

NATIONAL HURRICANE PROGRAM

**PRE-IMPACT GUIDANCE AND BEST
PRACTICES FROM EMERGENCY
MANAGERS**

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PREFACE

This *National Hurricane Program Pre-Impact Guidance and Best Practices for Emergency Managers Document* (hereafter referred to as the NHP Pre-Impact Guidance) is intended to:

Provide guidance to emergency managers based on well-established best practices and lessons learned to assist state and local emergency managers develop or update their hurricane response plans, training programs, and Hurricane Evacuation Studies (HES).

The purpose of this document is to present experience, best practices, and lessons learned from federal, state, and local emergency managers applied to a decision-making structure that emergency managers may reference, or use to develop pre-impact planning checklists and step-by-step processes that are meaningful to their jurisdiction.

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This document is organized into five chapters as presented below.

- **Chapter 1 – Introduction:** Provides basic background information for using this document, including its purpose and scope, and background information for the National Hurricane Program.
- **Chapter 2 – NHP Operational Model:** Presents a process diagram that depicts the critical activities in the tropical cyclone preparedness cycle, including activities and decisions in planning and response. The Operational Model serves multiple purposes for the NHP: it articulates the value of the NHP for tropical cyclone preparedness at the local and state level; and it helps support NHP strategic and investment decisions.
- **Chapter 3 – Hurricane Evacuation Studies:** Provides information on Hurricane Evacuation Studies (HES), which determines the vulnerability of a population to tropical cyclone hazards and provides guidance to local emergency managers for planning evacuations of at-risk populations. One of the key outputs of a HES is the matrix of evacuation clearance times—the number of hours it takes to move the threatened population to safety, given various factors such as the category of the tropical cyclone, the tourist occupancy (or population), and public responsiveness.
- **Chapter 4 – Real-Time Tropical Cyclone Response:** Discusses the five phases of tropical cyclone response. These five phases represent a consistent framework which emergency managers can use to support the development and update of their tropical cyclone response plans based on local jurisdiction best practices and lessons learned.
- **Chapter 5 – Training:** Discusses recommended tropical cyclone preparedness training for emergency managers. In addition Chapter 5 also describes the NHP Technology Modernization (TM) Effort, which is a pilot intended to enhance the types of training available to emergency managers.
- **Appendix A – HURREVAC:** Describes the data flow contained in HURREVAC as well as application of this data.

CHAPTER 1: INTRODUCTION

1.1 Purpose

The purpose of the NHP Pre-Impact Guidance is to present experience, best practices, and lessons learned from federal, state, and local emergency managers applied to a decision-making structure that emergency managers may reference, or use to support the development of checklists for pre-impact planning that are meaningful to their jurisdiction. This guidance is not intended to dictate how tropical cyclone planning and response must be done.

1.2 Scope

The NHP Pre-Impact Guidance covers the following topics:

- Overview of the NHP and the NHP Technology Modernization Project
- NHP roles and responsibilities, including the planners, decision-makers, and stakeholders for tropical cyclone planning and response
- The NHP Operational Model, which also serves as decision-making guidance for emergency managers
- Guidance for Hurricane Evacuation Studies
- Guidance for pre-impact tropical cyclone planning
- Recommendations for training

Technology for tropical cyclone planning and response (e.g., forecasting models, decision support tools, etc.) is referenced throughout the document. This document is one of the many products being developed in the National Hurricane Program Technology Modernization Project, which aims to provide enhanced methods and technology to improve tropical cyclone planning and response. The NHP Pre-Impact Guidance will describe methods/technologies that can be implemented and used today, as well as methods/technologies that the NHP TM Project will produce for future use. Furthermore, the guidance will evolve to reflect changes and advances in the National Hurricane Program.

1.3 Guidance Principles and Assumptions

The NHP Pre-Impact Guidance adheres to several overarching principles and assumptions, which are critical to understanding and utilizing the document. This guidance is meant to support emergency managers in developing and updating tropical cyclone response plans based on guidance and best practices from multiple local jurisdictions with significant tropical cyclone response experience.

The NHP Pre-Impact Guidance is structured to provide jurisdictional stakeholders flexibility in developing and updating their current response plans as local circumstances and conditions provide specificity to individual jurisdictions' tropical cyclone response plans.

1.4 Program Background

NHP Pre-Impact Guidance was written as part of the NHP Technology Modernization Project. This section provides background context on the National Hurricane Program and the NHP Technology Modernization Project.

National Hurricane Program

Tropical cyclones are a major threat to U.S. coastal regions, particularly along the Gulf and Atlantic coasts. These disasters often have major impacts to life and property in the regions directly impacted. Cases such as Andrew (1992) in Florida, Katrina (2005) in Louisiana and the Gulf Coast, and Sandy (2012) in the Northeast, demonstrated that tropical cyclones can impact areas well outside where landfall is made. As such, tropical cyclone preparedness and response require coordination and support at all levels of government.

The Federal Emergency Management Agency's (FEMA) National Hurricane Program (NHP), created in 1985 and further mandated by the 2006 Post Katrina Emergency Reform Act (PKEMRA), helps protect communities and residents from tropical cyclone hazards by providing evacuation preparedness technical assistance to state, local and tribal governments. FEMA's legislative mandate¹ is as follows:

“The Administrator, in coordination with the heads of the other appropriate Federal agencies, shall provide evacuation preparedness technical assistance to state, local, and tribal governments, including the preparation of tropical cyclone evacuation studies and technical assistance in developing evacuations plans, assessing storm surge estimates, evacuations zones, evacuation clearance times, transportation capacity, and shelter capacity.”

The NHP is a multi-agency partnership, involving FEMA, the National Oceanic & Atmospheric Association (NOAA) National Hurricane Center (NHC) and the U.S. Army Corps of Engineers (USACE). The NHP also coordinates with numerous other Federal agencies.

As stated in the National Preparedness Goal (FEMA, FEMA National Preparedness Goals, 2013) and the NHP Fiscal Year 2014-2018 Strategic Plan (FEMA, National Hurricane Program Strategic Program Plan 2014-2018, 2014), the NHP's three primary mission goals are:

¹ DHS and FEMA legislative mandate are under the Robert T. Stafford Disaster Relief and Emergency Assistance Act and the Post-Katrina Emergency Management Reform Act (Section 632). USACE participation is authorized by Section 206 of the 1960 Flood Control Act (PL 86-645) as amended.

- 1) Provide tools and resources to plan, prepare for, and protect against tropical cyclones at the local, state, regional, tribal and national levels.
- 2) Deliver comprehensive tropical cyclone evacuation training and technical support to local, state, and tribal emergency managers and to federal agency partners.
- 3) Provide real-time information and guidance to local, state, and tribal emergency managers to support their tropical cyclone evacuation decisions during a tropical cyclone's approach.

To address these goals, the NHP consists of eight major component program areas:

- Hazard Analysis
- Hurricane Evacuation Studies
- Decision Support Tools
- Training
- Real-time Operational Support
- Local, State and Federal Coordination
- Technology Integration and Modernization
- Post-Storm Assessment

The NHP Technology Modernization Project, as described below, aims to enhance and inform all eight of these programmatic goals.

National Hurricane Program (NHP) Technology Modernization (TM) Project

The NHP TM Project began in 2014. It is funded jointly by the Department of Homeland Security's (DHS) Science and Technology (S&T) and FEMA, and performed by MIT Lincoln Laboratory and Sandia National Laboratories. The goal of this 3-year (3 phased) DHS funded project is to bring enhanced capabilities and new technologies to tropical cyclone preparedness.

NHP TM Project – Phase 1: In the first phase of the modernization project, a 6-month gap analysis was conducted to identify opportunities to augment the NHP by incorporating next-generation tools and processes. The analysis team reviewed NHP component materials; visited field sites; attended NHP trainings; and conducted interviews with more than 45 Subject Matter Experts (SMEs) representing over 20 organizations from 11 states and territories, The National Hurricane Center (NHC), FEMA, USACE, and others. The analysis identified capability gaps, which were subsequently validated and then organized using a cost-benefit framework. At the conclusion of the gap analysis process, the NHP had a clear vision for next generation tools and processes related to tropical cyclone preparedness and response that will leverage the latest research and technology developments. Phase 1 ended with the following NHP recommendations:

- Evolve HURREVAC into an integrated decision-support platform

- Transform weather forecast information products into information and guidance that can improve local decision-making
- Provide more comprehensive and accessible training
- Improve the efficiency of the HES process
- Establish, document, and share best practices for the NHP
- Extend the scope of NHP beyond response level planning and resilience towards inclusion of mitigation planning for critical facilities and infrastructure

NHP TM Project – Phases 2 & 3: Currently underway, the second and third phases of the NHP TM Project involve development of new capabilities and products to address the Phase 1 NHP recommendations. Pilots for integrating HURREVAC, updating HESs, and expanding training. This NHP document is an example of current efforts in Phases 2 and 3 to address the programmatic recommendations.

CHAPTER 2: NHP OPERATIONAL MODEL

The NHP Operational Model (OM) is a process diagram that depicts the critical activities in the tropical cyclone preparedness cycle. The OM provides a holistic view of what decisions are made, when, and by whom, and illustrates what information is communicated between stakeholders. The OM serves the following purposes for the National Hurricane Program:

- The OM articulates the value of the NHP for tropical cyclone preparedness at the local and state level.
- The OM supports the NHP strategic and investment decisions. Specifically, the OM enables systems-level analyses that inform programmatic-level investment priorities (e.g., prioritizing NHP investment funds).

2.1 Operational Model Overview

The OM provides new state and local emergency managers a general roadmap of critical tropical cyclone planning and response activities over time. The OM, which is shown in Figure 1, includes activities and decisions that take place in planning and response.

