjusted Weight}$$

Built-up Roofing	N/A
Poured Concrete Deck	33.0 psf
Poured Concrete Joist	22.0 psf
Total Dead Weight	**55.0 psf**

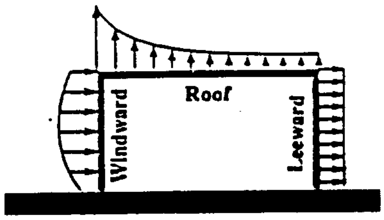
- <u>Item 11.3</u> - Hipped roofs are relatively wind-resistant due to their inherent structural reinforcing. Basically this is a roof system with a center ridge and slopes down all four sides.

HIP ROOF



Four Sloped Sides

- Item 11.4 - Flat roofs are very vulnerable to uplift forces present under hurricane conditions. Such roofs have historically performed poorly under hurricane conditions. ARC 4496 recommends avoiding buildings with flat roofs. A flat roof is one with a roof slope of one degree or less.

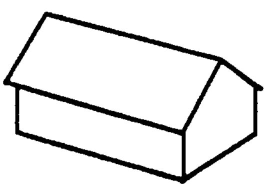


Wind pressures on flat roof

Similarly, shallow slope roofs (slopes greater than one degree and less than 11 degrees) are very vulnerable to uplift forces. The steeper the slope , the less uplift force the roof is subjected to.

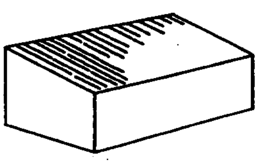
- Item 11.5 - Gable-ended - A sloped roof with a ridge and flat, gable ends. Check to ensure that such roofs have "X" bracing in the roof to brace the flat gable ends against wind forces acting directly against them.

GABLE ROOF



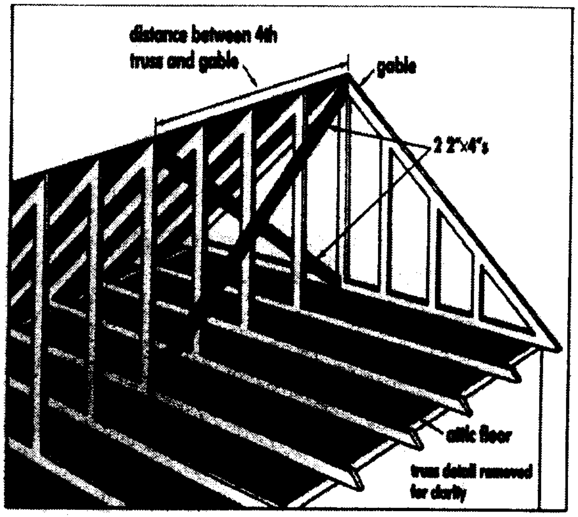
Two Sloped Sides

- Shed System - A sloped roof (lean-to appearance) with one side higher than the other.

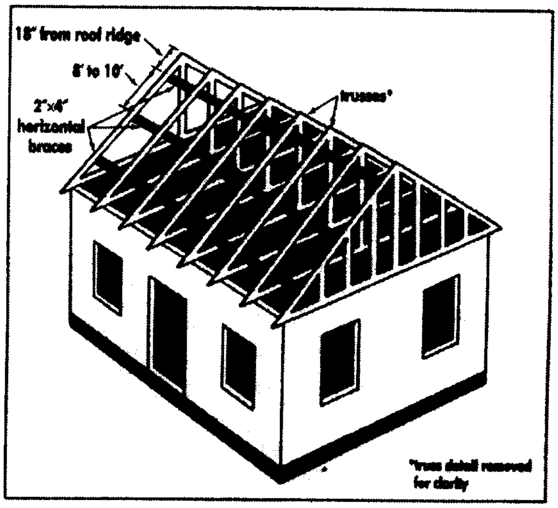


SHED ROOF

- Item 11.5.1 Gable-ends have proven vulnerable to hurricane winds unless braced to resist the wind loads on the gable ends. Here look for either cross-bracing, truss-bracing, or for masonry gable ends with reinforcements from foundation up through the gable ends to the roof.



Gable End Bracing



Truss Bracing

- Item 11.6 - Buildings with steep-pitched roofs should be preferred for use as an HES, as wind uplift forces are reduced significantly.

  - The term "steep-pitched," as referred to in ARC 4496, commonly is defined as a roof having a slope of greater than 30 degrees. A roof with this slope will have a downward acting wind force on the windward side of the building instead of an uplift force.

  - A roof with a moderate slope of 11 to 30 degrees has a reduced vulnerability when compared to flat- or low- slope roofs but still has an uplift force on both the windward and leeward sides of the building.

  - The steeper the roof slope of a moderately sloped roof system, the lesser the uplift force.

  - As buildings with moderate sloped roofs are less vulnerable to wind uplift damage than flat- or shallow-sloped roof systems, there may be some flexibility in their use as an HES.

  - Roof slopes can generally be found in roof section drawings. If not, use the table below to determine roof slopes.

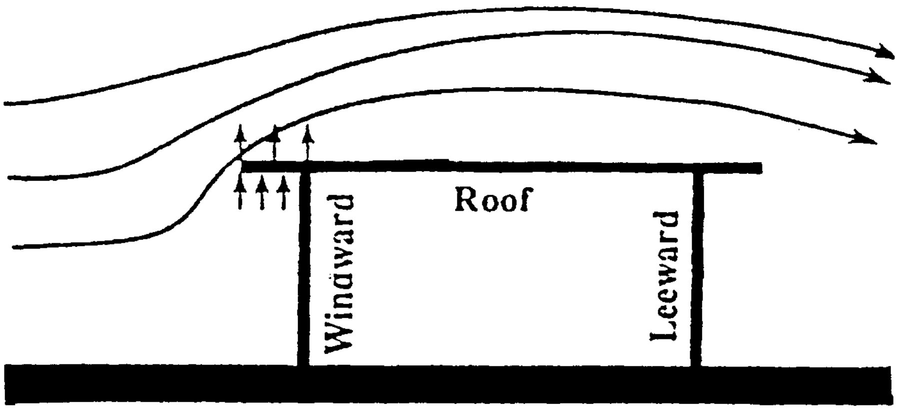
Roof Pitches/Slopes Conversion Table		
Height/Width (ratio)	Slope (degrees)	Pitch (inches height/inches width)
.0208	1	1/4"/12
.083	5	1/12
.17	10	2/12
.25	14	3/12
.33	18	4/12
.42	23	5/12
.5	27	6/12
.5833	30	7/12

To determine roof slope by field dimensions, measure the height of the roof ridge from the roof trusses' bottom chord. Then measure the length of the bottom chord, including overhang length. Use the following formula to determine the height-to-width ratio (h/w ratio).

$$\frac{\textbf{Roof Ridge Height, ft}}{\textbf{Bottom Chord Length, ft / 2}} = \textbf{h/w ratio}$$

With the h/w ratio calculated, compare the calculated h/w ratio to the standard h/w ratio in the left-hand column above. Note the h/w ratio from the table that most closely matches the calculated value. The roof slope that corresponds to the noted h/w ratio is the approximate roof slope.

- Item 11.6.1 - Shallow slope roofs are subject to strong uplift forces. The steeper the slope, the less uplift force the roof is subject to.
- Item 11.7 - A large overhang can act as a wind sail and catch hurricane force winds. This results in additional uplift forces acting on the roof system from below and can severely test the roof to wall/frame connections.



SECTION

Wind Effects on a Building Overhang

- If construction drawings are available, turn to the roof framing plan. If the building has exterior loadbearing walls, the outline of the walls typically will be shaded gray. The overhang will clearly be present extending beyond the walls' outer faces.

  - •• For loadbearing frames, the exterior wall may not be present on the drawings. However, support beams or trusses should be indicated, with columns below. Again, the overhang will clearly be present extending beyond the support beam or truss.

  - •• Using a scale, or directly reading the dimension off the drawings, identify the width the overhang extends beyond its support

  - •• If the overhang's width dimension varies, note the widest length if it is present for at least 20 percent of a side's perimeter dimension or if it is located at an outside corner.

  - •• If construction drawings are not available, the overhang's width can be measured at the site.

  - •• If a roof's overhang is greater than one foot in width, it will significantly increase uplift forces on the roof.

  - •• If the building was constructed prior to 1987, the building codes and standards did not reflect the amplified uplift pressures that are present at overhangs.

- •• Therefore, buildings that are constructed prior to 1987 and have overhangs that exceed one foot should be avoided.

- •• Buildings constructed after 1987 with overhangs that do not exceed three feet provide for some flexibility.

- Determine if the overhang is an extension of the roof system or is an independent architectural feature. If the overhang structurally is independent of the roof, damage to the overhang will have a negligible impact upon the roof system.

  - •• Check wall sections in the architectural drawings to confirm the overhang's construction and attachment method to wall, frame and/or roof system. The overhang's construction materials and connection type should be noted.

- <u>Item 11.8</u> - Different roof covering types indicate different vulnerabilities to wind forces and debris impact. Use the technical drawings to determine the covering types, but verify on-site if possible.

- <u>Item 11.9</u> - Generally an older roof will be more vulnerable to wind forces. Age can be determined by the technical drawings, but should be verified by the building custodian.

- <u>Items 11.10.-11.10.1</u> -Mechanical equipment mounted on the roof can be exposed to the strong winds present under hurricane conditions.

  - Air conditioner units and large vents are very vulnerable to damage, unless securely fastened to the roof structure. If torn off these units can cause breaches of the building roof envelope, leading to subsequent interior damage and roof failures.

  - Use the technical drawings to determine if the equipment is attached directly to the supporting frame or roof structure.

  - Verify on-site whether the equipment is currently attached to a frame. It is not uncommon for equipment not to be completely reattached when returned after repairs (i.e., the equipment is simply placed back on the frame without replacing some or all the bolts).

- Items 11.10.2-11.10.3 - Lightweight rooftop structures are very vulnerable to damage from hurricane force winds and windborne debris impact.

SECTION 11 - ROOF CONSTRUCTION/ROOF SLOPE

11.1 What is the Roof Construction type of the Building?

- ❑ Cast-in-place Reinforced Concrete (standard wgt concrete, 4 " min.)
- ❑ Plywood on wood or metal joist or truss (spacing: ______)
- ❑ Precast Concrete Panels ("T's", "Double T's", Planks, etc.)
- ❑ Wood boards or T & G deck on wood joist or truss (spacing: ______)
- ❑ Metal Decking w/standard wgt concrete (3 " min.) on metal joist, truss, or beam (spacing: ______)
- ❑ Fiberboard or Cementitious fiber planks on wood or metal joist or truss (spacing: ______)
- ❑ Other Metal Decking Systems (insulating concrete and/or rigid insulation or other light coverings)
- ❑ Poured Gypsum on Formboard Decking on wood or metal joist or truss (spacing: ______)
- ❑ Other: ______

11.1.1 If a Metal Decking System, what is the gage of the metal decking?

❑ Thinner than 22 gage (26 gage, etc.) ❑ 22 gage or thicker (18 gage, 16 gage, etc.) ❑ Not Applicable

YES		**11.2 Does the building have a heavyweight roof system?**
NO		

11.2.1 What is the estimated roof weight? ❑ Heavy weight (50 pounds per square foot or greater)

❑ Lightweight (25 pounds per square foot or less) ❑ Mediumweight (26-49 pounds per square foot)

YES		**11.3 Does the building have a hipped roof system?**
NO		
YES		**11.4 Does the building have a flat roof system?**
NO		

11.5 If not a hipped or flat roof system, what is the roof geometry of the Building?

❑ Gable-ended ❑ Shed System ❑ Other: ______

11.5.1 If Gable-ended, are the gable-ends braced against collapse? ❑ Yes ❑ No ❑ Not Applicable

If yes, describe: ______

YES		**11.6 Is the Roof Slope steep-pitched [greater than 30 degrees (7:12)]?**
NO		

11.6.1 What is the roof pitch? ❑ flat slope (0-1 degrees)

❑ shallow slope (2-10 degrees) ❑ moderate slope (11-29 degrees) ❑ steep slope (30+ degrees)

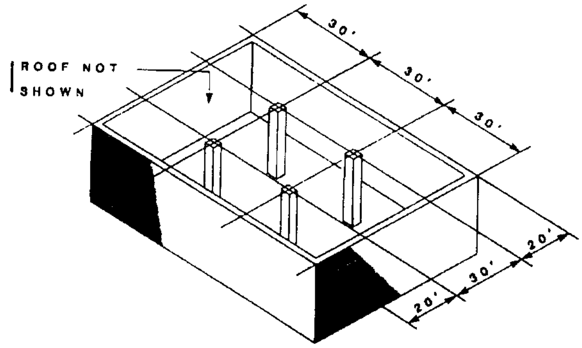
SECTION 11 - ROOF CONSTRUCTION/ROOF SLOPE		
11.7 What is the width of the roof overhang? ______________ feet		
11.8 What type of roof covering is used? ❑ Built-up roofing (O with gravel; O without gravel) ❑ Single-ply membrane with gravel or pavers ❑ Shingles ❑ Standing Seam Metal roof ❑ Tile Roof ❑ Slate Roof ❑ Metal Panels ❑ Single-Ply membrane mechanically fastened or fully adhered ❑ Unknown ❑ Other: ______________________________		
11.9 What is the age of the roof covering? ❑ Less than 5 years ❑ 5-10 years ❑ 11-15 years ❑ 16-20 years ❑ Greater than 20 years ❑ Unknown		
YES		11.10 Are there structures on the roof top vulnerable to high wind forces?
NO		
11.10.1 What mechanical equipment is on the roof (i.e., air conditioners, ventilators, etc.)? ❑ air conditioners ❑ air handling units ❑ large vents ❑ Not Applicable ❑ Other: ______________________________		
11.10.1.1 Is the mechanical equipment on the roof securely fastened to the roof structure? ❑ YES ❑ NO		
11.10.2 Are there lightly constructed structures or penthouses on the roof? ❑ YES ❑ NO Describe: ______________________________		
11.10.3 Are there any stacks, antennas or lights on the roof? ❑ YES ❑ NO Describe: ______________________________		
11.11 Comments: ______________________________		

4.3.1.10 Section 12 - Roof Open Span

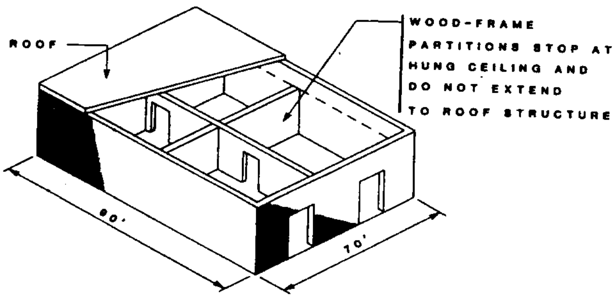
- Item 12.1 - Historically, long open-span roofs have performed poorly in major hurricanes. Such roofs are generally light in weight and, therefore, cannot resist wind uplift forces effectively. Further, these roofs undergo excessive deflections, reverse bending, and vibrations. Inadequately connected roof framing systems may slip from their bearing points or may shear off bearing connections provided on the supporting walls.

- Item 12.1.1 - The term "long- or open-span roof," as referred to in ARC 4496, commonly is defined as an unsupported span of 40 feet or greater.

Not Open Span because the largest span is 30 feet between vertical supports.



Open Span (70 feet between vertical supports)



- To determine if a building has a long-span roof, review the construction drawings for the roof framing plan.

  •• Buildings with a structural frame, columns, and beams typically are laid out in bays. A bay means a space defined either by bearing walls or columns.

  ••• The maximum distance spanned between columns is the length that is compared to the 40-foot long-span criteria; if the maximum span is greater than 39'-11", a long-span condition is present.

  •• For wallbearing buildings, the loadbearing walls typically will be shaded, indicating a connection and bearing point for the roof support system. Any sheer walls should be considered boundaries.

  •• Some buildings may be a combination of structural frame and wallbearing systems. The same procedure applies as described previously.

- If construction drawings are not available, and site inspection is the only available option, care must be taken to identify all loadbearing components.

    - •• It is common for interior partition walls to extend above the ceiling line, but walls will only be nominally attached to roof framing members or deck to provide lateral support for the partition. Roof support members (beams, joists, etc.) also may extend through walls, and the walls sealed around the member with a smoke and fire resistant barrier, but the joists will not be supported by the wall. There must be a bearing plate and/or framed connection to a bearing wall, beam, or column at both ends of the roof support to establish the span distance.

    - •• Measure the distance with a measuring tape, or count ceiling tiles, or other uniformly spaced material to determine the span distance. Then compare the measured distance to the 40-foot span criteria to determine if a long span exists.

- For buildings that have both long-span and short-span areas, the HES evaluator should determine if failure (including catastrophic failure) of the long-span area will impact short-span areas.

    - •• In situations where the long-span area is separated structurally (compartmentalized) by bearing walls, and roof support systems of the long- and short-span areas are independent, the short-span area may comply with ARC 4496.

    - •• Care must be taken to assure that progressive failure, which may be initiated by damage to the long-span roof area, will not significantly increase the risks to persons in the HES area(s).

- <u>Item 12.1.2</u> - Here list the actual spans and where they are located: "55' span over kitchen," "65' span over gym area," etc.

- <u>Item 12.1.3</u> - Hipped roofs with moderate to steep slopes are inherently more wind resistant than flat roofs and may permit longer spans up to 50 feet. Also, lightweight and medium weight roofs with moderate to steep slopes may permit longer spans up to 50 feet.

SECTION 12 - ROOF OPEN SPAN		
YES		**12.1 Does the building have a long or open roof span?** (A long or open span is a roof span of greater than 40 feet between vertical supports.)
NO		

12.1.1 Is there a span greater than 40 feet between vertical supports? ❑ YES ❑ NO

12.1.2 List the areas with span(s) greater than 40 feet: ____________

12.1.3 If under a hipped roof system with moderate to steep slope, or a lightweight/medium weight roof system with moderate to steep slopes, is there a span greater than 50 feet between vertical supports?

❑ YES ❑ NO ❑ Not Applicable

12.1.3.1 List the areas with span(s) greater than 50 feet: ____________

12.1.4 Comments: ____________

4.3.1.11 Section 13 - Roof Drainage/Ponding Information

- Item 13.1 - This is the height of the parapet above the roof. This height impacts roof drainage and to some degree on protection of roof mounted equipment from wind forces. Generally, a parapet wall less than four inches high will not trap enough water on the roof to cause a roof system failure.

- Item 13.2 - Scuppers serve to supplement roof drains on roofs with parapet walls. An absence of scuppers may indicate a greater vulnerability to roof ponding.

- Item 13.3 -13.4 - Here you are looking for indications of roof problems. If such problems exist under non-hurricane conditions, then it is reasonable to assume the problems will be exaggerated under hurricane conditions.

SECTION 13 - ROOF DRAINAGE / PONDING INFORMATION

13.1 What is the height of the parapet wall around the roof's perimeter?

❑ Four inches or less ❑ Greater than four inches ❑ No parapet wall

13.2 Are there scuppers in all the parapet walls? ❑ YES ❑ NO ❑ Not Applicable

If some but not all walls, describe which walls have scuppers: ____________

SECTION 13 - ROOF DRAINAGE / PONDING INFORMATION
13.3 Is there evidence of roof covering degradation or interior water damage on the top floor of the building? ❑ YES ❑ NO Describe: ____________
13.4 Is there evidence of ponding on the roof? ❑ YES ❑ NO
13.5 Comments: ____________

4.3.1.12 Section 14 - Interior Safe Space

- Item 14.1.1 - Provide the actual square footage of the interior corridor/rooms. Obtain from the technical drawings or on-site measurements.
- Item 14.1.2 - Determine from structural drawings the construction type of the corridor walls. ARC 4496 recommends against using rooms attached to, or immediately adjacent to, unreinforced masonry walls.
- Item 14.1.3 - Determine this from on-site observation. The information may be available in the technical drawings, but doors may have been changed since the technical drawings were used in a project.
- Item 14.1.4 - Same as above. Large glass areas in exterior doors can be a softspot and allow access of hurricane force winds into an interior corridor, if breached by windborne debris.
- Item 14.1.5 - Drawbolts can increase the wind resistance of the exit doors. If some exit doors have them, and others do not, then comment in Item 14.1.8.
- Item 14.1.6 - Concrete slabs, or metal decking, if properly attached to the corridor walls, can seal off the interior corridor and help provide a "core" area inside a building. Determine this from technical drawings and verify on-site.
- Item 14.1.7 - If the decking or slab is resting on the interior corridor walls with only grouting as a connection, then mark "Gravity loaded". If anchored or bolted to the interior corridor walls, then "Anchored". If there is no decking or slab, then mark "Not Applicable".

- Items 14.2- 14.2.3- Here identify the actual usable space in the HES building.

SECTION 14 - INTERIOR SAFE SPACE

YES		**14.1 Does the building have an interior corridor(s) or interior rooms that could be used as hurricane evacuation shelter space ?**
NO		

14.1.1 What is the square footage of the interior corridor(s) or interior rooms in the building?

____________ square feet

14.1.2 What is the Interior Corridor Wall Construction type? *(Check only one)*

- ❑ Reinforced Masonry (Rebar @ 4 ft. centers or closer)
- ❑ Light Wood or Metal Stud w/ ½ inch or thicker plywood
- ❑ Partial Reinforced Masonry (Rebar @ 8 ft. centers to 4 ft. centers)
- ❑ Partial Reinforced Masonry (Four-bar Pilasters 13 feet on center or less))
- ❑ Unreinforced Masonry or Rebar spacings unknown
- ❑ Large Panel Glass or other Glazed Panel or Block System
- ❑ Reinforced Concrete or Precast Concrete Panels
- ❑ Metal Sheets or Panels or other Light Architectural Panel Systems
- ❑ Light Wood or Metal Stud w/ light non-plywood sheathing
- ❑ Not Applicable/ No Interior Corridor
- ❑ Other: ____________

14.1.3 What type of door(s) open onto the interior corridor from inside the building?

- ❑ Hollow Metal Door, no windows
- ❑ Wood Door, no windows
- ❑ Not Applicable
- ❑ Hollow Metal Door, view window
- ❑ Wood Door, view window
- ❑ Metal Door, large window
- ❑ Wood Door, large window
- ❑ Glass Door, metal frame
- ❑ Other: ____________

14.1.4 What type of door(s) open onto the interior corridor from outside the building?

- ❑ Metal Door, no windows
- ❑ Wood Door, no windows
- ❑ Not Applicable
- ❑ Metal Door, view window
- ❑ Wood Door, view window
- ❑ Metal Door, large window
- ❑ Wood Door, large window
- ❑ Glass Door, metal frame
- ❑ None
- ❑ Other: ____________

14.1.5 Are there drawbolts on the top and bottom of the interior corridor exit doors? ❑ YES ❑ NO ❑ Not Applicable

SECTION 14 - INTERIOR SAFE SPACE

14.1.6 What type of ceiling deck or cap is over the interior corridor? (This is not the drop ceiling but a structural decking that seals off the corridor from the roof system)

❑ Normal-weight Concrete Deck/Slab ❑ Poured Gypsum Decking ❑ Metal Decking

❑ Precast Concrete Slab ❑ Concrete Tees ❑ No corridor decking, just drop ceiling and building roof decking above.

❑ Not Applicable

❑ Other: ______________________________

14.1.7 If there is a ceiling deck or cap, how is it connected to the interior corridor walls?

❑ Gravity loaded ❑ Anchored ❑ Not Applicable

❑ Other: ______________________________

14.1.8 Comments: ______________________________

____

14.2. What is the total floor (footprint) area of the building? ______________ square feet

14.2.1 What is the total floor area available (in the building) for use as shelter area (exclude interior corridors)?

(This is the total square footage of those rooms or areas to be used as shelter areas

As-Is: ________ square feet.

Additional Area After Minor Retrofit: ________ square feet

Additional Area After Major Retrofit: ________ square feet

14.2.2 Excluding walking area and areas with immoveable furniture, how much of the shelter floor area is actually usable for personal shelter space? (Note: show shelter space on building sketch maps)

______________ square feet

14.2.3 Comments: ______________________________

____

4.3.1.13 Section 15 - Life Safety/ Emergency Power

- Item 15.1 - ARC 4496 guidelines state: "Buildings must be in compliance with all local building and fire codes." Check with local building officials and determine if there are any known life safety/fire code violations in the specified building. If possible have a life safety/fire code inspection done on the potential HES building.

- Items 15.2-15.2.14 - Address the potential for emergency power at the site. Commercial electrical power is often disrupted, sometimes for extended periods, during hurricanes.

SECTION 15 - LIFE SAFETY/EMERGENCY POWER

YES		**15.1 At the time of the survey, is the building known to be noncompliant with any life safety or fire codes?**
NO		
Unknown		

15.1.1 If yes, describe area(s) of non-compliance: ____________________

YES		**15.2 Is there a survivable on-site emergency power system?**
NO		

15.2.1 Is there an emergency power supply generator on-site? ❑ YES ❑ NO (If **No**, go to section **15.2.13**)

15.2.2 If yes, what are its ratings? ❑ Not Applicable

_______ KW, _______ Amperes, _____/_____ Volts; ❑ Single Phase ❑ Three Phase

❑ Three-Wire ❑ Four-Wire Configuration; Brand Name: ____________________

15.2.3 Is the generator storm hazard protected? ❑ YES ❑ NO ❑ Not Applicable

Describe: ____________________

15.2.4 Is the generator securely anchored? ❑ YES ❑ NO ❑ Portable Generator ❑ Not Applicable

Describe: ____________________

15.2.5 Is the generator regularly maintained? ❑ YES ❑ NO ❑ Unknown ❑ Not Applicable

Describe: ____________________

15.2.6 What is the fuel type of the generator? ❑ Not Applicable ❑ Gasoline ❑ Diesel ❑ LP

❑ Natural Gas ❑ Other: ____________________

15.2.7 What is the on-site fuel storage capacity (size of tank)? _______ gallons; ❑ Not Applicable

15.2.8 What is the type of fuel tank? ❑ Not Applicable ❑ Above ground ❑ Below ground

❑ Portable ❑ Anchored/Fixed ❑ Heavy Steel ❑ Concrete ❑ Lightweight metal

❑ Other: ____________________

15.2.9 Is the fuel tank storm hazard protected? ❑ YES ❑ NO ❑ Not Applicable

Describe: ____________________

15.2.10 What building(s) are connected to the emergency power generator system? ❑ Not Applicable

❑ All on-site ❑ Specify: ____________________

SECTION 15 - LIFE SAFETY/EMERGENCY POWER

15.2.11 What load(s) are connected to the emergency power generator system? ❑ Not Applicable

❑ Safety lights ❑ Exit lights ❑ Freezers ❑ Well pumps ❑ Fire Alarms

❑ Security Alarms ❑ Emergency Lighting ❑ Lift Station(s) ❑ Kitchen Equipment

❑ Other(s): ______________________________

15.2.12 Comments: ______________________________

____

15.2.13 Is the building pre-wired for connection to a portable generator? ❑ YES ❑ NO

_______ KW, _____/_____ Voltage, _____ Phase, _____ Wire Configuration

15.2.14 Comment: ______________________________

____

4.3.2 Confirm Pre-Survey Data

- In those cases where some information was provided from other sources (i.e., Part One of the survey checklist), the surveyor/local emergency management agency should verify the data provided. This is especially true in the cases of Storm Surge Inundation (Section 1) and Rainfall Flooding/Dam Consideration (Section 2). In the case of Hazmat & Nuclear Power Plant Considerations (Section 3), most surveyors/local emergency management agencies will need to rely on the expertise of local hazmat experts but at least a quick check of the pertinent 302/312 hazardous material facilities reports is recommended.

    - In the case of Storm Surge Inundation and Rainfall Flooding/Dam Consideration, it is recommended that photocopied pages of the pertinent Surge Atlas plate and FIRM map panel, with the location of the HES building clearly marked, be attached to the survey checklist. Be sure that the identification of the Surge Atlas plate and FIRM map shows clearly on the photocopied page. This will simplify verification and provide supporting documentation if needed.

    - Regarding the Hazmat & Nuclear Power Plant Considerations, a quick check of the pertinent 302/312 hazardous material facilities reports should show if any known vulnerability zones intersect the HES building location. Also, any potential hazmat facilities in or around the building that are spotted during the site visit should be noted. In both these cases, the potential threat to the HES building should be evaluated specifically by the local hazmat experts and addressed in the pertinent survey checklist/LRDM table. If there is any question about a threat presented by a hazardous material facility to the HES, have the local hazmat experts address it specifically in writing.

- For verification procedures see Chapter III, Items 3.4.1 - 3.4.4

Chapter V

THE LEAST-RISK DECISION MAKING PROCESS

5.0 General

- A Least-Risk Decision Making (LRDM) table will provide:
    - A summary of the evaluation's findings in a brief, easy-to-interpret format that will indicate clearly the relative vulnerabilities of the building(s) surveyed.
    - Data essential to making informed decisions on risk acceptance with respect to local shelter inventories to emergency management and other agencies with roles in shelter planning and operations.

5.1 Preparation of Least-Risk Decision Making Table

- An LRDM table for a building:
    - Summarizes all criteria for storm surge inundation, inland flooding, wind and structural hazards, and hazardous materials vulnerabilities into preferred, marginal, and noncompliant categories.
    - Helps identify mitigation measures needed for upgrading a building from the noncompliant category to a compliant category.
- **A building with even <u>one</u> criterion falling into the noncompliant category should be scrutinized to determine whether the risk potential outweighs the necessity of the building's use.**

(1) <u>Storm Surge Inundation</u>:

- The key issues here are whether the evaluated HES is within a storm surge evacuation zone and, if so, what the potential risks to shelterees are.
    - Two feet or less of inundation exposure may be considered an acceptable risk under certain circumstances.
    - More than two feet of inundation potential is noncompliant. An exception may be in the case of multi-story buildings, where upper stories are above the surge. In such cases, a structural and/or coastal engineer should be consulted to evaluate the

risk.

- Land-falling Hurricanes versus Exiting Storms

  - •• A building in a Category 5 or lower zone will not receive the same level of surge from an exiting storm, as from a land-falling storm.

  - •• In those cases where exiting storm surge data is available as well as land-falling storm surge data, evaluate the potential HES for both cases.

  - •• Compare the elevation of the site and/or shelter building to the Maximum Surge Elevation (MSE) of the expected maximum surge from a Category 5 storm (for a landfalling storm and, if the data is available, for an exiting storm).

    - ••• If the elevation indicates more than two feet of water could rise in the building, the HES is noncompliant, except perhaps in the case of multi-story buildings, where the potential shelter level is above the water level.

  - •• The access route to the facility also must be evaluated to determine if it may be inundated in a Category 5 event. The storm surge is a short-term event, typically lasting six hours or less. Therefore, minor inundation of the building and/or its access route may be only a temporary situation.

- It should be noted that a particular HES building may be marginal for an exiting storm and noncompliant for a landfalling storm. Both items should be specified on the building's LRDM table.

- Preferred:

  - Buildings located outside the Category 5 storm surge inundation zone, as determined by the latest edition of SLOSH

  - Also, at least one access road must be outside of, or elevated above, the Category 5 storm surge zone.

- Marginal:

  - Buildings within a Category 5 storm surge zone, and inundation potential that does not exceed two feet.

- Also, access routes may be within the Category 5 inundation zone, therefore the potential for isolation exists. Note that either inundation of the building or its access route is sufficient for this category to apply. Building inundation depth **must** be clearly noted on the LRDM table when building inundation is a threat. Damage to infrastructure due to saltwater inundation and/or erosion is possible in this circumstance.

- Noncompliant:

  - Buildings subject to Category 5 hurricane storm surge inundation depths greater than two feet within the building and/or subject to velocity inundation.

  - Coastal barrier islands always will be considered noncompliant due to their extreme isolation potential in the post-storm period.

  - Buildings subject to velocity inundation will always be considered noncompliant and should not be used as hurricane evacuation shelters.

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
1. Storm Surge Inundation			

(2) Rainfall Flooding/Dam Considerations:

- Information is derived from Flood Insurance Rate Maps (FIRM).

- Vulnerability is evaluated in a manner similar to the storm surge criteria; both inundation potential of the facility and its access route(s) are evaluated.

- The HES may be in a flood zone but elevated above probable flood elevations. ARC 4496 requires staying outside 100-year floodplains.

  - If the HES lies above the flood, then isolation due to flooded access roads may be acceptable under some circumstances.

  - If the elevation indicates a potential of more than two feet of water in the building, then the HES is unacceptable.

- Rainfall flooding typically is considered a long term event, therefore, evacuation of the HES population probably will be necessary in the post-storm period.

- <u>Preferred</u>:

  - Buildings should be outside the 500-year floodplain [Zones C or X (with white background)], as determined in the latest edition of FIRM.

  - At least one access route must lie above the 100-year floodplain.

  - Also, the building and its access route must not be subject to inundation due to dam or levee failure following hurricane-related flooding.

- <u>Marginal</u>:

  - When the building's floor elevation is at or above the 100-year floodplain BFE, but the building's site is within the 500-year floodplain [Zones B or X (with light-gray background)], the building will be considered marginal.

  - Building inundation depth should be clearly noted on the LRDM table when building inundation is a potential threat.

  - Buildings where access roads are below the 100-year floodplain BFE (riverine or shallow ponding) will be considered marginal, as flooding may cause isolation. Damage to infrastructure due to inundation and/or erosion is possible in this circumstance.

  - The building and its access route may be subject to minor inundation of less than two feet due to dam or levee failure following hurricane-related flooding.

- <u>Noncompliant</u>:

  - Buildings that are within the 100-year floodplain.

  - Buildings that are within an outflow area of a dam or reservoir that is subject to containment failure due to hurricane related flooding, and the expected inundation depth is greater than two feet.

  - All buildings subject to <u>velocity inundation</u> are noncompliant and shall not be used as an HES.

Exceptions:

In situations where there is no other option than use of buildings within the 100-year floodplain, shallow inundation may be considered an acceptable risk. Buildings with inundation depths of less than 2 feet, for a 500-year event, may be considered marginal. The building's ground floor elevation must be above the BFE. Buildings subject to velocity inundation shall not be used as an HES.

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
2. Rainfall Flooding / Dam Considerations			

(3) **Hazardous Materials and Nuclear Power Plant Considerations:**

- If possible, have local hazardous materials experts evaluate the risks to the HES from known hazmat facilities.
- Assume there will be damage to buildings and exposed containers during the hurricane event, unless extraordinary measures are taken.
- On-site hazards
  - Significant quantities of unusually hazardous materials must be on the facility's site for this item to apply (normally generator fuel or janitorial supplies would not qualify).
  - In most cases the facility must be manufacturing, using, or storing materials in reportable quantities under the Emergency Planning and Community Right-to-Know Act (EPCRA).
- Off-site hazards
  - The location of an HES within the two-mile EPZ of a Nuclear Power Plant (NPP) is unacceptable.

  - Whether the location of an HES within the vulnerability zone (VZ) of any other type hazardous material facility is acceptable, is a judgement call on the part of the local emergency management director and sheltering agency(ies).

  - The expected risk of loss of containment of the hazardous material due to hurricane effects or storm surge, and the expected risk of exposure to the HES occupants, should both be noted in the LRDM table.

- The surveyor should specify:

  - The type(s) of hazardous material

  - Distance from potential HES

  - Risk of release during a hurricane event

- The surveyor/local hazmat experts should determine:

  - Does the hazmat facility have a plan to implement in the prehurricane situation that would substantially reduce the risk of release.

  - Whether the hazmat facility has remedial measures to reduce post-hurricane problems.

  - Whether the facility has a means of communicating with emergency management officials to notify them of a hazardous material release.

  - Whether there is a way to evacuate the HES, if need be, in the post-hurricane period and, if there is a release, what is the actual risk potential of the release (i.e., proximity to HES, type of materials and time for evacuation).

  - Guidance regarding these matters is available from LEPCs and the local fire departments.

- Preferred:

  - There are no hazardous materials stored within the HES building or in close proximity that if released during a hurricane event could present a risk to the shelterees (fumes, fire, explosion, etc.).

  - The building is outside of any EPCRA, Section 302/312 vulnerability zones and outside of 10-mile Nuclear Power Plant (NPP) Emergency Planning Zones (EPZ).

- Marginal:
    - There are small quantities of hazardous materials stored within the HES building or in close proximity, but adequate precautions are taken to prevent release in the event of hurricane-related damage.
    - The building is inside Section 302, EPCRA, VZ(s) but with low-release potential with respect to hurricane effects.
    - The potential HES is inside the 10-mile NPP EPZ, but outside of two-mile NPP EPZ(s).
- Noncompliant:
    - Significant quantities are manufactured, used, or stored hazardous materials within the HES building or in close proximity, with high potential for release during a hurricane event.
    - The HES building is within the VZ of a Section 302 facility that has a moderate/high release potential in a hurricane event.
    - The HES building is inside a two-mile NPP EPZ.

