Evaluating Wind Speed Response Thresholds During Tropical Cyclones

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Certification Statement

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

Signed: 

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Abstract

With the dangers that hurricanes and other tropical systems bring, having a plan in place to amend response for crew safety is important. The problem is the Oviedo Fire Department (OFD) has not developed specific guidelines for emergency operations during tropical cyclones, including when to cease response. The purpose is to determine at what thresholds emergency operations should cease during tropical cyclones in the OFD.

A descriptive research approach was utilized, including document/literature review, personal communications, and survey of external agencies. The research evaluated: current policies and procedures of the OFD regarding ceasing emergency response when tropical cyclones approach; criteria used to determine when emergency response should cease when tropical cyclones approach; tools/technology other Fire/EMS agencies utilize to identify when to cease emergency response when tropical cyclones approach.

Findings of the research support a tiered system of amending response. Ambulances were found to be at greater risk of deviation or overturning and should cease response in sustained winds as low as 35 MPH, while fire engines and SUV's can operate safely in sustained winds of 50 MPH. Research also indicated that latitude should be given to shift commanders to decide if the thresholds identified are appropriate based on risk/reward and other hurricane related dangers at a given location. A departmental Standard Operating Procedure (SOP) should be implemented based on the research conducted, and trained on prior to each hurricane season.

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Firefighting is an inherently dangerous job. Whether it is fighting a structure fire, extricating a patient from a traffic accident on the side of a freeway, or one of the myriad of responses that firefighters are expected to be proficient in, firefighters are regularly put in harm's way. As a fire service, safety should be the main priority, and by minimizing the dangers that are faced, or finding safer ways to operate, we can hopefully reduce the amount of injuries and fatalities that are experienced. Not only are the emergency calls a cause of concern for responders, but outside factors such as vehicular traffic, building construction, disease, and weather conditions can play into responder safety.

With the high prevalence of tropical cyclones that affect Florida, and Oviedo's proximity to the coast, consideration needs to be given to the crew's safety in responding during these potentially catastrophic events. The problem is that the Oviedo Fire Department does not have specific guidelines to determine the threshold at which emergency operations cease during tropical cyclones. The purpose of this research is to determine the threshold at which emergency operations should cease during tropical cyclones in the Oviedo Fire Department.

A descriptive research approach will be utilized, including document/literature review, personal communications, and survey of external agencies to evaluate the following research questions: a) What policies and procedures does the Oviedo Fire Department have in place for ceasing emergency response when tropical cyclones approach? b) What criteria are used in determining when emergency response should cease when tropical cyclones approach? c) What tools/technology are other Fire/EMS agencies utilizing to identify when to cease emergency response when tropical cyclones approach?

Background and Significance

The City of Oviedo is nestled just east of Orlando, FL. Spread over 15 sq miles, more than 40,000 people reside in the city with that number growing steadily ("Census QuickFacts," 2017). The City of Oviedo Fire Rescue Department (OFD) employs 54 personnel. 6 administrative personnel and 48 shift personnel that are assigned to a 24 hr. on/48 hr. off shift schedule providing 24 hr. coverage to the community. Based out of 2 stations, the shift personnel are assigned to 3 engines, 3 rescues, and 1 battalion vehicle.

The Oviedo Fire Department has an interlocal agreement in place with neighboring agencies to provide the best service coverage possible to its citizens, as well as those nearby. With this response system, the closest unit responds regardless of who's jurisdiction the incident is located. The agencies that participate in the Seminole County First Response Agreement include: Seminole County Fire Department, Longwood Fire Department, Sanford Fire Department, Lake Mary Fire Department, Orlando Sanford International Airport Fire Department, and Oviedo Fire Department. In 2017, the Oviedo Fire Department ran approximately 4,500 calls for service with approximately 65% of the responses for EMS.

While not a beachfront location, its proximity to the ocean influences the impact that hurricane and tropical storm force winds have on the community. At its closest, Oviedo is 26 miles from beach and 18 miles from inland intercoastal waterways (as the crow flies).

"Hurricane" and "typhoon" are specific terms for a "tropical cyclone," but vary depending on the region. For the purposes of this research, all 3 terms will be used synonymously. A "tropical depression" is the term used for tropical cyclones whose maximum sustained winds are less than 39 mph, and once the sustained wind speed reaches winds greater than 39 mph, they are referred to as a "tropical storm" (or in Australia, a Category 1 cyclone). At this point the tropical cyclone is assigned a name. Once winds surpass 74 mph, depending on the region they are located, they can be referred to as a "hurricane, typhoon, or tropical cyclone (National Aeronautics and Space Administration [NASA], n.d.).