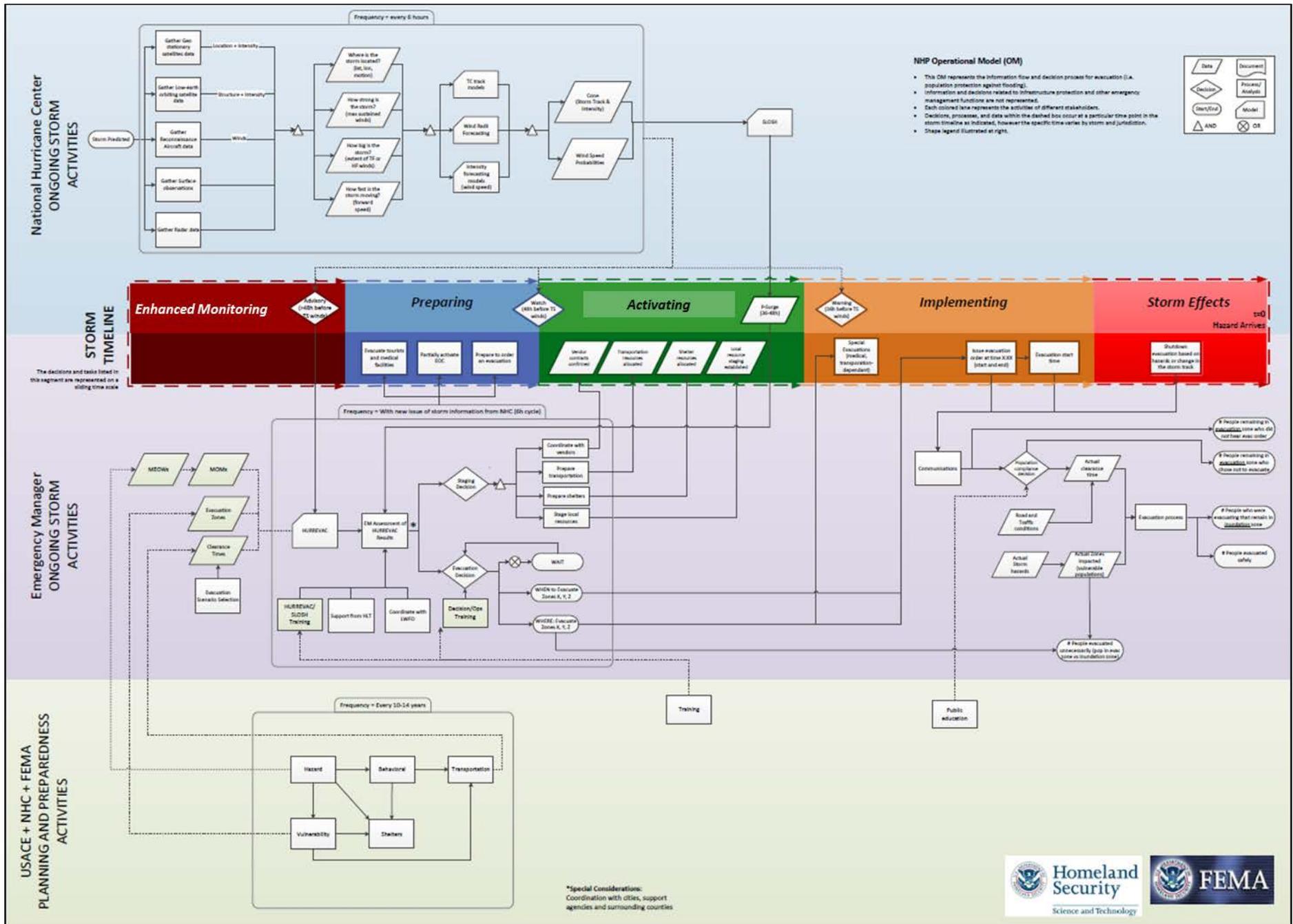


Figure 1. Complete Operational Model

The OM is color-coded according to various roles and responsibilities for planning and response. The storm timeline, which is the brightly colored dashed box, is based on the Real-Time Hurricane Response Phases (defined further in Chapter 4). Decisions and activities included in the storm timeline are represented on a sliding time scale. The specific times at which these activities occur vary by storm and jurisdiction. All other activities and decisions outside of the storm timeline are ongoing, iterative, and/or recurring, therefore are not fixed to the specific time in the storm timeline. The OM consists of three “lanes” of storm-related activity that drive the decisions and activities in the storm timeline. A simplified view of the lanes and the storm timeline is shown in Figure 2.

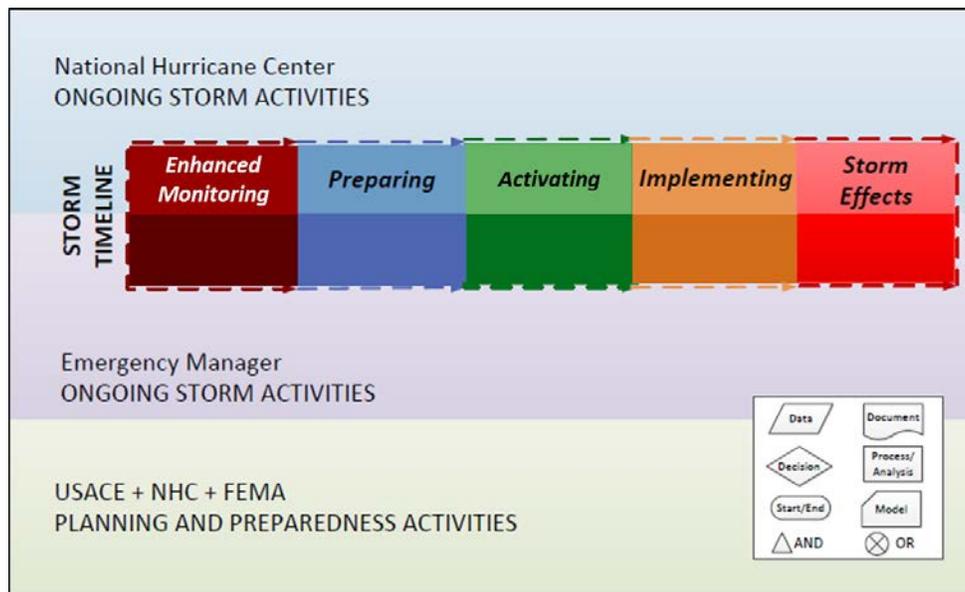


Figure 2. Three “lanes” of storm-related activity drive decisions and activities that occur in the storm timeline.

- Emergency Manager ongoing storm activities (Purple Lane): This lane illustrates how emergency managers utilize NHC products along with their local HES information to make decisions about evacuation and resource allocation. Activities and decisions are closely linked to the Real-Time Hurricane Response Phases that make up the storm timeline. Emergency manager activities (including the use of HURREVAC) and decisions (including when and where to evacuate) are described in detail in Chapter 4.
- National Hurricane Center (NHC) ongoing storm activities (Blue Lane, Figure 3): This lane shows the data gathering and analysis steps performed by the NHC to produce storm products (advisories, warnings, predictions, etc.) that are used by emergency managers and other stakeholders leading up to the storm.

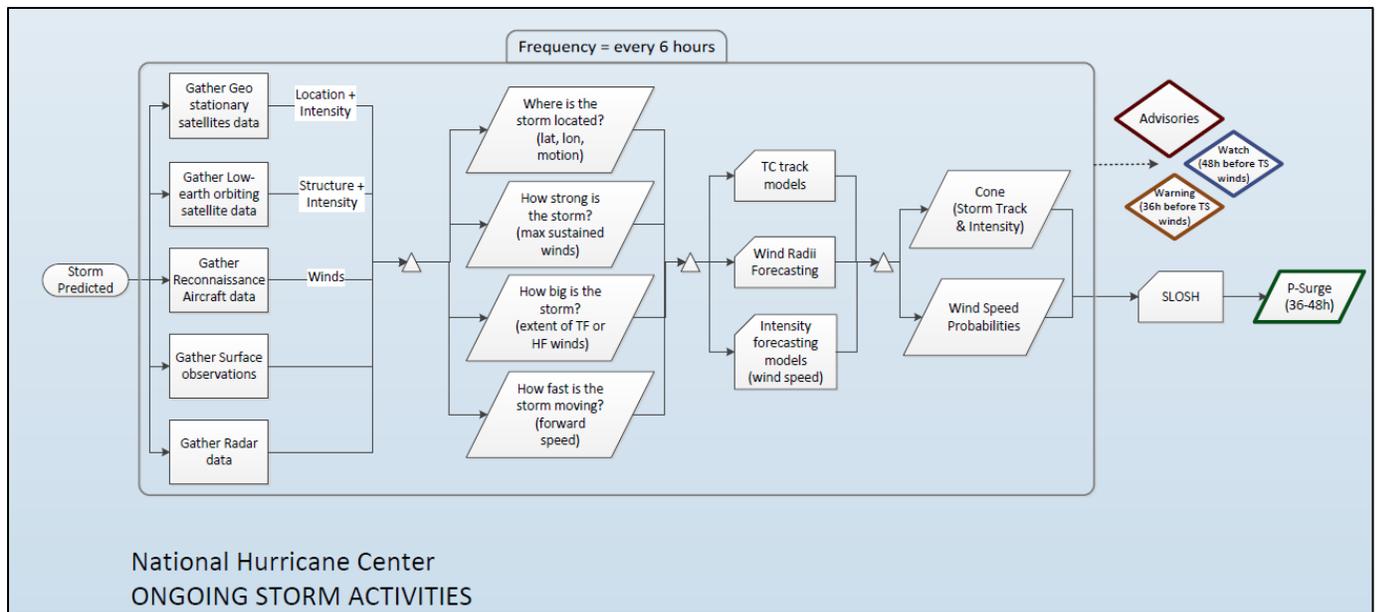


Figure 3. NHC activities leading up to a tropical cyclone.

- Planning and Preparedness Activities (Green Lane, Figure 4): NHP supports many additional preparedness activities outside of tropical cyclone season including emergency manager training and public education campaigns (e.g. “know your zone”). In addition, the U.S. Army Core of Engineers (USACE), NHC, and FEMA periodically conduct Hurricane Evacuation Studies for different communities that are threatened by hurricanes. Among several other products (e.g. storm surge mapping, vulnerability assessments, shelter assessments, and behavioral assessments), these studies produce two key pieces of data that are used by emergency managers for decision making in real storm situations: evacuation zones and clearance times. The HES process is summarized below as five interconnected analyses (hazard, vulnerability, behavioral, shelter, and transportation) and is described in more detail in Chapter 3.

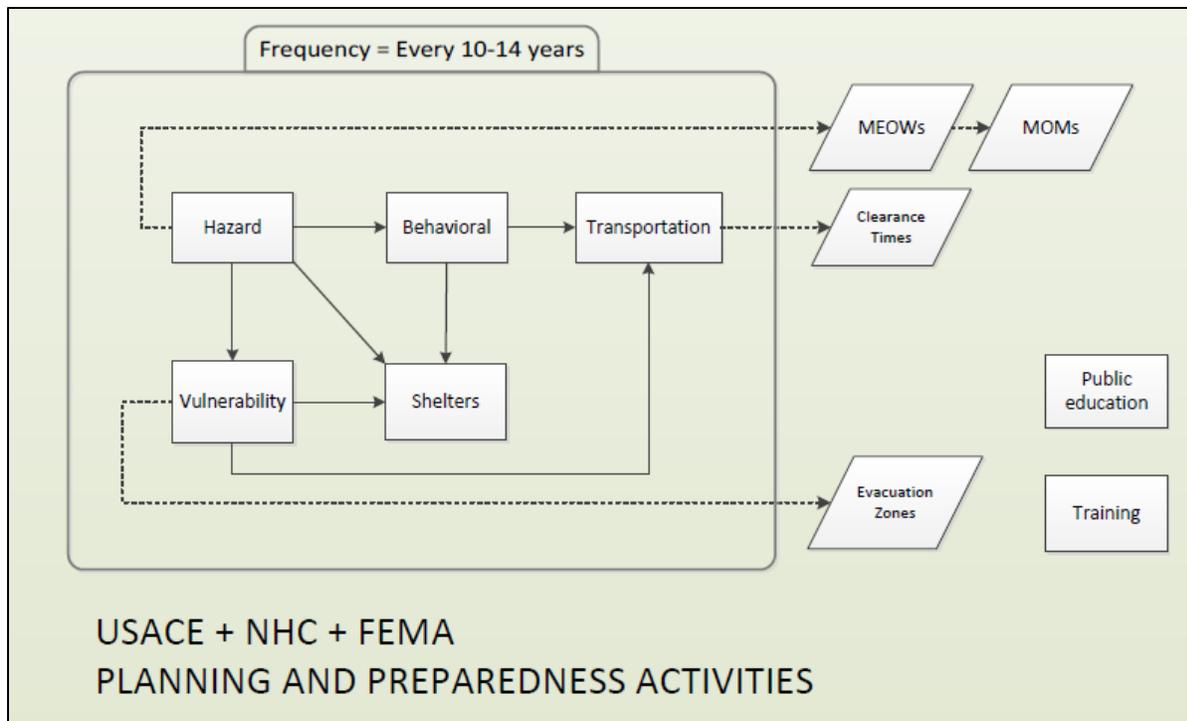


Figure 4. NHP planning and preparedness activities that support hurricane response.

2.2 Metrics

The Operational Model also illustrates tropical cyclone outcomes metrics, which the NHP is using to measure the performance and the impact of the Program’s sponsored technology modernization projects. These metrics offer a consistent assessment of the Program’s effectiveness as well as assist the NHP in identifying areas for improvement.