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
3. Hazmat and Nuclear Power Plant Considerations			

(4) Lay-Down Hazard Exposure:

- Determine the risk of a large tree or other structure (towers, chimneys, steeples, billboards, utility poles, etc.) falling on the HES during a storm. Look for a tree/structure that is large enough and near enough to damage/breach the building's envelope, thus allowing access to hurricane force winds and rain.
- Note any medium size trees that could "batter" the roof or walls.

- There must be no potential lay-down hazards within close proximity to the shelter area(s).

- Preferred:

  - There are no large trees or other tall structures within lay-down range of the building.

  - At least one access route is not tree-lined and will not be blocked by fallen trees during and after a hurricane.

- Marginal:

  - There may be trees or other large/tall structures within lay-down range of the HES, but they are **not** considered:

    - Large enough to inflict a significant breach of the building's structural envelope; and/or

    - Within lay-down range of actual shelter area(s) within building.

  - All access routes are tree-lined. (Note: local emergency management/sheltering agencies should have plans to clear fallen trees from these routes).

- Noncompliant:

  - Trees or other large/tall structures within lay-down range of the HES are:

    - Large enough to inflict a significant breach of the building's structural envelope; and/or

    - Within lay-down range of the actual shelter area(s) within building.

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
4. Lay-down Hazard Exposure			

(5) **Wind and Debris Exposure**:

- The terrain in which a potential HES is located can significantly change pressures exerted by wind forces and, therefore, the damage vulnerability of the building.

- Determine the level of wind exposure for the building.

- Determine if there are material sources within close proximity to the HES that could generate wind-borne debris during a hurricane. Wind-borne debris may breach the structural envelope, thus permitting wind entry into the building.

- Note that two different items (i.e., wind exposure and debris exposure) are being recognized as a single criterion. The evaluator must include an entry for each of the items within a single block, with the overall compliance to this criterion controlled by the factor with the greatest risk.

- Preferred:

  - The building has a sheltered exposure.

  - No large unanchored objects subject to "roll-over" impact of the HES building are within 100 feet.

  - No potential lofted heavy debris sources within 100 feet, and

  - No large or small windborne debris sources are within 300 feet.

- Marginal:

  - The building has a limited wind exposure.

  - No large unanchored objects subject to "roll-over" impact are within 100 feet of facility.

  - No potential lofted heavy debris sources within 100 feet, and

  - There is minimal exposure to large and/or small windborne debris sources within 300 feet.

- Noncompliant:

  - The building has unsheltered exposure.

- Large objects that may be subject to "roll-over" impact are within 100 feet of facility.

- This classification also applies where buildings are within 100 feet, constructed in a manner that could lead to catastrophic failure and generate massive windborne objects, such as large portions of roof, bond beams, porticos, and walkways.

- There is excessive exposure to large and/or small wind-borne debris sources within 300 feet of facility.

Exceptions:

In situations where there is no significant debris exposure, but wind exposure is considered unsheltered, there may be latitude in use of the building, if the remaining criteria of LRDM table are classified as preferred or marginal. In this situation, special attention should be given to the wind design, construction type, roof and wall characteristics, and aperture protection. If possible, this exception should only apply to buildings designed and constructed after 1987.

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
5. Wind and Debris Exposure			

(6) Wind Design Verification:

- National Consensus Standards, such as ASCE or ANSI Standards, are considered state-of-the-art design criteria and reflect the knowledge base of research and experimental findings at the time of their publication.

- Model Codes are often based upon National Consensus Standards but are modified by a voting membership of lay persons in the fields of codes enforcement, engineering and design, and construction trades.

- Model codes often are not as stringent in their wind design criteria as National Consensus Standards.

- The following are considered model codes for the purposes of this survey procedure:
  - Standard Building Code (SBC, Southern)
  - Uniform Building Code (UBC)
  - The pre-1994 South Florida Building Code (SFBC)
  - The former National Building Code (NBC)
  - The Metal Building Manufacturers Association (MBMA)
  - Local codes, or custom codes, that include wind regulations similar to those of the listed model codes also are considered equivalent.
  - The advice of the local building department should be sought to determine the local history of building code adoption and enforcement.
  - If the building was designed by an architect or an engineer, in 1960 or later, assume that the building's design includes some degree of wind resistance provisions.
- Preferred:
  - The building's wind design is in accordance with ASCE 7-88 or a later edition.
  - The building is designed and constructed prior to 1989, and uses the wind design criteria of ANSI A58 (1982)
  - **NOTE: Do not assume a building has been designed to ASCE 7 unless definitive proof exists in the "AS-BUILT" construction drawings and specifications.**
- Marginal:
  - The building's wind design is in accordance with the Standard Building Code or other model codes, and there are no apparent design/construction flaws that could impact wind resistance.
  - In addition, HES buildings should receive a ranking based upon the following table. The ranking scale is 0-4, with 0 being the least wind resistant and 4 being the most wind resistant.

Model Building Code Ranking					
Model Code(s)	**Ranking**				
	Promulgation Period				
	Pre-1960	1960-1976	1977-1986	1987-1989	1990 +
SBC	0	1	2	3	4
SFBC	0	2	2	2	2*
UBC	0	1	2	3	4
NBC	0	1	N/A	N/A	N/A
MBMA	0	0	0	3	3

* - Buildings constructed to SFBC after 1994 are required to comply with ASCE 7. Therefore, they are not considered built to a model code.

- Noncompliant:
  - A building designed and constructed prior to 1960 and is a single story. There may be individual exceptions to this rule (e.g.,some large courthouses built as bomb shelters), however, in every case a structural engineer should review any building built prior to 1960.
  - A building where field surveys and other research indicate a lack of good wind engineering design and construction attention, or
  - The building is designed to wind speeds less than a Category 1 hurricane (94 mph), and/or
  - Evaluated by a structural engineer to wind speeds less than local building code wind design requirements.

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
6. Wind Design Verification			

(7) Construction Type / Loadpath Verification:

- Focus on the Main Wind Force Resistance System (MWFRS) and the presence of a definable and continuous loadpath throughout the building's superstructure.
    - The MWFRS must be capable of transferring all wind-induced lateral, debris impact and uplift forces to the building's foundation.
    - Multistory structures with concrete floor diaphragms and reinforced masonry or concrete shear walls typically perform well as a MWFRS.
- **NOTE: This criterion is not to be confused with the exterior wall construction criterion. In some situations, buildings may have exterior walls that are loadbearing and serve both the MWFRS and exterior envelope functions.**
- Preferred:
    - A building has a heavy steel or reinforced concrete frame and/or fully reinforced masonry or concrete loadbearing/shear walls.
    - A clearly defined and continuous loadpath from roof deck to foundation must be present.
    - All connections between MWFRS components must be able to withstand vertical uplift and shear forces. Connections that depend upon gravity, grout/friction, or withdrawal reactions do not provide a continuous loadpath.
- Marginal:
    - Buildings that have masonry exterior walls with partial reinforcement (complies with NCMA TEK 63 [1975], or the equivalent) with or without a pinned steel frame.
    - Buildings constructed of light wood or metal stud wall systems that meet SSTD 10-93 (or more recent versions).

- Preengineered Metal Buildings (PEMBs) designed to the MBMA (1986 or later edition) will also be included in the marginal classification, if bracing is present in both the roof diaphragm and longitudinal wall planes and if clearly defined loadpaths from roof deck to foundation are present.

- Noncompliant:

    - A building has unreinforced masonry loadbearing walls, or roof systems that lack sufficient shear connections to provide diaphragm action effectively.

    - PEMBs constructed to a standard other than MBMA (1986) or better and lacking adequate bracing.

    - Buildings with no observable or verifiable continuous loadpath from roof deck to foundation to resist wind uplift forces.

    - All buildings that have connections between MWFRS components that depend upon gravity, grout/friction, or withdrawal reactions are considered to not have a continuous loadpath, and are therefore noncompliant.

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
7. Construction Type / Loadpath Verification			

<u>(8) Building Condition</u>:

- Focus here on the overall condition of the building with respect to wind resistance.

    - Note any signs of deterioration, observable cracks, or corrosion that may significantly increase the building's vulnerability to wind storms. Particular attention should be given to loadpath and structural envelope components that affect lateral stability and uplift action.

    - Ascertain any history of wind/storm damage to the building. This will assist in determining any special vulnerabilities of the building, as well as any recently repaired areas.

- The building owner or facilities manager should be able to provide the needed information. Be sure to check out areas reported damaged in the recent past.

- <u>Preferred</u>:
  - The building is in good condition with no apparent signs of deterioration.
  - The building is approximately as sound as it was when new, and the structure shows none of the signs of deterioration indicated in the following categories.

- <u>Marginal</u>:
  - A building has minor deterioration. There are some cracks in walls and other signs of slight deterioration that do not appear to impact significantly on wind resistance.

- <u>Noncompliant</u>:
  - A building shows major deterioration. This is observable deterioration of a facility's superstructure that may impact on wind resistance.

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
8. Building Condition / Wind Damage History			

<u>(9) Exterior Wall Construction</u>:

- The integrity of the wall envelope (walls, doors, windows, louvers, etc.) is critical to the survivability of the HES.
  - Only one percent of the windward side opened is sufficient for a building to begin to pressurize, reaching maximum internal pressure with as little as five percent opened. At the maximum internal pressure, the outward pressure on side and leeward walls, as well as uplift on the roof doubles. Even if the roof remains intact, openings in the wall envelope subject the building and its contents to wind, debris impact, and water damage. This damage can significantly reduce the suitability of the building as a post-storm mass care shelter.

- In addition to the wall envelope integrity, the resistance capability of the exterior walls to both wind effects and to windborne debris impact must be considered.

- <u>Preferred</u>:

  - A building's exterior walls are constructed of fully reinforced masonry or concrete wall systems and has less than five percent of any wall face's area comprised of softspot area.

  - No softspot area in the building can have direct exposure to the shelter area(s).

  - Fully reinforced masonry is defined per ACI 530. Generally, if #5 rebar (or larger) is spaced four feet on center or closer, at the corners and wall-to-wall intersections, and around all openings, this indicates that a building probably complies with ACI 530 requirements.

- <u>Marginal</u>:

  - The building has partially reinforced masonry exterior walls.

  - Other masonry exterior wall systems with similar wind-resistance characteristics (flexural, shear, uplift loadpath, etc.) to partially reinforced masonry.

  - Other nonmasonry systems that include light wood or steel framed exterior walls, fully wrapped in ½ inch or greater thickness plywood, with a relatively impact-resistant exterior veneer or cladding. The veneer or cladding should have impact resistance characteristics similar to four-inch brick or stone veneer.

  - A building with greater than five percent of any wall face's area comprised of softspot area but the softspot area cannot have direct exposure to the shelter area(s).

- <u>Noncompliant</u>:

  - A building has unreinforced masonry exterior walls, glass panel facade walls, light metal cladding, EIFS cladding, or other lightweight panels.

  - Any building that has a softspot with direct exposure to the shelter area(s).

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
9. Exterior Wall Construction			

(10) Fenestrations and Window Protection:

- The ability of fenestrations (windows, doors, overhead doors, louvers, skylights, etc.), or aperture assemblies, to resist hurricane windloads and windborne debris impacts will have a significant role in the survivability of an HES.
  - The connection of the fenestrations assembly to the surrounding walls is as important as the actual wind- and debris-impact resistance.
  - Other important considerations are the size, type and location of glass panes.
- Preferred:
  - All exterior wall fenestration assemblies and/or protection systems comply with, or exceed, the performance standards/protocols of SSTD 12-94, or the Dade County version of the South Florida Building Code (Sections 2314.1, 2314.5, and 2315.1-2315.4).
- Marginal:
  - A building has other types of fenestration protective systems that are not certified to meet the standards/protocols required for the preferred category above.
  - All fenestrations with direct access to shelter area must be protected from penetration by windborne debris.
  - **Note: Systems not certified to, or exceeding, the standards listed in the "Preferred" criterion above may not provide sufficient windborne debris impact and/or wind load resistance under hurricane conditions.**
- Noncompliant:

- A building has unprotected fenestration(s) that lead into shelter areas.

Exceptions:

In situations where a fully enclosed core area, or portion of a building, is physically separated by a construction joint and wall barrier, latitude may be given to the five percent fenestration total area requirement if destruction of the weak portion of the building will have a negligible effect upon the core area or stronger portion of building. For example, a 1994 classroom addition is constructed adjacent to a 1968 classroom building. The new addition is constructed of fully reinforced masonry exterior walls with a single-window fenestration (3' x 5' emergency egress) at each classroom unit; the maximum percent aperture is four percent. A common 10-foot wide corridor runs down the middle of the building and has metal security-type doors at the ends. The older building is constructed of unreinforced masonry and has larger (9' x 5') fenestrations; the maximum percent aperture is 12 percent. The roofs of the two buildings are joined at a temperature expansion joint and the exterior walls are separated by a control joint. The older building also has a common 10-foot wide corridor that connects the buildings with a fire-rated metal security door separating the two buildings. In this situation, the roof expansion joint and wall control joints will reduce the impact of destruction of the older building, therefore, HES space may be available in the new addition.

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
10. Fenestrations / Window Protection			

(11) Roof Construction / Roof Slope:

- The type of construction, geometry, weight, slope, and other characteristics of the roof are evaluated for compliance with ARC 4496.
  - A shallow roof is one which has a slope from one to 10 degrees.
  - A moderate slope roof has a slope from 11 to 30 degrees and
  - a steep roof has a slope of 31 to 45 degrees.
  - A lightweight roof weighs 25 psf or less.

- A moderate weight roof weighs 26 to 49 psf and
- A heavy roof weighs 50 psf or greater.

- This criterion may be heavily influenced by loadpath considerations; an inadequate loadpath between roof deck and supporting walls or beams will negate factors listed in preferred and marginal categories below. The absence of an adequate loadpath will render the potential HES noncompliant.

- <u>Preferred</u>:
  - A building has a roof of heavy construction, such as reinforced structural concrete with a four-inch-minimum-thickness deck.
  - A light or moderate weight deck with a roof slope 30 degrees or greater.
  - Roof eave or overhang lengths are limited to less than one foot.
  - Also, no unanchored roof appendages can be present.
  - Metal decks must be 22 gage or thicker.

- <u>Marginal</u>:
  - A building has a flat and/or lightweight roof system with engineered mechanical connections (bolts, welds, etc.) to support structures below.
  - The roof overhang must be less than one foot.
  - If it is a gable roof system, it must be braced against racking failure, or the gable walls must be constructed of a reinforced or partially reinforced masonry wall system.
  - Roof systems conform to preferred criteria above, except that a roof overhang between one and three feet is present.
  - No unanchored roof appendages are present.
  - Metal decks less than 22 gage (i.e., thinner, for example 26 gage).

- <u>Noncompliant</u>:
    - A building has a flat, lightweight roof system with gravity or friction/grout connection or other nominal connections to support structures below (i.e., fiberboard and PCF).
    - Includes all lightweight roof systems with a roof overhang that is greater than one foot and preferred-type systems with overhangs greater than three feet.
    - Unanchored roof appendages are present, thus the potential for a significant envelope breach exists.

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
11. Roof Construction / Roof Slope			

<u>(12) Roof Open Span</u>:

- Buildings with large open spans are susceptible to wind damage during a hurricane. Unless specifically designed with a high factor-of-safety, open-span roof systems typically have little redundancy or inherent reserve strength.
- This criterion may be heavily influenced by loadpath considerations; an inadequate loadpath between roof deck and supporting walls or beams will negate factors listed in preferred and marginal categories below.
- The absence of an adequate loadpath will render the potential HES noncompliant.
- <u>Preferred</u>:
    - The distance between vertical support elements (bearing walls and/or columns) of the roof are less than 40 feet.
- <u>Marginal</u>:
    - A building has a light- or medium-weight roof system(s) with a moderate to steep roof slope, or a hip roof with a maximum span between roof supports of 50 feet or less.

- For heavy weight roof systems, a shallow or greater slope and a maximum span between roof supports of 50 feet or less is considered marginal.

- Noncompliant:

    - A building has a flat or shallow slope, lightweight roof system with a distance between vertical supports that is greater than 40 feet.

    - Includes the marginal roof systems with open spans exceeding the maximum distances listed above.

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
12. Roof Open Span			

(13) Roof Drainage / Ponding:

- Standing water or ponding on a roof can result in a collapse under the weight of torrential rainfall during a hurricane.

    - Ponding can be a hazard only in situations where there is an area that is fully enclosed by a drainage-confining parapet.

        - An indication of ponding is prominent discoloration of roof membrane or ballast materials in relatively low-lying areas, typically near drains.

        - Inspection from underside of roof or ceiling materials also may give evidence for leakage.

        - Although one or two inches of water may help resist uplift forces by adding dead weight to the structure, excessive ponding may lead to roof collapse.

- Preferred:

    - A building has no parapet walls that confine roof drainage and no evidence of ponding.

- Marginal:
  - A building has a roof parapet that will confine rainfall drainage, and scuppers are present in parapet walls.
  - Scupper drainage capacity should equal or exceed the total area of roof drains.
  - If evidence of ponding exists, it should be minimal.
- Noncompliant:
  - A building has a roof parapet that will confine roof drainage, and
  - Scuppers are either not present or have insufficient drainage capacity.
  - There is significant evidence of ponding and/or roof damage due to excessive ponding to depths that could lead to roof collapse.

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
13. Roof Drainage / Ponding			

(14) Interior Safe Space:

- The focus of this criterion is on identifying an interior corridor or room that can be isolated from the rest of a building and used as a storm shelter area.
  - This is essential if the remainder of the building cannot comply with ARC 4496.
  - Is the roof or ceiling of the corridor sealed off (walls extend to roof deck)? If not, the corridor may not provide better protection than the building around it.
  - Consider the entranceway doors to the corridor. For example, glass entrance doors at the ends of corridors are vulnerable to windborne debris and, if breached, could in effect convert to a wind tunnel.
  - This criterion is not applicable if the building meets the previously listed criteria

for compliance with ARC 4496.

- Preferred:

  - A building has interior corridor/rooms with reinforced masonry walls.

  - Walls should be loadbearing, but at a minimum must extend to roof (or floor) support structures and/or deck above.

  - A definable and continuous loadpath must be present from roof/ceiling deck to corridor foundation.

- Marginal:

  - A building's interior corridor/rooms have partially reinforced masonry walls (or equivalent) and concrete or metal roof/ceiling deck.

  - A definable and continuous loadpath must be present from roof/ceiling deck to corridor foundation.

- Noncompliant:

  - ARC 4496 does not require an interior room or corridor to be present in an HES building, if the remainder of the HES is considered compliant.

  - Corridors with unprotected fenestrations that are directly exposed to wind effects and debris sources are noncompliant in those exposed areas.

  - Corridors with unreinforced masonry (or structurally weaker) walls are noncompliant.

  - Interior noncompliant corridors surrounded by noncompliant areas (i.e., exterior unreinforced CMU walls) are noncompliant.

  - Interior corridors or rooms surrounded on all sides by building areas that are compliant may be considered compliant.

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
14. Interior Safe Space			

(15) Life Safety / Emergency Power:

- The purpose of this criterion is to clarify the compliance of the potential HES building with fire and life safety codes and the presence/absence of an emergency power source. If a building cannot meet the pertinent fire and safety codes of the jurisdiction, it should not be used as an HES building. The primary need for emergency power is to support fire/life safety and security equipment and systems.

- Preferred:

  - The building has an Emergency or Standby Power Generator-Set with a minimum 24-hour on-site fuel supply (a 72-hour fuel supply is recommended). The generator, its fuel supply, and other ancillary equipment and fuel lines should be hazard protected.

  - The building must be in compliance with all pertinent fire and safety codes.

- Marginal:

  - The building will fall into the marginal category if it has battery backup exit signage and lighting.

  - Installation of generator prewiring systems for expediting connection of a portable gen-set is recommended.

  - The building must be in compliance with all pertinent fire and life safety codes.

- Noncompliant:

  - The building is not in compliance with the pertinent fire and safety codes.

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
15. Life Safety / Emergency Power			

5.2 Analysis of Least-Risk Decision Making Table

- Use the LRDM tables to evaluate and rank the relative risks in using each building as a potential HES
  - Safety of the HES occupants is the primary consideration.
  - The LRDM table will quickly identify the most likely points of failure or the greatest point(s) of risk in a particular building.
  - Those criteria in the noncompliant column should be retrofitted/mitigated prior to use of the building as an HES.
- In some cases, retrofit may not be practical, such as a building located in a Category 2 storm surge zone with over two feet of surge expected in the building in a Category 4 storm. It is difficult, if not impossible, to mitigate this problem. In such a case, even only one noncompliant entry will indicate the building is unsuitable as an HES.
- As indicated in ARC 4496 (see Figure 5.1 below) **certain exceptions may be necessary, but only if there is a high degree of confidence that the level of wind, rain, and surge activities will not surpass established shelter safety margins.**
- The location of a potential HES building in a floodplain normally would indicate the building is unsuitable (without retrofitting).
  - However, in some cases, the maximum expected height of water will result in less than two feet of water in the potential HES building and at least one major means of egress is not in danger of flooding.
  - In some circumstances, the local emergency management and other sheltering agencies may deem this an acceptable level of risk when compared with other available alternatives.

- In any case, ARC 4496 guidelines (see Figure 5.1 below) indicate "It is essential that elevations be carefully checked to avoid unnecessary problems."

- The elevation of the potential HES and of the major means of egress to the HES should be carefully checked against the potential height of flood waters to determine the actual risk to HES occupants.

- ARC 4496 guidelines (see Figure 5.1 below) indicate that, in the absence of certification by a structural engineer, the potential HES must be in compliance with all local building and fire codes.

- Use the LRDM table to evaluate each of the strong and weak points in a building and to determine what retrofits are needed to upgrade the building to HES status.

    - In some cases, the building will show numerous noncompliant entries. Such buildings should be considered a lower priority for retrofit compared to buildings with fewer problems and more preferred features.

    - A building that has entries only in the preferred or marginal categories can be considered suitable as an HES.

    - However, even in those cases where there are no noncompliant entries, but numerous marginal entries, retrofits to upgrade the various marginal areas should be considered.

- The LRDM table does not guarantee a building is safe. It is only a tool to reduce the risks in selecting HES buildings.

- A sample completed LRDM table is provided in Table 5.1 below. In the table the criteria are rated in categories of Preferred, Marginal, and Noncompliant.

    - The Preferred category indicates no further retrofitting or mitigation is necessary.

    - The Marginal category indicates acceptable conditions, but that further evaluation and retrofitting should be considered.

    - The Noncompliant category indicates areas do not meet the minimum ARC 4496 guidelines. These areas should be retrofitted prior to use as an HES area.

Least-Risk Decision Making (ARC 4496)

Safety is the primary consideration for the American Red Cross in providing hurricane evacuation shelters. When anticipated demands for hurricane evacuation shelter spaces exceed suitable capacity as defined by the preceding criteria, there may be a need to utilize marginal facilities. It is therefore critical that these decisions be made carefully and in consultation with local emergency management and public safety officials. Guidance should be obtained from Disaster Services at national headquarters, in consultation with the Risk Management Division.

This process should include the following considerations:

- No hurricane evacuation shelter should be located in an evacuation zone for obvious safety reasons. All hurricane evacuation shelters should be located outside of Category 4 storm surge inundation zones. **Certain exceptions may be necessary, but only if there is a high degree of confidence that the level of wind, rain, and surge activities will not surpass established shelter safety margins.**
- When a potential hurricane evacuation shelter is located in a flood zone, it is important to consider its viability. By comparing elevations of sites with FIRMs, one can determine if the shelter and a major means of egress are in any danger of flooding. Zone AH (within the 100-year flood plain and puddling of 1-3 feet expected) necessitates a closer look at the use of a particular facility as a sheltering location. Zones B, C, and D may allow some flexibility. **It is essential that elevations be carefully checked to avoid unnecessary problems.**
- In the absence of certification by a structural engineer, any building selected for use as a hurricane evacuation shelter must be in compliance with all local building and fire codes. **Certain exceptions may be necessary, but only after evaluation of each facility using the aforementioned building safety criteria.**
- The Red Cross uses the planning guideline of 40 square feet of space per shelter resident. During hurricane conditions, on a **short-term basis**, shelter space requirements may be reduced. Ideally, this requirement should be determined using no less than 20 square feet per person. Adequate space must be set aside for registration, health services, and safety and fire considerations. On a long-term recovery basis, shelter space requirements should follow guidelines established in ARC 3031, *Mass Care: Preparedness and Operations*.

Figure 5.1 Extract from ARC 4496

Table 5.1 Sample

Least-Risk Decision Making: ARC 4496 Guideline Compliance Summary

Survey Date: xx/xx/xx **County:** Bay

Facility Name: Cherry Street Elementary School, Building #1/Admin/Classrooms **Address:** 1125 Cherry Street

City: Panama City **State:** Florida **Zip Code:** 32401

Coordinates: Latitude: 30° 08' 47" N **Longitude:** 85° 38' 45" W

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
1. Storm Surge Inundation	Building and at least one access road are located above the Category 5 storm surge zone.		
2. Rainfall Flooding / Dam Considerations	The building and at least one access road are above the 500 year flood plain and not threatened by dam/dike/reservoir failures. Located in Zone C.		
3. Hazmat and Nuclear Power Plant Considerations		The Facility lies within the Vulnerability Zones of six different hazmat facilities. In all these cases the hazardous material was listed as chlorine, with a low risk of release.	

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
4. Lay-down Hazard Exposure			**On the south side of the building, a large pine tree is within lay-down range of the southwest corner of the building.**
5. Wind and Debris Exposure			**Facility is within one mile of large body of water and within a quarter mile of an open area. Facility has an unsheltered wind exposure, and high exposure to debris..**
6. Wind Design Verification		Assumed - Designed to SBC , wind speed - 110 mph plus importance factor of 0.11. Built 1987.	
7. Construction Type / Loadpath Verification		Loadbearing CMU walls with pilasters (four #5 rebar each) at 11 ft O.C. Continuous loadpath from roof to foundation.	
8. Building Condition	Good with no history of significant damage from recent hurricanes.		
9. Exterior Wall Construction		Eight inch CMU with pilasters (four #5 rebar each) at 11 ft O.C., with four inch brick veneer.	
10. Fenestrations / Window Protection			**About 12 percent of total exterior wall is unprotected glazings (about 766 sq.ft.).**

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
11. Roof Construction / Roof Slope			BUR over 22 gage metal decking on OWSJ. Slope is 5 degrees. **Roof is lightweight with three foot overhang.** Roof has pilaster reinforced masonry gable ends.
12. Roof Open Span	Roof spans were 35 foot between vertical supports.		
13. Roof Drainage / Ponding	No parapet walls. No indication of significant ponding/roof degradation.		
14. Interior Safe Space			1,360 sq.ft. of interior corridor. **Has unreinforced CMU walls (rebar at 16 ft O.C.). No deck cap over corridor.**
15. Life Safety / Emergency Power		Life Safety inspection not performed as part of this survey. No emergency power source.	

Chapter VI

SAMPLE SHELTER SURVEY REPORT

6.0 General

- This chapter contains samples and recommendations for preparation of a formal report of the findings of the HES surveys.
  - Section 6.1 explains the procedure for writing a formal report.
  - Section 6.2 shows various recommended backup documents.
  - Section 6.3 covers suggested general retrofit recommendations.

6.1 Preparation of a Formal Report

- Once the data collection form is completed use it to complete the LRDM table. Utilizing the LRDM table should facilitate writing a formal descriptive report on the potential HES building. This report should briefly describe the building, its location and surrounding, the observations made, and the various considerations for use as an HES. The report should clarify the LRDM entries, specify any special points of interest and address the following:
  - *Building Location*: Include the building's physical address, latitude and longitude, and access routes to the building. Generally describe the campus/complex, citing quantities and construction types, construction history, etc. Discuss which buildings are being surveyed and those that were not surveyed and why. Give a brief description of the surroundings, such as adjacent buildings, topography, trees and whether they pose a lay-down threat to the building and potential sources of windborne debris.
  - *Infrastructure and Electrical Systems Considerations:* The type of emergency generator (if present), its specifications, fuel type, and any required mitigation measures should be explained. Describe the water supply and sanitary systems and whether alternate provisions for water supply and sanitation are present.
  - *Surge Inundation*: Mention building elevation and source for data -- always confirm elevations. Be careful about determining elevations based solely on site drawings. Often the same drawings are used repeatedly to build similar facilities at different locations. The elevations are not always corrected when this is done. Also, many drawings will use "benchmark" elevations, which may not indicate elevation relative to mean sea level. It is important that the correct elevation be established. Otherwise a facility may deemed above an expected flood or surge

level when it is actually below the level, thus placing HES occupants at risk. If applicable, indicate surge inundation level in the building using SLOSH maps. Mention the same for the access routes.

- *Rainfall Flooding*: Indicate the FIRM zone for the building, including the FIRM panel number and date. Indicate the building's elevation and potential flood hazards. Mention the existence and condition of storm drainage systems and if there is any history of flooding in the area.

- *Hazardous Materials*: Discuss possible threats of hazardous materials located within the building and any hazardous material/nuclear facilities located close enough to pose a potential threat to the building.

- *Structural Considerations*: Mention all the structural considerations observed, reviewed and noted, such as superstructure, roofs, and walls. Note possible softspots or hazards and details of walls (reinforced, concrete, etc.), roofs (long spans, steep, etc.), and window area.

- *Mass Care Considerations*: Indicate usable floor space area, which is computed after deducting areas for walls, walkways, projections, and other fixed furnishings. Mention the shelter capacity in square feet (square feet allocated per person may vary from area to area). Indicate the primary areas to be used as HES areas and those that may be available for post-storm mass care operations. Give a brief description of the rooms to be used as host areas, access and security considerations for the rooms, and any possible modifications to the rooms.

- *Conclusion*: Include concluding remarks derived from this survey. Indicate whether this HES is compliant or non-compliant with ARC 4496 HES guidelines, and the reasons for deeming compliant or non-compliant. The pertinent LRDM table should follow the conclusion.

- *Retrofit Recommendations:* Include general retrofit recommendations to upgrade the HES to meet ARC 4496 guidelines.

- *Backup Documentation*: See Section 6.2 for recommended backup documentation.

6.2 Backup Documentation

Appropriate backup documentation should be provided with each report to demonstrate clearly the justification for decisions in the areas of surge, rainfall flooding, area usage, etc. Surge maps and FIRM maps are reissued with changes over periods of time and buildings are modified through various repair and maintenance programs. The backup documentation will show which maps/plans were used in the evaluation of the potential HES building at the time of the survey. The documentation will also enable a reviewer to quickly perform quality control checks on the survey. As a minimum recommend the following should be attached to the report: *(Note: see Appendix H for examples of the following documents)*

- A photocopied page (8.5" x 11") showing the building location and access route on the pertinent USGS map. (Show USGS map designation also.) An access route will consist of a paved road or combination of paved roads that lead from the building to a major U.S. Highway or Interstate, or other access route designated by the local emergency management agency.

- A photocopied page (8.5" x 11") showing the building location and access route on the pertinent Storm Surge Atlas plate. Ensure that the Surge Atlas date, county, and plate numbers are shown on the page and that the access route can be seen on the map.

- A photocopied page (8.5" x 11") showing the building location and access route on the pertinent FIRM map page. Ensure that the FIRM map date, title, and panel numbers are shown on the page.

- A page-sized photocopy of the site map, with the potential HES building clearly identified.

- A page-sized photocopy of the floorplan(s) of the potential HES building, with areas targeted for use as shelter areas clearly marked.

- Similar page-sized photocopy sheets showing typical wall sections, roof sections, and foundation plan.

- A completed (at least Parts I &II) Survey Checklist

- A completed LRDM table

6.3 Sample Retrofit Recommendations

Below are some sample retrofit recommendations for common deficiencies found in many potential HES buildings.

- For unprotected windows, skylights, other exterior glazings, and overhead doors:

Recommend installation of shutters or other protective systems on the windows/exterior glazing/overhead doors. These protective systems should meet the wind load and impact resistance standards in the SBC Standard SSTD 12-94, or the Dade County version of the South Florida Building Code (Sections 2314.1, 2314.5, and 2315.1-2315.4). This will reduce vulnerability of the windows and building to windborne debris and subsequent interior damage.

- For potential HES buildings without generators/pre-wiring and having ventilation systems without emergency backup power:

Inside the building there should be ceiling or portable fans provided for adequate air movement. These fans, lights in the shelter areas, and the kitchen area (in particular the electric burners), as well as any other electrical loads which are identified as being essential to the use of the building as a shelter, should be connected to an emergency generator/power system. This could be accomplished by pre-wiring the essential circuits of the building to a single connection point, with a compatible interface connection for portable generators. In the event that power is lost to the facility, a generator could be brought to the site and temporarily installed to provide emergency power for these circuits.

- For open span roof systems or flat, lightweight roof systems:

A structural engineer should evaluate the roof system (especially the open span roof area) and determine what additional bracing is needed to enable the roof system to withstand the uplift and reverse bending forces expected in a major hurricane.

- For unreinforced masonry exterior walls:

A structural engineer should evaluate the unreinforced masonry walls and determine what reinforcement techniques should be used upgrade the walls to the level defined as fully reinforced in ACI 530, or to the levels defined as partially reinforced in NCMA TEK 63 (1975). This will probably involve a major retrofit effort.

- For facilities with only public water and sanitary sewage systems:

The complex has only municipal water and sanitary sewage systems available. Such systems are often disrupted during hurricanes, sometimes for extended periods. Alternative *backup provisions should be planned.*

- If a nonpotable well or an abandoned septic tank, or a wastewater/water treatment plant is available on/near the site, consider retrofitting those utilities for use in emergencies.

- **Generally, structural deficiencies will require the attention of a structural engineer to analyze and determine the proper mitigation measures and this should be recommended.**

- Mass care issues can usually be met by backup provisions (portable toilets, bottled water, etc.).

- Emergency power deficiencies are usually best met with prewiring of the HES for quick hookup of an emergency generator.

    - This is less costly than installing an on-site generator and does not expose the generator to the impact of the hurricane.

    - In those cases where the need for emergency power is immediate and continuous (i.e., special needs shelters), consideration should be given to installing or arranging to rapidly install emergency generators.

    - If a generator is to be on-site prior to the arrival of a hurricane, then the generator should be hazard protected against the wind forces and windborne debris expected under hurricane conditions.

Appendix

Appendix A:
Mitigation Techniques
for
Marginal Buildings

Appendix A

Mitigation Techniques for Marginal Buildings

A.0 General

This chapter describes some mitigation techniques for marginal/noncompliant buildings. This chapter does not explain engineering design procedures for mitigation, but rather describes some practices that are accepted by the industry and are currently being used. Mitigation techniques are described for roofs, masonry walls, structural stability and load path problems, weak spots in the exterior envelope, fenestrations and for increasing the flood resistance characteristics of a building.

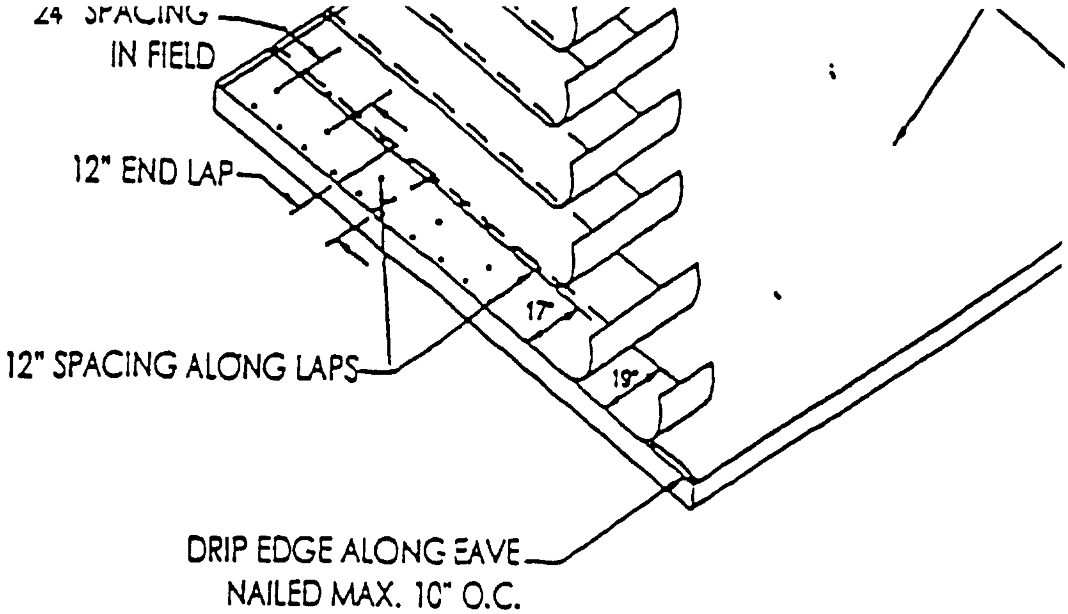
A.1 Mitigation Procedures for Roof Systems

To counteract wind uplift, roof decks should be secured firmly to the walls, and roof coverings should be attached securely to roof decks. In many existing buildings, the connections between roof decks and the walls can be enhanced easily. However, the connections of roof coverings to roof decks can be difficult to improve unless re-roofing is undertaken. The following sections describe mitigation techniques for a number of different types of roof systems.