Since 1851, 292 hurricanes have directly impacted the Eastern United States coastline (Texas to Maine). Of these storms, 120, or approximately 41% of them have directly hit Florida. That is almost twice the amount of direct hits than the next most frequently hit state, Texas, with 64 (Landsea, 2018). Most of the storms occur during the "hurricane season," which occurs between June 1 - November 30, with peak months being August and September (Federal Emergency Management Agency [FEMA], 2008).

"Hurricanes are among the most dramatic, damaging and potentially deadly weather events. The force of hurricane winds alone can cause tremendous devastation." (FEMA, 2008, p. 1) With as much widespread destruction as these storms cause, it should come as no surprise that of all hazardous weather conditions, hurricanes are responsible for over half of the total damage inflicted nationwide (National Science Board [NSB], 2007, p. 9) and half of the nation's wind damage has historically occurred in the State of Florida (Leatherman, 2011).

In 2004, Hurricane Charley traversed the state of Florida and made its way through Orlando. After traveling more than 125 miles over land, the hurricane still was the equivalent of an F2 tornado 30 miles across. Significant damage such as downed trees, damaged buildings, and power outages were common in the Central Florida area (Quaderer, 2004, p. 92).

According to Klotzbach & Bell (2018) from Colorado State University, the forecast for Atlantic basin hurricanes in 2018 is 12 named storms, 5 hurricanes, and 1 major hurricane. Between 1950 and 2000 an average of 9.6 named storms, 5.9 hurricanes, and 2.3 major hurricanes have formed in the Atlantic basin (Klotzbach & Bell, 2018). Even though 2018 projects to have an average number of storms, the likelihood of a named storm impacting the Central Florida region is between 36 and 42% in a given year (Appendix A).

FEMA recommends that "protocols or standard operating procedures (SOPs) are needed for the following: dispatch and response in high (over 39 mph) winds: go/no-go policies; swift water rescues; building collapse; water distribution system problems due to prolonged power failures; and street, bridges, and tunnel closures/access limitations" (U.S. Fire Administration [USFA], 2008, p. 15). In addition to this, one of the main focuses of the Executive Analysis of Fire Service Operations in Emergency Management (EAFSOEM) course is the utilization of National Incident Management System (NIMS), Incident Command System (ICS), and the National Response Framework (NRF). In handling all hazards incidents, a protocol of the NRF is to "save lives, protect the health and safety of the public, responders, and recovery workers" (*Executive Analysis of Fire Service Operations*, 2016, SM 1-11).

It is further impressed upon EAFOSEM students that to begin the mitigation process, local damage assessments need to be "rapid and as detailed as possible" since this information is "analyzed to determine whether supplemental assistance will be needed from state or federal agencies (*Executive Analysis of Fire Service Operations*, 2016, SM 3-5). Without a plan in place to amend response, disaster surveys or recovery efforts can be delayed, or possibly not even conducted. Equipment and personnel can be damaged or stuck in an area if they are responding in conditions that put them in danger.

The United States Fire Administration (USFA) utilizes efforts in "prevention, preparedness, and response" to assist in providing for the "safety and security of the American people" (U.S. Fire Administration, 2014, p. 1). By implementing response procedures, several of the USFA goals can be achieved. Goal 2 states "promote response, local planning and preparedness for all hazards." This includes "improving fire and emergency services' ability to identify, prevent, mitigate and respond to local community hazards (goal 2)" (U.S. Fire Administration, 2014, p. 11). A second goal that can be achieved by developing a response plan is "enhance the fire and emergency services' capability for response to and recovery from all hazards." This promotes the "adoption of technological tools to enhance fire and emergency services' capability of, preparation for, response to, and recovery from all hazards (goal 3)" (U.S. Fire Administration, 2014, p. 12).

Literature Review

Christopher Columbus, the first European to encounter hurricanes stated in a letter to King Ferdinand "Eyes never beheld the seas so high, angry and covered with foam. We were forced to keep out of this bloody ocean, seething like a pot of hot fire" (Carpenter & Carpenter, 1993, p. 14). For many years after, ships have encountered these disasters, often with devastating effects. It wasn't until Father Benito Vines came along that a method for predicting hurricanes and alerting people a storm was approaching was developed. He realized that a few hours of early warning could save many lives (Carpenter & Carpenter, 1993).

In 1806 the Royal Navy utilized a scale devised by Commander Francis Beaufort that aided commanders in determining the speed of the wind. This scale, known as the Beaufort scale classified winds into 13 "forces" (Appendix B). This scale was adopted at the International Meteorological Conference for use in 1874 and is still used today (Allaby, 2003). In 1944, forces 13-17 were added to the Beaufort scale, and were to be utilized in special cases, such as tropical cyclones ("Beaufort," 2010).

In 1870, the United States established the National Weather Service (NWS), and as part of the National Oceanic and Atmospheric Administration (NOAA) one of their functions is to utilize tools and technology to locate and track hurricanes (Carpenter & Carpenter, 1993).