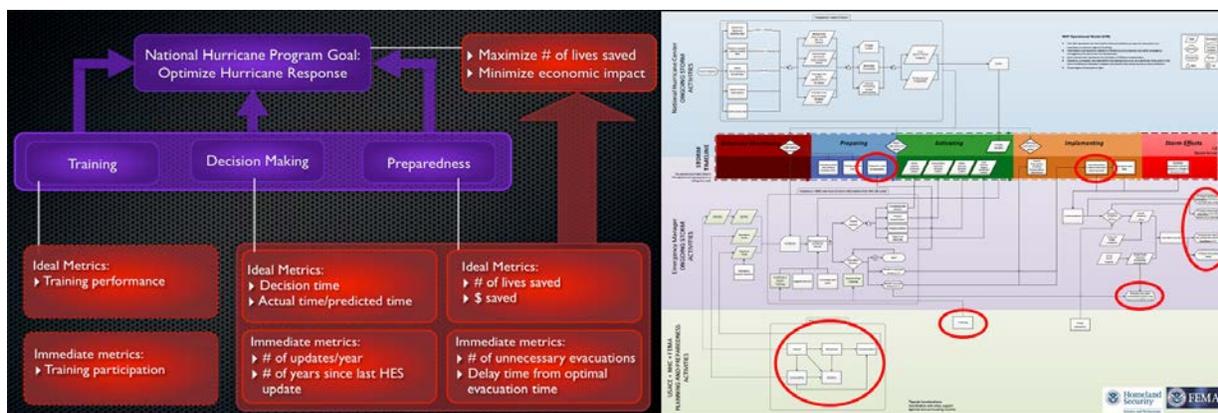


Figure 5. Components of the Operational Model circled in red (Right) are tied to ideal and immediate metrics developed for each of the NHP Program Goals (Left).

There are two types of metrics used for the NHP TM Project, ideal and immediate. While ideal metrics best represent the TM Project’s performance against goals, ideal metrics are difficult (to nearly impossible) to measure at this time. Immediate metrics, on the other hand, are directly

measurable components of the TM Project that can provide clear insight into programmatic-level performance. These metrics are not meant to comprehensively measure every aspect of every preparedness, decision-making, or training capability, but instead to representatively measure the most critical and/or relevant aspects of these capabilities. As solutions are implemented and gaps are addressed by the NHP, improvements in these metrics should be reflected.

CHAPTER 3: HURICANE EVACUATION STUDIES

3.1 Hurricane Evacuation Studies (HES)

Hurricane Evacuation Studies assess hazards, determine the vulnerability of a population to tropical cyclone threats, and provide guidance to local emergency managers for planning an evacuation of the at-risk population. One of the key outputs of a HES is the matrix of evacuation clearance times—the number of hours it takes to move the threatened population to safety given various factors such as the category of the storm, the tourist occupancy, population, and public responsiveness. Hurricane evacuation studies are typically composed of five interrelated analyses:

1. The tropical cyclone hazard
2. The vulnerability of populations, areas, and infrastructure
3. Population behavior
4. Shelter needs in the event of an evacuation
5. Transportation needs in the event of an evacuation

The NHP Technology Modernization Project includes a pilot for updating the HES process. This updated process improves efficiency and effectiveness through enhanced data and visualization as well as the integration and automation of analysis tools.

The following describes the five interrelated analyses of an evacuation study and presents best practices on application of the HES results.

Hazard Analysis

The purpose of the hazard analysis is to calculate the overall footprint of storm surge inundation. The National Oceanic and Atmospheric Administration (NOAA) Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model is used to calculate storm surge water surface elevation values used to create storm tide inundation maps. Since many factors influence storm surge heights, the maximum calculated surge heights are composited for thousands of different types of hurricanes within a storm surge (SS) category. Occurrence probabilities of these hurricanes are not considered.

The results from the simulations are used to identify possible areas of storm surge inundation and maximum surge heights from various combinations of hurricane forward speed, trajectory, storm size, and high tide level within each SS category. The surge height outputs from SLOSH are then compared to local high-resolution ground elevation data to finalize the areas of possible storm surge inundation for each SS category. These areas of potential inundation are shown on the Storm Tide Inundation Map. The SLOSH output, and therefore the Storm Tide Inundation Map, does not include any impacts from wave action. The inundation zone for an SS category shown on the Storm Tide

Inundation Map does not depict the expected storm surge from any one particular type of hurricane with that SS category. Rather, the Storm Tide Inundation Map depicts areas of possible flooding from thousands of hypothetical hurricanes within an SS category. The map provides an upper threshold estimate of potential storm surge inundation during a high tide landfall, which is important for the purpose of developing hurricane evacuation zones for HES. The Storm Tide Inundation Map is used for long-range hurricane planning and population protection, and is not used for regulatory or insurance purposes.

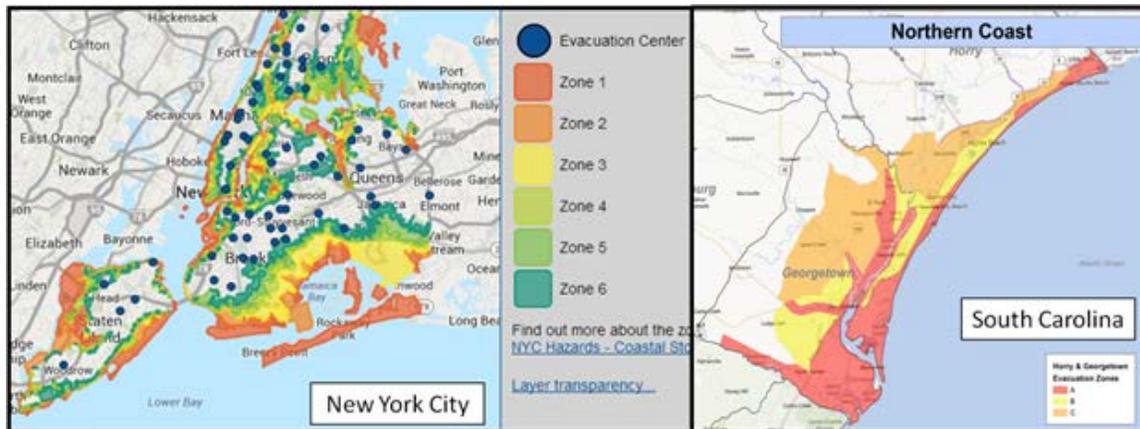


Figure 6. Example of tropical cyclone evacuation zones for New York City (left) and the Northern Coast of South Carolina (right)

Low lying coastal areas and beaches are generally the most vulnerable to surge, and are thus most likely to be evacuated. Areas further inland are only evacuated for higher category storms that bring increased storm surge. The most vulnerable areas are typically designated as Zone “A” or “1” with each successive region increasing by a letter or number. For some areas there is no need to designate multiple zones, while other areas have as many six or more zones.² Some coastal evacuation zones correspond to zip codes in order to minimize confusion regarding the zones residents live in. In addition to storm surge, the evacuation zones also take into account regions that have road access that could flood thereby isolating the region. Figure 6 illustrates two examples of hurricane evacuation zones.

Vulnerability Analysis

The purpose of a vulnerability analysis is to identify the areas, populations, and infrastructure vulnerable to tropical cyclone surge and, in some instances, flooding and/or wind damage. Evacuation zones are defined during the vulnerability analysis based on surge areas and other physical features (e.g. major roads, county borders, etc.). Population statistics are obtained from the U.S. Census Bureau and the vulnerable

² The Houston area evacuates by ZIP code.

population is determined by overlaying the population at the most detailed level available (typically block level) with storm surge and evacuation zone maps. Demographic analysis is performed to determine the population characteristics that may be impacted by storm surge. Some populations, including persons with disabilities and other access or functional needs, may require additional time to evacuate; areas of high population density may require special egress options like reversed lanes on major highways, and inner-city or populations without personal transportation means may require buses or other forms of public transportation.

Mobile homes are especially vulnerable to storm surge and tropical cyclone winds. The location of mobile homes is estimated based on three sources: 1) U.S. Census Data, 2) the 2010 American Community Survey (ACS) 1-year estimates (for areas with a population of 65,000 or more) and, 3) the 2005-2009 5-year estimates (factfinder.census.gov). The mobile home population in each evacuation zone and storm surge area is calculated by multiplying the number of mobile homes by the average household size for that county.

Tourist populations are also especially vulnerable to tropical cyclones and generally must be evacuated. The number of tourists in an area is estimated from data on hotel/motel and campground locations and seasonal occupancy rates. This information is typically collected at the state level. Additional seasonal, recreational, and occasional use residences are also considered. Together, this information is used to identify and locate the non-resident vulnerable populations within the evacuation zones.

A survey of vulnerable infrastructure is performed to identify roads, bridges, buildings, power generation facilities, and other infrastructure that require mitigation or protection from storm surge. The facilities and infrastructures selected for inclusion are determined in coordination with state and local emergency management. The number of vulnerable properties (residential, commercial, and industrial) is determined from detailed data sources like that from local tax assessors.

Behavioral Analysis

The purpose of the behavioral analysis is to estimate the evacuation behavior of vulnerable populations. The behavioral analysis provides an understanding of residents' attitudes and the potential evacuation response of a community, including residents, visitors, tourists, and those with access and functional needs. The analysis is based on public surveys that measure what people believe they will do in response to a tropical cyclone. The questions asked in the survey are used to determine:

- How likely people are to evacuate
- Where people will evacuate
- What method of transportation will be used for evacuation
- What items they might take with them (e.g. pets, towing trailers, etc.)
- When they will leave

- Where they will get tropical cyclone information

The analysis is used to predict, based on storm category, the number of people who will evacuate, the rate at which they will evacuate, and the shelter and transportation capacity needed for their evacuation.

Shelter Analysis

The purpose of the shelter analysis is to estimate the number of evacuees seeking public shelter and identifies the number and capacities of shelters required to meet this need. The shelter analysis uses the information gathered in the vulnerability and behavioral analyses to estimate the number of people who will seek public shelter and how many shelter spaces and other resources are needed to accommodate them. State and county emergency management offices can use this information to anticipate sheltering needs and develop plans to ensure that evacuees seeking public shelter will have adequate and safe shelter space. The shelter analysis also determines if structures used as shelters by the community are in an evacuation zone. Previous HESs have indicated very low public shelter demand in many areas. Particularly in tropical cyclone-prone areas, families often have their own plans of evacuating to other areas within their home state in order to stay with family or friends.

Transportation Analysis

The purpose of the transportation analysis is to calculate the time required for vulnerable populations to evacuate impacted areas. In most evacuation zones the most effective transportation mechanism is to travel by automobile; however, many roadways are not designed for the demand of a tropical cyclone evacuation. Based on the behavioral surveys, emergency managers estimate the number of people who will need to travel by car. Demand increases or decreases depending on the level of tourism (i.e. tourism peaks during the summer vacation season for most coastal communities).

Clearance times are estimated by comparing the expected traffic volume to the traffic capacity of evacuation routes. The rate of evacuation is impacted by the daily traffic demand (e.g., people are at work or home), local construction, tolls, and other factors. In some areas, significant traffic delays may occur. Transportation models are used to estimate where bottlenecks might occur and recommend potential alternatives or staged evacuations (e.g., odd/even license plates, road metering, reversed lanes).

Technology Insertions

Technology Insertions for HESs

Through the NHP technology modernization effort, a new tool will be developed to automate and modularize the HES process. Rather than compiling all the HES analysis results in a technical data report, the five analyses will be linked together in the standardized, modeling, mapping and data analysis platform called SUMMIT (Standard Unified Modeling Mapping and Integration Toolkit).

Hazard Analysis

In the HES Tool, the NOAA SLOSH model will continue to provide MEOW's and MOM's and USACE will create high-resolution surge maps as needed.

Proposed updates include the accessibility of SLOSH model results through SUMMIT. This standardized platform will allow for the uniform application of the SLOSH model results to subsequent HES components in an integrated, rapid, and user-friendly environment.

Vulnerability Analysis

The HES Tool will use the annually updated LandScan data to determine the number and location of people located in surge zones, while population demographic information will continue to be determined from U.S. Census data. Access to this data will be provided through SUMMIT. This pilot will also produce guidance for enhancing evacuation zoning and the benefits of this enhancement.