A.1.1 Plywood/OSB Panels on Wood Trusses or Rafters

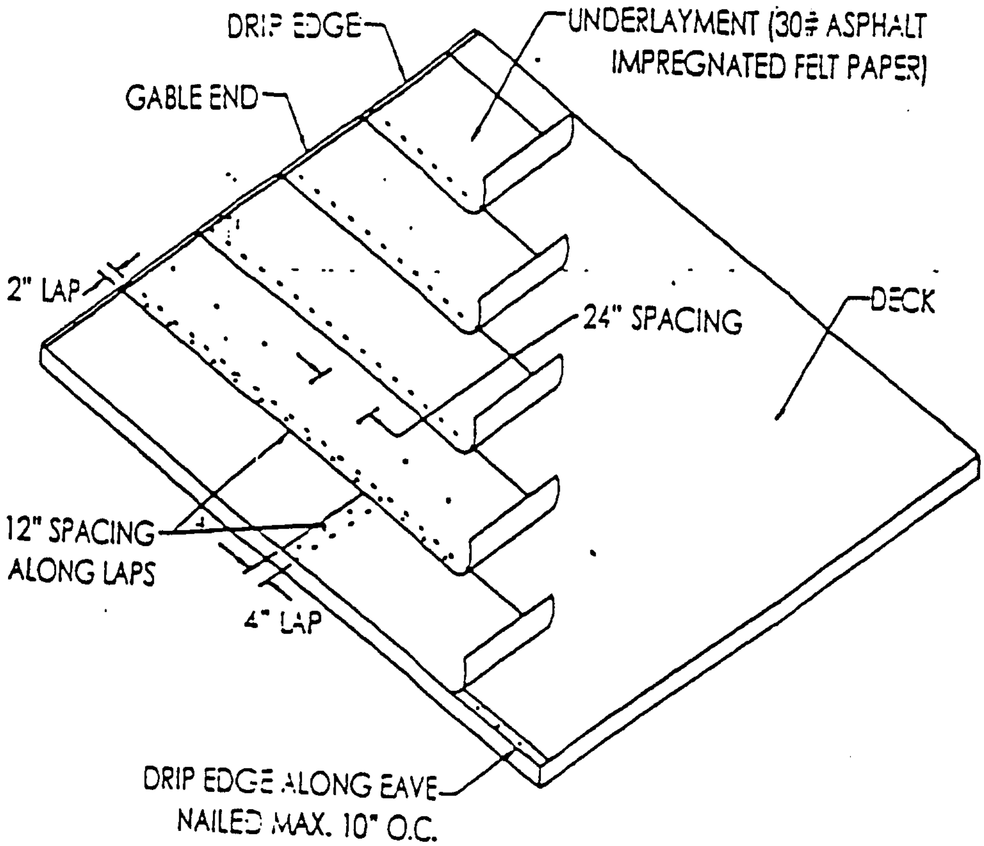
These roof systems are comprised of (i) roof coverings (asphalt shingles, clay tiles, concrete tiles), (ii) roof underlayment (15# or 30# roofing felts), (iii) roof decking (plywood, oriented strand board), and (iv) roof support structures (trusses or rafters). Previous storm damage investigations for Hugo (1989), Andrew (1992) and other hurricanes have documented wide-spread failure of plywood/OSB roof systems.

Typically, poor performance is related to blow-off of coverings and uncertainties in the wind and moisture resistance of the underlayments used. It is important, while re-roofing, to provide a second line of defense against water intrusion. A double layer of 15-lb felt paper should be installed according to details given in Figure A.1. Alternatively, a single layer of 30-lb felt paper can be installed on hot-mopped asphalt (see Figure A.2). In either case, one-inch diameter tin tags should be used with each fastener installed on the roofing felt. The idea is that if the roof covering (shingles or wood shakes) are blown off or broken, the felt paper will remain in place and prevent water intrusion through the roof.



NOTE: NAIL WITH 1-IN. DIA TIN TAGS

Figure 6.1 Double layer underlayment application



NOTE: NAIL WITH 1-IN. DIA TIN TAGS
MOP WITH HOT ASPHALT PRIOR TO PLACING FELT UNDERLAYMENT

Figure 6.2 Single layer underlayment application

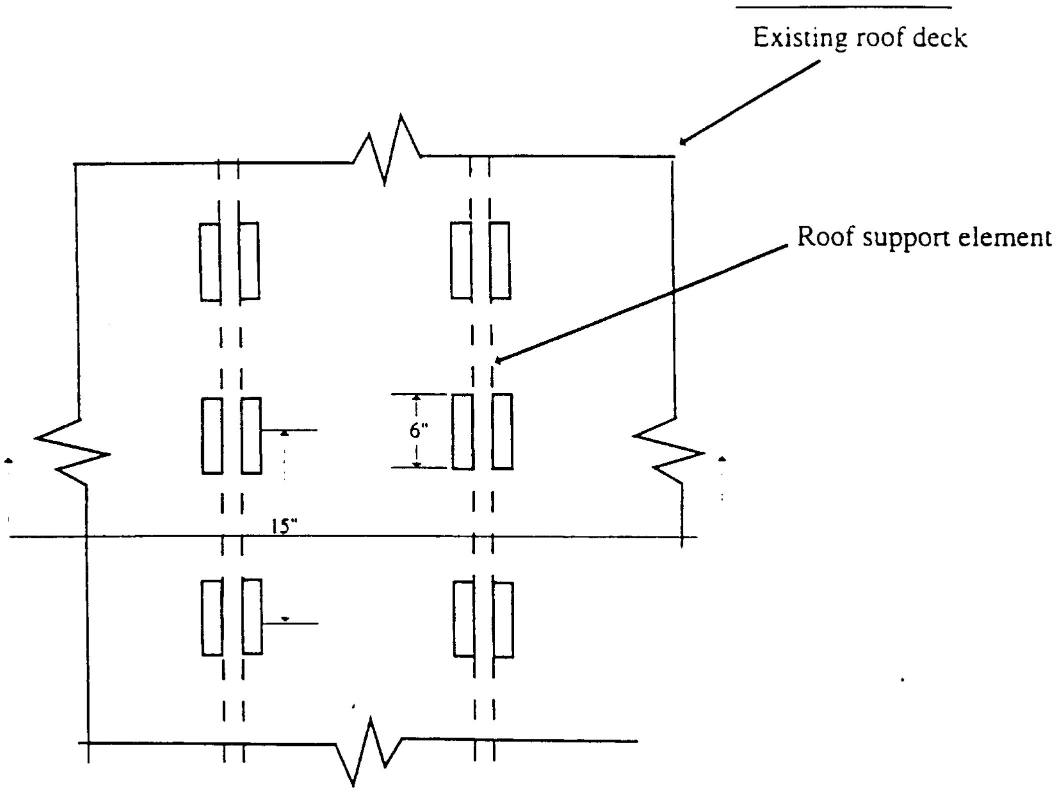
The common problems with plywood or OSB decking have been materials that are too thin, nails that are too small or have missed the underlying rafters or top chords of trusses. Better connections between sheathing panels and rafters are achievable with the use of spray applied foams and glues, for example, Foamseal™ or 3M™ Scotch-Grip Wood Adhesive 5230. These two particular products have been tested at the Clemson University and have been shown to provide adhesion that is three to four times stronger than that provided by 8d nails spaced 4 inches on center.

As an example for application, to use 3M™ Scotch Grip Wood Adhesive 5230, place one-inch x two-inch by six-inch long wood blocks at 15 inches on center, on both sides of the rafter, at the intersection of rafter and roof sheathing, as shown in Figure A.3. Static pressure tests conducted at Clemson University showed that the wood blocks and adhesive increased the wind uplift resistance by a factor of three. A quarter inch bead of adhesive six inches long is applied at the intersection of the roof deck and a roof support element (rafter or truss chord). The wood block is then pressed into the adhesive, ensuring the adhesive is dispersed evenly. Adhesive and blocks are placed on each side of the roof elements at 15 inches on center, as shown in Figure A.3.

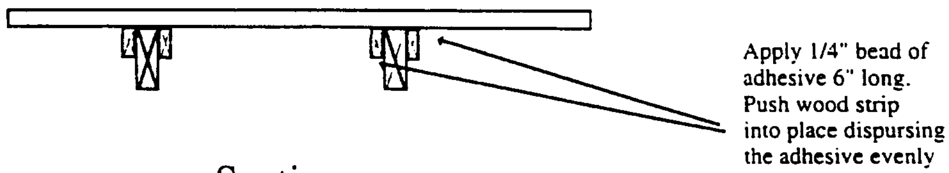
The gable end wall typically is formed by placing a roof truss over the top of the end wall and attaching wall sheathing to the truss. Under these circumstances the end truss is subjected to inward and outward forces. To improve wind resistance of roof gable end wall systems, provide eight foot long braces fastened to the bottom chord of the truss and the adjacent trusses (see Figure A.4). These braces should be perpendicular to the end truss, and spaced at six foot on center. Also, provide 2"x 4" blocking between the truss top chord at the ridge (see Figure A.5).

Examine the roof sheathing for rotted boards or sheathing. Replace as needed. Roof sheathing should be fastened more securely in roof corners and along the ridge and eaves. Highly localized pressure exists within about four feet of the corners, eaves and ridges. The nailing pattern should be at a recommended minimum. The uplift resistance is proportional to the number and size of fasteners. An alternative to additional nailing is to use screws. Add additional nails or screws to achieve the required uplift resistance. The advice of an architect or engineer is required to obtain the needed uplift resistance.

Improving the roof and top of the wall connections and anchorage in a wind load path is difficult because of limited access to the ends of the roof framing and to the bottom of the stud walls. These areas are normally covered by sheet rock on walls and the ceiling on the interior, and wall cladding and the soffit board on the exterior. In order to gain access for installing straps or hurricane clips, the roof sheathing should be removed around the perimeter of the roof to reveal the top of the wall. In addition, the soffit and exterior cladding near the top of the wall may need to be removed to reveal the



Plan View



Section

Figure 6.3 Installation of wood strips and adhesive to improve roof deck uplift resistance

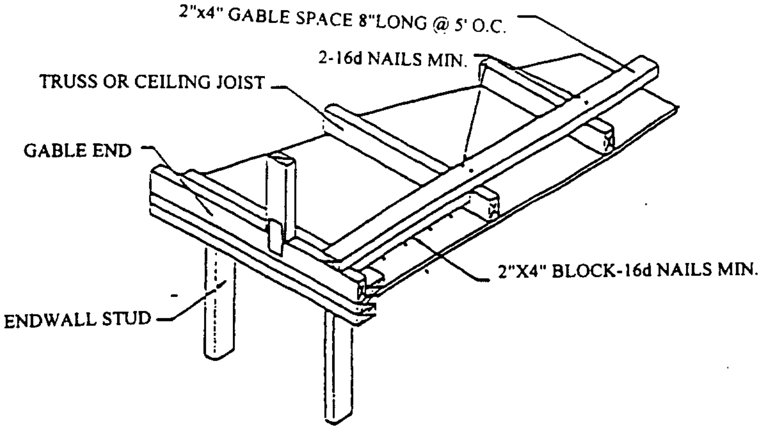


Figure 6.4 Gable end wall detail for wood stud walls

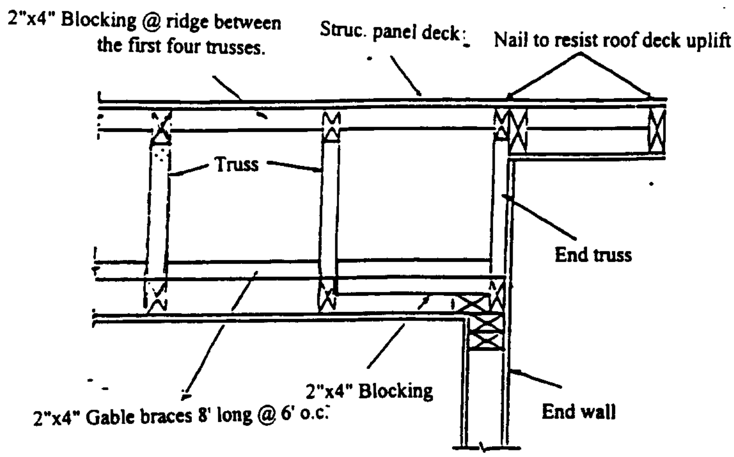


Figure 6.5 Gable end wall bracing details

top 12 to 18 inches of the wall. If the exterior cladding is brick veneer, the top three or four courses may also need to be removed to gain access to the space needed to install the straps and clips.

If trusses are used, the truss must be tied to the top plate and the top plate anchored to the wall stud. Alternatively, the truss can be strapped directly to the wall stud. The clips or straps should be positioned so that nails are stressed in shear under uplift forces. Figures A.6 illustrates several ways to anchor a roof to the top of a wall with straps and connections. In some buildings it may be possible to install hurricane clips at the roof-to-wall connection by removing soffit board at the overhang, exposing the top plate of the wall and the ends of the joists and rafters. Figure A.7 shows three examples of how hurricane clips might be installed through the soffit of the overhang.

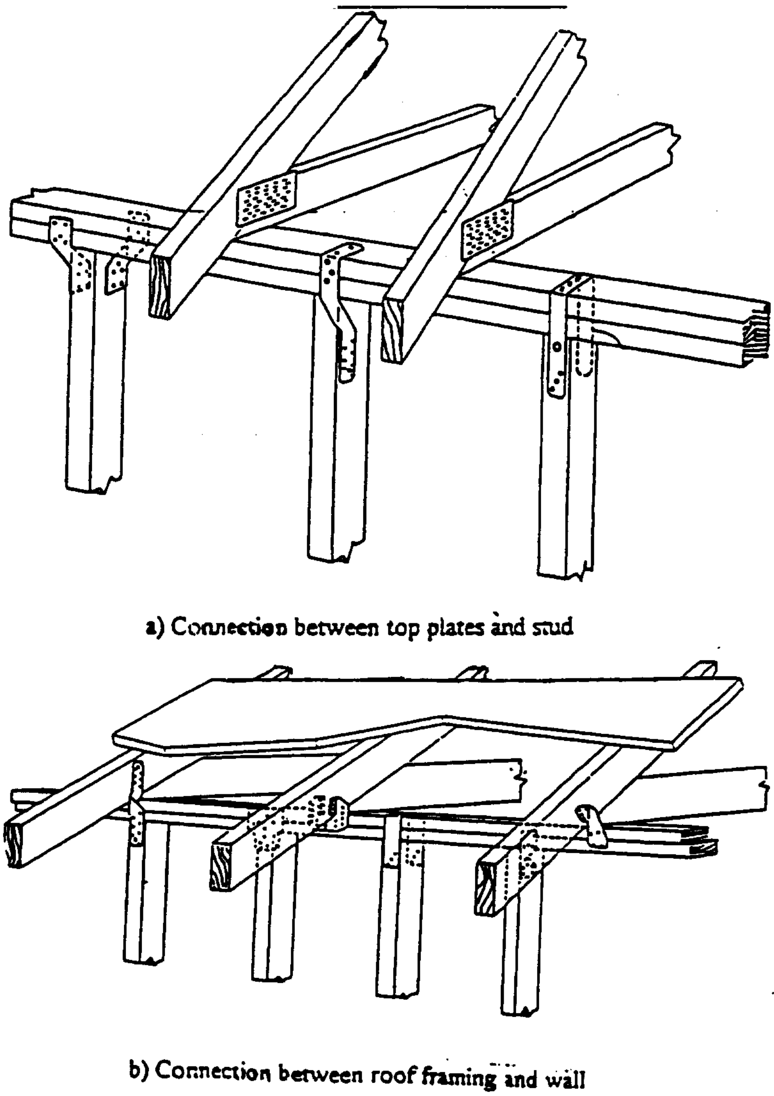
A.1.2 Mitigation for Roof Coverings

Wide spread damage to roof coverings: built-up roofs with ballast, single ply, pavers, shingles, concrete and clay tiles have been documented in windstorms. Poor performance typically is related to inadequate design attention, deficient material properties (which sometimes are related to aging), inadequate test methods for determining resistance of roof coverings and poor workmanship. Retrofitting existing roof coverings is extremely difficult. However re-roofing projects can substantially improve the resistance of roof coverings. Some mitigation techniques recommended by National Roofing Contractors Association (NRCA) are presented below:

A.1.2.1 Re-roofing Mitigation Techniques

When re-roofing, the tear-off of the existing membrane and insulation is recommended. After tear -off, the roof deck and /or framing should be inspected for deterioration. It should be ensured that the roof deck is adequately attached and deteriorated panels are repaired or replaced. Because of the great potential for missile-induced damage to roof coverings and subsequent leakage, it is recommended that the roof system incorporate a secondary waterproofing membrane. This can be a spray applied polyurethane foam (PUF) roof, or be a protected membrane with heavy-weight concrete paver ballast as described below:

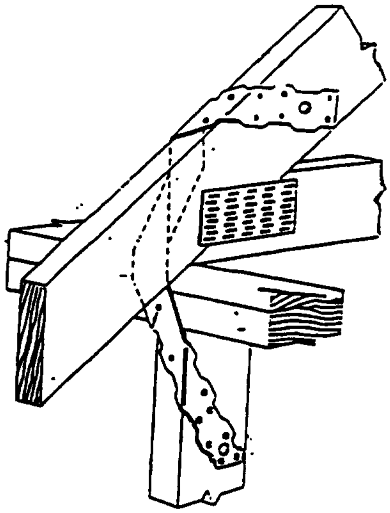
For systems other than PUF, or those protected with pavers, it is recommended that a minimum of two inches of insulation occur between the roof membrane and the secondary waterproofing membrane. The purpose of the insulation is to serve as missile protection for the secondary membrane. The secondary membrane could be a two-ply built-up membrane (as commonly used when constructing a hot-applied vapor retarder), or other suitable system. The secondary membrane should be sealed at perimeters and



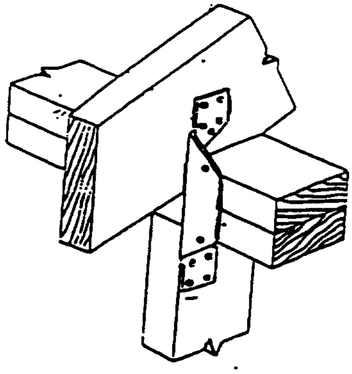
a) Connection between top plates and stud

b) Connection between roof framing and wall

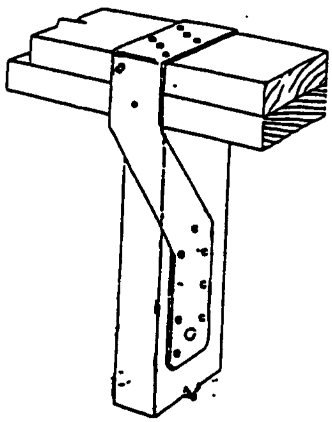
Figure 6.6 Typical anchorage between roof framing and wall



A. Hurricane clips installed through soffit of overhang



B. Hurricane clips installed through soffit of overhang



C. Hurricane clips used to tie top plates and stud together

Figure 6.7 Various placements of hurricane clips penetrations to maintain water tight integrity.

This recommendation is also applicable to steep-slope systems (including metal roofing). However, depending upon the system components, elimination of the insulation between the roof coverings and secondary membrane may be appropriate. For example, if metal panels occur over wood sheathing, use of a secondary membrane such as self-adhering modified bitumen without insulation, would likely be sufficient. Although a missile could puncture the secondary membrane, significant leakage with a membrane of this type on a steep-slope roof would be unlikely.

Because of the difficulty in assuring that the waterproof membrane integrity would be maintained, mechanically attached single-ply systems are not recommended unless a special secondary membrane is used that will ensure watertight integrity at fastener penetrations. (Note: Fasteners that are dynamically loaded are much more likely to promote leakage at the secondary membrane, compared to fasteners that are not dynamically loaded, e.g., insulation fasteners)

It is recommended that brittle roof coverings (e.g., slate or tile) not be utilized on HES buildings. These coverings can be broken by missile impact and generate additional missiles.

For PUF systems, if the coating is damaged by missiles the need for secondary membrane is unlikely due to the foam's resistance to water penetration. The foam should be a minimum of two inches thick, in order to decrease the potential of missiles puncturing all the way through the foam.

As an alternative to the two approaches described above, the membrane could be protected by a layer of extruded polystyrene insulation with heavy-weight concrete paver ballast (weighing a minimum of approximately 22 psf). With this alternative, it is recommended the system be designed in accordance with ANSI/ARMA/SPRI RP-4.

A.1.2.2 Mitigation Techniques for Existing Roof Coverings

Existing roof coverings, such as built-up roofs, single ply, concrete or clay tiles, and shingles, can also be strengthened by spraying polyurethane foam. A particular product of interest is an isocyanate and polyol combination that is mixed at the site using spray equipment. This product has been tested by the Factory Mutual Research Corporation and is also recommended by NRCA. An illustration of an asphalt shingle roof with spray applied PUF is shown on the next page. The resulting foam is about two feet thick and has a density of 2.8 to 3.0 pcf. The foam requires a protective coating on its top surface. A water based 100% acrylic coating is available that can be applied to top surface. This product has been applied to various types of roof coverings as a recover/retrofit effort in the last three years at several locations in Texas and Florida

(Trinity Engineering, Inc., Test Report #4680.11.95-I).

A.1.3 Pre-cast Concrete T-beams

The dead weight of precast concrete units helps to keep the roof deck in place. However, at roof corners and along perimeters, combined external and internal pressures can overcome gravity loads and produce net uplift. One way to improve the uplift resistance of precast panels, when panels are resting on masonry walls, is to drill a hole through the rib of the T-section as well as two holes in the tie beam adjacent to the rib of the T-section. U-bolts or U-shaped straps can then be inserted through the hole and anchored to the tie beam using epoxy or bolts. Another method, when T-sections are attached to walls, is to shoot web straps to the sides of the rib of the T-beam, bringing them down to the wall and connecting them to the wall using powder driven bolts. Also, fasten or weld a clip at the joint between two precast panels to enable the panels to act together for resisting wind uplift.

A.1.4 Metal Decks on Open Web Bar Joists

Metal decks are connected to load-bearing open-web-bar joists with puddle welds, spot welds or screws. Due to wind uplift and cyclic loading, tear out of metal decking at these points has been documented in the damage studies of many hurricanes. A 22 gauge or thicker metal deck will reduce the tear out problem. For existing buildings, however, connections between metal decks and bar joists can be improved by welding joists to the metal roof decks. This can be easily accomplished if the underlying ceiling is removed temporarily. To achieve a better connection, a clip should be welded between the metal deck and the top chord of the bar joist. These connections should not be farther apart than four feet on center.

Open web bar joists should also have wind bracing (bridging) that prevents lateral movement and lateral buckling of bar joists. Typically, an angle, ½ inch rod, or plate is welded to top and bottom chords of bar joists in a direction perpendicular to the span of the bar joists. Wind bracing can be easily installed if the ceiling is removed. A six to eight feet spacing should be adequate to provide stability in the lateral direction. Any bracing added to a roof system should be approved by a structural engineer.

Reverse bending and vibrations of long span roof can be reduced by adding additional column supports. If additional column supports are added a structural engineer should be consulted for strengthening the web section of open web bar joists at the support points. Addition of columns can induce tensile stresses in the top chord of bar joists, therefore revised design calculations and strengthening of bar joists will be needed.

A.2 Mitigation Measures for Unreinforced Masonry walls

Many old building are built with unreinforced concrete masonry block walls. A typical 10 foot high masonry wall should have #5 rebars four feet on center to develop adequate tensile bending strength to resist uniform wind loads. It should also have at least metal lath and stucco to resist the missile impact. Therefore, mitigation measures are needed to improve the wind and impact resistance of concrete block walls.

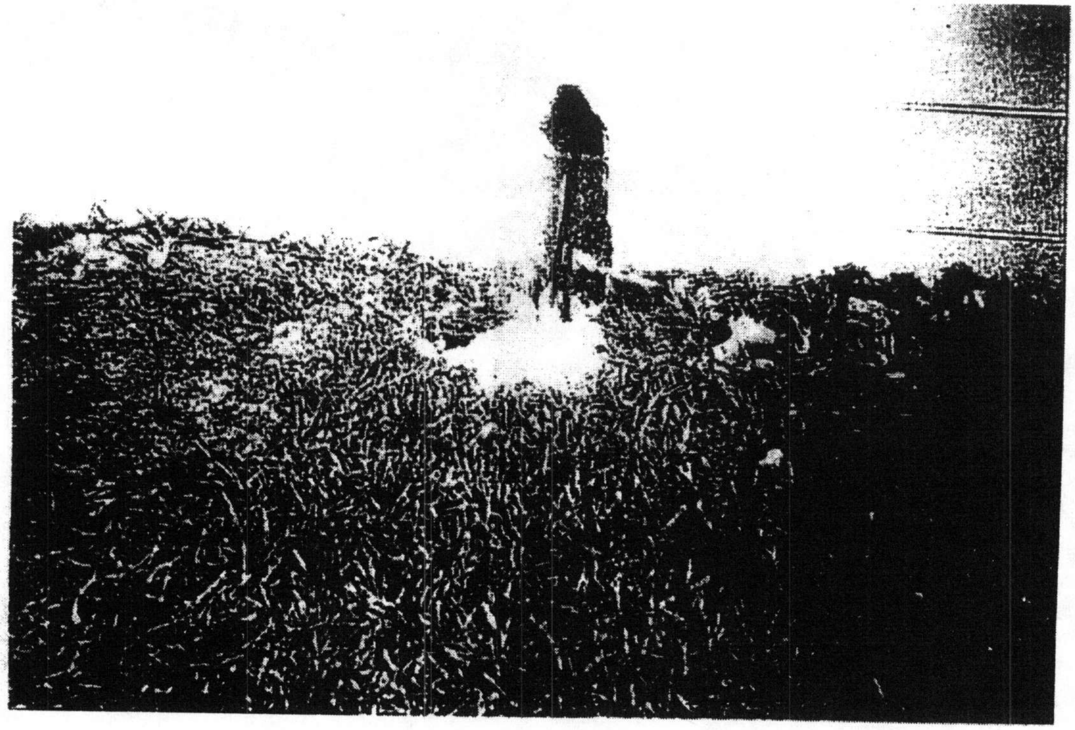
To place vertical reinforcement in existing masonry walls, knock off the face shell for two bottom and two top courses of the masonry wall (see Figures A.8a and A.8b). Using an 11/16" drill bit drill holes in the footing as well as tie beam at the top of the masonry (see Figure A.8b). Fill the holes with commercial grade epoxy and place 16" long #5 bars in the holes (see Figure A.8a). After placing the rebars thread two # 3 bars in the core and tie them to the anchored bars. Cover the broken face shells with plywood and the place grout in the core. Note that the additional grouting and rebar may require additional strengthening of the footer, as shown in Figure A.8c. Construction drawings showing strengthening of an existing masonry wall are shown in Figure A.8d.

Another procedure is to break the face shell in all courses of the masonry wall to create a continuous slot (vertical) for placement of rebar. If a continuous slot is created, holes can be drilled in the footing and the tie beam easily. Rebar is inserted in the vertical column, the tie beam and footing holes are sealed with commercial grade epoxy and grout is poured in. However, in such a procedure the wall will have to be formed for placement of grout. In addition, lateral reinforcement may also be needed. As in all the techniques above a structural engineer should review the planned procedure for a particular building for placement and number/types of reinforcement, and to determine the impact on the structural integrity of the target building.

A.3 Mitigation Measures for Structural Stability and/or Loadpath Condition

A building will be structurally stable if it has adequate hold down connections for sidewalls, adequate shear resistance in the shear walls and a continuous load path for transfer of windload forces to the ground. Improper connections between the roof and the top of walls and between wall and foundation will compromise the integrity of the entire wall and roof system.

Walls generally are covered by stucco, siding or other wall coverings. It will therefore be necessary to remove siding/wall covering near bottom of the wall. If there are no anchors, the following retrofit procedure should be followed. Drill holes through



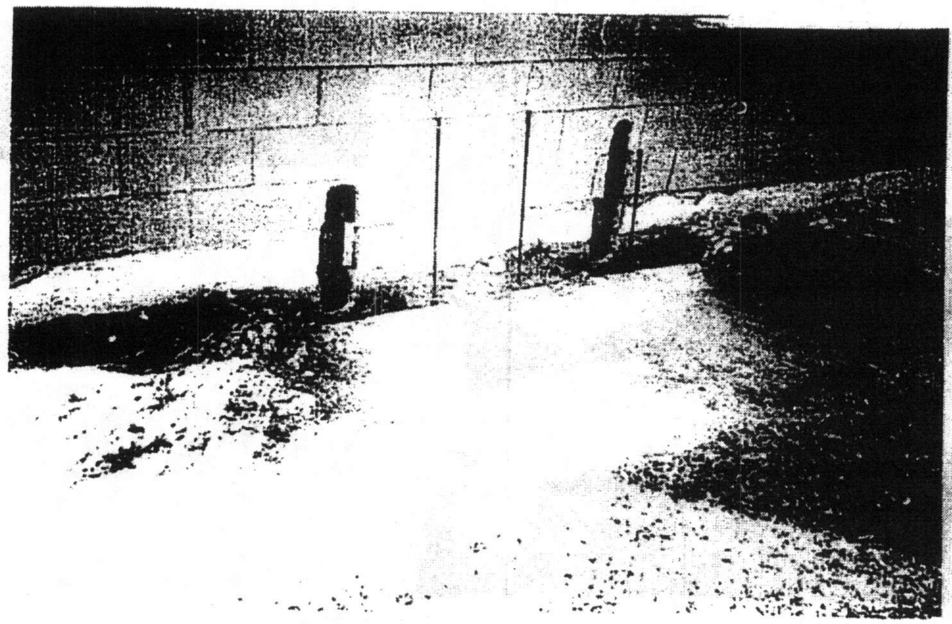
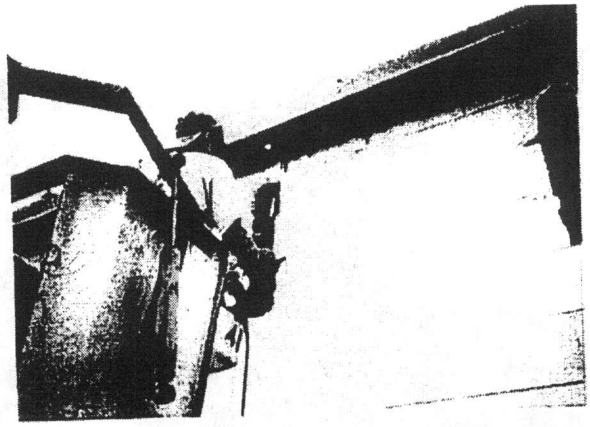


Figure 6.3a Knocking off the face shell at two bottom courses



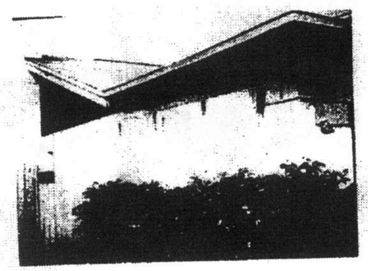


Figure 6.3b Knocking off the face shell at two top courses and drilling hole in the tie beam

Figure 8b Knocking off the face shell at two top course and drilling hole in the tie beam

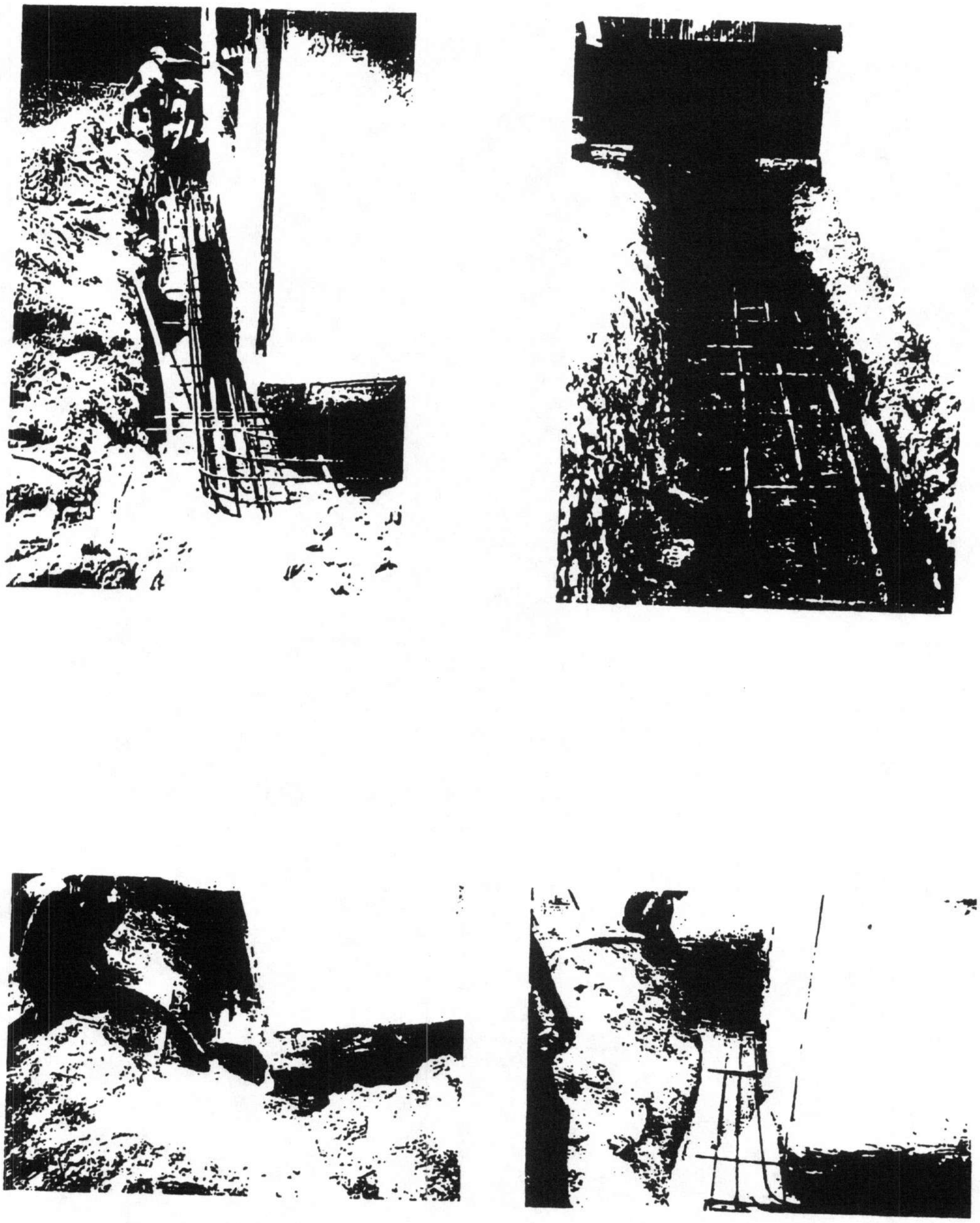
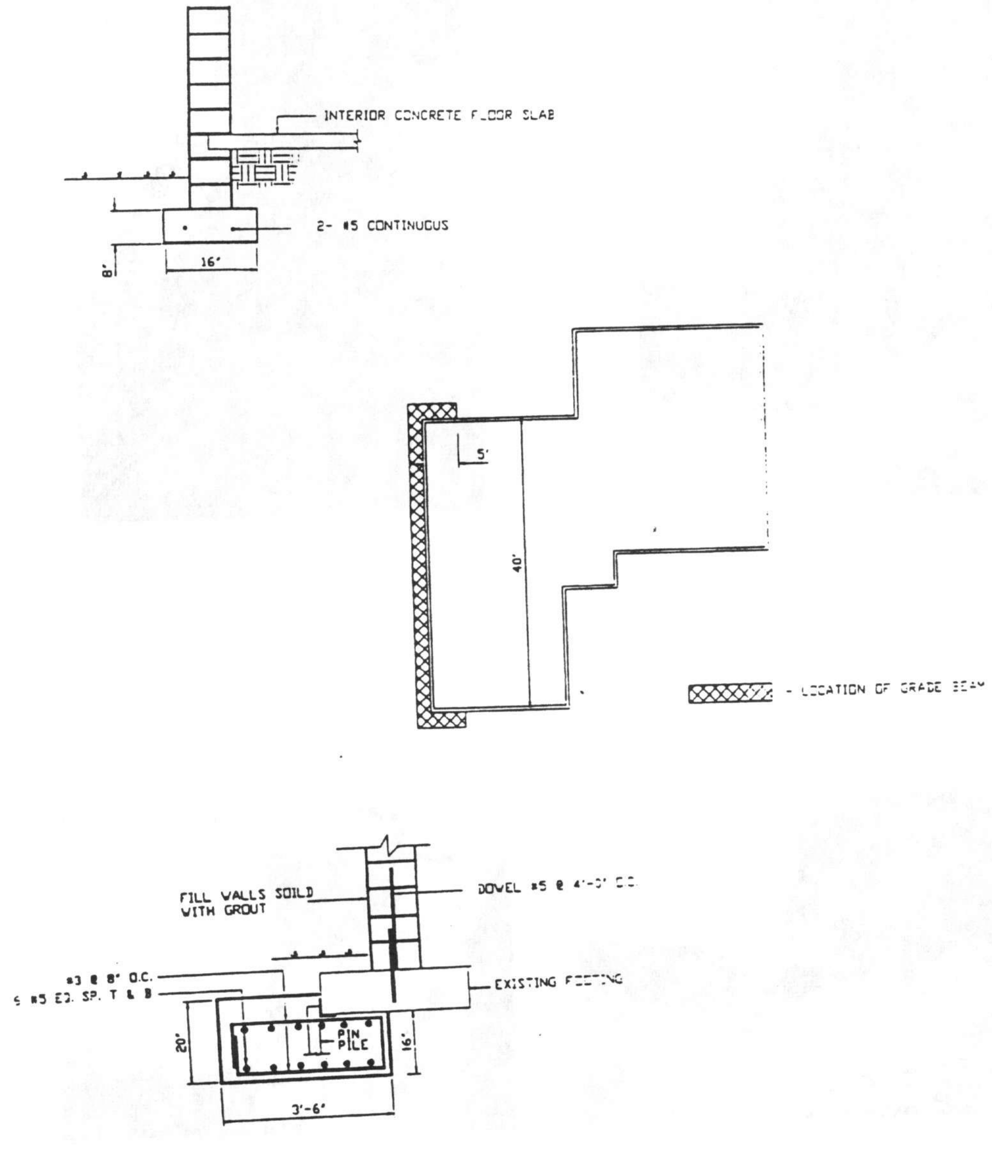


Figure 6.3c Strengthening of existing footing by addition of rebar and concrete



GRADE BEAM

Figure 6.3d Construction drawings for strengthening masonry walls existing sill into the concrete foundation for anchor bolts. A commercial grade epoxy may be used to install the anchor bolts. The minimum bolt spacing, force analysis of the shear and uplift loads must be determined by an engineer.