Hurricane Dangers

According to FEMA (2008), "hurricanes wield incredible power. As they near land, they can bring torrential rains, high winds, floods and flash floods and spawn tornadoes. Even more dangerous is the storm surge - a dome of water that, at its peak, can be 20 feet high and 50-100 miles wide. Surges can devastate coastal communities." During the storm, buildings can be damaged by winds or floodwater, and debris can damage buildings or block roadways.

"The devastation resulting from hurricanes is significant and widespread - more so than any other natural disaster" (NSB, 2007, p. 26). The primary hazards associated with tropical cyclones include: "storm surge flooding, inland flooding from heavy rains, destructive winds, tornadoes, and high surf and rip currents" (National Weather Service [NWS], n.d.).

Winds

Picking up where the Beaufort scale left off, Herb Saffir and Bob Simpson developed the Saffir-Simpson Wind Scale (Appendix C) to gauge a hurricane's intensity. The scale also provides examples of the types of damage and impact that could be expected depending on the intensity of the storm (Schott et al., 2012).

The Saffir-Simpson wind scale categorizes tropical cyclones into 5 classes based on "the maximum sustained surface wind speed (peak 1-minute wind at the standard meteorological observation height of 10 m [33 ft] over unobstructed exposure)" (Schott et al., 2012). The 5 classes include: category 1: 74-95 mph, category 2: 96-110 mph, category 3: 111-129 mph, category 4: 130-156 mph, category 5: 157+ mph (Schott et al., 2012). "This scale is based solely on estimated maximum wind speed within a hurricane, and in spite of its narrow perspective, has proven to be an adequate indicator of hurricane wind damage. However, reliance on this scale as an indicator of potential storm surge has led to serious misconceptions within the public and scientific communities alike" (Irish, Resio, & Ratcliff, 2008, p. 2003). One of the downsides to the Saffir-Simpson scale is that it does not consider other hurricane related impacts, such as storm surge, flooding, and tornadoes (Schott et al., 2012).

There are two main concerns involving winds: sustained winds and wind gusts. While the sustained winds are typically used to measure hurricane strength, wind gusts have a significant impact on storm damage. Gusts of wind cause more trees to become uprooted than sustained winds. The rocking of the trees shakes the roots, which causes smaller roots to break, and soil to loosen around the larger roots (Allaby, 2003).

Tropical cyclones wind speeds are drastically affected by the topography of the land, and the removal of the warm tropical waters that feed them. "The peak 1-minute winds in hurricanes are believed to diminish by one category within a short distance, perhaps a kilometer [~half a mile] of the coastline" (Schott et al., 2012, p. 1).

Though wind speeds typically diminish quickly, hurricane force finds (winds over 74 mph) can destroy buildings, mobile homes, topple trees, and turn debris into flying missiles (Williams, n.d.). Not only does the wind damage affect buildings, but it can also significantly impact the infrastructure of the community, impacting accessibility.

Storm Surge / Flooding

While winds arguably cause the most widespread damage, the deadliest aspect of a hurricane is the storm surge and the majority of flood damage is a direct result of the storm surge. These massive flows of water can reach heights exceeding 20 feet and can travel several miles inland (Williams, n.d.).

Weisberg and Zheng (2006) studied hurricane storm surge in relation to not only the Saffir-Simpson wind scale, but many other factors that affect the amount of storm surge that is produced. The other factors that they found that contribute to the overall storm surge produced include: point of landfall, direction of approach, speed of approach, wind stress, and overall storm size (radius to maximum winds).

More recent research has found that the width and slope of the continental shelf also affect the storm surge that is produced. Shallower slopes can potentially produce a larger storm surge than a steep shelf (National Hurricane Center [NHC], n.d.). In these areas with a shallow shelf, the communities affected can expect to see water inundation from the storm surge further inland.

In addition to the storm surge, inland flooding can cause significant damage. “Intense rainfall causes two types of destruction. The first is from seepage of water into buildings causing structural damage; if the rain is steady and persistent, structures may simply collapse from the weight of the absorbed water. The second, more widespread and common and much more damaging, is from inland flooding, which puts at risk all valleys along with their structures and critical transportation facilities, such as roads and bridges” (Organization of American States [OAS], n.d., Chapter 12).

Water damage is not only a coastal problem, due to the torrential rains that accompany tropical cyclones, flash flooding is a major threat for people living inland. Blocked storm drains and limited areas for water to go exacerbate this problem (Williams, n.d.). Additionally, apparatus responding in flooded areas are at risk. In water that is flowing, even at 30-35 mph, if water is half-way up the wheels, it can overturn a vehicle (Chaston, 1996).