Behavioral Analysis

The HES Tool will explore development of algorithms for estimating population behavioral response (e.g., seeking shelter, complying with evacuation orders) based on storm characteristics and population demographics.

Shelter Analysis

The HES pilot will use the National Shelter System and make this information accessible through SUMMIT to integrate this data with other HES data and analyses.

Transportation Analysis

The HES pilot will integrate RtePM (Real-Time Evacuation Planning Model) for transportation analyses, with the other HES data and analyses in SUMMIT.

Chapter 4: REAL-TIME HURRICANE RESPONSE PHASES

This section provides a framework that emergency managers can use to develop and update their tropical cyclone response plans. The framework is based on the five tropical cyclone response phases and corresponding activities that may be performed during each phase. These phases and the potential actions identified are based on best practices from emergency managers, and are presented for consideration while conducting hurricane response planning efforts. The 5 phases are defined below:

- Phase 1: **Enhanced Monitoring** - “Prepare to Prepare”; issuance of the initial National Hurricane Center storm advisory could begin more than 120 hours prior to the onset of hazardous conditions, depending on where the tropical cyclone forms, how large it is, and how fast it is forecast to move.
- Phase 2: **Preparing** - pre-positioning; consider staffing needs; possible partial EOC activation; preparing for decision to order an evacuation.
- Phase 3: **Activating** - activation of EOC; supplies prepositioned for response.
- Phase 4: **Implementing** - issuance of evacuation order for evacuees in need of transportation assistance (that may include medical evacuees and persons with disabilities or other access and functional needs), if needed based on available forecast information and guidance, followed by evacuation of the general population if needed; evacuation completed if needed.
- Phase 5: **Storm Effects** - onset of hazardous conditions.

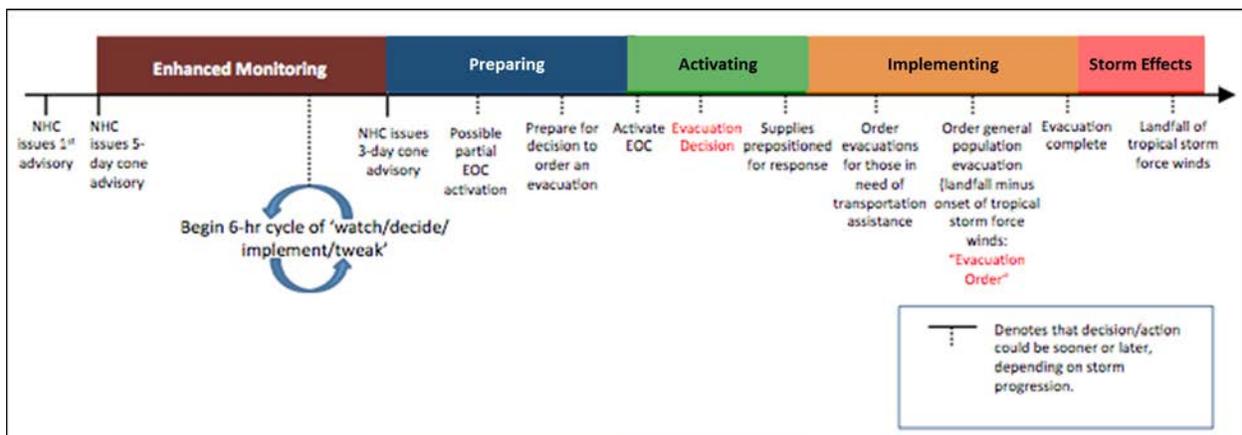


Figure 7. Hurricane Response Phases

(Note that the timeframe for phases and activities described in this section may vary greatly for different jurisdictions, and in different scenarios. Each jurisdiction should attach its own timeline to these phases based on their evacuation clearance times and storm timing.)

For each phase, considerations are included in the form of checklists and best practices for decision-making during tropical cyclone incidents, which can be modified as needed. The NHP Pre-Impact Guidance document is not intended to be comprehensive nor will all of the content

apply for every jurisdiction; rather it emphasizes tropical cyclone response decision-making based on historical emergency management response experience as well as lessons learned.³ Furthermore, it was written primarily for local emergency managers though it can inform federal, state, tribal, and territorial (FSTT) planning and response. Lastly, although some actions that are taken during response can help reduce restoration requirements, the NHP Pre-Impact Guidance focuses on real-time response, and does not cover restoration and recovery activities.

Topics covered in this chapter in greater detail include:

- Application of the HURREVAC Tool
- Analysis of data/ information received from National Weather Service
- Pre-positioning and Early Evacuations
- Characterization of the Forecast Impacted Zones
- Evacuation Decision
- Evacuation Order and Process
- Information and Communication to the Public

In addition to describing these decision points and key considerations for making these decisions, technology insertion points are suggested.

In Chapter 2 (Operational Model), the lane titled “Emergency Manager Ongoing Storm Activities” forms the framework for the emergency manager’s possible decision-making process. Chapter 4 – Real Time Hurricane Response Phases walks through the decisions/activities in this “Emergency Manager Ongoing Storm Activities” lane chronologically starting from the issuance of the first tropical cyclone advisory by the NHC (although multiple decisions/activities are underway after identification of a threat), and cover the topics listed above.

³ Sources for the guidance includes tropical cyclone response plans from Florida and Texas, and an in-depth set of interviews with 45 Subject Matter Experts (SMEs) representing over 20 organizations from 11 States and Territories, The National Hurricane Center (NHC), FEMA, US Army Corps of Engineers (USACE), and others.

4.1 Decision Making Process Phase 1: Enhanced Monitoring Phase

The figure below depicts the portion of the Operational Model addressed in this section: the decisions and activities shown in the “Emergency Manager Ongoing Storm Activities” lane (purple section).

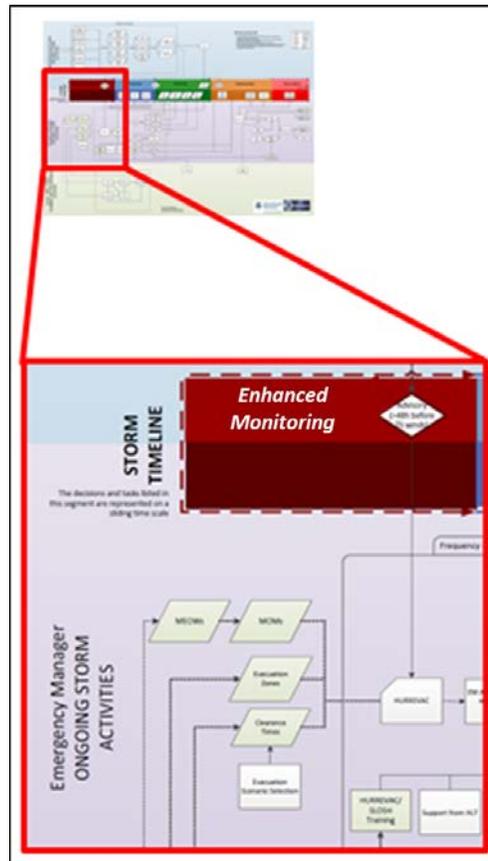


Figure 8. Operational Model: Enhanced Monitoring Phase

Jurisdictions continually monitor for tropical cyclone threats. For the purposes of this section, the assumption is being made that a potential tropical cyclone threat has been identified and its potential impacts are more than 5 days from occurring. Note: Tropical cyclones do not always present themselves as threats more than 5 days in advance of onset of hazardous conditions, formation may occur within 120 hours of onset. Also, in the event that tropical cyclones present themselves less than 5 days in advance, immediate response activities may be required.

4.1.1 Phase 1: Enhanced Monitoring Phase

The Enhanced Monitoring Phase includes preparation activities, such as monitoring the storm forecast data, and characterizing areas forecasted to be in the hazard zone. Timelines vary widely by jurisdiction, and depend on the current and forecast characteristics of the threatening tropical cyclone. The NHC begins issuing advisories upon formation of a tropical cyclone.

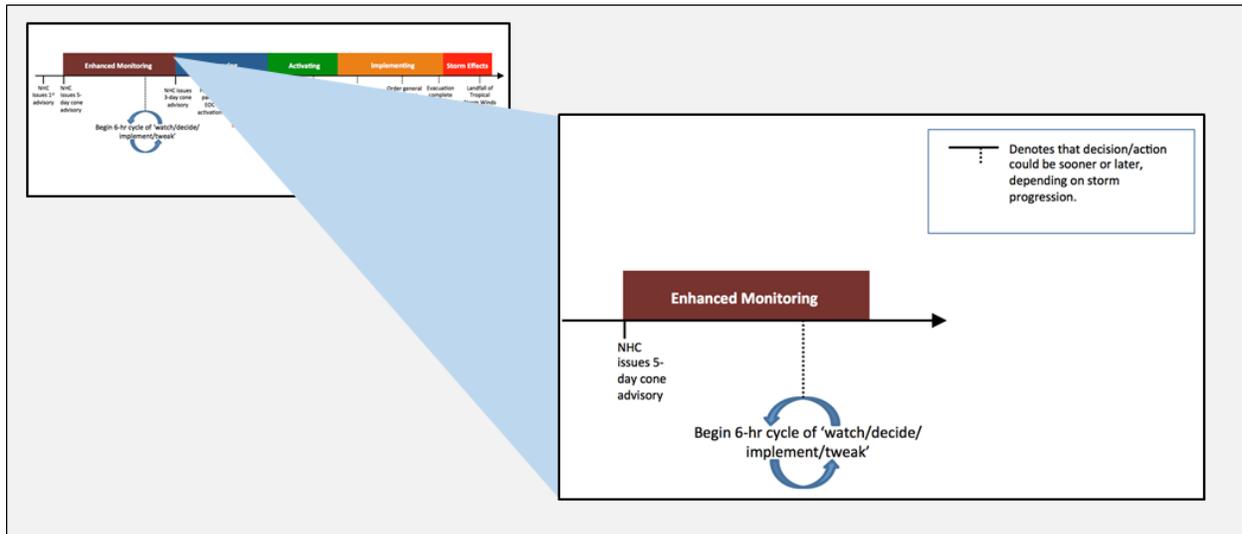


Figure 9. Enhanced Monitoring Phase

NHC Advisory

The NHC advisory includes a graphic (see Figure 10) with a “5-day cone.” The cone represents the probable track of the center of a tropical cyclone.



Figure 10. Example Graphic of 5-Day Track Forecast Cone

Definition of 5-day cone from National Hurricane Center¹

“The cone represents the probable track of the center of a tropical cyclone, and is formed by enclosing the area swept out by a set of circles (not shown) along the forecast track (at 12, 24, 36 hours, etc.). The size of each circle is set so that two-thirds of historical official forecast errors over a 5-year sample fall within the circle.

One can also examine historical tracks to determine how often the entire 5-day path of a cyclone remains completely within the area of the cone. Based on forecasts over the previous 5 years, the entire track of the tropical cyclone can be expected to remain within the cone roughly 60-70% of the time.”

There is a considerable amount of uncertainty in the storm forecast at this time, so any actions taken would be preparatory, such as EOC notification and public warning to prepare for the possibility of a tropical cyclone. Emergency managers might communicate with local and regional transportation providers (such as airlines and commuter rail) supporting potential evacuation needs. Regions with large tourist populations or convention centers might start to consider how and when this population should be evacuated. As social media is frequently a source of information, emergency management agencies may consider pushing out emergency preparedness messages while also monitoring social media outlets to address misinformation.

At the federal, state, tribal and territorial level, note that pre-positioning activities may begin to occur in this time period. State and federal mobilization of resources to aid the local level response (e.g., evacuation buses, debris removal supplies) may take more time to reach local communities.