The shear strength of concrete block walls will improve if continuous vertical reinforcement is placed and grouted. The vertical tensile strength as well as shear strength can be improved if the entire wall is grouted (see Figure A.9). A fully grouted masonry wall has two to three times more tensile bending strength compared to a similar ungrouted masonry wall. Shear strength of concrete masonry buildings can also be improved by adding additional wall segments to exterior walls or by constructing additional shear walls in the building. A structural engineer should be consulted when such retrofit measures are taken.

Many old wood frame walls have no exterior sheathing under the wall covering/siding. Shear strength of such walls can be improved by first removing siding and then installing exterior grade 5/8" plywood sheathing before replacing the siding.

The most common methods for increasing the shear resistance of an existing concrete frame building are: (i) addition of shear wall to existing frame, (ii) addition of bracing to existing frame, (iii) increasing dimensions of existing frame members, and (iv) addition of exterior structures to the existing structure. A structural engineer should be consulted for the selection of suitable options for a particular building.

A.4 Mitigation Measures for Wind and Impact-Resistance of Typical Non-Fenestrations

Mitigation techniques need to be carried out to improve the wind and impact-resistance of typical non-fenestration "soft spot" conditions, e.g., Exterior Insulation and Finish Systems (EIFS), masonry opening infill, cantilever wall conditions, etc.

For EIFS, it would be best to replace the existing EIFS systems with reinforced masonry or metal panel systems or pre-cast structural concrete. Another way to retrofit EIFS systems is to install a brick or stone veneer, to improve their impact and wind resistance.

Masonry opening infill needs to be reinforced by inserting flat metal bracings in the walls. In some cases it might be feasible by bracing the infill from inside by some kind of bracing, or pour them solid. Sometimes they will have to be replaced by reinforced masonry infill.

To mitigate cantilever wall conditions, the cantilever walls need to be braced by

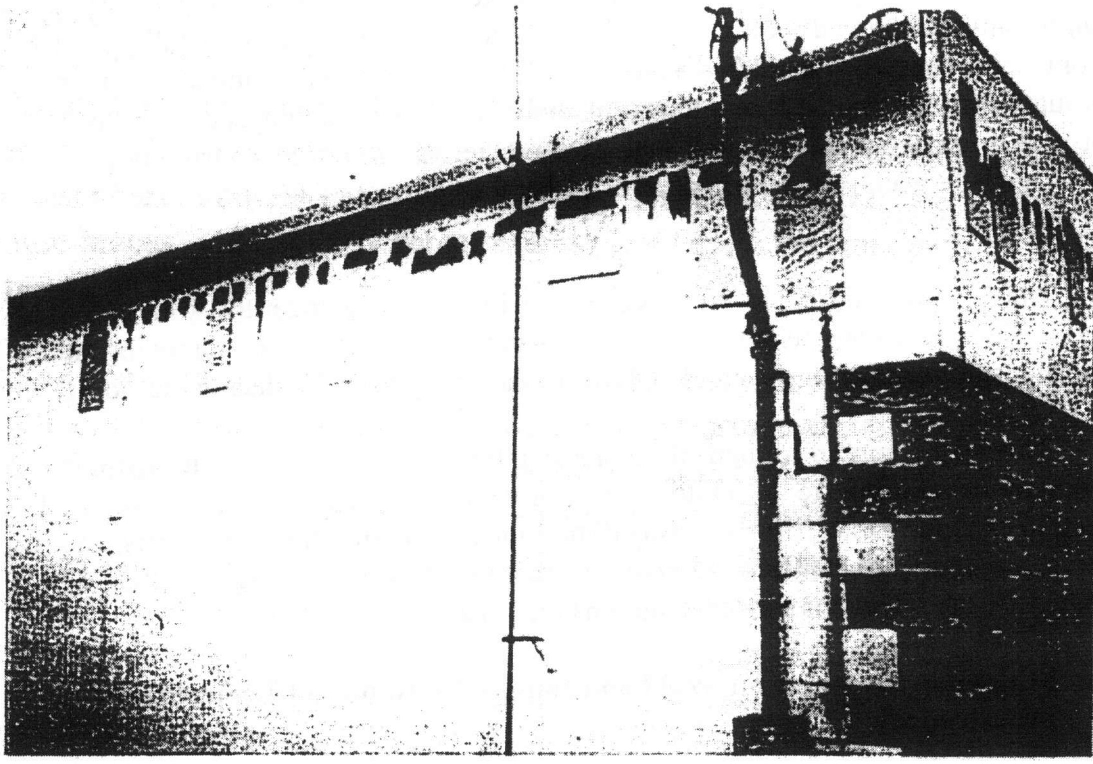


Figure 6.9 Strengthening of entire masonry wall by grouting

putting shear walls on either side to eliminate cantilever condition.

A.5 Mitigation Measures for Wind and Impact-Resistance of Typical Fenestrations

The wind and impact-resistance of typical fenestrations, e.g., personnel entry doors, large overhead doors, windows, and store-front windows, also can be improved.

To resist wind and impact loads, metal doors without glass should be preferred. Replace personnel entry doors by metal doors without glass as far as possible. The glass on doors and windows should be replaced by glass or protected by systems that meet the wind load and impact resistance standards in the SBCCI Standard SSTD 12-94, or the Dade County version of the South Florida Building Code (Sections 2314.1, 2314.5, and 2315.1-2315.4). This will reduce vulnerability of the windows and building to windborne debris and subsequent interior damage. Exterior doors should have adequate insulation. Large overhead doors should have heavier gauged steel. Change all aluminum louvers to stronger steel or concrete louvers. Provide shutters on louvers and windows. Provide anchor bolt locations to facilitate placement of temporary shutters which will be placed on the louvers and windows when the building is being used as a HES. Roll down shutters also can be used on the exterior of louvers. Tracks should be strengthened by providing angle braces. All these systems should meet the above standards for windload and impact resistance.

Buildings have generally either double or single entry doors. Solid wood, or hollow metal doors generally are strong to resist wind pressures and impact loads of debris generated in windstorms. The doors, whether single or double, should have at least three hinges and a heavy duty dead bolt security lock. Double doors should have at least three hinges and a heavy duty dead bolt security lock. Double doors should have a positive anchorage at top and bottom where the two doors come together. Otherwise, double doors have the same strength and hardware requirements as single doors. To enhance the wind resistant capabilities of double entry doors, attention should be paid to the connection at both the header and the threshold. It is important that the surface bolt extend into the door header and through the threshold into the subfloor. Sometimes, doors have windows or side lights. These should be protected as other windows in the building. Check the anchorage of door assemblies and if necessary install anchors as needed to resist the expected wind forces.

The windows should be tested and listed for debris impact resistance. Large areas of glass are very vulnerable to windborne debris. Therefore these windows should be equipped with permanent or temporary shutters. Temporary shutters may be made of metal panels. If they are, the tracks should be securely attached to the building walls and the panels should have been tested for impact resistance. Also check if any permanent shutters are in operable condition and have been tested and certified to resist debris impact.

In general all exterior doors, window protective systems, and other fenestration protective systems should conform to the wind load and impact resistance standards in the SBCCI Standard SSTD 12-94, or the Dade County version of the South Florida Building Code (Sections 2314.1, 2314.5, and 2315.1-2315.4). A complete listing of Dade County approved protective systems is maintained by the Building Code Compliance office of Dade County. This list can be accessed at www.buildingcodeonline.com on the internet, or can obtained by calling (305)375-2901.

A.6 Mitigation Measures for Improving Flood Resistance

Mitigation techniques to improve the shallow (up to 3 feet of inundation depth above ground floor level) flood resistance of a building exterior envelope needs to be carried out. There are different ways for retrofitting buildings against flood damage. Some are discussed below. While some brief descriptions are provided below, more substantive information is provided in two FEMA documents. These are the *Design Manual for Retrofitting Flood-prone Residential Structures* (FEMA 114/September 1986) and the *Floodproofing Non-Residential Structures* (FEMA 102/May 1986).

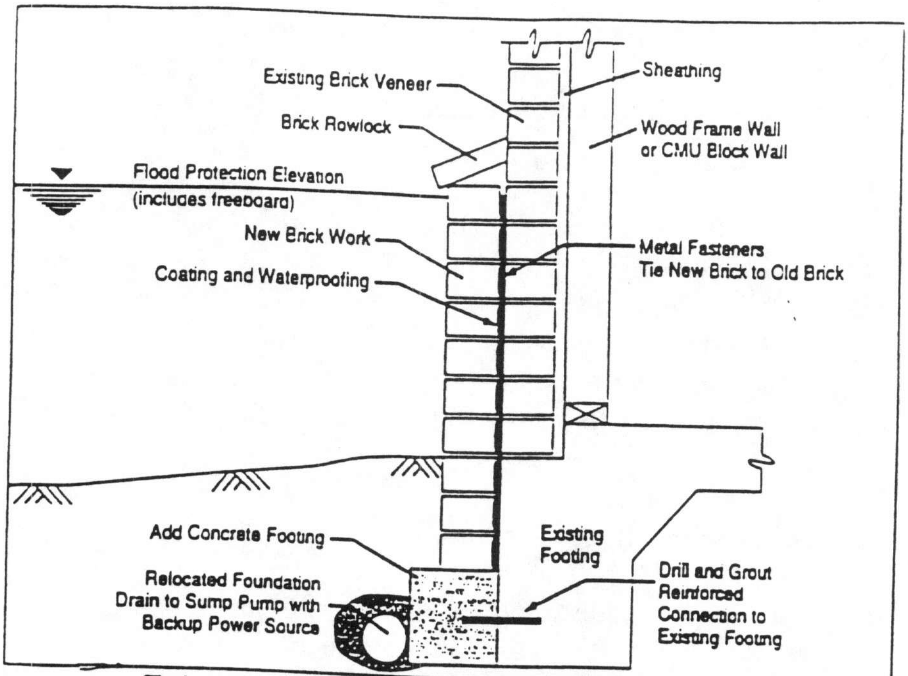
A.6.1 Waterproofing Existing Concrete or Masonry Walls

Concrete or masonry walls are generally not impermeable unless special construction techniques are applied. Waterproofing can be accomplished by use of (a) high quality concrete, (b) sealant materials, and/or (c) impermeable membranes.

The membrane method of waterproofing consists of surrounding all flood-prone surfaces of a structure with an impermeable membrane, Common membrane materials include PVC sheets, or coating of felt, canvas or similar materials that are set in layers of hot bituminous coatings (coal tar, pitch, or asphalt). The membrane method of waterproofing is applicable to all types of masonry and concrete construction. To be effective, the membrane must be continuous and it should be protected against injury by a layer of brick concrete or sand. An existing building may be water proofed on the inside by applying a membrane and then constructing an additional wall and slab within existing wall and slab(see Figure A.10).

A.6.2 Elevation of Structures

Elevating a structure to prevent floodwaters from reaching damageable portions is



. The best way to seal an existing brick-faced wall is to add an additional layer of brick with a seal in between. Just sealing the existing brick is also an option.

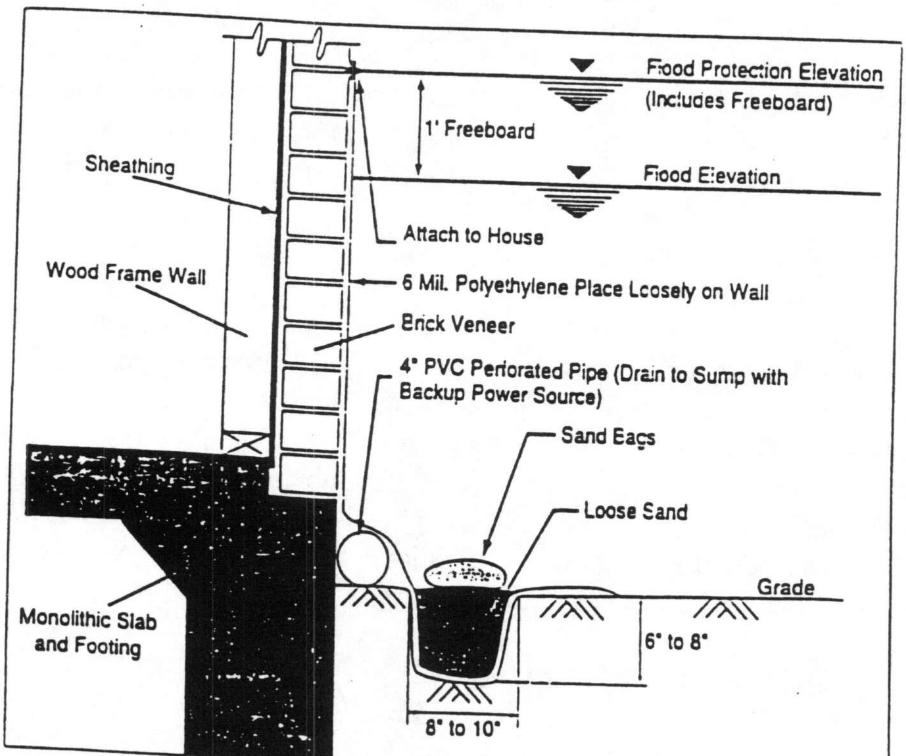


Figure 6.10 A wrapped house sealing system can be used to protect against low level flooding.

an effective retrofitting technique. The structure is raised so that the lowest floor is at or above a designated flood protection elevation (FPE). Heavy-duty jacks are used to lift the existing structure. Cribbing supports the structure while a new or extended foundation is constructed below. In lieu of building new support walls, open foundations such as piers, columns, posts, and piles are often used. Elevating a structure on fill is also an option in some situations.

While elevation may provide increased protection of a structure from floodwaters, other hazards must be considered before implementing this strategy. Elevated structures may encounter additional wind forces on wall and roof systems, and the existing footings may experience additional loading. Extended and open foundations (piers, piles, posts, and columns) are also subject to undermining, movement, and impact failures caused by seismic activity, erosion, ice or debris flow, mudslide, and alluvial fan forces, among others.

A.6.3 Elevation on Solid Perimeter Foundation Walls

Elevation on solid perimeter foundation walls is normally used in areas of low to moderate water depth and velocity. After the structure is raised from its current foundation, the support walls can often be extended vertically using materials such as masonry block or cast-in-place concrete. The structure is then set down on the extended walls. While this may seem to be the easiest solution to the problem of flooding, there are several important considerations. Depending on the structure and potential environmental loads (such as flood, wind, seismic, and snow), new, larger footings may have to be constructed. It may be necessary to reinforce both the footings and walls using steel reinforcing bars to provide needed structural stability.

A.6.4 Elevation on Piers

The most common example of an open foundation is piers, which are vertical structural members that are supported entirely by reinforced concrete footings. But the piers are primarily designed for vertical loading; when exposed to flooding, they may also experience horizontal loads due to moving floodwater or debris impact forces. For this reason, piers used in retrofitting must not only be substantial enough to withstand vertical load of structure but also must be sufficient to resist a range of horizontal forces that may occur. Piers are normally constructed of either masonry block or cast-in-place concrete. In either case, steel reinforcing should used for both the pier and its support footing.

A.6.5 Elevation on Posts or Columns

Elevation on posts or columns is frequently used when flood conditions involve moderate depths and velocities. Made of wood, steel, or precast reinforced concrete, posts are generally square-shaped to permit easy attachment to the building structure. Set in pre-dug holes, posts are usually anchored or embedded in concrete pads to handle substantial loading requirements. Concrete, gravel, earth or crushed stone is backfilled into the hole and around the base of the post. While piers are designed to act as individual support units, posts normally must be braced. There are a variety of bracing techniques such as wood knee and cross bracing, steel rods, and guy wires.

A.6.6 Elevation on Piles

Piles differ from posts in that they are generally driven, or jetted, deeper into the ground. As such they are less susceptible to the effects of high velocity floodwaters, scouring, and debris impact. Piles must either rest on a support layer, such as bedrock, or be driven deep enough to create enough friction to transfer anticipated loads to the surrounding soils. Piles are often made up of wood, but the most effective for retrofitting would be steel and reinforced precast or pre-stressed concrete. Similar to posts, they may also require bracing.

Several innovative methods have been developed for setting piles. These include jetting exterior piles in at an angle using high pressure water flow, and trenching, or auguring, holes for interior pile placement.

A.6.7 Floodwalls and Levees

Another retrofitting approach is the construction of localized barriers between the structure and the source of flooding. There are two types of basic barriers: levees and floodwalls. They can be built to any height but are usually limited to four feet for floodwalls and six feet for levees due to cost, aesthetics, access, water pressure, and space. Local zoning and building codes may also restrict use, size, and location.

A levee is typically a compacted earthen structure that blocks floodwaters from coming into contact with the structure. To be effective over time, levees must be constructed of suitable materials(i.e. impervious soils) and with correct side slopes for stability. Levees may completely surround the building or tie to high ground at each end. Levees are generally limited to buildings where floodwaters are less than 5 feet deep.

Floodwalls are engineered barriers designed to keep floodwaters from coming into contact with the structure. Floodwalls can be constructed in a wide variety of shapes and sizes but are typically built of reinforced concrete and/or masonry materials. A floodwall can surround an entire structure or depending on the flood levels, site topography, and design preferences, it can protect isolated structure openings such as doors, windows or basement entrances.

Types of Floodwalls

A - Gravity Floodwalls

A gravity floodwall depends upon its weight-as its name suggests-for stability. The gravity walls structural stability is attained by effective positioning of the mass of the wall, rather than the weight of the retained materials. The gravity wall resists overturning primarily by the dead weight of the concrete and masonry construction. It is simply too heavy to be overturned by the lateral flood load. See Figure A.11.

B - Cantilever Floodwall

A cantilever wall is a reinforced-concrete wall(cast-in-place or built with concrete block) that utilizes cantilever action to retain the mass behind the wall. Reinforcement of the wall is attained by steel bars embedded within the concrete or block core of the wall. Stability of this type of wall is partially achieved from the weight of the soil on the heel portion of the base, as shown in Figure A.12.

C - Counterfort Floodwall

A counterfort wall is similar to a cantilever retaining wall, except that it can be used where the cantilever is long or when very high pressure are exerted behind the wall. Counterforts, or intermediate traverse support bracing, are designed and built at intervals along the wall and reduce the design forces. Generally, counterfort walls are economical for wall heights in excess of 20 feet.

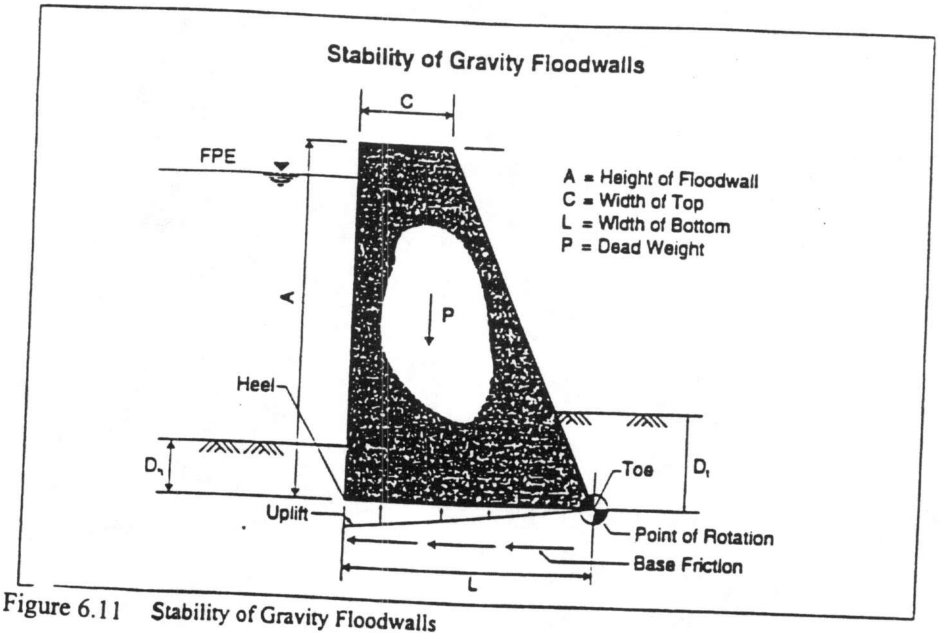


Figure 6.11 Stability of Gravity Floodwalls

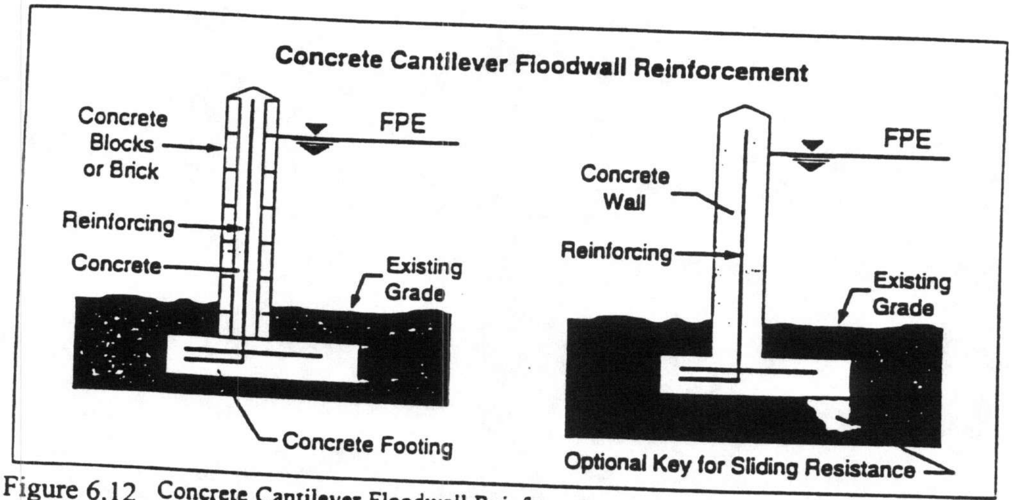


Figure 6.12 Concrete Cantilever Floodwall Reinforcement

Appendix B:
Survey Checklist & Index

Part One: (Local Emergency Management Provided)

SECTION 0 - Identification
0.1 Facility Name
0.2 Latitude/Longitude
0.3 County
0.4 Owner
0.5 Facility Type
0.6 Contact
0.7 Area/s of Facility planned for use
0.8 Alternate Communications
0.9 Power Company

SECTION 1 - Storm Surge Inundation
1.1 Coastal Barrier Island
1.2 Storm Surge Zone
1.3 Storm Surge Isolation

SECTION 2 - Rainfall Flooding/ Dam Considerations
2.1 Building's Floor Elevation
2.2 Flood Plain (100-year)
2.3 Flood Plain (500-year)
2.4 Flood Isolation
2.5 Levee/Dam/Reservoir Inundation
2.6 Levee/Dam/Reservoir Isolation
2.7 Engineered Stormwater Drainage System
2.8 Flooding/Ponding History
2.9 Comments

SECTION 3 - Hazmat And Nuclear Power Plant Considerations
3.1 Hazmat in/near Facility
3.2 Vulnerability Zonees
3.3 Two-Mile Emergency Planning Zone of a Nuclear Power Plant
3.4 Ten-Mile Emergency Planning Zone of a Nuclear Power Plant
3.5 Comments
3.6 Information provided By

Part Two: (Facility Surveyor Provided)

SECTION 0 - Identification
0.1 Facility Name
0.2 Latitude-Longitude
0.3 County
0.4 Owner
0.5 Facility Type
0.6 Contact
0.7 Surveyor/Date
0.8 Comments

SECTION 4 - Lay Down Hazard Exposure
4.1 Lay-Down/Roll-Over Hazard

SECTION 5 - Wind And Debris Exposure
5.1 Wind Exposure
5.2 Debris Exposure

SECTION 6 - Wind Design Verification
6.1 Certified to ASCE 7-88/ANSI A58(1982)
6.2 Designed by a professional architect/engineer

SECTION 7 - Construction Type/Load Path Verification
7.1 Definable/Continuous Loadpath/ Main Wind Force Resisting System (MWFRS)
7.2 Pre-Engineered Metal Building

SECTION 8 - Building Condition/ Wind Damage History
8.1 Overall Building Condition
8.2 Wind/Storm Damage History
8.3 Comments

SECTION 9 - Exterior Wall Construction
9.1 Exterior Walls - Wind & Debris Impact Resistant

SECTION 10 - Fenestrations/Window Protection
10.1 Shutters/Protective Systems
10.2 Overhead Doors
10.3 Skylights/Overhead Atrium
10.4 Comments
10.5 Building Sketch/Window Locations

SECTION 11 - Roof Construction/Roof Slope
11.1 Roof Construction Type
11.2 Roof System Weight
11.3 Hipped Roof System
11.4 Flat Roof System
11.5 Roof Geometry
11.6 Roof Slope
11.7 Roof Covering Type
11.8 Roof Covering Age
11.9 Rooftop Structures
11.10 Rooftop Structures Vulnerable To Wind
11.11 Comments

SECTION 12 - Roof Open Span
12.1 Roof Long or Open Span

SECTION 13 - Roof Drainage / Ponding Information
13.1 Parapet Wall Height
13.2 Scuppers
13.3 Roof Covering Degradation
13.4 Roof Ponding
13.5 Comments

SECTION 14 - Interior Safe Space
14.1 Interior Corridors/Rooms

SECTION 15 - Life Safety/Emergency Power
15.1 Building Life Safety/Fire Code Compliance
15.2 Survivable Emergency Power System

Part Three: (Mass Care Provider Supplied)

SECTION 0 - Identification
0.1 Facility Name
0.2 Latitude-Longitude
0.3 County
0.4 Owner
0.5 Facility Type
0.6 Contact

SECTION 16 - Site Infrastructure (OPTIONAL)
16.1 Survivable On-Site Potable Water Supply
16.2 Survivable On-Site Septic/Sanitary Sewage System
16.3 Comments

SECTION 17 - Mass Care Characteristics (OPTIONAL)
17.1 Food Preparation Capability
17.2 Kitchen Equipement
17.3 Servings per Meal
17.4 Cafeteria
17.5 Snack Bar
17.6 Comments
17.7 Toilets/Wash Basins/Showers
17.8 Health Care Area
17.9 Parking Lots
17.10 Comments

SECTION 18 - Communications (OPTIONAL)
18.1 Emergency Communications Capability
18.2 Information Provided By

14.2 Building Square Footage

Part One: (Local Emergency Management Provided)

SECTION 0 - IDENTIFICATION

0.1 Facility Name:____________	0.6 Contact: ____________
Building ID #: ____________	Title: ____________
Street Address:____________	Phone: ____________
City:____________	Alt. Phone: ____________
State, Zip+4:____________	Alternate 1: ____________
0.2 Latitude:____________	Title: ____________
Longitude:____________	Phone: ____________
	Alt. Phone: ____________
0.3 County:____________	Alternate 2: ____________
0.4 Owner:____________ Public ❑ Private ❑	Title: ____________
0.5 Facility Type: ○ vital - ○ shelter - ○ utility	Phone: ____________
○ other ____________	Alt. Phone: ____________

0.7 Indicate Area/s of Facility that are planned to be used as shelter; ❑ Cafeteria; ❑ Gymnasium; ❑ Auditorium;
❑ Classroom; ❑ Corridor; ❑ Kitchen; ❑ Clinic; ❑ Other: ____________

0.8 Does the building have Alternate Communications with local Emergency Management? ❑ YES ❑ NO

If yes, indicate type: ____________

0.9 Under normal conditions, which Power Company provides electrical power? ____________

SECTION 1 - STORM SURGE INUNDATION

YES	▒	**1.1 Is the Facility located on a coastal barrier island?**
NO		
YES		**1.2 According to the appropriate Storm Tide Atlas, is the Facility's site located above any Category 4 storm surge zone?** *(If not applicable, answer YES)*
NO	▒	

SECTION 1 - STORM SURGE INUNDATION

1.2.1 What is the site elevation above MSL? _________ feet above MSL

What is the building's ground floor elevation above MSL? _________ feet above MSL

1.2.2 What is the maximum predicted storm surge height at the Facility's site?

Cat. 2 ________ feet MSL Cat. 3 ________ feet MSL Cat. 4/5 ________ feet MSL

1.2.3 What is the maximum height of surge expected in the building?

Cat. 2 ________ feet MSL Cat. 3 ________ feet MSL Cat. 4/5 ________ feet MSL

YES	■	**1.3 According to the appropriate Storm Tide Atlas, is the Facility's site subject to isolation due to storm surge activity?**
NO		

SECTION 2 - RAINFALL FLOODING/ DAM CONSIDERATIONS

YES		**2.1 Is the building's first floor elevation on an equal or higher elevation than that of the base flood elevation level for site?**
NO	■	

2.1.1 What is the base flood elevation at the building? __________________ feet above MSL

2.1.2 If multi-storied, does the building have a floor level above the base flood elevation? ❑ YES ❑ NO

The (_____) floor elevation is ________________________ feet above MSL ❑ Not Applicable

YES		**2.2 According to the appropriate Flood Insurance Rate Map, is the Facility's site above the 100-year flood plain?**
NO	■	

2.2.1 What flood zone is the Facility's site located within? ❑ A_____; ❑ B; ❑ C;

❑ D; ❑ X; ❑ V; ❑ Panel Not Printed; ❑ Area Not Surveyed ;

YES		**2.3 According to the appropriate Flood Insurance Rate Map, is the Facility's site above the 500-year flood plain?**
NO	■	
YES	■	**2.4 According to the appropriate Flood Insurance Rate Map(s), is the Facility's site subject to isolation due to riverine and/or ponding inundation of roadways?**
NO		
YES	■	**2.5 Is the Facility's site subject to inundation due to failure of containment of levees, dams and reservoirs following hurricane-related flooding?**
NO		
YES	■	**2.6 Is the Facility's site subject to isolation due to failure of containment of dams and reservoirs following hurricane-related flooding?**
NO		
YES		**2.7 Is there an engineered stormwater drainage system at the Facility's site?**
NO		Condition: ❑ Clean and functional ❑ Marginally functional ❑ Non-functional

SECTION 2 - RAINFALL FLOODING/ DAM CONSIDERATIONS		
YES		**2.8 Is there a history of minor flooding/ponding at the Facility's site under normal rainfall conditions?** (minor flooding is the water level where water actually enters buildings)
NO		

2.9 Comments: ______________________________

SECTION 3 - HAZMAT AND NUCLEAR POWER PLANT CONSIDERATIONS		
YES		**3.1 Are hazardous materials manufactured, used, or stored (in reportable quantities) at, or in close proximity to the Facility's site?**
NO		❑ Data on the hazardous material facilities in the area was not available at the time of the survey.
YES		**3.2 Is the Facility's site located within the Vulnerability Zone of a facility that manufactures, uses, or stores materials that are considered extremely hazardous (Section 302)?**
NO		❑ Data on the hazardous material facilities in the area was not available at the time of the survey.
YES		**3.3 Is the Facility's site located within the two-mile Emergency Planning Zone (EPZ) of a nuclear power plant?**
NO		❑ Data on the hazardous material facilities in the area was not available at the time of the survey.
YES		**3.4 Is the Facility's site located within the ten-mile Emergency Planning Zone (EPZ) of a nuclear power plant, but outside the two-mile EPZ?**
NO		❑ Data on the hazardous material facilities in the area was not available at the time of the survey.

3.5 Comments: ______________________________

____

3.6 **INFORMATION PROVIDED BY:**

Name:	Title:
Address:	Phone:
City, State Zip:	Fax:

Part Two: (Facility Surveyor Provided)

SECTION 0 - IDENTIFICATION

0.1 Facility Name: ______________________

Building ID #: ______________________

Street Address: ______________________

City: ______________________

State, Zip+4: ______________________

0.2 Latitude: ______________________

Longitude: ______________________

0.3 County: ______________________

0.4 Owner: ______________________ Public ❑ Private ❑

0.5 Facility Type: ○ vital - ○ shelter - ○ utility

○ other ______________________

0.6 Contact: ______________________

Title: ______________________

Phone: ______________________

Alt. Phone: ______________________

Alternate 1: ______________________

Title: ______________________

Phone: ______________________

Alt. Phone: ______________________

Alternate 2: ______________________

Title: ______________________

Phone: ______________________

Alt. Phone: ______________________

0.7 Surveyor's Name: ______________________ Survey Date: ______________________

0.8 Comments: ______________________

SECTION 4 - LAY DOWN HAZARD EXPOSURE

YES		**4.1 Is there a lay-down hazard in close proximity to the Facility?**
NO		

4.1.1 Are there large/tall trees within lay-down range of the Facility? ❑ Yes ❑ No

4.1.2 Are there tall structures (e.g., towers, chimneys, steeples, etc.) within lay-down range of the Facility? ❑ Yes ❑ No

SECTION 4 - LAY DOWN HAZARD EXPOSURE

YES		**4.1 Is there a lay-down hazard in close proximity to the Facility?**

4.1.3 Are there potential roll-over hazards within 100 feet of the HES building? For example, unanchored relocatable buildings, vehicle parking lot, and unanchored HVAC units. ❑ Yes ❑ No

Describe: ____________________

4.1.4 Is there at least one access road not tree-lined? ❑ Yes ❑ No

4.1.5 Comments: *(Specify quantity and distribution of lay-down hazards in relation to building)*

____

____

SECTION 5 - WIND AND DEBRIS EXPOSURE

YES		**5.1 Will the Facility site be exposed to the full force of hurricane winds?**
NO		

5.1.1 What is the degree of wind exposure for the Facility?

❑ Sheltered Exposure ❑ Limited Exposure ❑ Unsheltered Exposure

5.1.1.1 What is the type of topography? ❑ Flat ❑ Sheltered ❑ Hill ❑ Promontory

5.1.1.2 What is the surrounding terrain?

North: ❑ Flat ❑ Hilly ❑ Low Lying (O marsh) ❑ Open ❑ Wooded (O heavily - O lightly) ❑ Rural ❑ Residential ❑ Lake/Pond ❑ Commercial Dist. (O shopping - O manufacturing) ❑ Many tall trees

❑ Other: ____________________

South: ❑ Flat ❑ Hilly ❑ Low Lying (O marsh) ❑ Open ❑ Wooded (O heavily - O lightly) ❑ Rural ❑ Residential ❑ Lake/Pond ❑ Commercial Dist. (O shopping - O manufacturing) ❑ Many tall trees

❑ Other: ____________________

East: ❑ Flat ❑ Hilly ❑ Low Lying (O marsh) ❑ Open ❑ Wooded (O heavily - O lightly) ❑ Rural ❑ Residential ❑ Lake/Pond ❑ Commercial Dist. (O shopping - O manufacturing) ❑ Many tall trees

❑ Other: ____________________

West: ❑ Flat ❑ Hilly ❑ Low Lying (O marsh) ❑ Open ❑ Wooded (O heavily - O lightly) ❑ Rural ❑ Residential ❑ Lake/Pond ❑ Commercial Dist. (O shopping - O manufacturing) ❑ Many tall trees

❑ Other: ____________________

5.1.1.3 Is the Facility within one mile of the ocean or other large body of water? ❑ Yes ❑ No

5.1.1.4 Is the Facility within a quarter mile of an open area? ❑ Yes ❑ No

SECTION 5 - WIND AND DEBRIS EXPOSURE

5.2 What is the degree of debris hazard exposure for the Facility?

❑ Minimal Exposure ❑ Limited Exposure ❑ High Exposure

5.2.1 Do the structures within a 300-foot radius have roof gravel? ❑ Yes ❑ No

5.2.2 Is there potential of debris from metal, wood frame, and masonry buildings, loose material or roofing

Within a 100 foot radius? ❑ Yes ❑ No Within a 300 foot radius? ❑ Yes ❑ No

5.2.3 Are there other debris generating sources within a 100 foot radius (e.g., lumber yard, junk yard, plant nursery, tree branches, etc.)? ❑ Yes ❑ No Within a 300 foot radius? ❑ Yes ❑ No

5.2.4 Are there relocatable/portable buildings located on-site? ❑ Yes ❑ No

5.2.4.1 Are the relocatable/portable building(s) securely anchored? ❑ Yes ❑ No ❑ Not Applicable

5.2.4.2 Are the relocatable/portable building(s) within 100 feet of the HES? ❑ Yes ❑ No ❑ Not Applicable

5.2.5 Comments: *(Specify quantity, types, and distribution of debris sources)*

____

____

____

____

SECTION 6 - WIND DESIGN VERIFICATION

YES		**6.1 Has a structural engineer certified this building as being capable of withstanding wind loads according to ASCE 7-88 or ANSI A58 (1982) structural design criteria?**
NO		(Give preference, in selecting shelters, to buildings designed to ASCE-7 or ANSI A58, in lieu of other model codes)

6.1.1 If yes, Specify actual wind design parameters (e.g., ASCE-7, 110 mph) ______________

YES		**6.1.2 Does the building have more than one story?**
NO		

6.1.2.1 How many stories does the building have? ❑ One ❑ Two ❑ Three ❑ Four-Five ❑ Six +

6.1.2.2 What is the overall height of the building? ❑ 0-30 feet ❑ 31-59 feet ❑ 60+ feet

YES		**6.2 Was this building designed by a professional architect or structural engineer?**
NO		❑ Unknown

SECTION 6 - WIND DESIGN VERIFICATION

6.2.1 What type(s) of technical design drawings were available for the survey?

□ Architectural ❍ Full ❍ Preliminary ❍ Partial ❍ As-Built ❍ None

□ Structural ❍ Full ❍ Preliminary ❍ Partial ❍ As-Built ❍ None

❍ Drawings do NOT furnish a high level of detail; ❍ Drawings are more representative of residential drawings.