HURREVAC

HURREVAC is a tropical cyclone tracking and decision support tool available to government emergency managers and provides guidance on evacuation timing. However, HURREVAC does not tell emergency managers whether or not to recommend evacuation. NHC tropical cyclone advisory and forecast data is automatically imported to HURREVAC. HURREVAC data and information can be used for storm tracking in the Enhanced Monitoring Phase. In subsequent phases, HURREVAC data and information can help inform the timing and extent of preparedness and early response activities. For a description of HURREVAC, see Appendix A.

More broadly, several resources are available to emergency managers to assist in use of NHC products. One such resource is the National Weather Service Weather Forecast Office (WFO), which assists in the interpretation of the hazards and risks for local jurisdictions. During the Enhanced Monitoring Phase, emergency managers may initiate a dialogue with the WFO regarding the use of NHC products, but it will be difficult for the WFO to identify or determine local impacts based on the hazards and risk data at this time. Nonetheless, the WFO is a critical resource for local emergency managers to use in addition to NHC products in subsequent phases described later in this document. Additionally, the local NWS office, neighboring jurisdictions and states, state planning officials, and FEMA regional offices are resources not just for interpreting HURREVAC results, but also for planning, response and recovery for tropical cyclone incidents.

Applied Use of the Hurricane Liaison Team

- Collaboration with the Hurricane Liaison Team (HLT) may assist in the rapid exchange of information between the NHC and your jurisdiction.
- The Hurricane Liaison Team can help interpret forecast products and HURREVAC data associated with current and past tropical cyclone advisories.

Considerations for State, Local, Tribal Emergency Managers

State and local emergency management professionals have collaborated to review the following Considerations Checklist during the Enhanced Monitoring Phase. The checklist is not intended to be a comprehensive list, prescriptive guidance, or planning requirements. Not all actions on the checklist will apply to all jurisdictions. The checklist provides a list of considerations for emergency managers at the state, local, and tribal levels to use if applicable as a resource when developing or updating their response plans.

Considerations Checklist: Enhanced Monitoring Phase
<ul style="list-style-type: none">• Contact the Hurricane Liaison Team to begin initial situational awareness discussions• Conduct (or update) initial tropical cyclone hazard analysis• Use Hurricane Evacuation Study data to establish clearance time estimates for the evacuation scenarios that may be applicable to the tropical cyclone incident• Develop and distribute the 5-Day Cone situational awareness information/report according to current planning protocols• Begin the 6-hour cycle of ‘Watch/Decide/Implement/Tweak’ as new NHC Advisory updates are issued• Contact the NWS’ local WFO to begin assessment collaboration• Monitor conference calls with participating entities such as NWS, NHC, FEMA, and other state level agencies involved with forecasting, decision support, and response.• Monitor weather and relevant media outlets• Perform an initial staffing assessment to include provisions for your emergency management staff to prepare their own homes and families• Conduct appropriate monitoring and assessment activities relevant to evacuees in need of transportation assistance, including individuals in medical care facilities and person with disabilities or other access and functional needs• Prepare to deploy supplies for shelters and other pre-storm operations; review existing logistics/vendor contracts

Technology Insertions

<u>Technology Insertions for the Enhanced Monitoring Phase</u>
<ul style="list-style-type: none">• Refine the worst case planning assumptions in the HES for vulnerable populations and infrastructure.• Follow updates in NHC Storm Advisories on HURREVAC to revise and refine your characterization of forecast impacted zones.

4.1.2 Decision Making Process Phase 2: Preparing Phase

Figure 11 below depicts Preparing Phase of the Operational Model that is addressed in this section. For the emergency manager, during this time period, critical activities include monitoring and assessing the forecast, and deciding whether and when an evacuation should be ordered. Once an evacuation decision is made, emergency managers may begin communicating to the public about the preferred evacuation window (i.e. start and end time).

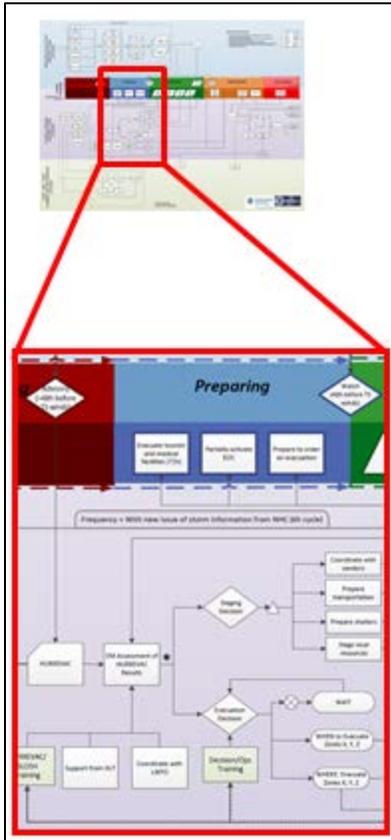


Figure 11. Operational Model: Preparing Phase

4.1.3 Phase 2: Preparing Phase

The Preparing Phase involves actions such as pre-positioning assets and partial activation of emergency operations centers.

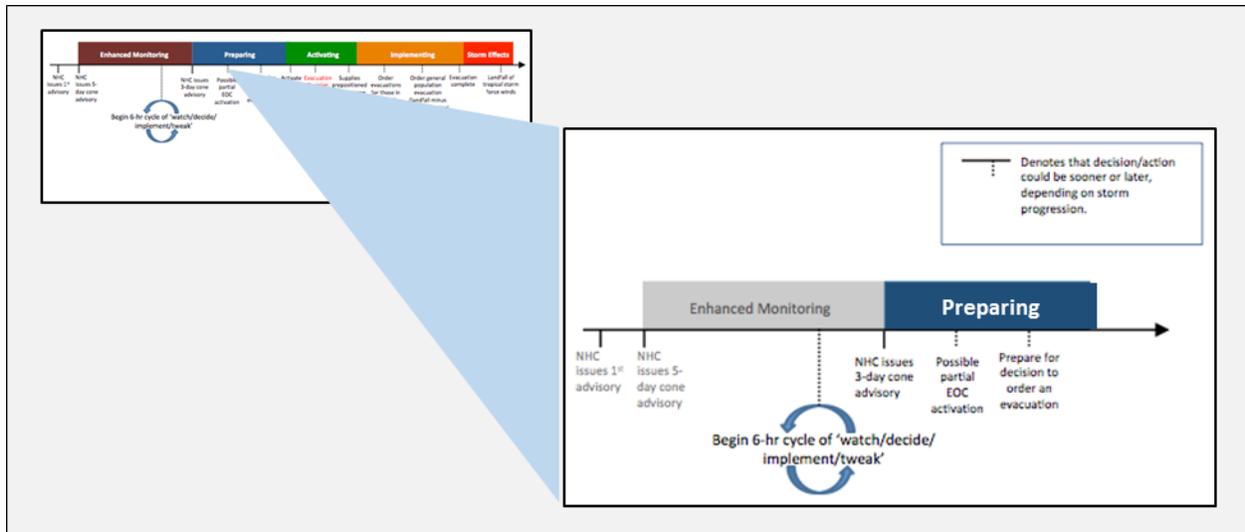


Figure 12. Preparing Phase

Starting from its initial advisory, the National Hurricane Center produces forecasts that emergency managers can use to help answer questions such as:

- Where is the storm located?
- How strong is the storm?
- What is the extent of the storm?
- Which areas may be subject to wind hazards?
- Which areas may experience storm surge flooding?

The primary challenge during the Preparing Phase is the general lack of data and/or uncertainty in data needed to make critical decisions such as opening shelters, pre-positioning resources, and identifying the impacted evacuation zones. The accuracy and availability of this decision support data improves over time, as the storm gets closer to impacting land, and as more precise data from sources such as reconnaissance aircraft and radar become available to forecast models. The NHC will provide updated forecast data every 6 hours. If new data becomes available within this 6-hour cycle and if tropical cyclone watches and warnings have been issued, the NHC will issue an intermediate advisory that updates the current location of the tropical cyclone center. No new forecast data is included in the intermediate advisory unless something happens that was not forecast, such as rapid intensification or a sharp unexpected change in the storm track. In such instances, the NHC will issue a special advisory with new forecast data and information.

Characterize the Forecast Impacted Zones

Once the possibility of evacuation or other tropical cyclone response activities exists, the forecast impacted zones should be characterized, in terms of the population, critical infrastructure, and any operational factors that will affect the timing, efficiency, and effectiveness of response activities. Generalized estimates from planning documents, HES, or other sources may include answers to the following:

- What is the current population distribution? (e.g. is it high tourist season?) This is known as “occupancy” in the Hurricane Evacuation Studies (HESs).
- For the population that responded to the evacuation order, how quickly did they evacuate? This is known as “response” in the HES (response in evacuation clearance time). The levels of occupancy and response both must be estimated to evaluate clearance times.
- Will the population be able to evacuate using their own means (i.e. persons needing evacuation assistance)?
- How much of the population have safe destinations vs. potentially planning on going to a shelter (i.e. shelter demand rate)?
- What are the food and water requirements for both the sheltering population and for the general public that did not evacuate?
- What critical infrastructure is in the potential impacted storm surge risk areas and evacuation zones? What are the potential consequences to critical services if this infrastructure is flooded and exposed to severe wind?
- What actions can be taken to harden/protect critical infrastructure and services that are at risk of degradation?
- What are the operational constraints and factors that may need to be considered in the timing of evacuation orders and other response activities? (e.g., Are any potential evacuation routes not in service? Are schools in session?)

Considerations for Characterizing Impacted Zones

In-depth and earlier characterization of impacted zones can help emergency managers improve responsiveness and reduce consequences on population and critical infrastructure.

Major factors that determine whether a household may require a public shelter are income level and home ownership. Lower income households and ones that do not own their home are more likely to require public shelter. [Hubbard**]

The collected data will assist the emergency management agency with many pre-positioning activities to include staging and early evacuations.

Staging and Early Evacuations

Staging is a set of activities that are taken prior to the onset of tropical cyclone hazards, to prepare for the emergency response actions that may be initiated. Since it is difficult to provide a time estimate (i.e. number of days before the onset of hazards) for staging activities to begin, emergency managers should reference existing planning documents though staging activities may start during the Preparing Phase.

Depending on the information available about the tropical cyclone, emergency managers may consider the following activities:

- Confirm assets are not located in areas that have any risk of being flooded and are protected from high winds
- Notify partner agencies to prepare to activate contracts for resources, such as evacuation buses, ambulances, shelters, water and ice, responder base camps, and portable restrooms
- Contact government organizations, public utilities, tourism industry notifying of early evacuations
- Prepare pre-landfall disaster declaration request for FEMA
- Prepare resource request documentation to FEMA
- Consider activation of resource staging areas (RSAs)
- Review point of distribution (PODs) site plans
- Notify the American Red Cross, faith-based and other volunteer organizations active in disasters
- Review evacuation routes with fuel distributors
- Contact any local public transportation partners that assist in evacuation
- Review/draft pre-scripted mission requests (e.g. request for National Guard deployment. This may be applicable only for home rule jurisdictions)

As hazardous impacts become more likely and closer to occurring, some decisions on actions may be required. Updated forecast data from the NHC should help support the necessity and timing of these decisions:

Considerations for Staging

The most important staging consideration at this point is to protect resources from flood risk and from high winds. The MOM mapping in the HES and the FEMA flood insurance rate map data can assist with determination of flood risk. The wind risk is a function of assets being secured in a location that can sustain high winds or located far enough inland that tropical cyclone force winds are unlikely to occur. The NHC wind decay model in HURREVAC can assist with this determination.

Once early evacuations begin, the local population will begin to inquire about their evacuation—be prepared to answer their questions and publish a communication channel for them to get these answers.

Staging may have an unintended effect of causing the local population to begin to evacuate. This population that is self-evacuating should be monitored and accounted for in the evacuation plans. For example, self-evacuees in zones that won't be impacted may use up resources (e.g., fuel, road throughput) that those in the impacted zones may eventually need.