❍ Truss anchors and/or reinforcement in masonry was not addressed.

6.2.2 The building was designed in what year? ________________ □ Actual □ Estimated

6.2.3 In what year(s) were major addition(s) built? ________________________________

6.2.4 What type of wind resistance code was utilized (or prevalent) at the time of **design**?

□ Model Building Code (❍ SBC - ❍ SFBC - ❍ Other: ________________)

□ Custom Code □ MBMA □ Unknown □ None

6.2.5 To what wind speed was the building designed? ____ mph _______ importance factor ❑ Unknown

6.2.6 Comments: ____

____

____

SECTION 7 - CONSTRUCTION TYPE/LOAD PATH VERIFICATION

YES		**7.1 Is there a definable and continuous load path from the building's roof to its foundations?**
NO		

7.1.1 What is the primary roof support system? ❑ Reinforced Concrete ❑ Steel Beam

❑ Steel Truss ❑ Open Web Steel Joist ❑ Tapered Steel Beam ❑ Wood Truss ❑ Unknown

❑ Glue Laminated Wood Beam ❑ Other: ________________________________

7.1.2 What is the primary load-bearing structure of the building? ❑ Wood Frame

❑ Unreinforced Masonry Walls ❑ Reinforced Concrete Frame ❑ Heavy Steel Frame

❑ Tapered Steel Frame ❑ Reinforced Masonry Walls ❑ Heavy Timber Frame

❑ Laminated Beam Frame ❑ Unknown ❑ Other: ________________

SECTION 7 - CONSTRUCTION TYPE/LOAD PATH VERIFICATION		
7.1.3 How is the primary roof support system connected to the primary load-bearing system? Description: ______________________ ______________________ ______________________		
7.1.4 How is the primary load-bearing system connected to the foundation? Description: ______________________ ______________________ ______________________		
YES		**7.2 Is the building a Pre-engineered (steel pre-fabricated) building built <u>OR</u> designed prior to the mid 1980's?** *(Specify year built/designed: ______________________)*
NO		

SECTION 8 - BUILDING CONDITION/ WIND DAMAGE HISTORY
8.1 From observation, what is the overall condition of the building? ❑ Good Condition ❑ Minor Deterioration ❑ Major Deterioration
8.2 Is there any history of damage from high winds, or storms at this building? ❑ YES ❑ NO
8.3 Comments: *(Specify damage history):* ______________________ ______________________ ______________________ ______________________

SECTION 9 - EXTERIOR WALL CONSTRUCTION		
YES		**9.1 Are the exterior walls relatively wind and debris impact resistant?**
NO		
YES		**9.1.1 Does the building have unreinforced masonry walls on its exterior?** ❑ Unreinforced Masonry <u>or</u> ❑ Rebar Spacings Unknown
NO		

SECTION 9 - EXTERIOR WALL CONSTRUCTION

9.1.1.1 If no, what is the Exterior Wall Construction type? *(Check only one)*

- ❑ Reinforced Masonry (Rebar @ 4 ft. centers or closer)
- ❑ Light Wood or Metal Stud w/ ½ inch or thicker plywood
- ❑ Partial Reinforced Masonry (Rebar @ 8 ft. centers to 4 ft. centers)
- ❑ Light Wood or Metal Stud w/ light non-plywood sheathing
- ❑ Partial Reinforced Masonry (Four-bar Pilasters 13 feet on center or less)
- ❑ Large Panel Glass or other Glazed Panel or Block System
- ❑ Reinforced Concrete or Precast Concrete Panels
- ❑ Metal Sheets or Panels or other Light Architectural Panel Systems
- ❑ Other: ________________________________

9.1.1.2 If Metal Sheets or Panels (e.g. PEMB structures), what is the gage of the metal sheets or panels?

❑ Thinner than 22 gage (26 gage, etc.) ❑ 22 gage or thicker (18, 16, etc.) ❑ Not Applicable

9.1.2 Do the exterior walls have a brick or stone veneer (3 to 4 inches thick)? ❑ YES ❑ NO

9.1.3 Do the exterior walls have an Exterior Insulating and Finish System (EIFS)? ❑ YES ❑ NO

9.1.4 Are there cantilevered walls (walls connected/supported at the base/foundation, but not at the roof) on the exterior of the building? ❑ YES ❑ NO

Describe: ________________________________

9.1.5 Are there any other softspots noted in the building's exterior wall/roof? ❑ YES ❑ NO

Describe: ________________________________

____

SECTION 10 - FENESTRATIONS/WINDOW PROTECTION

YES		**10.1 Are all the windows in the building adequately protected by shutters/protective systems?**
NO		

10.1.1 What is the percentage of Glass in the exterior walls ? ❑ 0% to 1% ❑ 2% to 5% ❑ 6%+

(________ sq. ft. of glazings ÷ ________ sq. ft. of exterior walls x 100 = ____)

10.1.2 Are there "store-front", atrium, or clerestory sections of glazing in the exterior walls? ❑ YES ❑ NO

10.1.3 What type of glass is utilized in the exterior walls? ❑ Unknown

❑ Fully Tempered ❑ Laminated Glass ❑ Other ________________

SECTION 10 - FENESTRATIONS/WINDOW PROTECTION

10.1.4 Are all the windows in the exterior walls of the building shuttered/protected against windborne debris?

❑ YES ❑ NO ❑ Not Applicable

10.1.5 Has the shuttering/protective system used to protect the windows been certified to meet the windload and impact resistance standards in the Dade County version of the South Florida Building Code (Sections 2314.1, 2314.5, and 2315.1-2315.4), or SBC Standard SSTD 12-94?

❑ YES ❑ NO ❑ Not Applicable ❑ Unknown

10.1.6 If there is a shuttering/protective system in use but it is not certified to the standards in 10.1.5 above, is there documentation indicating the system was designed to transfer impact and wind loads to the building walls?

❑ YES ❑ NO ❑ Not Applicable ❑ Unknown

10.1.6.1 Does it appear that the system was installed per the manufacturers' design documentation?

❑ YES ❑ NO ❑ Not Applicable ❑ Unknown

10.1.6.2 Is the shuttering/protective system frame directly anchored into the wall around the window?

❑ YES ❑ NO ❑ Not Applicable ❑ Unknown

10.1.6.3 If a film protective system is used, does the film cover the entire glazing (exposed glass and portions embedded in the frame)?

❑ YES ❑ NO ❑ Not Applicable ❑ Unknown

10.2 Are there overhead/large door(s) in the building? ❑ YES ❑ NO

10.2.1 Have the overhead/large door(s) and framing been modified with additional bracing to resist high wind loads?

❑ YES ❑ NO ❑ Not Applicable ❑ Unknown

10.3 Are there skylights or overhead atrium glass or plastic? ❑ YES ❑ NO

Describe: ______________________________

10.4 Comments: ______________________________

____

____

____

____

____

SECTION 10 - FENESTRATIONS/WINDOW PROTECTION

10.5 Draw "footprint" sketch of building showing overall dimensions & window location.

Window/Door Types and sizes:

A Size____x____ - Type ______________________: G Size ____ x____ - Type______________________:

B Size ____ x ____ - Type ______________________: H Size ____ x ____ - Type ______________________:

C Size ____ x ____ - Type ______________________: I Size ____ x ____ - Type ______________________:

D Size ____ x ____ - Type ______________________: J Size ____ x ____ - Type ______________________:

E Size ____ x ____ - Type ______________________: K Size ____ x ____ - Type ______________________:

F Size ____ x ____ - Type ______________________: L Size ____ x ____ - Type ______________________:

SECTION 11 - ROOF CONSTRUCTION/ROOF SLOPE

11.1 What is the Roof Construction type of the Building?

❑ Cast-in-place Reinforced Concrete (standard wgt concrete, 4 " min.)

❑ Plywood on wood or metal joist or truss (spacing: ____________________)

❑ Precast Concrete Panels ("T's", "Double T's", Planks, etc.)

❑ Wood boards or T & G deck on wood joist or truss (spacing: ____________)

❑ Metal Decking w/standard wgt concrete (3 " min.) on metal joist, truss, or beam (spacing: ______)

❑ Fiberboard or Cementitious fiber planks on wood or metal joist or truss (spacing: ____________________)

❑ Other Metal Decking Systems (insulating concrete and/or rigid insulation or other light coverings)

❑ Poured Gypsum on Formboard Decking on wood or metal joist or truss (spacing: ____________________)

❑ Other: ____

11.1.1 If a Metal Decking System, what is the gage of the metal decking?

❑ Thinner than 22 gage (26 gage, etc.) ❑ 22 gage or thicker (18, 16, etc.) ❑ Not Applicable

YES		**11.2 Does the building have a heavyweight roof system?**
NO	▒	

11.2.1 What is the estimated roof weight? ❑ Heavy weight (50 pounds per square foot or greater)

❑ Lightweight (25 pounds per square foot or less) ❑ Mediumweight (26-49 pounds per square foot)

YES		**11.3 Does the building have a hipped roof system?**
NO	▒	
YES	▒	**11.4 Does the building have a flat roof system?**
NO		

11.5 If not a hipped or flat roof system, what is the roof geometry of the Building?

❑ Gable-ended ❑ Shed System ❑ Other: ____________________

11.5.1 If Gable-ended, are the gable-ends braced against collapse? ❑ Yes ❑ No ❑ Not Applicable

If yes, describe: ____

YES		**11.6 Is the Roof Slope steep-pitched [greater than 30 degrees (7:12)]?**
NO	▒	

11.6.1 What is the roof pitch? ❑ flat slope (0-1 degrees)

❑ shallow slope (2-10 degrees) ❑ moderate slope (11-29 degrees) ❑ steep slope (30+ degrees)

11.7 What is the width of the roof overhang? __________ feet

SECTION 11 - ROOF CONSTRUCTION/ROOF SLOPE

11.8 What type of roof covering is used?

❑ Built-up roofing (○ with gravel; ○ without gravel) ❑ Single-ply membrane with gravel or pavers

❑ Shingles ❑ Standing Seam Metal roof ❑ Tile Roof ❑ Slate Roof ❑ Metal Panels

❑ Single-Ply membrane mechanically fastened or fully adhered ❑ Unknown

❑ Other: ______________________________

11.9 What is the age of the roof covering? ❑ Less than 5 years ❑ 5-10 years

❑ 11-15 years ❑ 16-20 years ❑ Greater than 20 years ❑ Unknown

YES		11.10 Are there structures on the roof top vulnerable to high wind forces?
NO		

11.10.1 What mechanical equipment is on the roof (i.e., air conditioners, ventilators, etc.)?

❑ air conditioners ❑ air handling units ❑ large vents ❑ Not Applicable

❑ Other: ______________________________

11.10.1.1 Is the mechanical equipment on the roof securely fastened to the roof structure? ❑ YES ❑ NO

11.10.2 Are there lightly constructed structures or penthouses on the roof? ❑ YES ❑ NO

Describe: ______________________________

11.10.3 Are there any stacks, antennas or lights on the roof? ❑ YES ❑ NO

Describe: ______________________________

11.11 Comments: ______________________________

SECTION 12 - ROOF OPEN SPAN

YES		**12.1 Does the building have a long or open roof span?** (A long or open span is a roof span of greater than 40 feet between vertical supports.)
NO		

12.1.1 Is there a span greater than 40 feet between vertical supports? ❑ YES ❑ NO

12.1.2 List the areas with span(s) greater than 40 feet: ______________________________

12.1.3 If under a hipped roof system with moderate to steep slope, or a lightweight/medium weight roof system with moderate to steep slopes, is there a span greater than 50 feet between vertical supports?

❑ YES ❑ NO ❑ Not Applicable

12.1.3.1 List the areas with span(s) greater than 50 feet: ______________________________

12.1.4 Comments: ______________________________

____

____

____

SECTION 13 - ROOF DRAINAGE / PONDING INFORMATION

13.1 What is the height of the parapet wall around the roof's perimeter?

❑ Four inches or less ❑ Greater than four inches ❑ No parapet wall

13.2 Are there scuppers in all the parapet walls? ❑ YES ❑ NO ❑ Not Applicable

If some but not all walls, describe which walls have scuppers: ______________________________

13.3 Is there evidence of roof covering degradation or interior water damage on the top floor of the building?

❑ YES ❑ NO Describe: ______________________________

13.4 Is there evidence of ponding on the roof? ❑ YES ❑ NO

13.5 Comments: ______________________________

____

____

____

SECTION 14 - INTERIOR SAFE SPACE

YES		**14.1 Does the building have an interior corridor(s) or interior rooms that could be used as hurricane evacuation shelter space ?**
NO		

14.1.1 What is the square footage of the interior corridor(s) or interior rooms in the building?

_______________ square feet

14.1.2 What is the Interior Corridor Wall Construction type? *(Check only one)*

❑ Reinforced Masonry (Rebar @ 4 ft. centers or closer)

❑ Light Wood or Metal Stud w/ ½ inch or thicker plywood

❑ Partial Reinforced Masonry (Rebar @ 8 ft. centers to 4 ft. centers)

❑ Partial Reinforced Masonry (Four-bar Pilasters 13 feet on center or less))

❑ Unreinforced Masonry or Rebar spacings unknown

❑ Large Panel Glass or other Glazed Panel or Block System

❑ Reinforced Concrete or Precast Concrete Panels

❑ Metal Sheets or Panels or other Light Architectural Panel Systems

❑ Light Wood or Metal Stud w/ light non-plywood sheathing

❑ Not Applicable / No Interior Corridor

❑ Other: _______________

14.1.3 What type of door(s) open onto the interior corridor from inside the building?

❑ Hollow Metal Door, no windows
❑ Wood Door, no windows
❑ Not Applicable
❑ Hollow Metal Door, view window
❑ Wood Door, view window
❑ Metal Door, large window
❑ Wood Door, large window
❑ Glass Door, metal frame
❑ Other: _______________

14.1.4 What type of door(s) open onto the interior corridor from outside the building?

❑ Metal Door, no windows
❑ Wood Door, no windows
❑ Not Applicable
❑ Metal Door, view window
❑ Wood Door, view window
❑ Metal Door, large window
❑ Wood Door, large window
❑ Glass Door, metal frame
❑ None
❑ Other: _______________

14.1.5 Are there drawbolts on the top and bottom of the interior corridor exit doors? ❑ YES ❑ NO

❑ Not Applicable

SECTION 14 - INTERIOR SAFE SPACE

14.1.6 What type of ceiling deck or cap is over the interior corridor? (This is not the drop ceiling but a structural decking that seals off the corridor from the roof system)

❑ Normal-weight Concrete Deck/Slab ❑ Poured Gypsum Decking ❑ Metal Decking

❑ Precast Concrete Slab ❑ Concrete Tees ❑ No corridor decking, just drop ceiling and building roof decking above.

❑ Not Applicable

❑ Other: ______________________________

14.1.7 If there is a ceiling deck or cap, how is it connected to the interior corridor walls?

❑ Gravity loaded ❑ Anchored ❑ Not Applicable

❑ Other: ______________________________

14.1.8 Comments: ______________________________

____

14.2. What is the total floor (footprint) area of the building? ______________ square feet

14.2.1 What is the total floor area available (in the building) for use as shelter area (exclude interior corridors)?

(This is the total square footage of those rooms or areas to be used as shelter areas); __________ square feet.

14.2.2 Excluding walking area and areas with immoveable furniture, how much of the shelter floor area is actually usable for personal shelter space? (Note: show shelter space on building sketch maps)

As-Is: ______________ square feet

Additional Area After Minor Retrofit: ______________ square feet

Additional Area After Major Retrofit: ______________ square feet

14.2.3 Comments: ______________________________

____

SECTION 15 - LIFE SAFETY/EMERGENCY POWER

YES		**15.1 At the time of the survey, is the building known to be noncompliant with any life safety or fire codes?**
NO		
Unknown		

15.1.1 If yes, describe area(s) of non-compliance: ____________________

____

YES		**15.2 Is there a survivable on-site emergency power system?**
NO		

15.2.1 Is there an emergency power supply generator on-site? ❑ YES ❑ NO (If **No**, go to section 15.2.13)

15.2.2 If yes, what are its ratings? ❑ Not Applicable

_______ KW, _______ Amperes, ____/____ Volts; ❑ Single Phase ❑ Three Phase

❑ Three-Wire ❑ Four-Wire Configuration; Brand Name: ____________

15.2.3 Is the generator storm hazard protected? ❑ YES ❑ NO ❑ Not Applicable

Describe: ____________

15.2.4 Is the generator securely anchored? ❑ YES ❑ NO ❑ Portable Generator ❑ Not Applicable

Describe: ____________

15.2.5 Is the generator regularly maintained? ❑ YES ❑ NO ❑ Unknown ❑ Not Applicable

Describe: ____________

15.2.6 What is the fuel type of the generator? ❑ Not Applicable ❑ Gasoline ❑ Diesel ❑ LP

❑ Natural Gas ❑ Other: ____________

15.2.7 What is the on-site fuel storage capacity (size of tank)? _______ gallons; ❑ Not Applicable

15.2.8 What is the type of fuel tank? ❑ Not Applicable ❑ Above ground ❑ Below ground

❑ Portable ❑ Anchored/Fixed ❑ Heavy Steel ❑ Concrete ❑ Lightweight metal

❑ Other: ____________

15.2.9 Is the fuel tank storm hazard protected? ❑ YES ❑ NO ❑ Not Applicable

Describe: ____________

15.2.10 What building(s) are connected to the emergency power generator system? ❑ Not Applicable

❑ All on-site ❑ Specify: ____________

SECTION 15 - LIFE SAFETY/EMERGENCY POWER

15.2.11 What load(s) are connected to the emergency power generator system? ❑ Not Applicable

❑ Safety lights ❑ Exit lights ❑ Freezers ❑ Well pumps ❑ Fire Alarms

❑ Security Alarms ❑ Emergency Lighting ❑ Lift Station(s) ❑ Kitchen Equipment

❑ Other(s): ______________________________

15.2.12 Comments: ______________________________

____

15.2.13 Is the building pre-wired for connection to a portable generator? ❑ YES ❑ NO

________ KW, _____/_____ Voltage, _____ Phase, _____ Wire Configuration

SECTION 15 - LIFE SAFETY/EMERGENCY POWER

15.2.14 Comment: ________________________________

SECTION 0 - IDENTIFICATION

0.1 Facility Name: ____________________

Building ID #: ____________________

Street Address: ____________________

City: ____________________

State, Zip+4: ____________________

0.2 Latitude: ____________________

Longitude: ____________________

0.3 County: ____________________

0.4 Owner: ____________________ Public ❑ Private ❑

0.5 Facility Type: ○ vital - ○ shelter - ○ utility

○ other ____________________

0.6 Contact: ____________________

Title: ____________________

Phone: ____________________

Alt. Phone: ____________________

Alternate 1: ____________________

Title: ____________________

Phone: ____________________

Alt. Phone: ____________________

Alternate 2: ____________________

Title: ____________________

Phone: ____________________

Alt. Phone: ____________________

SECTION 16 - SITE INFRASTRUCTURE (OPTIONAL)

YES		**16.1 Is there a survivable on-site potable (i.e., bottled or drinkable) water supply?**
NO		

16.1.1 What is the primary on-site **potable** water source?

❑ Public Utility ❑ On-site Well ❑ Other ____________________

16.1.2 What are the secondary on-site **potable** water sources? ❑ None

❑ On-site Water Tank (__________ Gals.) ❑ Other ____________________

16.1.3 What are the on-site **<u>non</u>-potable** water sources? ❑ None

❑ Irrigation Well ❑ Swimming Pool ❑ Other ____________________

YES		**16.2 Is there a survivable on-site septic/sanitary sewage system?**
NO		

16.2.1 What is the on-site sanitary sewage system? ❑ Public Utility ❑ Wastewater Treatment Plant

❑ Septic Tank ❑ Other ____________________

SECTION 16 - SITE INFRASTRUCTURE (OPTIONAL)

16.2.2 What are the potential secondary sanitary sewage systems on-site? ❑ None ❑ Abandoned Septic Tank

❑ Portable Units ❑ Other ____________________

16.3 Comments: ____________________

____

SECTION 17 - MASS CARE CHARACTERISTICS (OPTIONAL)

17.1 What type of food preparation capability does the building have? ❑ None ❑ Full Kitchen

❑ Warming Oven Kitchen ❑ Other: ____________________

17.2 What types of equipment are available in the kitchen?

❑ Refrigerator(s) #______ Size(s): ____________________

❑ Walk-in Refrigerator(s) #______ Size(s): ____________________

❑ Freezer(s) # ______ Size(s): ____________________

❑ Walk-in Freezers(s) #______ Size(s): ____________________

❑ Burner(s) #_____ Fuel Type(s): ○ Electric; ○ Nat. Gas; ○ LP Gas; ○ Other: ____________

❑ Griddle(s) #_____ Fuel Type(s): ○ Electric; ○ Nat. Gas; ○ LP Gas; ○ Other: ____________

❑ Oven(s) #_____ Fuel Type(s): ○ Electric; ○ Nat. Gas; ○ LP Gas; ○ Other: ____________

❑ Convection Oven(s) #____ Fuel Type(s): ○ Electric; ○ Nat. Gas; ○ LP Gas; ○ Other: ____________

❑ Microwave Oven(s) #_____ Size(s): ____________________

❑ Tilting Fryer(s) #____ Fuel Type(s): ○ Electric; ○ Nat. Gas; ○ LP Gas; ○ Other: ____________

❑ Icemaker #_________ Size(s): ____________________

❑ Steamer Oven(s) #____ Fuel Type(s): ○ Electric; ○ Nat. Gas; ○ LP Gas; ○ Other: ____________

❑ Vertical Warmer(s) #____ Fuel Type(s): ○ Electric; ○ Nat. Gas; ○ LP Gas; ○ Other:____________

❑ Other: ____________________

17.3 How many servings can the kitchen handle per meal? #____________

17.4 Is there a cafeteria in the building? ❑ YES ❑ NO (If yes, shelter usable square footage : ________)

SECTION 17 - MASS CARE CHARACTERISTICS (OPTIONAL)

17.5 Is there a Snack Bar in the building? ❑ YES ❑ NO (If yes, shelter usable square footage: ________)

17.6 Comments: ____

____

____

17.7 What are the total number of toilets available inside the building? #____________

17.7.1 Toilets: # **Male** ___ (# handicap: ___); # **Female** ___ (# handicap: ___); # **Unisex** ____ (# handicap: ___)

17.7.2 Wash Basins: # **Male** _____; # **Female** ____; # **Unisex** _____;

17.7.3 Showers: # Male _____ # Female ______

17.7.4 Comments: ____

____

17.8 Health Care: #____________ rooms Total square footage: ____________ #__________ beds

17.9 What are the size(s) and number of paved/unpaved parking lots on-site?

❑ Paved #_______ lots, # cars: _______; ❑ Unpaved #_____ lots, # cars: ______;

17.10 Comments: ____

____

____

SECTION 18 - COMMUNICATIONS (OPTIONAL)

YES		**18.1 Does the building have an emergency communications capability?**
NO		

18.1.1 Does the building have land line telephone(s)? ❑ YES ❑ NO

18.1.2 Does the building have any land line telephone(s) that will continue to function even after electrical power is lost (i.e., an emergency telephone line)? ❑ YES ❑ NO

SECTION 18 - COMMUNICATIONS (OPTIONAL)
18.1.3 What weather warning communications capabilities are available to the building? ❑ NOAA weather alert radio; ❑ Weather Channel(s) - Cable; ❑ Commercial Radio Broadcasts; ❑ Short-Wave Radio; ❑ Local Emergency Management Radio Broadcasts; ❑ Other: ______
18.1.4 Does the building have an intercom system? ❑ YES (○ One-Way; ○ Two-Way); ❑ NO
18.1.5 If yes, does the intercom work when electric power is lost? ❑ YES ❑ NO
18.1.6 Comments: ______

18.2 INFORMATION PROVIDED BY:	
Name:	Title:
Address:	Phone:
City, State Zip:	Fax:

Appendix C:

ARC 4496 - Guidelines for Hurricane

Evacuation Shelter Selection

Guidelines for Hurricane Evacuation Shelter Selection

The following guidelines, prepared by an interagency group, reflect the application of technical data compiled in Hurricane Evacuation Studies, other hazard information, and research findings related to wind loads and structural problems. These guidelines are intended to supplement information contained in ARC 3031, *Mass Care: Preparedness and Operations*, concerning shelter selection for hurricane evacuation situations.

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Planning considerations for hurricane evacuation shelters involve a number of factors and require close coordination with local officials responsible for public safety. Technical information contained in Hurricane Evacuation Studies, storm surge and flood mapping, and other data can now be used to make informed decisions about the suitability of shelters.

In the experience of the American Red Cross, the majority of people evacuating because of a hurricane threat generally provide for themselves or stay with friends and relatives. However, for those who do seek public shelter, **safety from the hazards associated with hurricanes must be assured.** These hazards include—

- Surge inundation.
- Rainfall flooding.
- High winds.
- Hazardous materials.

Recommended guidelines follow for each of these hurricane-associated hazards.

Surge Inundation Areas

In general, hurricane evacuation shelters should not be located in areas vulnerable to hurricane surge inundation. The National Weather Service has developed mathematical models, such as Sea, Lake, and Overland Surges from Hurricanes (SLOSH) and Special Program to List Amplitudes of Surges from Hurricanes (SPLASH), that are critical in determining the potential level of surge inundation in a given area.

- Carefully review inundation maps in order to locate all hurricane evacuation shelters outside Category 4 storm surge inundation zones.
- Avoid buildings subject to isolation by surge inundation in favor of equally suitable buildings not subject to isolation. Confirm that ground elevations for all potential shelter facilities and access routes obtained from topographic maps are accurate.
- Do not locate hurricane evacuation shelters on barrier islands.

Rainfall Flooding

Rainfall flooding must be considered in the hurricane evacuation shelter selection process. Riverine inundation areas shown on Flood Insurance Rate Maps (FIRMs), as prepared by the National Flood Insurance Program, should be reviewed. FIRMs should also be reviewed in locating shelters in inland counties.

- Locate hurricane evacuation shelters outside the 100-year floodplain.
- Avoid selecting hurricane evacuation shelters located within the 500-year floodplain.
- Do not locate hurricane evacuation shelters in areas likely to be isolated due to riverine inundation of roadways.
- Make sure a hurricane evacuation shelter's first floor elevation is on an equal or higher elevation than that of the base flood elevation level for the FIRM area.
- Consider the proximity of shelters to any dams and reservoirs to assess flow upon failure of containment following hurricane-related flooding.

Wind Hazards

Consideration of any facility for use as a hurricane evacuation shelter must take into account wind hazards. Both design and construction problems may preclude a facility from being used as a shelter. Local building codes are frequently inadequate for higher wind speeds.

Structural Considerations

- If possible, select buildings that a structural engineer has certified as being capable of withstanding wind loads according to ASCE (American Society of Engineers) 7-88 or ANSI (American National Standards Institute) A58 (1982) structural design criteria. Buildings must be in compliance with all local building and fire codes.
- Failing a certification (see above), request a structural engineer to rank the proposed hurricane evacuation shelters based on his or her knowledge and the criteria contained in these guidelines.
- Avoid uncertified buildings of the following types:
  - Buildings with long or open roof spans
  - Un-reinforced masonry buildings
  - Pre-engineered (steel pre-fabricated) buildings built before the mid-1980s
  - Buildings that will be exposed to the full force of hurricane winds
  - Buildings with flat or lightweight roofs
- Give preference to the following:
  - Buildings with steep-pitched, hipped roofs; or with heavy concrete roofs

- Buildings more than one story high (if lower stories are used for shelter)
- Buildings in sheltered areas
- Buildings whose access routes are not tree-lined

Interior Building Safety Criteria During Hurricane Conditions

Based on storm data (e.g., arrival of gale-force winds), determine a notification procedure with local emergency managers regarding when to move the shelter population to pre-determined safer areas within the facility. Consider the following guidelines:

- Do not use rooms attached to, or immediately adjacent to, un-reinforced masonry walls or buildings.
- Do not use gymnasiums, auditoriums, or other large open areas with long roof spans during hurricane conditions.
- Avoid areas near glass, unless the glass surface is protected by an adequate shutter. Assume that windows and roof will be damaged and plan accordingly.
- Use interior corridors or rooms.
- In multi-story buildings, use only the lower floors and avoid corner rooms.
- Avoid any wall section that has portable or modular classrooms in close proximity, if these are used in your community.
- Avoid basements if there is any chance of flooding.

Hazardous Materials

The possible impact from a spill or release of hazardous materials should be taken into account when considering any potential hurricane evacuation shelter.

All facilities manufacturing, using, or storing hazardous materials (in reportable quantities) are required to submit Material Safety Data Sheets (emergency and hazardous chemical inventory forms) to the Local Emergency Planning Committee (LEPC) and the local fire department. These sources can assist you in determining the suitability of a potential hurricane evacuation shelter or determining precautionary zones (safe distances) for facilities near potential shelters that manufacture, use, or store hazardous materials.

- Facilities that store certain types or quantities of hazardous materials may be inappropriate for use as hurricane evacuation shelters.
- Hurricane evacuation shelters should not be located within the ten-mile emergency planning zone (EPZ) of a nuclear power plant.
- Service delivery units must work with local emergency management officials to determine if hazardous materials present a concern for potential hurricane evacuation shelters.

Hurricane Evacuation Shelter Selection Process

General procedures for investigating the suitability of a building or facility for use as a hurricane evacuation shelter are as follows:

- Identify potential sites. Evacuation and transportation route models must be considered.
- Complete a risk assessment on each potential site. Gather all pertinent data from SLOSH and/or SPLASH (storm surge), FIRM (flood hazard), facility base elevation, hazardous materials information, and previous studies concerning each building's suitability.
- Inspect the facility and complete a *Red Cross Facility Survey Form* and a *Self-Inspection Work Sheet / Off-Premises Liability Checklist*, in accordance with ARC 3031. Note all potential liabilities and the type of construction. Consider the facility as a whole—one weak section may seriously jeopardize the integrity of the building.
- Have the building certified as being capable of withstanding the wind loads according to ASCE 7-88 or ANSI A58 (1982) structural design criteria. In the absence of certification, have a structural engineer review the facility and rate its suitability to the best of his or her ability.
- Ensure that an exhaustive search for shelter space has been completed. Work with local emergency management officials and others to identify additional potential sites.
- Review, on a regular basis, all approved hurricane evacuation shelters. Facility improvements, additions, or deterioration may change the suitability of a selected facility as a hurricane evacuation shelter. Facility enhancements may also enable previously rejected facilities to be used as hurricane evacuation shelters.
- If possible, work with officials, facility managers, and school districts on mitigation opportunities. Continue to advocate that the building program for new public buildings, such as schools,

should include provisions to make them more resilient to possible wind damage. It may also be possible to suggest a minor modification of a municipal, community, or school building in the planning stages to make for a more useful hurricane evacuation shelter site, such as the addition of hurricane shutters.

Least-Risk Decision Making

Safety is the primary consideration for the American Red Cross in providing hurricane evacuation shelters. When anticipated demands for hurricane evacuation shelter spaces exceed suitable capacity as defined by the preceding criteria, there may be a need to utilize marginal facilities. It is therefore critical that these decisions be made carefully and in consultation with local emergency management and public safety officials. Guidance should be obtained from Disaster Services at national headquarters, in consultation with the Risk Management Division.

This process should include the following considerations:

- No hurricane evacuation shelter should be located in an evacuation zone for obvious safety reasons. All hurricane evacuation shelters should be located outside of Category 4 storm surge inundation zones. **Certain exceptions may be necessary, but only if there is a high degree of confidence that the level of wind, rain, and surge activities will not surpass established shelter safety margins.**
- When a potential hurricane evacuation shelter is located in a flood zone, it is important to consider its viability. By comparing elevations of sites with FIRMs, one can determine if the shelter and a major means of egress are in any danger of flooding. Zone AH (within the 100-year flood plain and puddling of 1–3 feet expected) necessitates a closer look at the use of a particular facility as a sheltering location. Zones B, C, and D may allow some flexibility. **It is essential that elevations be carefully checked to avoid unnecessary problems.**
- In the absence of certification by a structural engineer, any building selected for use as a hurricane evacuation shelter must be in compliance with all local building and fire codes. Certain exceptions may be necessary, but only after evaluation of each facility, using the aforementioned building safety criteria.
- The Red Cross uses the planning guideline of 40 square feet of space per shelter resident. During hurricane conditions, on a short-term basis, shelter space requirements may be reduced. Ideally, this requirement should be determined using no less than 20 square feet per person. Adequate space must be set aside for registration, health services, and safety and fire considerations. Disaster Health Services areas should still be planned using a 40 square feet per person calculation. On a **long-term recovery basis**, shelter space requirements should follow guidelines established in ARC 3031, *Mass Care: Preparedness and Operations.*

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ARC 4496
July 1992

Appendix D:
Blank Least-Risk Decision Making Table

Least-Risk Decision Making: ARC 4496 Guideline Compliance Summary			
Survey Date: ______________		County: ______________	
Facility Name: ______________		Address: ______________	
City: ______________	State: ______	Zip Code: ________ + ______	
Coordinates: Latitude ______________		Longitude ______________	
CRITERIA	**PREFERRED**	**MARGINAL**	**NON-COMPLIANT**
1. Storm Surge Inundation			
2. Rainfall Flooding / Dam Considerations			
3. Hazmat and Nuclear Power Plant Considerations			
4. Lay-down Hazard Exposure			
5. Wind and Debris Exposure			
6. Wind Design Verification			

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
7. Construction Type / Loadpath Verification			
8. Building Condition / Wind Damage History			
9. Exterior Wall Construction			
10. Fenestrations / Window Protection			
11. Roof Construction / Roof Slope			
12. Roof Open Span			
13. Roof Drainage / Ponding			
14. Interior Safe Space			
15. Life Safety / Emergency Power			

Appendix E:
Roof Construction Material Weights

Appendix E: Roofing Material Weights

These weights are based on the best available data. Variations in weight exist from one section of the country to another, as they do from one manufacturer to another. When the building plans and specifications show a particular manufacturer's product, the manufacturer's weights should be obtained and used.