Communicate and coordinate with neighboring jurisdictions, especially ones that share evacuation routes, that provide mutual aid, and that would be indirectly affected by response activities in your jurisdiction.

- Tourist evacuation
- Evacuation of medical facilities due to the amount of time required to move supporting medical resources
- Timing of possible mass transit shutdowns, including bridges and ferries that may stop traffic on evacuation routes
- Initiate preparation to staff evacuee shelters
- Evacuation of those in need of transportation assistance (that may include medical evacuees and persons with disabilities or other access and functional needs)

The timing of specific staging activities should be based on the activity and its required duration. For example, shelter preparation and shipment of food commodities begins in some locations as early as 110; medical evacuations may begin as early as 60 hours; as much as 48 hours may be needed to transport evacuation buses to the coast. In other locations, shelter preparation (i.e. shelters are placed on standby) may begin within 72 hours as well as communications with hospitals, which includes discussions regarding evacuations and transport of patients.

Considerations for State, Local, Tribal Emergency Managers

State and local emergency management professionals have collaborated to review the following Considerations Checklist during the Preparing Phase. The checklist is not intended to be a comprehensive list of preparatory actions, nor a prescriptive programmatic-level issuance of guidance, or planning requirements for response plans. The Preparing Phase checklist, like the Enhanced Monitoring Phase checklist, provides a list of considerations for emergency managers to use as guidance when appropriate. As in the Preparing Phase, not all items will apply in all jurisdictions.

Considerations Checklist: Preparing Phase
<ul style="list-style-type: none"> • Consider decisions on early evacuation and execute if needed • Refer to applicable staging plans from other government agencies involved in response. • If an early evacuation decision is made, the following are example considerations for emergency managers: <ul style="list-style-type: none"> ○ Initial assessment of traffic management plans ○ Broad spectrum of public information strategies and the coordination of messages between government entities ○ Clearance times for general public • Continue the 6-hour cycle of ‘Watch/Decide/Implement/Tweak’ as new NHC Advisory updates are issued • Notify emergency management staff of the timing of potential EOC activations • Develop and distribute the 3-Day/5-Day Forecast Track Cone situational awareness information/report according to current planning protocols (the 3-Day highlighted section in white has less forecast error than the 4-5-Day section) • Consult sheltering plans and consider need for actions on shelter selection and staffing.

- Continue use of HURREVAC data to refine evacuation clearance times estimates for evacuation scenarios that are applicable to the specific characteristics of this tropical cyclone incident
- Continue collaboration with the NWS' local WFO to refine initial assessments
- Monitor conference calls with participating entities such as NWS, NHC, and other state level agencies involved with your hurricane response actions. Leverage the HLT through the state as needed
- Continue coordination with private sector vendors that may be needed to support response
- Review interoperable communications protocols and conduct equipment tests (as appropriate)
- Continue to refine public information strategy and messaging based on the latest available forecast information and the timing of possible response/evacuation actions

Technology Insertions

Technology Insertions for Staging

- MEOWs may significantly influence which zones are evacuated and decisions will need to be made regarding evacuation of those zone with clearance times in excess of 48 hours.
- Maximize the use of your EOC's web-based, situational awareness platform, which will have resource request and resource tracking capabilities.
- NHC wind probability products may become available during the Preparing Phase and can assist to quantify the uncertainty in the actual forecast.

4.1.4 Decision Making Process Phase 3: Activating

Figure 13 below shows the Activating Phase of the Operational Model. For the emergency manager, during this time period, critical activities include prepositioning supplies in preparation for response.

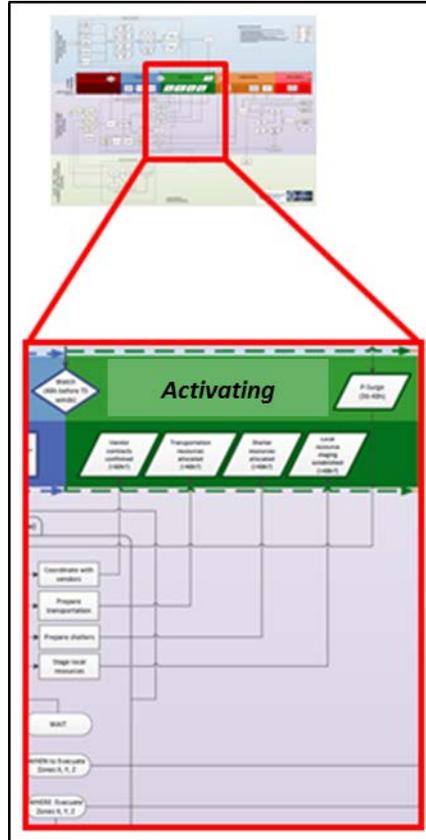


Figure 13. Operational Model: Activating Phase

4.1.5 Phase 3: Activating

The Activating Phase includes significant activities such as full activation of the emergency operations center and activation of shelters.

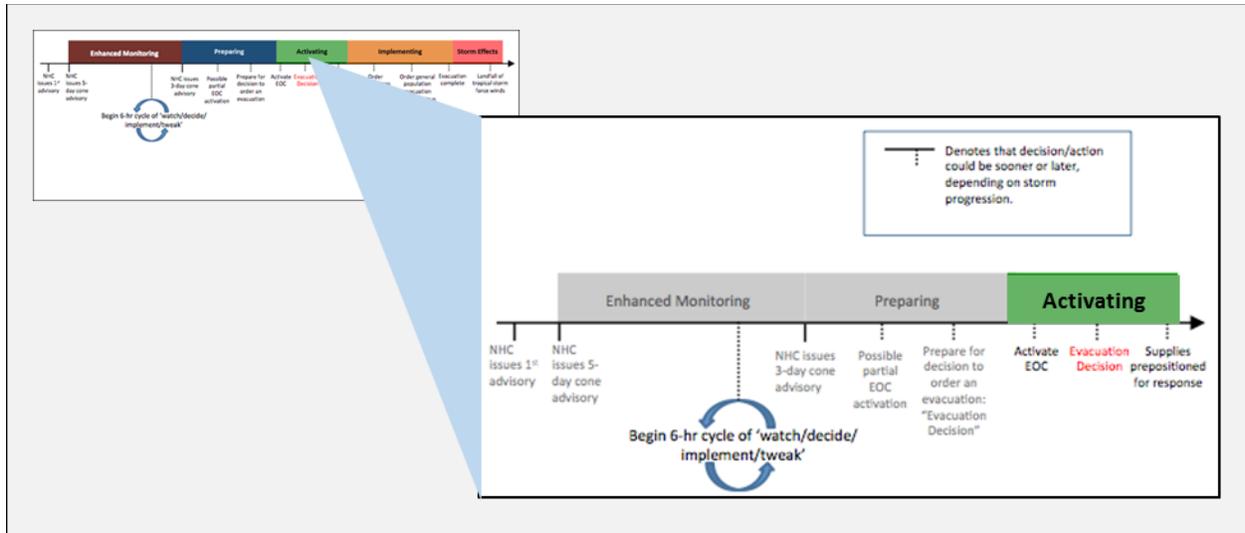


Figure 14. Activating Phase

Evacuation Decision

The authority to issue a mandatory evacuation order resides with the local government (elected public officials) in home rule states, and with the state government otherwise. In many cases, emergency managers recommend an evacuation course of action for elected public officials to order.

The timing for issuing an evacuation order depends on numerous factors, which may include the following: predicted timing of winds and flooding, predicted evacuation clearance times for the evacuation scenario being considered, current traffic and roadway conditions, and the number of people being evacuated. The order should be made early enough so that evacuees can leave the hazard zone prior to the onset of sustained tropical storm force winds or storm surge inundation of coastal evacuation routes. Once winds are sustained at this level, travel becomes hazardous not only because of the wind, but also because of the onset of other hazards, such as heavy rain and flooding.

In regions that conduct Hurricane Evacuation Studies, clearance times for evacuation zones have been estimated. The timing of the evacuation order should be the forecast time of hazards onset minus the evacuation clearance time. For example, the Activating Phase

Considerations for Evacuation Decision

Public safety is the most important consideration for an evacuation decision. Evacuating multiple zones requires an understanding of the clearance times and the more zones called for evacuation; the earlier the evacuations must begin. Be mindful that the earlier evacuations begin, the more uncertainty there is in the forecast and more difficult it may be to get the population in those zones to comply with the evacuation order. HURREVAC will show the evacuation start times based on clearance times for various zone combinations as well as the forecasted arrival time of tropical storm force winds, but it does not account for storm surge timing.

Evacuating more zones than necessary should not result in people being stranded on roads at the onset of hazardous conditions, unless the evacuation began too late.

timeline may be compressed as highly urban areas with a complex geography as evacuation clearance times for evacuation zones may be lengthy. The evacuation timing may be adjusted to establish a start time when it is safe to travel that is not in the middle of the night, and to account for the current traffic conditions and concurrent evacuation of neighboring zones. If many zones are being evacuated and traffic is flowing very slowly, more time should be allotted for evacuation. Understanding the estimated clearance time is critical to safe and a successful evacuation.

The area to evacuate should be based on MEOWs, NHC P-surge forecasts (if clearance times is less than 48 hours), and in coordination/consultation with local WFOs to fully understand the local flooding potential. Even if the hazard forecasts are high resolution, execution of an evacuation order that only evacuates select zones may be operationally difficult, depending on public perception of the tropical cyclone. Emergency managers may consider phasing evacuations. Phasing evacuations is a possibility once it becomes likely that the highest-risk evacuation zone is going to experience flooding. That highest-risk zone, and only that zone, can begin evacuation. During this time, forecast confidence may increase and subsequent zones that will experience flooding can be evacuated. A phased evacuation may allow more time for forecasts to improve and prevent over-evacuation and increase the efficiency of those zones that are being evacuated.

Forecasts have associated uncertainty; responsive actions, especially high consequence actions like evacuation, should compensate for uncertainty. For example, instead of taking forecasts “as is”, consider being conservative and assume a higher intensity hurricane (e.g. Category 4 instead of Category 3) for decision-making purposes.

Considerations for State, Local, Tribal Emergency Managers

If a tropical cyclone necessitates large-scale evacuation, the unpredictability of the strength, speed, and direction of a tropical cyclone among other factors makes the timing of ordering an evacuation a significant challenge. The earlier in the storm timeline that an evacuation decision is necessary, the more forecast uncertainty there will be when the decision needs to be made, and the more difficult it may be to convince decision makers and the public that an evacuation is needed. A variety of complicated and inter-connected activities and actions are involved during the Activating Phase, which are not presented in this document. Therefore, the Activating Phase checklist is not intended to be a comprehensive list, for example, to activate your EOC, activate your emergency response plans (and annexes), or for population evacuation. The Activating Phase checklist is for emergency managers at the state, local, and tribal levels to use as appropriate to review and determine whether or not any of the following considerations are appropriate to include in their current plans.

Considerations for Evacuation Decision

Emergency managers in tropical cyclone-prone areas advise that evacuation zones should be fixed as year-round in order to educate the public on tropical cyclone awareness and preparation. Mid-incident changes to these zones would be difficult to communicate.