Material	Weight (P.S.F.)
Acoustical Tile	
Applied directly with mastic to ceiling	1/2
Attached to rock lath and furring channels	4-1/2
Attached to wood furring strips	2-1/2
Asbestos	
Board, 3/16"	2
Corrugated	4
Asphalt Bituminous Paving	
"Black Top", 1"	12
Brick	
4" Common	40
Built-up Roofing	
3 Ply felt composition, no gravel	3
5 Ply felt composition, no gravel	4
3 Ply felt and gravel	5-1/2
5 Ply felt and gravel	6-1/2
Ceramic Tile	
5/16" Mosaic Floor Tile	2-1/2
with 1" mortar bed	11-1/2
Paver Tile	
3/8" thick	4
1/2" thick	6

Material	Weight (P.S.F.)
Ceramic Tile (cont'd)	
Quarry Tile	
1/2" thick	6
3/4" thick	8-1/2
Concrete, Lightweight	
Aerocrete, 1"	4 to 6-1/2
Haydite, 1"	7 to 8-1/2
Nailcode, 1"	6-1/4
Perlite, 1"	3 to 4
Pumice, 1"	5 to 7-1/2
Vermiculite, 1"	2 to 5
Concrete and Hollow Clay Tile Floor System (One-Way Concrete Joists)	
16" inch wide tile and 4" inch wide concrete joists	
4" deep with 2" topping	52
5" deep with 2" topping	56
6" deep with 2" topping	62
7" deep with 2" topping	67
8" deep with 2" topping	71
9" deep with 2" topping	75
10" deep with 2" topping	79
Fiber Board	
1/2" thick	1
Fiber Sheathing	
1/2" thick	1
Glass	
1/4" Plate	3-1/2
1/2" Plate	6-1/2

Material	Weight (P.S.F.)
Glass (cont'd)	
Window	1
Block	18-20
Gypsum	
Block	
2" Solid	11-1/2
3" Hollow	10 to 12
4" Hollow	13 to 15-1/2
6" Hollow	17 to 22
Gypsum, 1" plain, in mineral form	4
Pour gypsum on steel rails per inch of thickness	5
Roof planks - 2" thick	12
Insulation	
Bats, blankets, 1"	1/2
Cork board, 1"	1/2
Fiber glass	1-1/2
Foam glass	1
Rigid insulation boards	1-1/2
Metals	
Plate steel, 1"	41
Corrugated steel sheets, 20 guage	2
Steel panels, 18 guage	3
Lead	
1"	59
1/2"	29
1/4"	14
Movable steel office panels	5
Steel decks (without insulation or finish)	2 to 20-1/2

Material	Weight (P.S.F.)
Mortar	
1" thick	9
Plaster	
plaster, portland cement, sand, 1" thick	8
plaster directly applied, 3/4" thick	6
plaster on fiber lath, 1/2" thick	5
plaster on gypsum lath, 1/2" thick	6
plaster on metal lath, 3/4" thick	6
plaster on wood lath, 3/4" thick	5
plaster on suspended channels and metal lath, 1" thick	10
Stucco, 1"	11
7/8" stucco on metal lath	10
3/4" stucco on wood lath	9
Precast Cementitiuous-Fiber Planks/Panels	3
Precast Concrete Planks	
Doxplank	
4" thick	20
with 1-5/8 inch concrete topping	40
6" thick	35
with 1-5/8 inch concrete topping	55
8" thick	45
with 2" inch concrete topping	69
10" thick	55
with 2" inch concrete topping	79
Spancrete	
4" thick	30
6" thick	45
8" thick	60
10" thick	75
12" thick	90

Material	Weight (P.S.F.)
Flexicore	
Standard weight	
6" thick	45
with 2" concrete topping	70
8" thick	53
with 2" concrete topping	78
12" thick	68
with 2-1/2" concrete topping	100
Light weight	
6" thick	35
with 2" concrete topping	60
8" thick	43
with 2" concrete topping	68
12" thick concrete topping	87

Shingles

Asbestos, 5/32"	2
Asphalt strip shingles	3
Tile, cement flat	13
Tile, cement ribbed	16
Tile, clay mission	13-1/2
Tile, clay shingle type	8 to 16
Wood	2-1/2

Slate

3/16"	7
1/4"	9-1/2

Soils

Clay and gravel, 1"	8-1/2
Earth, dry and loose, 1"	6
Earth, dry and packed, 1"	8
Sand or gravel, dry and loose, 1"	7

Material	Weight (P.S.F.)
Stone Masonry	
Cast stone, 1 "	12
Granite ashler, limestone, marble, 1 inch	13
Sandstone, 1"	11
Terrazzo	
1"	13
1-1/2" on 1" mortar bed	28-1/2 to 30
1" on 2"	38
Wood	
3" creosoted blocks on motar 1/2" mortar bed	21
2" creosoted blocks on motar 1/2" mortar base	18
3" creosoted blocks on motar 1/8" mastic bed	12
2" creosoted blocks on motar 1/8" mastic bed	9
25/32" hardwood floor	3
3/4" sheathing, yellow pine	3-1/2
3/4" sheathing & sub-flooring, spruce, hemlock, fir	2-1/2
7/8" sheathing, white pine	2-1/2
Siding	
6" bevel	1
8" bevel	1-1/2
Shingles	
6-1/2" to weather	1
Plywood	
5/16" finished	1
1/2" finished	1-1/2
3/8" sheathing	1

Appendix F:

Abbreviations

Appendix F: Abbreviations

ACI - American Concrete Institute

ADA - Americans with Disabilities Act

ANSI - American National Standards Institute

APA - American Plywood Association

ARC - American Red Cross

ASCE - American Society of Civil Engineers

ASL - Above Sea Level

BFE - Base Flood Elevation

BUR - Built-Up Roofing

CMU - Concrete Masonry Unit

DCA - Department of Community Affairs

DEM - Division of Emergency Management

DOE - Department of Education

EIFS - Exterior Insulation and Finish System

EPCRA - the Emergency Planning and Community Right-to-Know Act

EPZ - Emergency Planning Zone

FAC - Florida Administrative Code

FEMA - Federal Emergency Management Agency

FHBM - Flood Hazard Boundary Map

FIRM - Flood Insurance Rate Map

FS - Florida Statutes

Hazmat - Hazardous Material

HES - Hurricane Evacuation Shelter

HVAC - Heating, Ventilation and Air Conditioning (equipment or system)

IIPLR - Insurance Institute for Property Loss Reduction

KW - Kilowatt

LEPC - Local Emergency Planning Committee

LRDM - Least Risk Decision Making

LP - Liquid Propane

MBMA - Metal Building Manufacturers Association

MCB - Main Circuit Breaker

MLO - Main Lugs Only

MSE - Maximum Surge Elevation

MSL - Mean Sea Level

MWFRS - Main Wind Force Resisting System

NBC - National Building Code

NCMA - National Concrete Masonry Association

NEMA - National Electrical Manufacturers Association

NFIP - National Flood Insurance Program

NGVD - National Geodetic Vertical Datum

NPP - Nuclear Power Plant

OSB - Oriented Strand Board

OWSJ - Open Web Steel Joist

PC - Precast Concrete (Structural Elements)

PCF - Precast Cementitious-Fiber (Planks or Panels)

PEMB - Pre-engineered Metal Building

SBC - Standard Building Code

SBCCI - Southern Building Code Congress International

SFBC - South Florida Building Code

SLOSH - Sea, Lake and Overland Surges from Hurricanes

SSTD - Standard (reference from SBCCI)

SREF - State Requirements for Educational Facilities

T&G - Tongue and Groove (wood board connection)

UBC - Uniform Building Code

USGS - United States Geological Survey

VZ - Vulnerability Zone

Appendix G:

Definitions

Appendix G: Definitions

Access Route - For the purposes of HES evaluations the access route is defined as a route along paved roads from the HES building to a major highway or interstate, or a resupply point (i.e., airport, train station, etc.), or to an evacuation point (airport, staging area, etc.).

Base Flood Elevation (BFE) - The elevation for an area, for which there is a one percent chance in any given year that flood levels will equal or exceed it.

Beam - A structural member whose primary function is to carry (or transfer) vertical loads horizontally to load-bearing columns or walls.

Benchmark Elevations - An elevation indicating additional elevation from a base elevation. On a site plan it may indicate an elevation of 30 feet, but it is 30 feet from a standard elevation.

Rigid Frame Bent (or Tudor Arch) - A combination of two structural elements (beam and column) with tapered sections (variable cross-section) that are connected in a manner that permits them to react monolithically within their design parameters. This type of system is common in preengineered long span structures.

Bond Beam - A concrete beam, usually cast-in-place, with steel reinforcement that is designed and constructed to join a wall to floor or roof to facilitate the transfer of all loads and load combinations.

Bottom Chord - Under normal loading conditions, the main tension member of a truss or joist that is positioned at the lowest elevation with respect to the members section.

Bracing - Structural elements installed to provide restraint or support (or both) to other members or structural systems so that the complete assembly forms a stable structure; may consist of knee braces, cables, rods, struts, ties, shores, diaphragms, rigid frames, etc.

Bridging - Consists of cross bracing (wood or metal) or full-depth blocking between joists that is used to stiffen the joists and resist buckling.

Brick Veneer - A facing of brick that is a single wythe in thickness (3" to 4") that is anchored or adhered to a structural backing, but not designed to carry loads other than its own weight.

Building Envelope - The external surface components that together fully enclose a building; such as walls, windows, doors, roof, floor, etc.

Built-up Roofing - A continuous roof covering made up of laminations or plies of bitumen (asphalt or coal-tar pitch) saturated or coated roofing felts, alternated with layers of bitumen as an adhesive, and surfaced with a layer of gravel or slag in a heavy coat of bitumen or finished with a cap sheet, generally used on flat- or low-pitched roofs.

Cantilever Wall - A wall that is supported/connected only at one end. For example, an exterior wall may be anchored at the base, but not at the roof line.

Cavity Wall - A hollow wall built of masonry units arranged to provide a continuous air space within the wall (with or without insulation) and in which the inner and outer wythes of the wall are tied together.

Cladding - Architectural sheathing materials used as a noncombustible weather barrier and aesthetic Elements that are either directly loaded by wind forces or receive wind loads originating at relatively close locations and that transfer these loads to the main wind force-resisting system.

Clerestory - An upper zone of wall pierced with windows that admit light to the center of a lofty room.

Column - In structures, a relatively tall, slender structural member that transfers axial vertical compression loads to a building's foundation.

Concrete Masonry Unit (CMU) - A block or brick cast of Portland cement and suitable aggregate, with or without admixtures (additives), and intended for laying up with other units, as in normal stone masonry construction.

Critical Facility - A "structure" from which essential services and functions for victim survival, continuation of public safety actions, and disaster recovery are performed or provided. Examples include: hospitals, police stations, fire/rescue stations, potable water liftstations, sewage treatment plant etc.

Curtain Wall - An exterior nonload-bearing wall, typically constructed of glass, metal, or other material, that forms a barrier between the interior of the building and the external environment.

Diaphragm - Structural member(s) usually seen as some type of decking (i.e., roof or floor decking), primarily used for lateral stability of horizontal structural components. Diaphragms are used to transfer lateral forces from walls facing winds to walls/frame members that are oriented perpendicular to the winds, thus providing lateral support.

Drain (roof drain) - Piping or conduit used to channel water runoff from a roof to a desired discharge point. Drains may be found at the roof perimeter or at relatively low spots in the field of a flat roof.

Dry Floodproofing - A floodproofing method that uses a structure's modified exterior walls (in concert with flood shields, closures, sealants, and membranes), as the water-resistant barrier during a flood event.

Egress - a path or opening for going out, an exit.

Expansion Joint - A joint between adjacent parts of a building, structure, or concrete work that permits relative movement due to temperature changes (or other conditions) without rupture or damage.

Exiting Hurricane - A hurricane leaving land and heading out to sea.

Exterior Insulation and Finish System (EIFS) - A lightweight exterior wall cladding system commonly installed on low and mid-rise commercial and multi-unit residential buildings. EIFS construction typically is composed of sheathing (e.g., gypsum board) attached to structural wall framing (e.g., steel -studs), over which rigid insulation boards are glued or mechanically fastened and a weather membrane applied to the exterior surface.

Felt - A fabric composed of matted, compressed fibers, usually manufactured from the cellulose fiber found in wood, paper, rags, from asbestos or glass fibers.

Fenestration - An opening in the surface of a structure.

Fiberboard - A building material, usually composed of wood fiber or cane or other vegetable fiber, compressed with a binder into a sheet form.

Fire Wall - An interior or exterior wall having sufficiently high fire resistance and structural stability under conditions of fire. Its primary function is to restrict the spread of a fire to adjoining areas or buildings. It usually extends from the lowest floor level to about three feet above the roof and has all openings protected by self-closing fire doors or fire shutters.

Flat roof - Any roof with a slope of approximately one degree (1/4-inch pitch).

Floodproofing - Any combination of structural and non-structural additions, changes, or adjustments to properties and structures that reduce or eliminate flood damage to lands, water and sanitary facilities, structures, and building contents.

Floodshield - Permanent or temporary closures and assemblies that serve as structural barriers to resist all flood-induced loads that act on their surface(s) to include hydrostatic (pressure exerted by nonmoving water), hydrodynamic (pressures exerted by moving water), and impact loads (loads induced from collision by floating debris).

Frame (Structural) - A combination of beams and columns mechanically connected (bolted or welds for steel or precast or monolithic poured concrete) such that the final structure is able to support all vertical live and dead loads of roof, as well as floors (if multistory), without necessitating the use of load-bearing walls. The frame may or may not have significant lateral-force resistance.

Gable-end Roof System - A ridged roof system that has triangular wall sections at the ends.

Generator - A machine that converts mechanical energy into electrical energy.

Generator PreWiring system - See Prewiring.

Generator Ready - Generic term used to express the modification of a facility's electrical system to simplify and expedite connection with a compatible alternate power supply or generator.

Global Positioning System - A satellite-supported digital plotting used for rapidly determining longitude and latitude at a given point.

Hip (connection) - The external angle formed by the meeting of two sloping sides of a roof. See Hip-Roof System.

Hip-Roof System - Roof system that slopes up toward a ridge from all sides (similar to a pyramid), requiring a hip at each corner.

Host Shelter - A facility that is relatively safe and provides essential support services. Facilities are designated as Host Shelters when they are located in an area that is outside the projected path of an approaching hurricane or severe storm. As local conditions are not expected to present hazards such as surge inundation, rainfall flooding, high winds, or hazardous materials which exceed the building codes of the facilities in use, shelter selection guidelines in ARC 4496 do not have to be considered. The shelter population may include evacuees who flee from the threat of a hurricane or severe storm in their home counties. For planning purposes, the operational period of a Host Shelter is from 24 hours prior to landfall until 72 hours after landfall of a hurricane or severe storm. A total of 20 square feet of usable floor space per person is recommended in the calculation of shelter capacity.

Hurricane Evacuation Shelter (HES) - A building or facility that conforms to the hurricane evacuation guidelines in ARC 4496, and is intended to shelter persons in the path of a major storm or hurricane. The designation does not imply that a facility is capable of affording complete protection or is free from hazards but only that it meets established safety criteria. See also Storm Shelter and Risk Shelter.

Infill Wall - A nonload-bearing wall used to fill the spaces within the plane of a structural frame; provides additional thermal insulation, fire resistance, and in some cases, stiffness (bracing).

Infrastructure - The basic facilities, equipment, and installations necessary for functioning of a system, building, or community.

Inundation - The submersion of land, buildings, and infrastructure by flood waters.

Joint Reinforcement - Wire gauge steel reinforcement laid horizontally between courses of masonry to resist excessive vertical cracking or joint separation during foundation settlement. This reinforcement is typically "Ladder" or "Z-truss" shaped and serves only as a tension member within the wall plane. It does not provide significant flexural strength to loads perpendicular to the wall plane (i.e., wind loads).

Joist - One of a series of parallel beams of timber, reinforced concrete, or steel used to support floor and roof loads, and supported in turn by larger beams, girders, or bearing walls.

Kilowatt (KW) - Unit of electrical power equal to 1,000 watts.

Landfalling Hurricane - A hurricane that is coming to land from the sea.

Leeward Wall - The wall of a building that is on the side of the building opposite the building side that is being directly impacted by the wind. The wall on the side of the building not exposed to the wind or prevailing winds.

Lightweight roofs - Roof systems of relatively light construction, to include wood board, plywood, fiberboard, precast cementitious fiber planks, and metal decking on wood or metal truss/joists. Typically the dead weight of these roof systems will not exceed the basic wind uplift-loading requirements of local building codes (25 psf +/-).

Load-Bearing Wall - A wall that supports any vertical loads of the building or structure in addition to its own weight.

Load Path - The structural element or combination of elements that form a continuous path for the transfer or distribution of loads to the building's foundation.

Long Span - See Open Span.

Main Wind Force Resisting System (MWFRS) - An assemblage of major structural elements designed to provide support (lateral stability, uplift resistance, etc.) for secondary members and cladding. The system typically receives wind loading from more than one direction.

Major Retrofit - A retrofit effort or project that requires major modifications to include demolition to parts or all of a building's structure.

Maximum Surge Elevation - The maximum depth of inundation for an area, as predicted by the SLOSH modeling method, for a worst-case scenario event -- typically a Category 4 hurricane.

Metal Deck - Structural system of light-gage steel or metal panels, usually 18 to 26 gage, used for roof or floor deck, or as a structural form in which other materials (i.e., concrete or composition roofing) and building live loads are supported.

Miami-Style Windows - Multipane windows that when fully open create 45 degree angles with respect to each window's vertical plane.

Minor Retrofit - A retrofit effort or project that does not require significant demolition. Some examples are shuttering windows, bracing roof trusses, and other minor modifications to a building's existing structure.

Mitigation - Actions taken to prevent or reduce the risk to life, property, social, economic activities, and natural resources from natural or technological hazards.

Moment Resistant - The inherent ability of a structural system (i.e., beam-to-column connection) to resist movement or rotation (bending or racking) within the plane of the frame.

Nonload-Bearing Wall - A wall that supports no vertical loads other than it's own weight.

Open Area - An area generally of flat and open terrain extending for a ½ mile or more.

Open Side - A side of a structure where less than 50 percent of its exterior wall is capable of resisting lateral shear forces.

Open Span - An area in a structure where the clear distance between supporting elements (beams, columns, etc.), in the shortest direction, is 40 feet or more.

Paralleling Hurricane - A hurricane paralleling the coastline without entering or exiting.

Parapet - Low guarding wall at any point of sudden drop, as at the edge of a terrace, roof, battlement, or balcony.

Ponding - The rapid accumulation of water on a flat roof contained by parapets walls with insufficient scuppers/drains.

Partially Reinforced Concrete Masonry - Wall masonry construction that is designed as plain (unreinforced) masonry, except that vertical reinforcement is provided in some portions to provide flexual support. Vertical rebar will be spaced no more than eight feet apart, with vertical bars at wall corners, wall intersections, and on each side of window and door openings. Horizontal reinforcing must be present at roof and floor levels and above and below window or door openings. Masonry construction of this type will conform to the design criteria of NCMA TEK

63 (1975).

Pilaster - The reinforced portion of a wall that may serve as either a vertical beam or a column, or both. In masonry construction, the pilasters may or may not project beyond either face of the wall.

Precast Concrete (PC) - Cement or concrete unit with or without steel reinforcement that is cast in the form of a structural element before being placed in its final position. Precast concrete shapes may include girders and beams, spandrels, planks, "Tees" and "double Tee's," tilt-up walls.

Precast Cement-Fiber Planks (PCF Planks) - A common building material that is manufactured from cement and fiber (cementitious fiber) and cast into a composite panel or plank. Typical uses include roof decking and sound absorption panels on interior wall surfaces.

PreEngineered Metal Building (PEMB) - An easily recognizable prefabricated, standardized type of light steel frame building, which is found in similar form throughout the United States. It consists of two types of steel frame systems -- transverse (short axis) moment-resistant frames, typically rigid frame bents with tapered sections, and longitudinal (long axis) braced frames. This class of building is typically one story or has only a minor mezzanine/partial second story, lightweight cladding, or stud-framed walls.

Prewiring - The modification of a facilities electrical system to simplify and expedite connection with a compatible alternate power supply or generator.

Primary Host Shelter - A designation for a host shelter area, that if utilized as such, will prohibit the normal day-to-day functioning of only the building or area utilized as the shelter and is not the primary function of the remainder of the facility. For example, using a school gymnasium will only prohibit gym classes, with the remainder of the school facility continuing to function normally.

Recovery Shelter - A facility that is relatively safe and provides essential support services. Facilities designated as Recovery Shelters are used after there is no longer a threat of hurricane or severe storm in the area. All Host Shelters and those Risk Shelters that have essential support services may be used as Recovery Shelters. As local conditions are not expected to present hazards such as surge inundation, rainfall flooding, high winds, or hazardous materials which exceed the building codes of the facilities in use, shelter selection guidelines in ARC 4496 do not have to be considered. The shelter population may include evacuees from the local area or evacuees who flee from the threat of hurricane or severe storm in their home counties and are not yet cleared to return to their homes. For planning purposes, the operational period of a Recovery Shelter is from 72 hours after landfall and beyond. A total of 40 square feet of usable floor space per person is recommended in the calculation of shelter capacity.

Refuge - A place or building that serves as an escape from real and immediate danger as a last resort to save one's life.

Reinforced Concrete Walls - Monolithically cast-in-place concrete wall construction with vertical reinforcing steel bars in both the horizontal and vertical directions, with spacing based upon design requirements. Horizontal reinforcing must be present at roof and floor levels and above and below window or door openings. Concrete construction of this type will conform to the design criteria of ACI 318.

Reinforced Concrete Masonry - Masonry wall construction in which steel reinforcement is integrally embedded in a manner that permits the two materials to act together in resisting forces. Masonry of this type shall have vertical reinforcing steel bars spaced no more than four feet apart, with vertical bars at wall corners, wall intersections, and on each side of window and door openings. Horizontal reinforcing must be present at roof and floor levels and above and below window or door openings. Masonry construction of this type will conform to the design criteria of ACI 530 or ASCE 5.

Retrofit - Modifications performed upon an existing structure or infrastructure with the goal of significantly reducing or eliminating potential damage due to a specific hazard.

Risk Shelter - A facility that complies with shelter selection guidelines prescribed in Guidelines for Hurricane Evacuation Shelter Selection (ARC 4496, July 1992). Facilities designated as Risk Shelters lie in the projected path of an approaching hurricane or severe storm and who have been directed to evacuate. The designation does not imply that a facility is capable of affording complete protection or is free from hazards but only that it meets established safety criteria. A total of 20 square feet of usable floor space per person is recommended in the calculation of shelter capacity. See Hurricane Evacuation Shelter and Storm Shelter.

Saffir-Simpson Scale - The current prevalent system of classifying hurricanes based on five categories that relate hurricane strength and, therefore, damage potential, with the central pressure, wind velocity, and storm surge.

Scuppers - An opening (or outlet) in a wall or parapet of a building for draining overflow water from a flat or shallow slope roof.

Secondary Host Shelter - A designation for a host shelter area, that if utilized as such, will prohibit the normal day-to-day functioning of the entire campus/complex and not just the building or area utilized as the shelter. For example, using a school cafeteria or classroom area as a host shelter could result in school closure.

Shear Wall - A wall that resists horizontal forces acting in the plane of the wall, which keeps a structure from sliding or racking, in response to lateral forces. Typically, these walls extend from the roof level to the foundation

Shelter - A predesignated place or building of relative safety that temporarily provides essential support services with the goal of preserving life and reducing human suffering.

Shutters - Permanent or temporary closures or shields and assemblies that serve as structural barrier to resist wind induced loads that act on their surface(s) to include aerodynamic and windborne debris impact loads.

Softspot - A weakpoint in a building's envelope that is vulnerable to wind loads or windborne debris impact.

SLOSH modeling - A modeling methodology that predicts the maximum envelope and depth of coastal and inland storm surge inundation with respect to categories of hurricane.

Storm Shelter - A building or facility that conforms to the hurricane evacuation shelter guidelines as established in ARC 4496 and is intended to be used to shelter persons in the path of a severe storm or hurricane. The designation does not imply that a facility is capable of affording complete protection or is free from hazards but only that it meets established safety criteria. See also Hurricane Evacuation Shelter and Risk Shelter.

Storm Surge - An abnormal rise in water level at the shoreline of a large body of water caused by wind and pressure forces of a storm or hurricane.

T-beam - Reinforced concrete beam, typically precast, or a rolled metal shape having a cross section resembling the letter "T."

Tie Beam (or Collar) - In roof framing, a horizontal beam connecting two opposite rafters at their lower ends to prevent them from spreading.

Tongue-and-Groove (T&G) - A joint made by fitting the edge (tongue) of one board into a matching slot (groove) on another board.

Truss - A combination of members, such beams, bars, and ties, usually arranged in two-dimensional triangular units to form a rigid framework for supporting loads over a long span.

Unreinforced Masonry - Masonry without vertical steel reinforcement or with vertical reinforcements spaced at distances of nine feet on-center or greater.

Velocity Zone (flooding) - A special flood inundation zone where water flow rates are anticipated to exceed two feet per second. Facilities located in velocity zones will be subjected to possible foundation scour (erosion) and high hydrodynamic and debris impact loading.

Veneered Wall - A wall having a facing of masonry units or other weather-resisting, non-combustible materials securely attached to a backing of supporting material but not bonded so as to exert a common reaction under load.

Waterproofing - The application of sealants or use of construction materials with properties that permit them to serve as impermeable barriers to water intrusion.

Windward Wall - The wall of a building on the side from which the wind is blowing. The wall of a building that the wind is blowing directly against.

Appendix H:
Sample Completed LRDM Table, Survey Checklist, and Documentation

Least-Risk Decision Making: ARC 4496 Guideline Compliance Summary

Survey Date: xx/xx/xx County: Bay

Facility Name: Cherry Street Elementary School, Building #1/Admin/Classrooms Address: 1125 Cherry Street

City: Panama City State: Florida Zip Code: 32401

Coordinates: Latitude: 30° 08' 47" N Longitude: 85° 38' 45" W

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
1. Storm Surge Inundation	Building and at least one access road are located above the Category 5 storm surge zone.		
2. Rainfall Flooding / Dam Considerations	The building and at least one access road are above the 500 year flood plain and not threatened by dam/dike/reservoir failures. Located in Zone C.		
3. Hazmat and Nuclear Power Plant Considerations		The Facility lies within the Vulnerability Zones of six different hazmat facilities. In all these cases the hazardous material was listed as chlorine, with a low risk of release.	

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
4. Lay-down Hazard Exposure			**On the south side of the building, a large pine tree is within lay-down range of the southwest corner of the building.**
5. Wind and Debris Exposure			**Facility is within one mile of large body of water and within a quarter mile of an open area. Facility has an unsheltered wind exposure, and high exposure to debris.**
6. Wind Design Verification		Assumed - Designed to SBC , wind speed - 110 mph plus importance factor of 0.11. Built 1987.	
7. Construction Type / Loadpath Verification		Loadbearing CMU walls with pilasters (four #5 rebar each) at 11 O.C. Continuous loadpath from roof to foundation.	
8. Building Condition	Good with no history of significant damage from recent hurricanes.		
9. Exterior Wall Construction		Eight inch CMU, partially reinforced, with four inch brick veneer.	

CRITERIA	PREFERRED	MARGINAL	NON-COMPLIANT
10. Fenestrations / Window Protection			**About 12 percent of total exterior wall is unprotected glazings (about 766 sq.ft.).**
11. Roof Construction / Roof Slope			BUR over 22 gage metal decking on OWSJ. Slope is 5 degrees. **Roof is lightweight with three foot overhang**. Roof has partially reinforced masonry gable ends.
12. Roof Open Span	Roof spans were 35 foot between vertical supports.		
13. Roof Drainage / Ponding	No parapet walls. No indication of significant ponding/roof degradation.		
14. Interior Safe Space			1,360 sq.ft. of interior corridor. **Has unreinforced CMU walls (rebar at 16 ft O.C.). No deck cap over corridor.**
15. Life Safety / Emergency Power		Life Safety inspection not performed as part of this survey. No emergency power source.	

Part One: (Local Emergency Management Provided)

SECTION 0 - IDENTIFICATION [SAMPLE]

0.1 Facility Name: Cherry Street Elementary School

Building ID #: Building #1/Admin/Classrm

Street Address: 1125 Cherry Street

City: Panama City

State, Zip+4: Florida, 32401

0.2 Latitude: 30° 08' 47" N

Longitude: 85° 38' 45" W

0.3 County: Bay

0.4 Owner: Bay County Schoolboard Public ■ Private ❑

0.5 Facility Type: ○ vital - ● shelter - ○ utility

○ other ____________

0.6 Contact: John Smith

Title: Custodian

Phone: 555-2525

Alt. Phone: ____________

Alternate 1: ____________

Title: ____________

Phone: ____________

Alt. Phone: ____________

Alternate 2: ____________

Title: ____________

Phone: ____________

Alt. Phone: ____________

0.7 Indicate Area/s of Facility that are planned to be used as shelter; ❑ Cafeteria; ❑ Gymnasium; ❑ Auditorium;
■ Classroom; ■ Corridor; ❑ Kitchen; ❑ Clinic; ❑ Other: ____________

0.8 Does the building have Alternate Communications with local Emergency Management? ■ YES ❑ NO

If yes, indicate type: Bay County Emergency Management has placed a one-way warning receiver at this and other campuses, which are regularly monitored for emergency information. This campus' receiver is located in the administrative building. This system could be used to receive information during the pre-storm and post-storm periods if electric power is available. The campus does not have a NOAA weather alert radio; the Bay County Emergency Management warning receiver serves a similar role. Televisions with a cable connection can receive The Weather Channel (TWC). Information and warnings can be received via this media, but it is not regularly monitored.

0.9 Under normal conditions, which Power Company provides electrical power? Gulf Power Corp.

SECTION 1 - STORM SURGE INUNDATION [SAMPLE]

YES		**1.1 Is the Facility located on a coastal barrier island?**
NO	X	
YES	X	**1.2 According to the appropriate Storm Tide Atlas, is the Facility's site located above any Category 4 storm surge zone?** *(If not applicable, answer YES)*
NO		

1.2.1 What is the site elevation above MSL? __30__ feet above MSL

What is the building's ground floor elevation above MSL? __30__ feet above MSL

1.2.2 What is the maximum predicted storm surge height at the Facility's site?

Cat. 2 __6.7-7.9__ feet MSL Cat. 3 __8.7-9.9__ feet MSL Cat. 4/5 __15.6-15.7__ feet MSL

1.2.3 What is the maximum height of surge expected in the building?

Cat. 2 __N/A__ feet MSL Cat. 3 __N/A__ feet MSL Cat. 4/5 __N/A__ feet MSL

YES		**1.3 According to the appropriate Storm Tide Atlas, is the Facility's site subject to isolation due to storm surge activity?**
NO	X	

SECTION 2 - RAINFALL FLOODING/ DAM CONSIDERATIONS [SAMPLE]

YES	X	**2.1 Is the building's first floor elevation on an equal or higher elevation than that of the base flood elevation level for site?**
NO		

2.1.1 What is the base flood elevation at the building? __N/A__ feet above MSL

2.1.2 If multi-storied, does the building have a floor level above the base flood elevation? ❑ YES ❑ NO

The (_____) floor elevation is ____________ feet above MSL ■ Not Applicable

YES	X	**2.2 According to the appropriate Flood Insurance Rate Map, is the Facility's site above the 100-year flood plain?**
NO		

2.2.1 What flood zone is the Facility's site located within? ❑ A_____; ❑ B; ■ C;

❑ D; ❑ X; ❑ V; ❑ Panel Not Printed; ❑ Area Not Surveyed ;

YES	X	**2.3 According to the appropriate Flood Insurance Rate Map, is the Facility's site above the 500-year flood plain?**
NO		
YES		**2.4 According to the appropriate Flood Insurance Rate Map(s), is the Facility's site subject to isolation due to riverine and/or ponding inundation of roadways?**
NO	X	

SECTION 2 - RAINFALL FLOODING/ DAM CONSIDERATIONS [SAMPLE]		
YES		**2.5 Is the Facility's site subject to inundation due to failure of containment of levees, dams and reservoirs following hurricane-related flooding?**
NO	X	
YES		**2.6 Is the Facility's site subject to isolation due to failure of containment of dams and reservoirs following hurricane-related flooding?**
NO	X	
YES		**2.7 Is there an engineered stormwater drainage system at the Facility's site?**
NO	X	Condition: ❑ Clean and functional ❑ Marginally functional ❑ Non-functional
YES		**2.8 Is there a history of minor flooding/ponding at the Facility's site under normal rainfall conditions?**
NO	X	(minor flooding is the water level where water actually enters buildings)
2.9 Comments: The campus is in an area with moderately sloping terrain, and is actually located at a relatively high spot with respect to adjoining properties. Rainfall drainage is generally to the southwest corner of campus where a retention pond has been constructed. Minor ground ponding of about an inch was observed in the vicinity of the buildings during the survey, but not a significant hazard. The campus is located in a Zone C area as indicated on the relevant FIRM (Panel Number 120012 0010 D). The Zone C designation means the school campus is located in an area of minimal flooding. There is at least one access route above any 100-year flood plain. An interview with the campus' custodian indicates no apparent history of minor flooding at the campus.		

SECTION 3 - HAZMAT AND NUCLEAR POWER PLANT CONSIDERATIONS [SAMPLE]		
YES		**3.1 Are hazardous materials manufactured, used, or stored (in reportable quantities) at, or in close proximity to the Facility's site?**
NO	X	❑ Data on the hazardous material facilities in the area was not available at the time of the survey.
YES	X	**3.2 Is the Facility's site located within the Vulnerability Zone of a facility that manufactures, uses, or stores materials that are considered extremely hazardous (Section 302)?**
NO		❑ Data on the hazardous material facilities in the area was not available at the time of the survey.
YES		**3.3 Is the Facility's site located within the two-mile Emergency Planning Zone (EPZ) of a nuclear power plant?**
NO	X	❑ Data on the hazardous material facilities in the area was not available at the time of the survey.
YES		**3.4 Is the Facility's site located within the ten-mile Emergency Planning Zone (EPZ) of a nuclear power plant, but outside the two-mile EPZ?**
NO	X	❑ Data on the hazardous material facilities in the area was not available at the time of the survey.

SECTION 3 - HAZMAT AND NUCLEAR POWER PLANT CONSIDERATIONS [SAMPLE]
3.5 Comments: The Facility lies within the Vulnerability Zones of six different hazardous material facilities. These are: Arizona Chemical, Bay County Water Plant, Cherry Street Treatment Plant, Lynn Haven Irrigation, Panama City Wastewater Treatment Plant, and the Stone Container Plant. In all these cases the hazardous material was listed as chlorine, with a low risk of release. This information derived from 302/312 reports held at County Emergency Management offices.

3.6 **INFORMATION PROVIDED BY:**	
Name:	Title:
Address:	Phone:
City, State Zip:	Fax:

Part Two: (Facility Surveyor Provided)

SECTION 0 - IDENTIFICATION [SAMPLE]

0.1 Facility Name: Cherry Street Elementary School	0.6 Contact: John Smith
Building ID #: Building #1/Admin/Classrooms	Title: Custodian
Street Address: 1125 Cherry Street	Phone: 555-2626
City: Panama City	Alt. Phone:
State, Zip+4: Florida 32401	0.7 Alternate 1: Jane Doe
0.2 Latitude: 30° 08' 47" N	Title: Vice Principal
Longitude: 85° 38' 45" W	Phone: 555-2626
0.3 County: Bay	Alt. Phone:
0.4 Owner: Bay County School Board — Public ■ Private ❑	0.8 Alternate 2: N/A
0.5 Facility Type:	Title:
○ vital - ● shelter - ○ utility	Phone:
○ other	Alt. Phone:

0.9 Surveyor's Name: Danny Kilcollins 0.10 Survey Date: xx/xx/xx

0.11 Comments:

SECTION 4 - LAY DOWN HAZARD EXPOSURE [SAMPLE]

YES	X	**4.1 Is there a lay-down hazard in close proximity to the Facility?**

SECTION 4 - LAY DOWN HAZARD EXPOSURE [SAMPLE]		
NO		

4.1.1	Are there large/tall trees within lay-down range of the Facility? ■ Yes ❑ No
4.1.2	Are there tall structures (e.g., towers, chimneys, steeples, etc.) within lay-down range of the Facility? ❑ Yes ■ No
4.1.3	Are there potential roll-over hazards within 100 feet of the HES building? For example, unanchored relocatable buildings, vehicle parking lots, and unanchored HVAC units. ■ Yes ❑ No Describe: There are approximately 25 paved vehicle parking spaces on the south side of Building #1. Vehicles parked during hurricane conditions could present a roll-over hazard to Building #1.
4.1.4	Is there at least one access road not tree-lined? ■ Yes ❑ No

4.1.5 Comments: *(Specify quantity and distribution of lay-down hazards in relation to building)* On the south side of the building, a large pine tree is within lay-down range of the southwest corner of the building. If this tree struck and breached the building's envelope during a sustained high wind event, progressive failure of the remainder of the structure is possible. If the joists in the classroom areas are damaged or destroyed, damage to the corridor roof system is likely. Recommend removal of this tree prior to use of the building as a shelter. A couple of smaller pine trees may also be in lay-down range, but do not appear to pose as significant a threat as the largest tree. The smaller trees should also be removed or regularly pruned to reduce lay-down and debris generation hazards.

SECTION 5 - WIND AND DEBRIS EXPOSURE [SAMPLE]		
YES	X	**5.1 Will the Facility site be exposed to the full force of hurricane winds?**
NO		

5.1.1	What is the degree of wind exposure for the Facility? ❑ Sheltered Exposure ❑ Limited Exposure ■ Unsheltered Exposure
5.1.1.1	What is the type of topography? ❑ Flat ❑ Sheltered ■ Hill ❑ Promontory
5.1.1.2	What is the surrounding terrain?

SECTION 5 - WIND AND DEBRIS EXPOSURE [SAMPLE]

North: ☐ Flat ☐ Hilly ☐ Low Lying (○ marsh) ☐ Open ■ Wooded (○ heavily - ● lightly) ☐ Rural
■ Residential ☐ Lake/Pond ☐ Commercial Dist. (○ shopping - ○ manufacturing) ☐ Many tall trees
■ Other: Open play fields for approximately 1/4 mile, residential exposure beyond.

South: ☐ Flat ☐ Hilly ☐ Low Lying (○ marsh) ☐ Open ■ Wooded (● heavily - ○ lightly) ☐ Rural
■ Residential ☐ Lake/Pond ☐ Commercial Dist. (○ shopping - ○ manufacturing) ■ Many tall trees
☐ Other: ____________________

East: ☐ Flat ☐ Hilly ☐ Low Lying (○ marsh) ☐ Open ■ Wooded (○ heavily - ● lightly) ☐ Rural
☐ Residential ☐ Lake/Pond ☐ Commercial Dist. (○ shopping - ○ manufacturing) ☐ Many tall trees
☐ Other: ____________________

West: ☐ Flat ☐ Hilly ☐ Low Lying (○ marsh) ☐ Open ■ Wooded (○ heavily -● lightly) ☐ Rural
☐ Residential ☐ Lake/Pond ■ Commercial Dist. (● shopping - ○ manufacturing) ☐ Many tall trees
☐ Other: ____________________

5.1.1.3 Is the Facility within one mile of the ocean or other large body of water? ■ Yes ☐ No

5.1.1.4 Is the Facility within a quarter mile of an open area? ■ Yes ☐ No

YES	X	**5.2 Will the Facility site be exposed to wind borne debris?**
NO		

5.2.1 What is the degree of debris hazard exposure for the Facility?
☐ Minimal Exposure ☐ Limited Exposure ■ High Exposure

5.2.2 Do the structures within a 300-foot radius have roof gravel? ■ Yes ☐ No

5.2.3 Is there potential of debris from metal, wood frame, and masonry buildings, loose material or roofing
Within a 100 foot radius? ■ Yes ☐ No Within a 300 foot radius? ■ Yes ☐ No

5.2.4 Are there other debris generating sources within a 100 foot radius (e.g., lumber yard, junk yard, plant nursery, tree branches, etc.)?☐ Yes ■ No Within a 300 foot radius? ■ Yes ☐ No

5.2.5 Are there relocatable/portable buildings located on-site? ■ Yes ☐ No

5.2.5.1 Are the relocatable/portable building(s) securely anchored? ■ Yes ☐ No ☐ Not Applicable

5.2.5.2 Are the relocatable/portable building(s) within 100 feet of the HES? ☐ Yes ☐ No ☐ Not Applicable

SECTION 5 - WIND AND DEBRIS EXPOSURE [SAMPLE]

5.2.6 Comments: Nature Park's trees that front onto Cherry Street are within the 300 foot hazard radius for the campus' south facing buildings; in particular Building #1. As the strongest winds of a hurricane would be coming from the south and east directions, the Nature Park could be a significant debris generator; primarily tree limbs. With the exception of several homes that are located opposite the school buildings on the east side of Harris Avenue, the majority of nearby buildings are beyond the 300 foot hazard radius. The buildings that are within the hazard radius are a mixture of masonry and wood-frame construction with asphalt roof shingles. They appear to have been built prior to the 1980's, therefore it is uncertain whether or not hurricane anchors and clips were used during construction. Consequently, the potential types of windborne debris that could be generated include portions of roof structures and other construction materials, asphalt shingles, home furnishings, and tree limbs. Given this potential for windborne debris impact upon the school's buildings, any building considered for use as a storm shelter (or refuge) should have a structural envelope that will resist debris impact penetration.

The campus walkways are constructed of metal pipe columns with wood beams and joists, a plywood roof deck, and a weather membrane of built-up roofing and gravel ballast; hurricane clips were not present at the time of the survey. This type of walkway is often damaged or destroyed in a major hurricane, thus making it's usefulness in the post-hurricane period very questionable. It may also generate significant levels of windborne debris; both large (portions of the roof deck) and small (roof gravel) objects.

The campus' portable units are constructed of wood framing and wood panel exterior siding (T-111), and are elevated above the ground on masonry blocks. The perimeter of the units are anchored to the ground via metal hurricane straps. It is assumed that the construction standards for these units complies with 6A-2, F.A.C. Though hurricane force winds can damage or destroy portable units, the threat of debris generation from this type of portable unit is relatively low. Debris generation from this source would predominantly impact Buildings #4, #5 and #8, if the winds are out of the north.

The majority of the permanent buildings constructed of unreinforced CMU walls, a shallow sloped poured gypsum on formboard roof decking system, and a built-up roofing membrane with gravel ballast. This type of construction is vulnerable to damage from severe wind events. In particular, the roofing materials and gravel may become windborne debris, and thus have an impact upon other more wind-resistant buildings.

SECTION 6 - WIND DESIGN VERIFICATION [SAMPLE]		
YES		**6.1 Has a structural engineer certified this building as being capable of withstanding wind loads according to ASCE 7-88 or ANSI A58 (1982) structural design criteria?**
NO	X	(Give preference, in selecting shelters, to buildings designed to ASCE-7 or ANSI A58, in lieu of other model codes)

6.1.1 If yes, Specify actual wind design parameters (e.g., ASCE-7, 110 mph) N/A

YES		**6.1.2 Does the building have more than one story?**
NO	X	

6.1.2.1 How many stories does the building have? ■ One ❑ Two ❑ Three ❑ Four-Five ❑ Six +

6.1.2.2 What is the overall height of the building? ■ 0-30 feet ❑ 31-59 feet ❑ 60+ feet

YES	X	6.2 Was this building designed by a professional architect or structural engineer?
NO		❑ Unknown

6.2.1 What type(s) of technical design drawings were available for the survey?

■ Architectural ● Full ● Preliminary ○ Partial ○ As-Built ○ None

■ Structural ● Full ● Preliminary ○ Partial ○ As-Built ○ None

○ Drawings do NOT furnish a high level of detail; ○ Drawings are more representative of residential drawings.

○ Truss anchors and/or reinforcement in masonry was not addressed.

6.2.2 The building was designed in what year? 1983 □ Actual ■ Estimated

6.2.3 In what year(s) were major addition(s) built? N/A

6.2.4 What type of wind resistance code was utilized (or prevalent) at the time of design?

■ Model Building Code (● SBC - ○ SFBC - ○ Other: ________) --- Assumed

□ Custom Code □ MBMA □ Unknown □ None

6.2.5 To what wind speed was the building designed? * 110 mph * 0.11 importance factor ❑ Unknown

*wind speed and importance factor are assumed

SECTION 6 - WIND DESIGN VERIFICATION [SAMPLE]
6.2.6 Comments: A full set of architectural and structural drawings was available for the structural considerations evaluation. An "AS-BUILT" stamp was not impressed upon the construction drawings reviewed, but field observation of the relevant details/features did not indicate a significant discrepancy. A construction standard or model code was not given on the drawings. Given its year of construction (1987), the building code can be assumed to be the standard code (SBC) with a wind design requirement of 110 miles-per-hour, plus an 0.11 importance factor. This is equivalent to a 122 mile-per-hour wind loading design. Buildings constructed after 1986 were required to conform to more stringent wind design standards than pre-1986 buildings; thus reducing the building's vulnerability to wind damage relative to pre-1986 buildings. Special windborne debris impact resistance considerations were probably not included in the design.

SECTION 7 - CONSTRUCTION TYPE/LOAD PATH VERIFICATION [SAMPLE]		
YES	X	**7.1 Is there a definable and continuous load path from the building's roof to its foundations?**
NO		

7.1.1 What is the primary roof support system? ❑ Reinforced Concrete ❑ Steel Beam
❑ Steel Truss ■ Open Web Steel Joist ❑ Tapered Steel Beam ❑ Wood Truss ❑ Unknown
❑ Glue Laminated Wood Beam ❑ Other: ______

7.1.2 What is the primary load-bearing structure of the building? ❑ Reinforced Masonry Walls
❑ Unreinforced Masonry Walls ❑ Reinforced Concrete Frame ❑ Structural Steel Frame
❑ Tapered Steel Frame ❑ Wood Frame ❑ Heavy Timber Frame
❑ Laminated Beam Frame ❑ Unknown ■ Other: 8" CMU with vertical pilasters (four #5 rebar) at 11 ft OC

7.1.3 How is the primary roof support system connected to the primary load-bearing system?

Description: The connection of the metal decking to the joists was not indicated; for survey purposes, assumed connection was per manufacturer's specifications for metal deck systems. The connection of the joists to the bearing walls is via welds to bearing plates cast into the top bond-beam. Thus, a definable load path exists from roof deck to loadbearing walls.

SECTION 7 - CONSTRUCTION TYPE/LOAD PATH VERIFICATION [SAMPLE]		
7.1.4 How is the primary load-bearing system connected to the foundation? Description: The exterior CMU walls have vertical pilasters (8 inch depth by 16 inch width dimensions and embedded into the wall plane, at varying spacings around the building's full perimeter; typically 11 feet on-center. The pilaster's reinforcement is four #5 rebars, doweled to foundation and extending into the wall's top bond-beam. The pilasters provide a loadpath from the wall's top bond-beam to the foundation to resist wind induced uplift loads.		
YES		**7.2 Is the building a Pre-engineered (steel pre-fabricated) building built or designed prior to the mid 1980's?** *(Specify year built/designed:* N/A *)*
NO	X	

SECTION 8 - BUILDING CONDITION/ WIND DAMAGE HISTORY [SAMPLE]
8.1 From observation, what is the overall condition of the building? ❑ Excellent, well-maintained ■ Good, no noticeable problems ❑ Average, some cracks, other problems, none major ❑ Poor, obvious poor maintenance ❑ Bad, major repairs urgently needed
8.2 Is there any history of damage from high winds, or storms at this building? ❑ YES ■ NO
8.3 Comments: *(Specify damage history)* All building superstructure and envelope components that were observed during the survey appeared to be in good condition. There was no significant damage reported due to Hurricanes Erin and Opal.

SECTION 9 - EXTERIOR WALL CONSTRUCTION [SAMPLE]		
YES	X	**9.1 Are the exterior walls relatively wind and debris impact resistant?**
NO		
YES		**9.1.1 Does the building have unreinforced masonry walls on its exterior?** ❑ Unreinforced Masonry or ❑ Rebar Spacings Unknown
NO	X	

SECTION 9 - EXTERIOR WALL CONSTRUCTION [SAMPLE]
9.1.1.1 If no, what is the Exterior Wall Construction type? *(Check only one)* ❑ Reinforced Masonry (Rebar @ 4 ft. centers or closer) ❑ Light Wood or Metal Stud w/ ½ inch or thicker plywood ❑ Partial Reinforced Masonry (Rebar @ 8 ft. centers to 4 ft. centers) ❑ Light Wood or Metal Stud w/ light non-plywood sheathing ■ Partial Reinforced Masonry (Four-bar Pilasters 13 feet on center or less) ❑ Large Panel Glass or other Glazed Panel or Block System ❑ Reinforced Concrete or Precast Concrete Panels ❑ Metal Sheets or Panels or other Light Architectural Panel Systems
9.1.1.2 If Metal Sheets or Panels (e.g., PEMB structures), what is the gage of the metal sheets or panels? ❑ Thinner than 22 gage (26 gage, etc.) ❑ 22 gage or thicker (18 gage, 16 gage, etc.) ■ Not Applicable
9.1.2 Do the exterior walls have a brick or stone veneer (3 to 4 inches thick)? ■ YES ❑ NO
9.1.3 Do the exterior walls have an Exterior Insulating and Finish System (EIFS)? ❑ YES ■ NO
9.1.4 Are there cantilevered walls (walls connected/supported at the base/foundation, but not at the roof) on the exterior of the building? ❑ YES ■ NO Describe: ______________________________
9.1.5 Are there any other softspots noted in the building's exterior walls/roof? ❑ YES ■ NO Describe: N/A

SECTION 10 - FENESTRATIONS/WINDOW PROTECTION [SAMPLE]		
YES		**10.1 Are all the windows in the building adequately protected by shutters/protective systems?**
NO	X	
10.1.1 What is the percentage of Glass in the exterior walls ? ❑ 0% to 1% ❑ 2% to 5% ■ 6%+ (766 sq. ft. of glazings ÷ 6,192 sq. ft. of exterior walls x 100 = 12%)		
10.1.2 Are there "store-front", atrium, or clerestory sections of glazing in the exterior walls? ❑ YES ■ NO		
10.1.3 What type of glass is utilized in the exterior walls? ❑ Unknown ■ Fully Tempered ❑ Laminated Glass ❑ Other ______________		
10.1.4 Are all the windows in the exterior walls of the building shuttered/protected against windborne debris? ❑ YES ■ NO ❑ Not Applicable		

SECTION 10 - FENESTRATIONS/WINDOW PROTECTION [SAMPLE]

10.1.5 Has the shuttering/protective system used to protect the windows been certified to meet the windload and impact resistance standards in the Dade County version of the South Florida Building Code (Sections 2314.1, 2314.5, and 2315.1-2315.4), or SBC Standard SSTD 12-94?

❑ YES ❑ NO ■ Not Applicable ❑ Unknown

10.1.6 If there is a shuttering/protective system in use but it is not certified to the standards in 10.1.5 above, is there documentation indicating the system was designed to transfer impact and wind loads to the building walls?

❑ YES ❑ NO ■ Not Applicable ❑ Unknown

10.1.6.1 Does it appear that the system was installed per the manufacturers' design documentation?

❑ YES ❑ NO ■ Not Applicable ❑ Unknown

10.1.6.2 Is the shuttering/protective system frame directly anchored into the wall around the window?

❑ YES ❑ NO ■ Not Applicable ❑ Unknown

10.1.6.3 If a film protective system is used, does the film cover the entire glazing (exposed glass and portions embedded in the frame)?

❑ YES ❑ NO ■ Not Applicable ❑ Unknown

10.2 Are there overhead door(s) in the building? ❑ YES ■ NO

10.2.1 Have the overhead door(s) and framing been modified with additional bracing to resist high wind loads?

❑ YES ❑ NO ■ Not Applicable

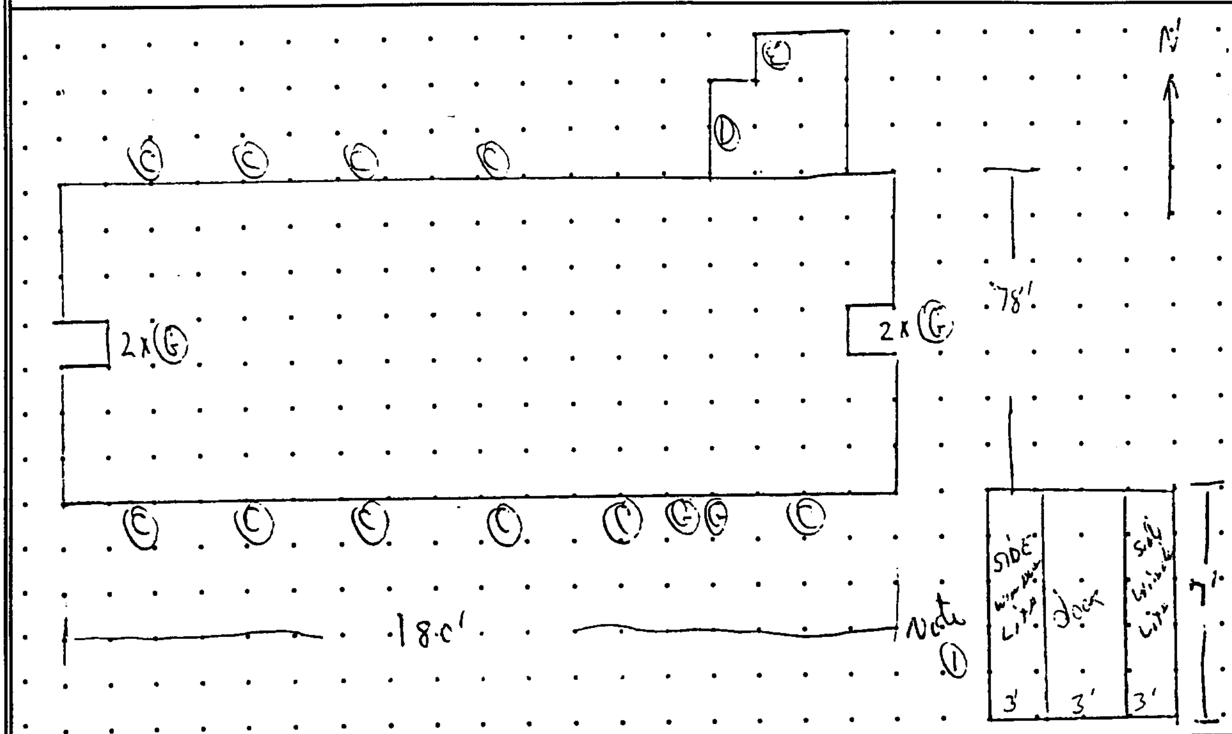
10.3 Are there skylights or overhead atrium glass or plastic? ❑ YES ■ NO

Describe: ______________________________

10.4 Comments: **The exterior window units of the classroom areas have an emergency egress hatch, which will limit the options of systems and products available.** The windows are located predominantly on the north and south faces of the building, comprising approximately 20 percent of their surface areas. The west face does not have exterior windows, the only fenestration is the corridor access double doors. The east wall face also has some window area, but not as high a percentage as the north and south faces. If the windows are broken (an envelope breach) during high wind events, the interior of the building will become pressurized and its vulnerability to progressive failure exacerbated.

SECTION 10 - FENESTRATIONS/WINDOW PROTECTION [SAMPLE]

10.5 Draw "footprint" sketch of building showing overall dimensions & window location.



Window/Door Types and sizes:

A Size 4' 6" x 6' 0" - Type Single window unit : e Size 4' 0" x 4' 8" - Type double window unit :

B Size 5'4" x 8' 0" - Type double window unit : f Size 7' 0" x 9' 0" - Type Door w/window lites (note 1):

C Size 5' 4" x 12' 0" - Type triple window unit : g Size 7' 0" x 3" 0" - Type metal doors :

D Size 5' 4" x 3' 4" - Type single window unit : h Size ____ x ____ - Type ____________________:

SECTION 11 - ROOF CONSTRUCTION/ROOF SLOPE [SAMPLE #1}

11.1 What is the Roof Construction type of the Building?

- ❑ Cast-in-place Reinforced Concrete (standard wgt concrete, 4 " min.)
- ❑ Plywood on wood or metal joist or truss (spacing: ____________)
- ❑ Precast Concrete Panels ("T's", "Double T's", Planks, etc.)
- ❑ Wood boards or T & G deck on wood joist or truss (spacing: ____________)
- ❑ Metal Decking w/standard wgt concrete (3 " min.) on metal joist, truss, or beam (spacing: ______)
- ❑ Fiberboard or Cementitious fiber planks on wood or metal joist or truss (spacing: ____________)
- ■ Other Metal Decking Systems (insulating concrete and/or rigid insulation or other light coverings)
- ❑ Poured Gypsum on Formboard Decking on wood or metal joist or truss (spacing: ____________)
- ❑ Other: ____________

11.1.1 If a Metal Decking System, what is the gage of the metal decking?

❑ Thinner than 22 gage (26 gage, etc.) ■ 22 gage or thicker (18 gage, 16 gage, etc.) ❑ Not Applicable

YES		**11.2 Does the building have a heavyweight roof system?**
NO	X	

11.2.1 What is the estimated roof weight? ❑ Heavyweight (50 pounds per square foot or greater)

■ Lightweight (25 pounds per square foot or less) ❑ Medium weight (26-49 pounds per square foot)

YES		**11.3 Does the building have a hipped roof system?**
NO	X	
YES		**11.4 Does the building have a flat roof system?**
NO	X	

11.5 If not a hipped or flat roof system, what is the roof geometry of the Building?

■ Gable-ended ❑ Shed System ❑ Stepped ❑ Other: ____________

YES		**11.6 Is the Roof Slope steep-pitched [greater than 30 degrees (7:12)]?**
NO	X	

11.6.1 What is the roof pitch?

■ shallow slope (0-10 degrees) ❑ moderate slope (11-29 degrees) ❑ steep slope (30+ degrees)

SECTION 11 - ROOF CONSTRUCTION/ROOF SLOPE [SAMPLE #1}		
11.7 What is the width of the roof overhang? ___3___ feet		
11.8 What type of roof covering is used? ■ Built-up roofing (● with gravel; ○ without gravel) ❑ Single-ply membrane with gravel or pavers ❑ Shingles ❑ Standing Seam Metal roof ❑ Tile Roof ❑ Slate Roof ❑ Metal Panels ❑ Single-Ply membrane mechanically fastened or fully adhered ❑ Unknown ❑ Other: ________		
11.9 What is the age of the roof covering? ❑ Less than 5 years ❑ 5-10 years ■ 11-15 years ❑ 16-20 years ❑ Greater than 20 years ❑ Unknown		
YES		11.10 Are there structures on the roof top vulnerable to high wind forces?
NO	X	
11.10.1 What mechanical equipment is on the roof (i.e., air conditioners, ventilators, etc.)? ❑ air conditioners ❑ air handling units ❑ small vents ❑ large vents ■ Not Applicable ❑ Other: ________		
11.10.1.1 Is the mechanical equipment on the roof securely fastened to the roof structure? ❑ YES ❑ NO ■ Not Applicable		
11.10.2 Are there lightly constructed structures or penthouses on the roof? ❑ YES ■ NO Describe: ________		
11.10.3 Are there any stacks, antennas or lights on the roof? ❑ YES ■ NO Describe: ________		
11.11 Comments: The roof system is composed of a metal deck (1 ½-inch depth, 22 gage) on "K-series" OWSJ spaced at five (5) feet on-center, and three rows of cross-bridging provided for each roof bay. The top chord of the joists have been extended beyond the interior corridor wall to form the corridor roof support. The east and west faces of the roof have short gabled-end walls. The masonry construction with pilaster stiffeners should reduce the vulnerability of the gables to lateral failure. An assessment by a structural engineer to determine modifications to enhance the gables' wind performance should be considered. No significant roof appendages (e.g., attic ventilators) were noted during the survey.		

SECTION 12 - ROOF OPEN SPAN [SAMPLE]		
YES		**12.1 Does the building have a long or open roof span?** (A long or open span is a roof span of greater than 40 feet between vertical supports.)
NO	X	

12.1.1 Is there a span greater than 40 feet between vertical supports? ❑ YES ■ NO

12.1.2 List the span(s) greater than 40 feet: N/A

12.1.3 If under a hipped roof system, is there a span greater than 50 feet between vertical supports?

❑ YES ❑ NO ■ Not Applicable

12.1.3.1 List the areas with span(s) greater than 50 feet: N/A

12.1.4 Comments: The roof joists span 35 feet from exterior walls to the corridor walls, therefore not a long-span situation.

SECTION 13 - ROOF DRAINAGE / PONDING INFORMATION [SAMPLE]

13.1 What is the height of the parapet wall around the roof's perimeter?

❑ Less than one foot ❑ 1-3 feet ❑ Greater than 3 feet ■ No parapet wall

13.2 Are there scuppers in the parapet wall? ❑ YES ❑ NO ■ Not Applicable

13.3 Is there evidence of roof covering degradation or interior water damage on the top floor of the building?

❑ YES ■ NO Describe: ____________________

13.4 Is there evidence of ponding on the roof? ❑ YES ■ NO

13.5 Comments: ____________________

SECTION 14 - INTERIOR SAFE SPACE [SAMPLE]		
YES		**14.1 Does the building have an interior corridor(s) or interior rooms that could be used as hurricane evacuation shelter space ?**
NO	X	

14.1.1 What is the square footage of the interior corridor(s) or interior rooms in the building?

1,360 square feet

SECTION 14 - INTERIOR SAFE SPACE [SAMPLE]

14.1.2 What is the Interior Corridor Wall Construction type? *(Check only one)*

- ❑ Reinforced Masonry (Rebar @ 4 ft. centers or closer)
- ❑ Light Wood or Metal Stud w/ ½ inch or thicker plywood
- ❑ No Interior Corridor
- ❑ Partial Reinforced Masonry (Rebar @ 8 ft. centers to 4 ft. centers)
- ❑ Partial Reinforced Masonry (Four-bar Pilasters 13 feet on center or less))
- ■ Unreinforced Masonry or Rebar spacings unknown
- ❑ Large Panel Glass or other Glazed Panel or Block System
- ❑ Reinforced Concrete or Precast Concrete Panels
- ❑ Metal Sheets or Panels or other Light Architectural Panel Systems
- ❑ Light Wood or Metal Stud w/ light non-plywood sheathing
- ■ Other: Unreinforced eight inch CMU with vertical rebar at 16 feet on center

14.1.3 What type of door(s) open onto the interior corridor from inside the building?

- ❑ Hollow Metal Door, no windows
- ❑ Wood Door, no windows
- ❑ Not Applicable
- ■ Hollow Metal Door, view window
- ❑ Wood Door, view window
- ❑ Metal Door, large window
- ❑ Wood Door, large window
- ❑ Glass Door, metal frame
- ❑ Other: ____________________

14.1.4 What type of door(s) open onto the interior corridor from outside the building?

- ❑ Metal Door, no windows
- ❑ Wood Door, no windows
- ❑ Not Applicable
- ■ Metal Door, view window
- ❑ Wood Door, view window
- ❑ Metal Door, large window
- ❑ Wood Door, large window
- ❑ Glass Door, metal frame
- ❑ None
- ❑ Other: ____________________

14.1.5 Are there drawbolts on the top and bottom of the interior corridor exit doors? ■ YES ❑ NO

❑ Not Applicable

SECTION 14 - INTERIOR SAFE SPACE [SAMPLE]

14.1.6 What type of ceiling deck or cap is over the interior corridor? (This is not the drop ceiling but a structural decking that seals off the corridor from the roof system)

- ☐ Normal-weight Concrete Deck/Slab ☐ Poured Gypsum Decking ☐ Metal Decking
- ☐ Precast Concrete Slab ☐ Concrete Tees ■ No corridor decking, just drop ceiling and building roof decking above.
- ☐ Not Applicable
- ☐ Other: ______

14.1.7 If there is a ceiling deck or cap, how is it connected to the interior corridor walls?

- ☐ Gravity loaded ☐ Anchored ■ Not Applicable
- ☐ Other: ______

14.1.8 Comments: The exterior doors of the building are out-ward swinging standard metal security doors; similar to doors found in most modern school facilities. They have small view window lites that are made of 5/8-inch tempered safety glass. The door framing connection to surrounding walls is via strap anchors set into grouted cells, per the construction drawings. An four foot in-set from the outer exterior wall face at the corridor's ends may reduce the debris impact threat for the exterior doors. The corridor access doors to the classrooms are of metal construction with small view windows. The classroom and administration area doors swing into the corridor, but if adequate consideration is given to closing and latching the doors they should remain closed if an envelope breach takes place in a classroom.

14.2. What is the total floor (footprint) area of the building? 14,040 square feet

14.2.1 What is the total floor area available (in the building) for use as shelter area (exclude interior corridors)? (This is the total square footage of those rooms or areas to be used as shelter areas); 7,817 square feet.

14.2.2 Excluding walking area and areas with immoveable furniture, how much of the shelter floor area is actually usable for personal shelter space? (Note: show shelter space on building sketch maps)

As-Is: 5,077 square feet

Additional Area After Minor Retrofit: 5,077 square feet

Addtional Area After Major Retrofit: 5,077 square feet

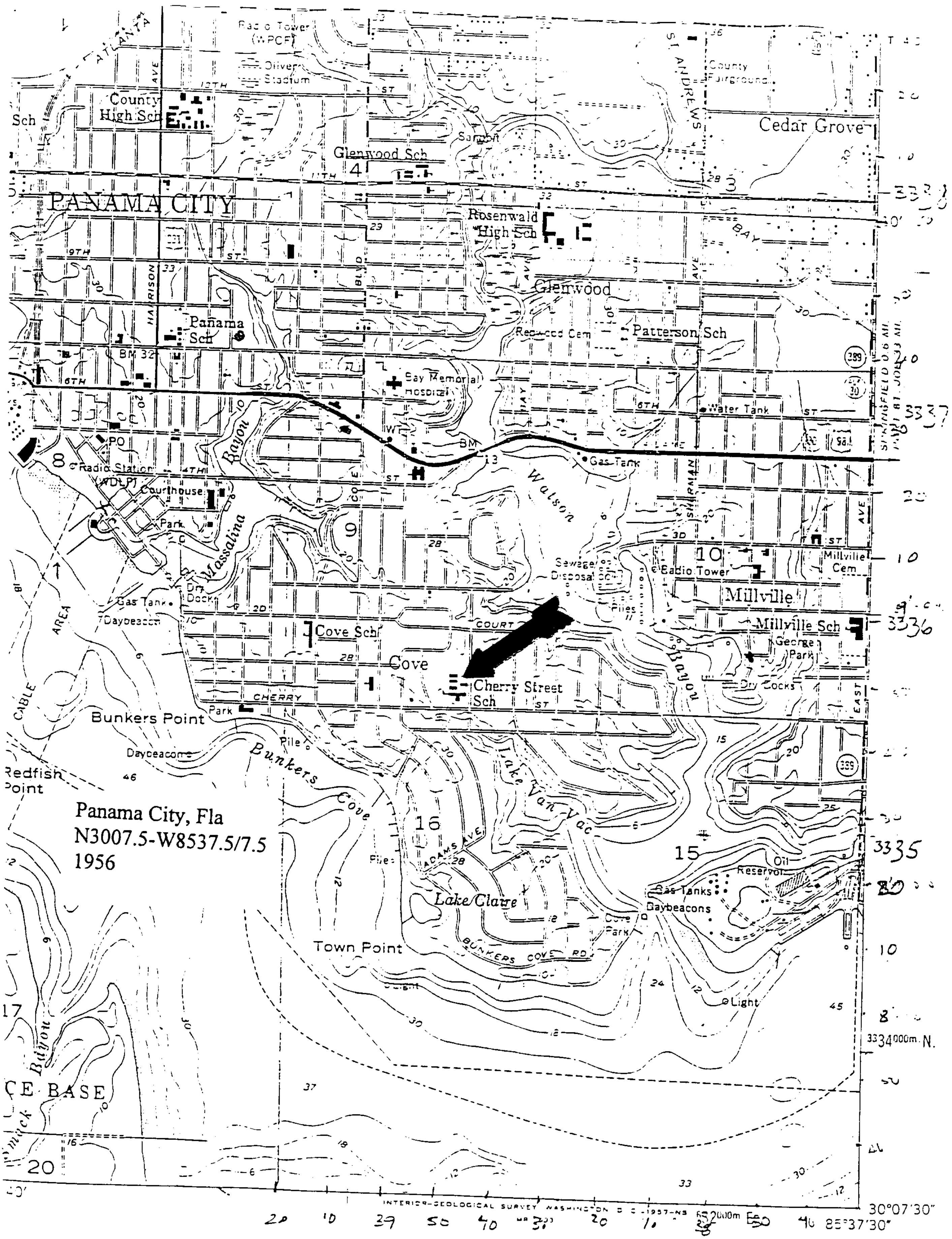
SECTION 14 - INTERIOR SAFE SPACE [SAMPLE]
14.2.3 Comments: If the exterior windows were protected by an adequate hurricane shutter or other system that resists both wind and impact loads, the classroom areas could be utilized. This would provide an additional 6,277 sq. ft of regular classroom space and 1,540 of multi-purpose space, for a total of 7,817 sq. ft.; based upon open dimensions that exclude storage, bathroom, and fixed cabinets. This floor area should additionally be reduced by a factor of 35 percent due to non-fixed furnishings. Therefore, a total of 5,077 sq. ft. of non-corridor space could be available. The multi-purpose area has a retractable wall that can be closed to create two separate rooms, or a single large room with open dimensions of 30 feet by 55 feet.