Considerations Checklist: Activating Phase

- Partially (or fully) activate EOC and initiate notifications
- Contact state supported evacuee transportation resources to include prioritization of the movement of critical transportation evacuees including medical evacuees
- Activate evacuee tracking systems (if available)
- Review the information for health and medical statewide evaluation of transportation resources, mass care, and assessment of hospitals and schools in evacuation zones
- Confirm the evacuation of medical care facilities
- Initiate the traffic management plans as needed
- Continue the 6-hour cycle of ‘Watch/Decide/Implement/Tweak’ as new NHC Advisory updates are issued
- Conduct emergency management staff briefing
- Alert shelters and notify them of activation as needed
- Use HURREVAC for guidance on evacuation start times
- Continue collaboration with the NWS’ local WFO
- Participate in conference calls with participating entities such as NWS, NHC, and other state level agencies involved with your hurricane response actions
- Verify backup communications systems are operable
- Activate animal response operations and coordinate with needed partners and organizations through activation of contracts and MOUs
- Implement the public information strategy per existing protocols with local and state agencies
- Further coordination activities with hospital and/or healthcare coalitions to prepare for mass care activities
- Initiate the process for a state of emergency declaration (if appropriate during the Activating Phase)
- Coordinate with neighboring jurisdictions regarding evacuation decisions, timing of evacuations, and collaboration on execution of the evacuation
- Initiate evacuation communication protocols with the private sector

Technology Insertions

Technology Insertions for Evacuation Decision

- Utilization of HURREVAC data in combination with the NHC forecast data as well as any pre-determined evacuation clearance times.
- Hurricane Evacuation Study areas for coastal areas for storm-surge vulnerability analysis. As previously stated, HES provide planning assumptions such as evacuation clearance times for the population within designated hurricane evacuation zones.

4.1.7 Phase 4: Implementing

As depicted in the Operational Model, the Implementing Phase generally involves such significant activities such as ordering the evacuation of those in need of transportation assistance and the issuance of a public “Evacuation Order” (landfall minus clearance time). The Implementation Phase can be very fluid as ordering resident evacuation (which includes a significant public information campaign) and ensuring the completion of evacuation involves many overlapping and interconnected response actions.

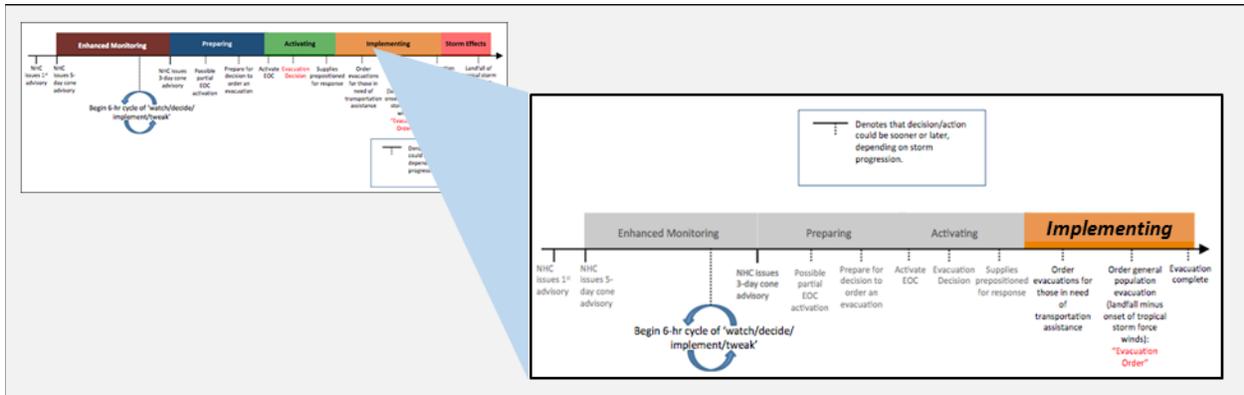


Figure 16. Implementing Phase

Evacuation Order and Process

The timing of the evacuation order should be based off the evacuation clearance time for the zones being evacuated. Evacuation clearance time is the time necessary for the entire population in the evacuation zone(s) to safely evacuate. Clearance times are estimated in the Hurricane Evacuation Studies (for those regions that have HESs), for best case (Category 1 tropical cyclones, low tourist period, rapid evacuation response rate) and worst case (Category 5 tropical cyclones, high tourist period, slow evacuation response rate). Traffic conditions and other factors will govern the actual clearance time and the success of the evacuation process (i.e. those ordered to evacuate, successfully evacuated as ordered).

Once an evacuation order is given, the evacuation process and its subsequent success depends on several factors, including:

- How effectively the order is communicated
- Population compliance with the evacuation order, for both the evacuated and non-evacuated zones.

Population compliance depends on:

- Whether they heard the evacuation order and understood the order applied to them
- Whether someone has a place to go

Considerations for Evacuation Order and Process

Coordinate evacuation routing with neighboring, upstream and downstream jurisdictions. Make sure routing doesn't conflict, assumptions for the # of people who will be trying to evacuate is a regional number (not just for your jurisdiction).

Successful evacuation relies on the whole community hearing the evacuation order, and those people complying with the order.

- Whether someone has the means (i.e. public or private transportation) to go
- Whether someone wants to leave (e.g., will not leave their pets or property)
- Whether public shelters accommodate pets
- Whether the public perceives the order as necessary/accurate based on necessity/accuracy of previous evacuation orders
- Traffic and road conditions
- Transportation provided for those who cannot evacuate using their own resources
- Fuel availability
- Availability of shelters or other safe destinations
- Concern of leaving property and personal possessions unprotected
- Employment requirements prohibiting evacuation

The success of the population following an evacuation order depends largely on conveying/convincing the public that their homes are not safe due to impending life threatening consequences from the tropical cyclone even though they may feel their homes are safe. This false public perception can significantly jeopardize public safety in those zones ordered for evacuation.

Considerations for State, Local, Tribal Emergency Managers

Many of the considerations for the Implementing Phase checklist pertain to the evacuation process as well as the importance of public information and communication. As previously discussed, these considerations are for emergency managers at the state, local, and tribal levels to use as appropriate to review and determine whether or not any of the following considerations are appropriate in augmenting their current plans.

Considerations for Evacuation Awareness

Provide education throughout the year to make the public aware of their evacuation zones and what to expect if there is a tropical cyclone incident resulting in an evacuation order. For example, “Know Your Zone” is a public awareness campaign undertaken by New York City and Pinellas County, Florida to prepare their residents year-round.

Plan and conduct response-time tests and public information and communication strategies as part of annual emergency preparedness exercises.

Considerations Checklist: Implementing Phase

- Ensure evacuation orders are delivered in multiple languages across multiple media outlets
- Verify the status of state-supported evacuee transportation resources to include prioritization of the movement of medical patients and others in medical care facilities
- Confirm the evacuation of transportation dependent evacuees needing government transportation assets to evacuate
- Initiate the traffic management plans as needed for the tropical cyclone incident
- Continue the 6-hour cycle of ‘Watch/Decide/Implement/Tweak’ as new NHC Advisory updates are issued
- Coordinate the selection of opening and alerting those shelters based on the storm surge flooding risk (i.e. do not open shelters at-risk to flood)
- Continue to utilize HURREVAC (if available)
- Continue collaboration with the NWS’ local WFO
- Continue to participate in conference calls with participating entities such as NWS, NHC, and other state level agencies involved with your hurricane response actions
- Maintain backup communications systems
- Ensure animal response operations and coordination is underway
- Maintain coordination activities with hospital and/or healthcare coalitions to prepare for mass care activities
- Confirm the state of emergency declaration (if appropriate during the Activating Phase)
- Coordinate evacuation routing with neighboring jurisdictions, counties, municipalities to make sure evacuation messages and traffic management plans are consistent
- Monitor evacuation compliance (e.g. contact local hotels/motels for occupancy data pre- and post-evacuation order)
- Ensure redundant public messaging (e.g., Reverse 911, websites, social media outlets)
- Designate a Public Information Officer whose job is to exclusively translate forecasts and emergency management decisions into public-friendly language and disseminate this message to the media, websites and other public sources.

Technology Insertions

Technology Insertions for Evacuation Order and Process

- Use modeling and simulation to test evacuation routes and plans against a range of road and traffic conditions.

Technology Insertions for Public Information and Communication

- Websites for year-round public education and communication
- Reverse 911 and 311
- Social media

- Maintain backup communications systems
- Maintain coordination activities with hospital and/or healthcare coalitions to prepare for mass care activities
- Initiate planning for post-storm effects activities to include the arrival of requested federal assistance
- Initiate planning for any recovery mutual aid requirements
- Review (and initiate if appropriate) the points of distribution site plans especially planned ingress and egress routes
- Initiate the refinement of post-Storm Effects public communication messages that include instructions for the public for disaster relief
- Activate Refuges of Last Resort (if appropriate for your jurisdiction)

CHAPTER 5: TRAINING

5.1 Introduction

Training is recommended for emergency managers, especially those new emergency managers, to assist in their efforts to maintain levels of preparedness, maintain readiness, and enhance response during a tropical cyclone event. Additionally, the NHP TM Project includes a training pilot, which will enhance the type of training available to emergency managers. As part of the modernization project, emergency managers' training would also include:

- How to interpret and use hurricane forecast data
- How to plan for and make decisions to implement protective actions from hurricanes, including how to use HES data
- How to use decision-support tools and other technology to support hurricane planning and response.

5.2 Recommended Training

The NHP currently has several well-established training courses ranging from one-day sessions at conferences to comprehensive hands-on, week-long training at the National Hurricane Center (NHC). In addition to the more formal classes listed below, NHP also conducts yearly HURREVAC training webinars and conducts classroom training at state and local facilities when funding allows. The HURREVAC user base is a good surrogate to represent the total number of emergency managers that are involved in hurricane evacuation planning. That user base currently stands at about 10,000 users in hurricane-impacted states. Descriptions of these training sessions were gathered from FEMA's Emergency Management Institute.

L324 Hurricane Preparedness for Decision-Makers (4/5 days)

This course, held at the NHC in Miami, Florida, instructs emergency managers on how to plan for and make decisions to implement and execute protective actions from hurricanes, particularly hurricane evacuations. Participants receive comprehensive instruction from NHC specialists on how to use hurricane forecasts and other NHC products to determine who they must evacuate from various types of approaching hurricanes and when the evacuations should take place. This includes learning how to interpret SLOSH product outputs such as MOM, MEOWs, P-Surge and official NHC forecast products. The course then provides instruction from FEMA and US Army Corps of Engineer specialists on using data from their HES to support state and local hurricane planning. In addition, the course provides hands-on instruction on the use of the HURREVAC computer software decision support tool for determining the optimum timing of their evacuation decisions and evacuation orders. The course includes a behind-the-scenes tour of the NHC and a demonstration of how the NHC specialists track and forecast hurricanes and their potential impacts. There are two interactive exercises, one is an exercise on building an HES and the other

is a tabletop exercise in which participants use all they have learned from creating a mock hurricane evacuation plan to the final evacuation decision.

Hurricane Preparedness for Decision-Makers course is limited to 30 participants at a time. There are typically three sessions annually, servicing a total of up to 90 emergency managers per year.

L320 Hurricane Preparedness for Decision-Makers: State-Specific (3 days)

This course, conducted on site at state locations, instructs state and local emergency managers and planners on how to plan for and make decisions to implement and execute protective actions against hurricanes, particularly hurricane evacuations. Participants receive comprehensive instruction from NHC specialists on how to use hurricane forecasts and other NHC products to determine who they must evacuate from various types of approaching hurricanes and when the evacuations should take place. This course is similar to L0324, but the direct interaction with NHC staff is more limited because the event is held outside of the NHC.

This course accommodates approximately 40 students and the NHP has the resources to run the course for only one state each year, servicing a total of up to 40 emergency managers per year.

IS-324 COMET Web course (self-paced)

The computer-based course, Community Hurricane Preparedness, provides those involved in the decision-making process for hurricanes with:

- Ways to identify the characteristic features of a hurricane and its potential impacts
- Ways in which meteorologists monitor hurricane development
- Information about the basic hurricane forecasting process and its limitations
- Ways to identify the forecast product to use for evacuation decision-making at various stages in an event
- Guidance for formulating a plan to deal with the potential hurricane disaster

Introduction to HURREVAC (National Hurricane Conference and in-state sessions)

HURREVAC is a decision support tool used by emergency managers to gather the information they need to assist their evacuation decisions. The software couples HES data with real-time weather forecast data from the NHC. This combination allows users to graphically display specific local evacuation times for decision-making as hurricanes approach.

The Introduction to HURREVAC course is a half-day class that teaches the basic usage of HURREVAC (e.g., how the interface works, how to access different types of information). This course has approximately 100 participants per session and there are two sessions per year.

Many state emergency management agency classrooms also host day-long, NHP-sponsored HURREVAC training in spring and early summer. Dozens of these courses are taught each year; at least one date per state is typically offered.

HURREVAC Web-based courses

NHP also provides Web-based tutorials covering all aspects of HURREVAC usage. Sessions include:

- Intro to HURREVAC and General Overview of Program
- Evacuation Timing Features
- Wind Forecast Features
- Additional Program Tools and Features
- Applied HURREVAC – Scenario-based Exercises

The trainings as part of the NHP TM Project provide emergency managers opportunities to interpret and apply a range of data to further inform decision-making and enhance preparedness at the state and local level.

APPENDIX A: HURREVAC

HURREVAC is a tropical storm tracking and decision support tool for emergency managers. The program combines live feeds of tropical cyclone forecast information with data from various state Hurricane Evacuation Studies (HES) to assist the local emergency manager in determining the most prudent evacuation decision time and the potential for significant storm effects such as wind and storm surge. For hurricane level storms one of the key factors for evacuation decisions is for the evacuees to have left the hazard zone prior to the start of sustained tropical storm force winds (63-117 km/h). Once winds are sustained at this level, travel becomes hazardous not only because of the wind but also because of associated heavy rain, flooding and storm surge.

The HURREVAC flowchart shows the general flow of data through the HURREVAC software. Tropical storm forecasts and advisories are ingested into HURREVAC from the NWS NHC. The advisories contain information of storm strength, location and movement – and, based on the location of the user, arrival time estimates for the onset of tropical storm force winds are generated.

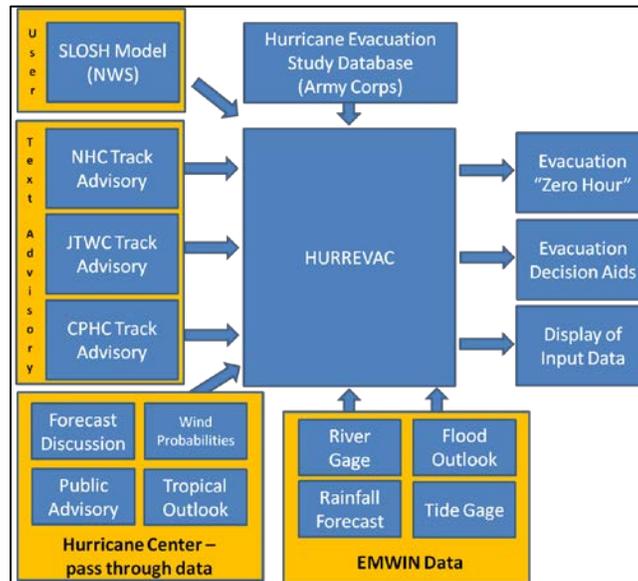


Figure 18. Data Flow in HURREVAC

Potential storm impacts (flooding/wind damage) vary from state to state and even mile-by-mile of coastline. Therefore, one of the critical HES products that is incorporated into HURREVAC is the “clearance time” required to evacuate at-risk areas to safety for various storm scenarios. Based on the HES for the region, HURREVAC subtracts the clearance time from the expected onset of tropical storm force winds to provide the user with a deadline for when evacuation declarations should be made.

Users are able to select appropriate storm scenarios based on a limited set of variables: Peak hurricane category (category 1-5), tourist occupancy (low/med/high/extreme), and response rate (immediate/rapid/medium/slow). The occupancy levels and response rates are based on a behavioral survey for that specific region that is conducted as part of the HES. Higher category hurricanes make acceptance of evacuation orders more likely, higher tourist occupancy slows down evacuations and, obviously, faster response rates speeds evacuations.

While evacuation times are the primary focus of HURREVAC the software provides additional supporting data and general situational awareness on the display. Hurricane position, intensity, and advisory-by-advisory updates of forecast are seen on a map. In addition, users may access cumulative rainfall totals, flood potential, river and tidal gauge data for monitoring flood potential.

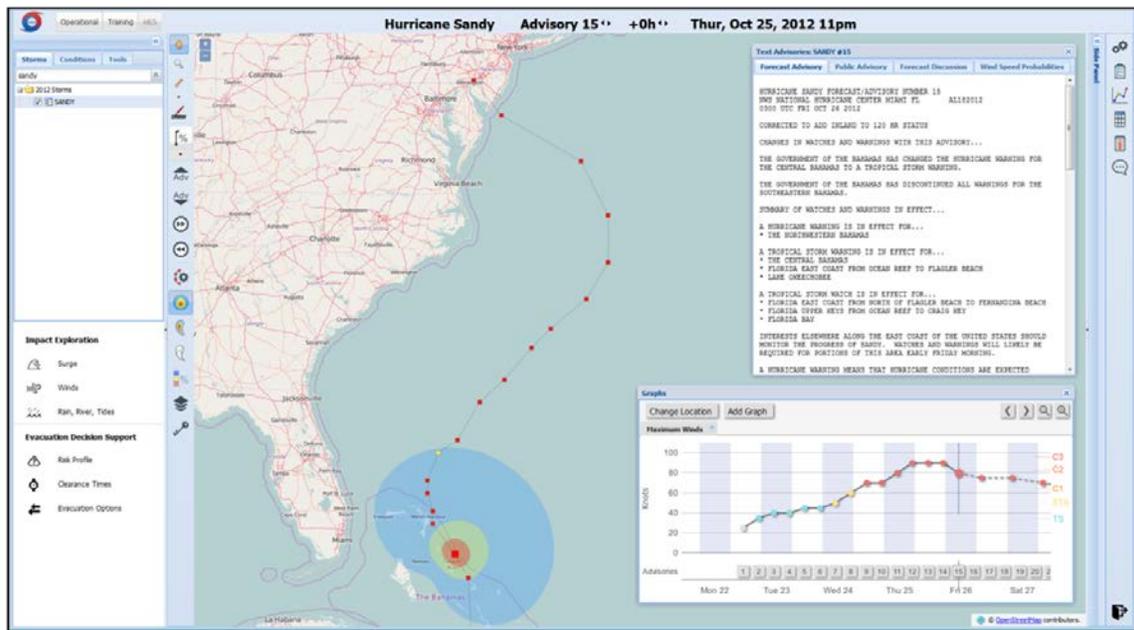


Figure 19. Screenshot of the modernized HURREVAC tool (called HV-X).

GLOSSARY

Term	Meaning
Clearance Times	The number of hours it takes to move the threatened population to safety, given various factors such as the category of the tropical cyclone, the tourist occupancy (or population), and public responsiveness.
Hurricane Evacuation Studies (HES)	Hurricane evacuation studies determine the vulnerability of a population to tropical cyclone hazards and provides guidance to local emergency managers for planning evacuations of at-risk populations.
Hurricane Evacuation Studies (HES): 5 Areas of Analyses	Hurricane evacuation studies are typically composed of five interrelated analyses: <ol style="list-style-type: none"> 1. The tropical cyclone hazard 2. The vulnerability of populations, areas, and infrastructure 3. Population behavior in the event of an evacuation 4. Shelter needs in the event of an evacuation 5. Transportation needs in the event of an evacuation
HURREVAC	A tropical storm tracking and decision support tool for emergency managers. The program combines live feeds of tropical cyclone forecast information with data from various state Hurricane Evacuation Studies (HES) to assist the local emergency manager in determining the most prudent evacuation decision time and the potential for significant storm effects such as wind and storm surge.
Maximum Envelope of Water (MEOW)	The Maximum Envelope of Water provides a worst case basin snapshot for a particular storm category, forward speed, trajectory, and initial tide level, incorporating uncertainty in forecast landfall location.
Maximum of Maximums (MOM)	The Maximum of the Maximum Envelope of High Water, or MOM, provides a worst case snapshot for a particular storm category under "perfect" storm conditions. Each MOM considers combinations of forward speed, trajectory, and initial tide level.
National Hurricane Center (NHC)	The National Hurricane Center is a component of the National Centers for Environmental Prediction (NCEP) located at Florida International University in Miami, Florida. The NHC mission is to save lives, mitigate property loss, and improve economic efficiency by issuing the best watches, warnings, forecasts, and analyses of hazardous tropical weather and by increasing understanding of these hazards.

Term	Meaning
National Hurricane Center 5-Day Cone	A “cone” represents the probable track of the center of a tropical cyclone, and is formed by enclosing the area swept out by a set of circles along the forecast track (at 12, 24, 36 hours, and so on). The size of each circle is set so that two-thirds of historical official forecast errors over a 5-year sample fall within the circle.
National Hurricane Center P-Surge	The Tropical Cyclone Storm Surge Probabilities determine the overall chances that the specified storm surge height will occur at each individual location during the forecast period indicated.
National Hurricane Program (NHP)	The National Hurricane Program is a multi-agency partnership, involving FEMA, the National Oceanic & Atmospheric Association (NOAA) National Hurricane Center and the U.S. Army Corps of Engineers (USACE). The NHP helps protect communities and residents from tropical cyclone hazards by providing evacuation preparedness technical assistance to state, local, and tribal governments.
NHP Technology Modernization Effort	The National Hurricane Program (NHP) Technology Modernization Project began in 2014. It is funded jointly by the Department of Homeland Security’s (DHS) Federal Emergency Management Agency (FEMA) and Science and Technology (S&T), and performed by MIT Lincoln Laboratory and Sandia National Laboratories. The goal of this 3-year (3 phased) DHS funded project is to bring enhanced capabilities and new technologies to tropical cyclone preparedness.
Operational Model (OM)	The National Hurricane Program Operational Model is a process diagram that depicts the critical activities in the tropical cyclone preparedness cycle. The OM provides a holistic view of what decisions are made, when, and by whom, and illustrates what information is communicated between stakeholders. The OM provides new state and local emergency managers a general roadmap of critical tropical cyclone planning and response activities over time.

Term	Meaning
Sea, Lake, and Overland Surges from Hurricane (SLOSH) model	The Sea, Lake and Overland Surges from Hurricanes model is a computerized numerical model developed by the National Weather Service (NWS) to estimate storm surge heights resulting from historical, hypothetical, or predicted hurricanes by taking into account the atmospheric pressure, size, forward speed, and track data. These parameters are used to create a model of the wind field, which drives the storm surge. The SLOSH model consists of a set of physics equations which are applied to a specific locale's shoreline, incorporating the unique bay and river configurations, water depths, bridges, roads, levees and other physical features.
Standard Unified Modeling Mapping and Integration Toolkit (SUMMIT)	A standardized, modeling, mapping and data analysis platform.

ACRONYMS

Acronym	Meaning
ACS	American Community Survey
DHS	Department of Homeland Security
EMA	Emergency Management Agency
EOC	Emergency Operations Center
FEMA	Federal Emergency Management Agency
FSTT	Federal, State, Tribal, and Territorial
HES	Hurricane Evacuation Studies
HLT	Hurricane Liaison Team
MEOW	Maximum Envelope of Water
MIT	Massachusetts Institute of Technology
MOM	Maximum of Maximums
MOU	Memoranda of Understanding
NCEP	National Centers for Environmental Prediction
NOAA	National Oceanic and Atmospheric Association
NHC	National Hurricane Center
NHP	National Hurricane Program
NHP TM Project	National Hurricane Center Technology Modernization Project
NWS	National Weather Service
OM	Operational Model
PKEMRA	Post Katrina Emergency Reform Act
POD	Points of Distribution
RSA	Resource Staging Areas
RtePM	Real-Time Evacuation Planning Model
SLOSH	The Sea, Lake and Overland Surges from Hurricanes
SME	Subject Matter Expert
S&T	Science and Technology Directorate at DHS
SS	Storm Surge
SUMMIT	Standard Unified Modeling and Mapping Toolkit
USACE	United States Army Corp of Engineers
WFO	Weather Forecast Office