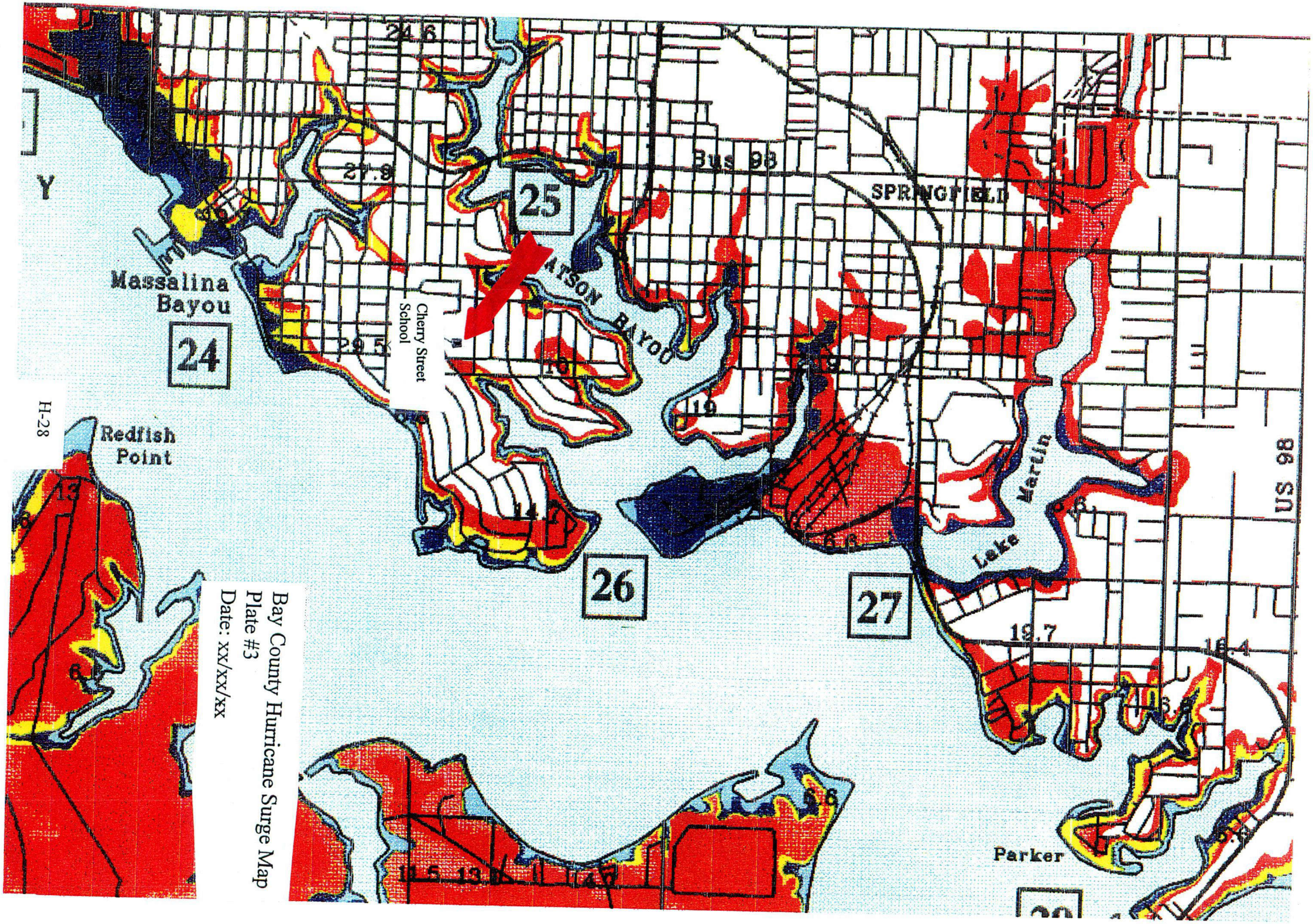
SECTION 15 - LIFE SAFETY/EMERGENCY POWER [SAMPLE]		
YES		**15.1 At the time of the survey, is the building known to be noncompliant with any life safety or fire codes?**
NO		
Unknown	X	
15.1.1 If yes, describe area(s) of non-compliance: A life safety code/fire code evaluation was not conducted during this survey. Should be performed by appropriate local officials.		
YES		**15.2 Is there a survivable on-site emergency power system?**
NO	X	
15.2.1 Is there an emergency power supply generator on-site? ❑ YES ■ NO (If No, go to section **15.2.13)**		
15.2.2 If yes, what are its ratings? ■ Not Applicable ________ KW, ________ Amperes, ____/____ Volts; ❑ Single Phase ❑ Three Phase ❑ Three-Wire ❑ Four-Wire Configuration; Brand Name: ____________		
15.2.3 Is the generator storm hazard protected? ❑ YES ❑ NO ■ Not Applicable Describe: ____________		
15.2.4 Is the generator securely anchored? ❑ YES ❑ NO ❑ Portable Generator ■ Not Applicable Describe: ____________		
15.2.5 Is the generator regularly maintained? ❑ YES ❑ NO ❑ Unknown ■ Not Applicable Describe: ____________		

SECTION 15 - LIFE SAFETY/EMERGENCY POWER [SAMPLE]
15.2.6 What is the fuel type of the generator? ■ Not Applicable ❑ Gasoline ❑ Diesel ❑ LP ❑ Natural Gas ❑ Other: ____________
15.2.7 What is the on-site fuel storage capacity (size of tank)? ________ gallons; ■ Not Applicable
15.2.8 What is the type of fuel tank? ■ Not Applicable ❑ Above ground ❑ Below ground ❑ Portable ❑ Anchored/Fixed ❑ Heavy Steel ❑ Concrete ❑ Lightweight metal ❑ Other: ____________
15.2.9 Is the fuel tank storm hazard protected? ❑ YES ❑ NO ■ Not Applicable Describe: ____________
15.2.10 What building(s) are connected to the emergency power generator system? ■ Not Applicable ❑ All on-site ❑ Specify: ____________
15.2.11 What load(s) are connected to the emergency power generator system? ■ Not Applicable ❑ Safety lights ❑ Exit lights ❑ Freezers ❑ Well pumps ❑ Fire Alarms ❑ Security Alarms ❑ Emergency Lighting ❑ Lift Station(s) ❑ Kitchen Equipment ❑ Other(s): ____________
15.2.12 Comments: Currently, the campus does not have an emergency power generator. The corridor, classrooms, multi-purpose room and administrative areas have battery powered (1-hour +/- duration) emergency egress lamps. If these units and other fire/security systems are on an independent circuit, a small generator could be connected via a pre-wiring system and meet minimum emergency power needs.
15.2.13 Is the building pre-wired for connection to a portable generator? ❑ YES ■ NO ______ KW, ____/____ Voltage, _____ Phase, _____ Wire Configuration

SECTION 15 - LIFE SAFETY/EMERGENCY POWER [SAMPLE]

15.2.14 Comment: ______________________________


Panama City, Fla
N3007.5-W8537.5/7.5
1956
PANAMA CITY
Radio Tower (WPCF)
Oliver Stadium
County High Sch
Glenwood Sch
Cedar Grove
County Fairground
Rosenwald High Sch
Glenwood
Panama Sch
Patterson Sch
Bay Memorial Hospital
Water Tank
Gas Tank
Radio Station (WDLP)
Courthouse
Park
Massalina Bayou
Walson Bayou
Sewage Disposal
Radio Tower
Millville
Millville Cem
Millville Sch
George Park
Dry Docks
Cove Sch
Cove
Cherry Street Sch
Bunkers Point
Bunkers Cove
Redfish Point
Lake Van-Vac
Lake Claire
Town Point
Cove Park
Oil Reservoir
Gas Tanks
Daybeacons
Light
BUNKERS COVE RD
CHERRY ST
COURT
ST ANDREWS BAY
INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—1957
3334000m. N.
30°07'30"
85°37'30"



Bay County Hurricane Surge Map
Plate #3
Date: xx/xx/xx

H-28

Bay County Hurricane Surge Map
Plate #3
Date: xx/xx/xx

SCALE = 1 : 48,000
(1 INCH = 4,000 FEET)

- WATER (Major)
- CATEGORY 1 (CAT1)
- CATEGORY 2 (CAT2)
- CATEGORY 3 (CAT3)
- CATEGORY 4 (CAT4)
- CATEGORY 5 (CAT5)

35 **HURRICANE SURGE HEIGHTS AT TIME HISTORY POINTS**

(in feet above N.G.V.D.)

POINT NUMBER	CAT1	CAT2	CAT3	CAT4	CAT5
4	5.3	7.9	10.4	13.2	16.9
5	5.2	8.3	11.4	14.3	16.6
23	5.0	7.9	10.2	12.2	15.9
24	4.8	7.9	9.9	14.4	15.6
25	4.6	7.4	9.5	13.7	17.5
26	4.3	6.7	8.7	12.4	15.7
27	3.5	3.5	3.5	12.5	17.1
28	4.0	6.0	7.8	9.9	12.8
29	4.1	6.1	7.8	9.8	12.7
30	4.0	6.0	7.8	9.8	12.7
33	5.9	8.4	11.2	14.9	17.4

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

CITY OF
PANAMA CITY,
FLORIDA
BAY COUNTY

PANEL 10 OF 10

COMMUNITY-PANEL NUMBER
120012 0010 D

MAP REVISED:
JANUARY 3, 1986

Federal Emergency Management Agency

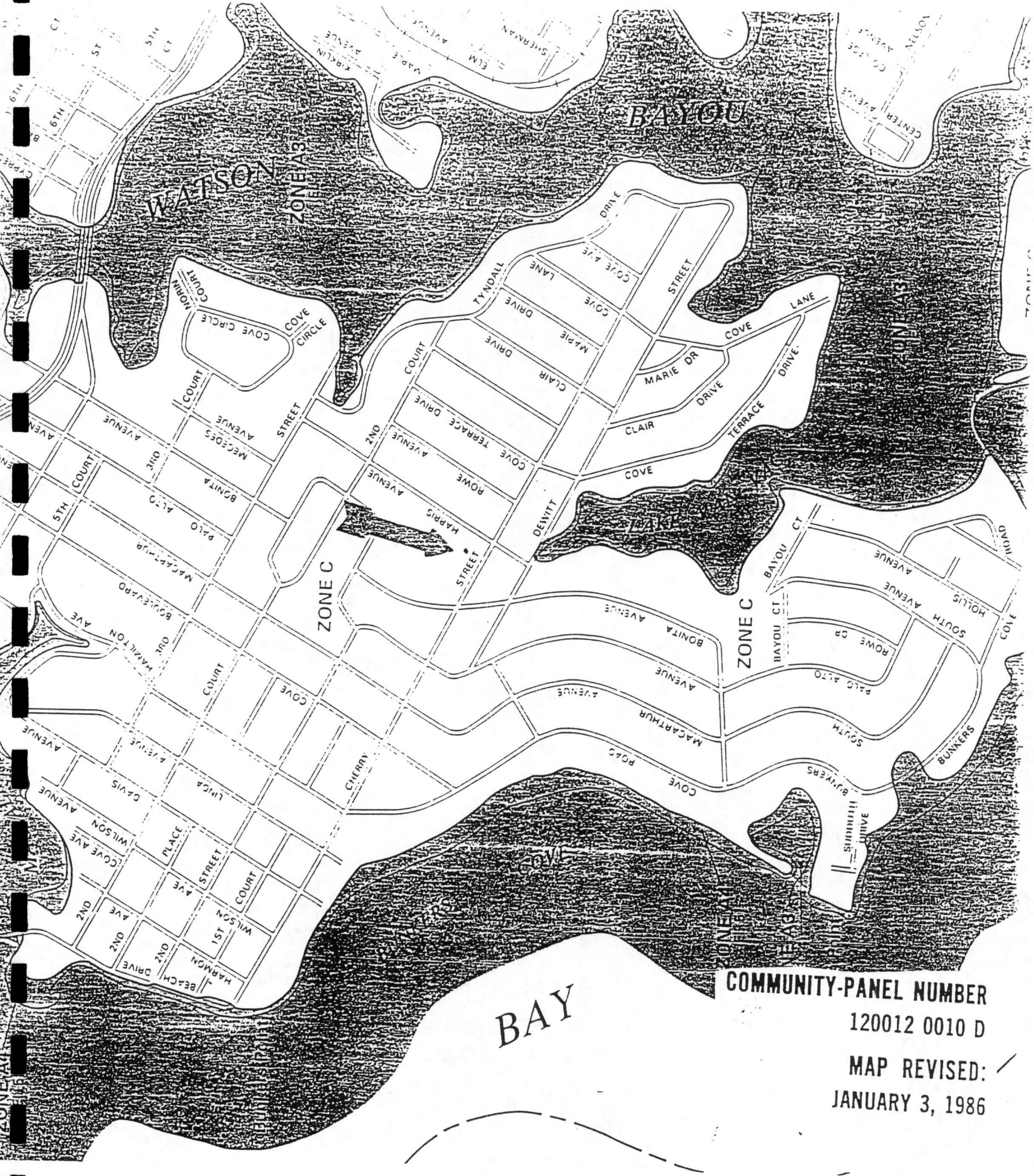
KEY TO MAP

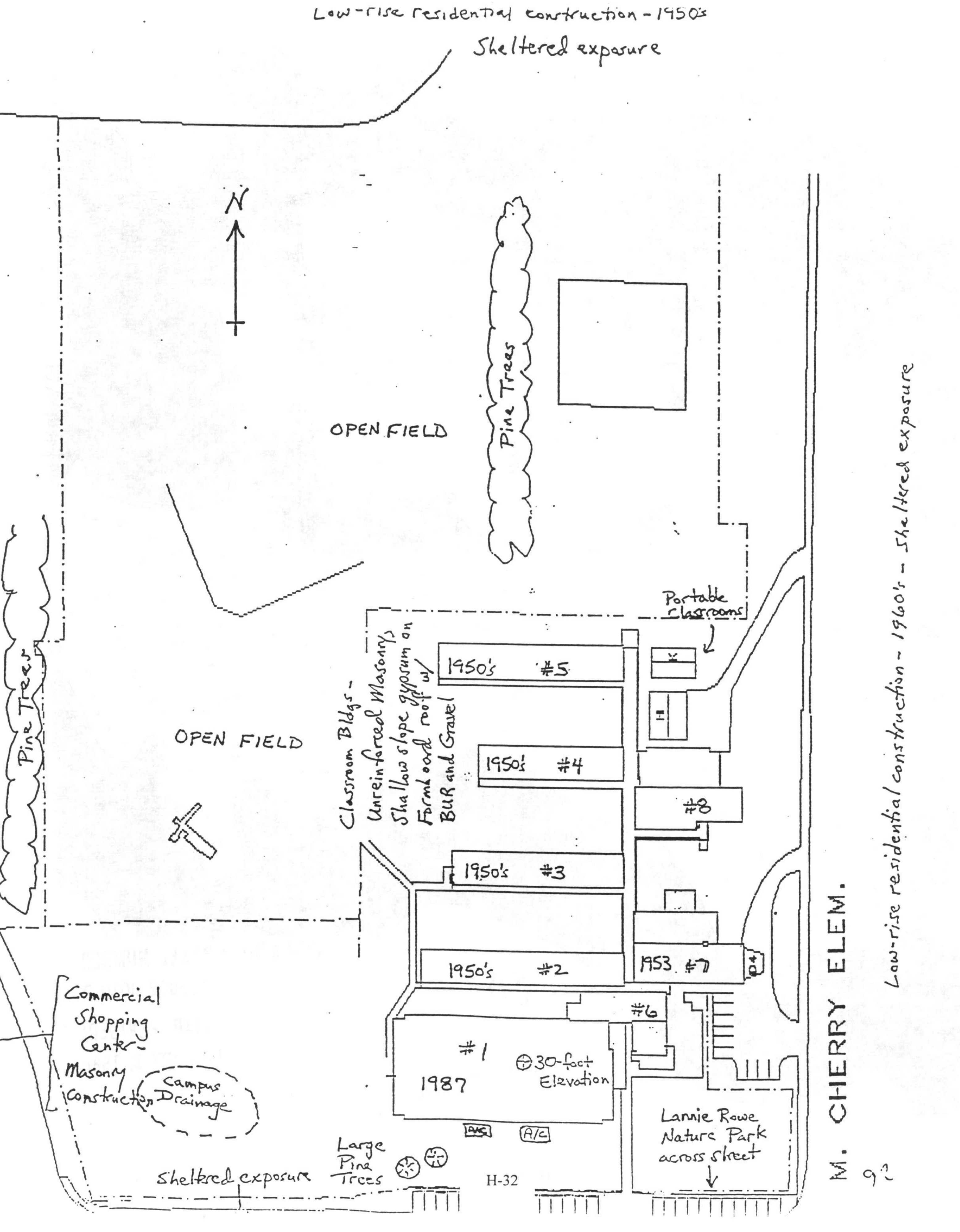
500-Year Flood Boundary	
100-Year Flood Boundary	ZONE B
Zone Designations*	
100-Year Flood Boundary	
500-Year Flood Boundary	ZONE B
Base Flood Elevation Line With Elevation In Feet**	513
Base Flood Elevation in Feet Where Uniform Within Zone**	(EL 987)
Elevation Reference Mark	RM7×
Zone D Boundary	
River Mile	•M1.5

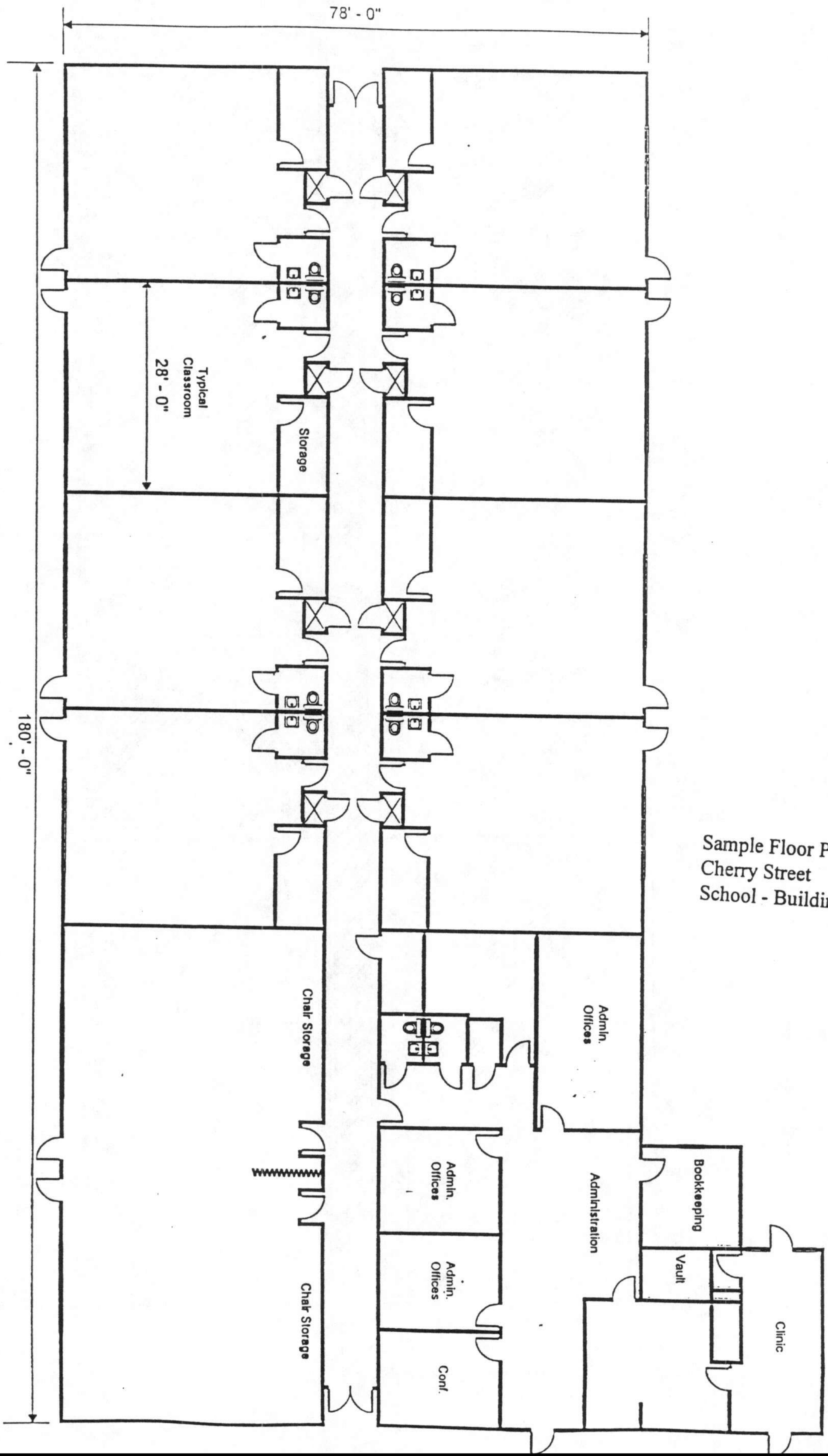
**Referenced to the National Geodetic Vertical Datum of 1929

*EXPLANATION OF ZONE DESIGNATIONS

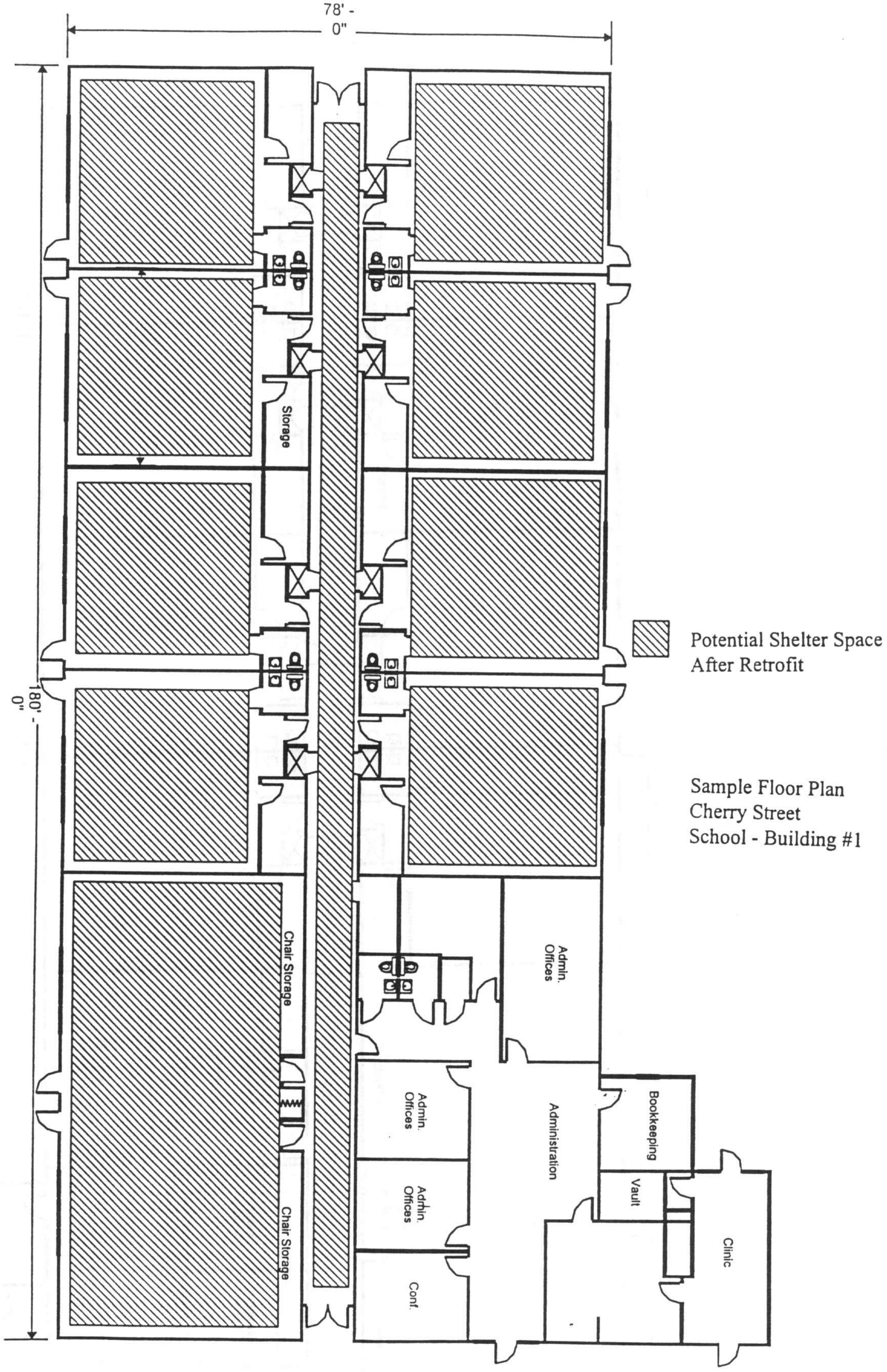
ZONE	EXPLANATION
A	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
A0	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
A99	Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C	Areas of minimal flooding. (No shading)
D	Areas of undetermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.


WATSON
BAYOU
ZONE A3
ZONE C
LAKE
BAY
COVE CIRCLE
TYNDALL DRIVE
COVE LANE
MARIE DRIVE
CLAIR DRIVE
COVE TERRACE DRIVE
ROWE AVENUE
HARRIS AVENUE
DEWITT STREET
2ND COURT
MERCEDES AVENUE
BONITA AVENUE
PALO ALTO
MACARTHUR BOULEVARD
HAMILTON AVE
CHERRY
CORY
BAYOU CT
SOUTH AVENUE
HOLLIS
BUNKERS
DAVIS
WILSON AVENUE
COVE AVE
LINDA
PLACE
STREET
COURT
1ST
2ND
HARMON
BEACH DRIVE
COMMUNITY-PANEL NUMBER
120012 0010 D
MAP REVISED:
JANUARY 3, 1986

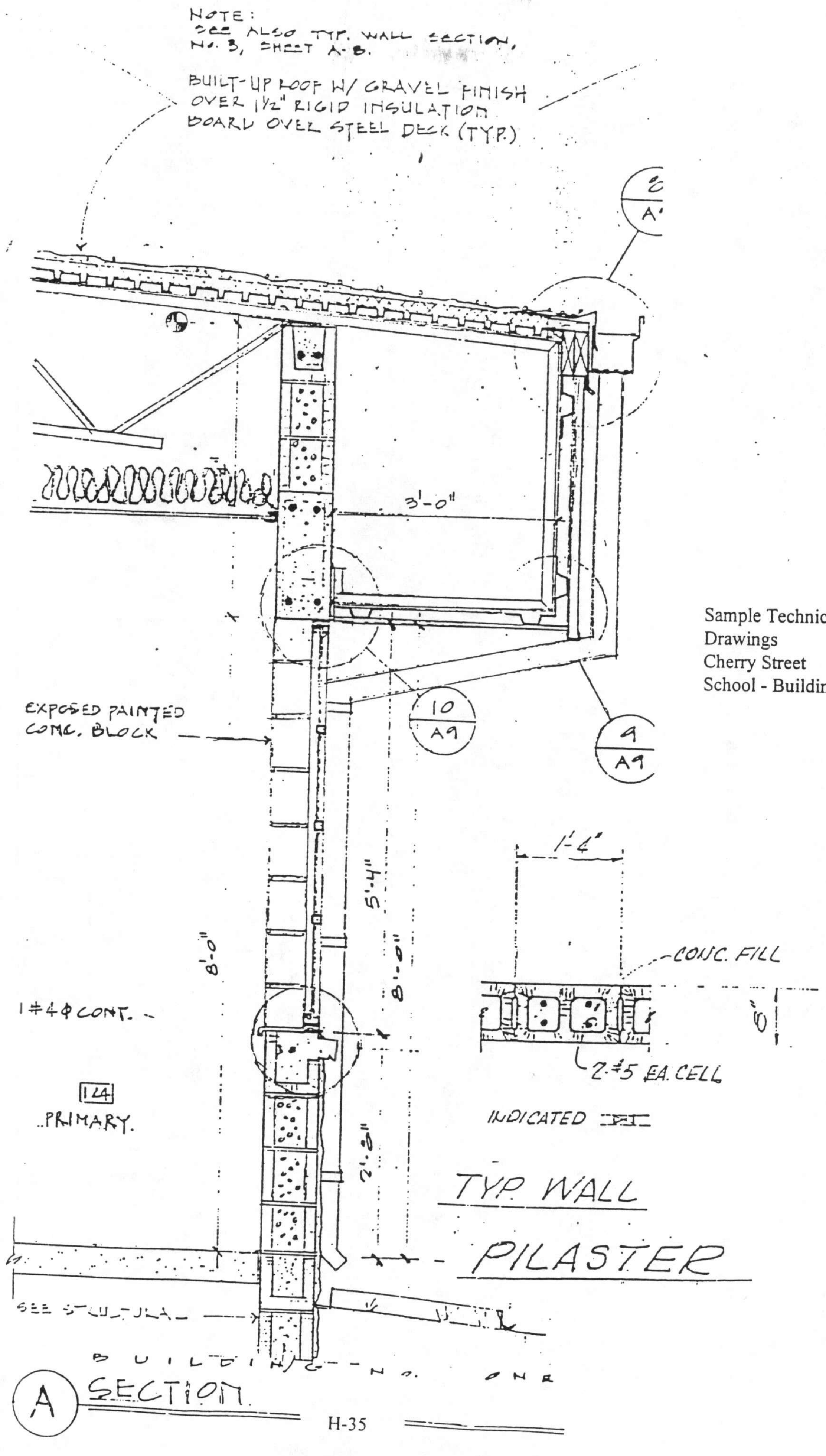

Low-rise residential construction - 1950's
Sheltered exposure
N
OPEN FIELD
Pine Trees
OPEN FIELD
Pine Trees
Classroom Bldgs - Unreinforced Masonry, Shallow slope gypsum on Formboard roof w/ BUR and Gravel
Portable classrooms
1950's #5
1950's #4
#8
1950's #3
1950's #2
1953 #7
#6
#1
1987
30-foot Elevation
A/C
A/C
Commercial Shopping Center - Masonry Construction
Campus Drainage
Large Pine Trees
Sheltered exposure
Lannie Rowe Nature Park across street
M. CHERRY ELEM.
Low-rise residential construction - 1960's - Sheltered exposure
92



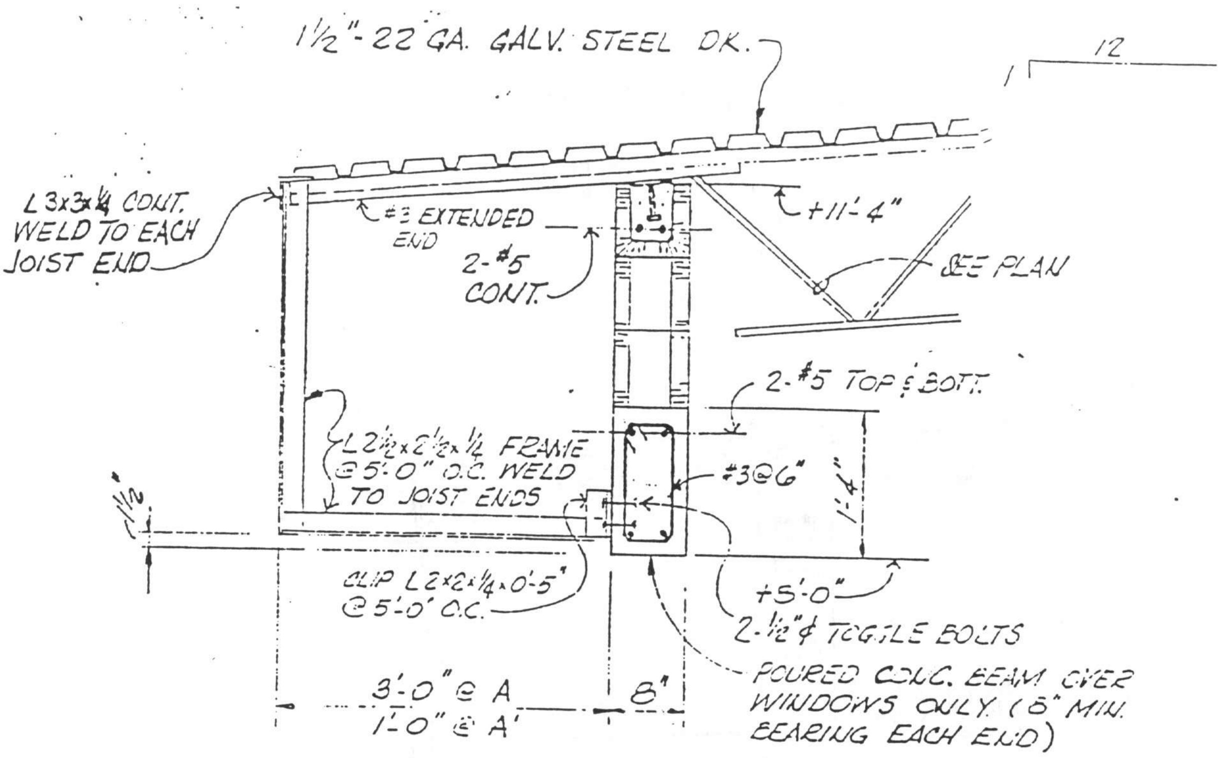
Sample Floor Plan
Cherry Street
School - Building #1



Sample Floor Plan
Cherry Street
School - Building #1

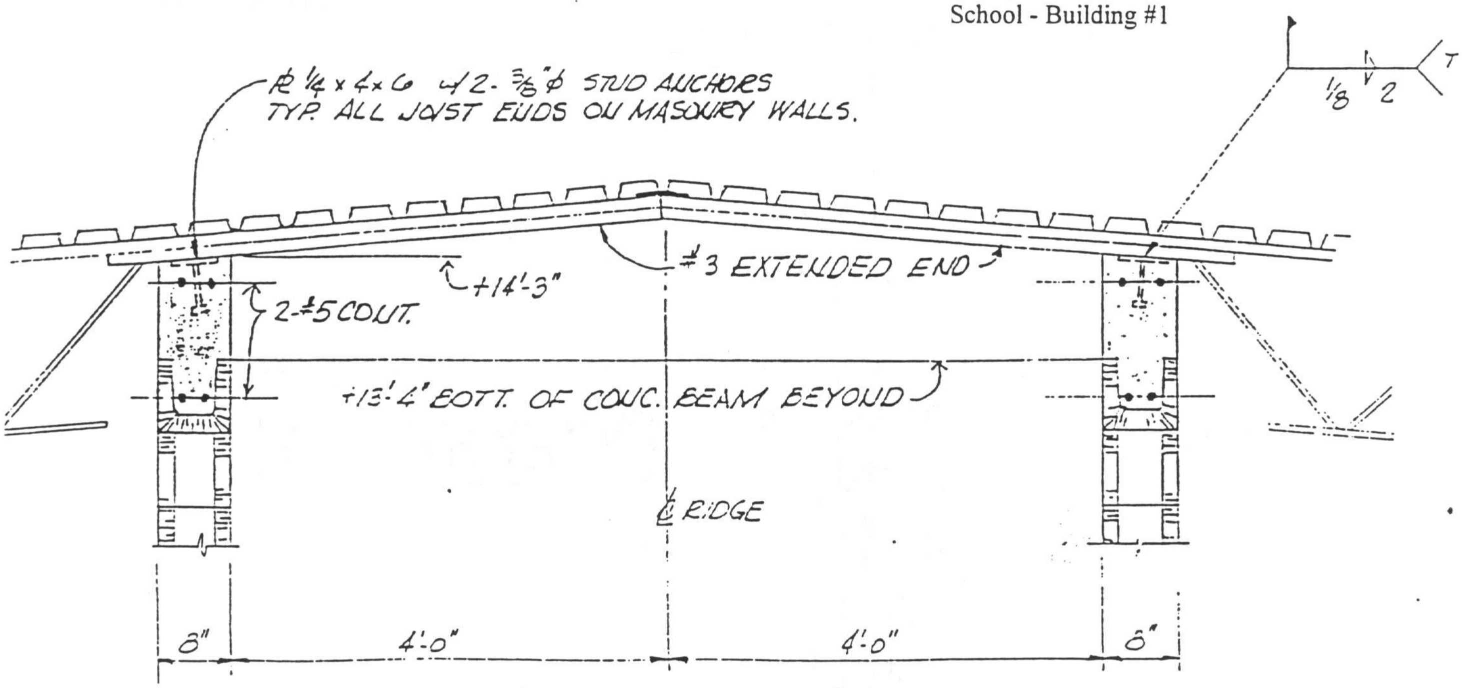


Sample Technical Drawings
Cherry Street School - Building #1

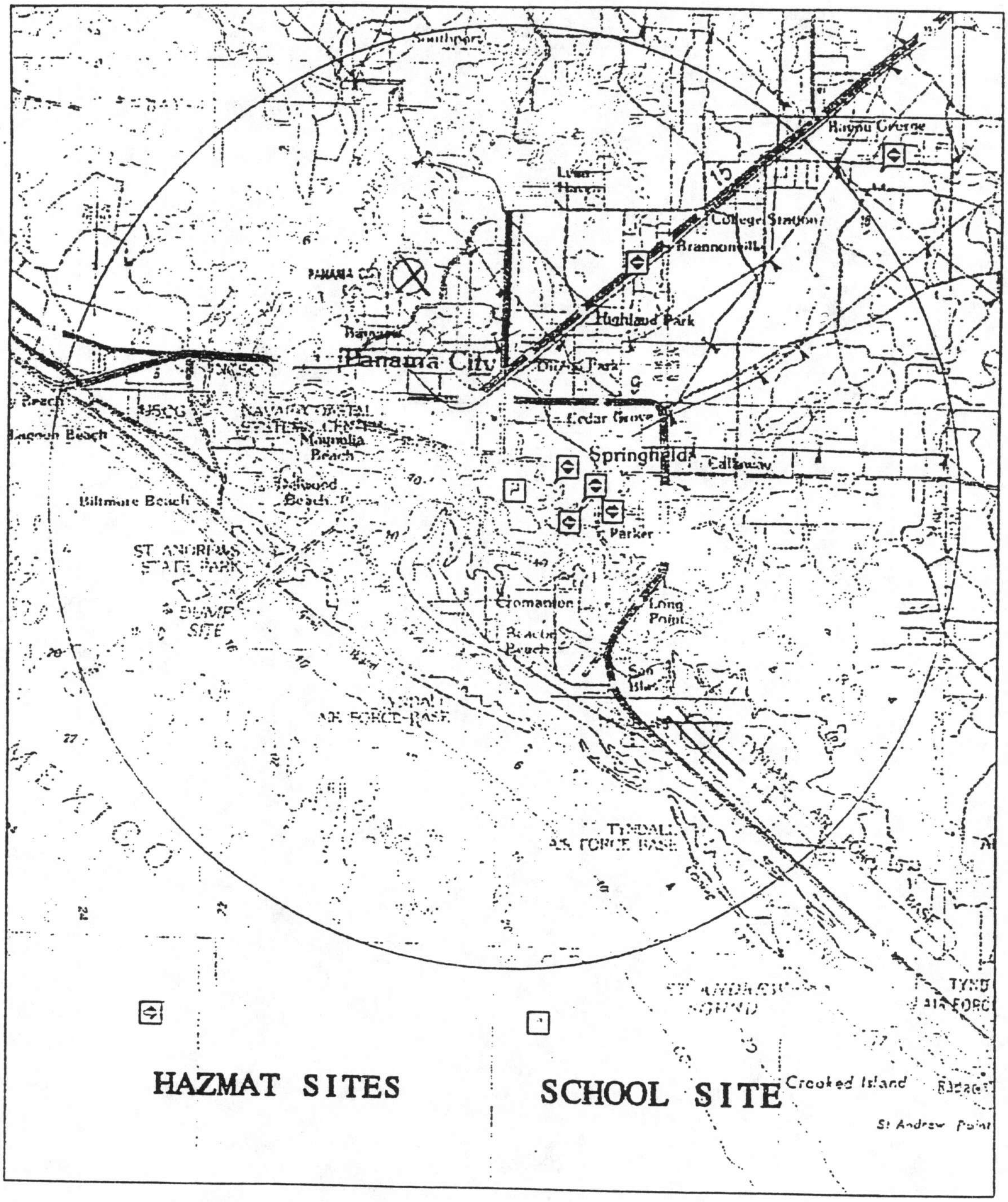


SECTION B

Sample Technical
Drawings
Cherry Street
School - Building #1



SECTION C


Southport
Lynn Haven
College Station
Brannonville
Bayou George
Highland Park
Panama City
Cedar Grove
Springfield
Callaway
Parker
Magnolia Beach
Hollywood Beach
Biltmore Beach
Lagoon Beach
ST. ANDREWS STATE PARK
DUMP SITE
Cromanton
Long Point
Beacon Beach
San Blas
TYNDALL AIR FORCE BASE
MEXICO
ST. ANDREWS SOUND
Crooked Island
St Andrew Point
HAZMAT SITES
SCHOOL SITE