Debris

In regards to wind damage, most of the damage caused during a tropical cyclone is caused by either the direct impact of the wind, or flying debris it generates. “The wind itself primarily damages agricultural crops. Entire forests have been flattened by forces that pulled the tree roots from the earth. Man-made fixed structures are also vulnerable. Tall buildings can shake or even collapse. The drastic barometric pressure differences in a hurricane can make well-enclosed structures explode and the suction can lift up roofs and entire buildings. But most of the destruction, death, and injury by wind is due to flying debris” (OAS, n.d., Chapter 12).

How fast the storm passes can influence the damage due to debris, and can extend the period of time that structures are battered. “Once damage has occurred, debris from both structures and vegetation become missiles that extend the impacts of high winds. . . heavy rain and flooding, that saturates the soil, loosens the root structures of trees, and initiates soil erosion” (World Meteorological Organization [WMO], 2017, p. 332). As well as its forward speed, the size of the storm determines how long an area is inundated with significant winds, rain, and debris. The longer a storm impacts an area, the more damage it incurs.

According to Dr. Albert Bleakley, associate professor of construction management at the Florida Institute of Technology, “damage from wind-blown debris is the most preventable problem” (Williams, n.d.). By taking preventative measures such as securing items kept outdoors, maintaining the vegetation, and ensuring that buildings are maintained debris generation can be minimized. Communities and utility companies can also help by reducing the threat to infrastructure through tree trimming campaigns.

Tornadoes

Due to the rotational winds that tropical cyclones form, it is not uncommon to find many tornadoes spawn along their path. Tropical cyclones can spawn tornadoes during the initial storm, as well as for days afterward (Williams, n.d.). The eyewall of the hurricane produces large amounts of thunder and lightning, along with disturbances in air movement. This air rotation frequently triggers tornadoes in close proximity to the eyewall (Allaby, 2003).

Tornadoes spawned around the hurricane eyewall are normally short lived, and not as damaging as typical tornadoes found elsewhere, “but while they last the wind speed increases greatly and there may be many of them appearing and vanishing unpredictably (Allaby, 2003, p. 113).

Importance of Developing a Response Plan

“The first step in Emergency Management consists of planning. . . Appropriate planning means that resources, trained personnel, and procedures are in place when a disaster occurs” (Nicholson, 2003, p. 290). By planning for a disaster, a course of action can be followed that considers lessons learned during previously encountered situations to reduce the damage, or expedite the mitigation process.

Some agencies are hesitant to put plans in place due to a fear of them failing, but courts typically protect those who have well intended efforts, and they rarely question the judgement of the people who have to operate in extreme situations. “Only the most flagrant or obvious deviations from procedure or good practice have been exposed to actions for negligence” (Nicholson, 2003).

In fact, there appears to be more of a liability in failing to establish a plan than deviating from on that is currently in place. Nicholson (2003) found 2 main lessons in his review of

Emergency Management case law. First, from a liability standpoint, it is ill advised to avoid drafting a disaster plan. Second, those planning for disasters should take careful consideration and write plans and procedures that clearly define the level of discretion that is allowed to the individuals implementing them.

Not only do agencies need to be cognizant of legal issues related to incident response during disasters, ensuring crew safety is paramount. Olson (2008) found 38% of respondents to his surveys had employees who were either injured or experienced a near miss. Of the respondents who gave detail, all but 1 were caused by “a flying limb or falling tree striking people, apparatus, or blocking apparatus,” showing how dangerous debris can be to crews.

Another reason that response plans should be in place prior to an event is because of the effects on vehicular performance. “Vehicle performance in harsh windy environments, especially during dynamic, gusty, intermittent wind loadings experienced during hurricane events, is an extremely important safety consideration and should be taken into account in any route closure assessment” (Rodriguez, 2014, p. 22). “EMS vehicles are subject to the same physical constraints as other production vehicles, including the opportunity to become stuck or stranded. The driver faces a real possibility of becoming stranded for hours until rescued by a plow or tow truck” (United States Department of Homeland Security [USDHS], 2015). Having a plan in place of when to limit response can help reduce the chance of crews becoming stranded during a tropical cyclone.

The power company takes a regionalized approach when determining when to cease response, and the decision to stop responding comes from the power company’s Emergency Operations Center (EOC). To assist in the decision making, an in-house meteorologist that is based out of Charlotte, NC deploys to the impacted region to become part of the incident management team in the EOC (J. Guzman, personal communication, September 26, 2018).

In her research, Madigan found that the majority of departments interviewed had criteria in place, but did not follow them and improvised a call screening system. Weather information was determined by gathering information from a decentralized source and considered current and potential weather conditions (Madigan, 2005). This consideration of potential weather conditions is important, because conditions may change dramatically within a matter of minutes. The International Association of Fire Chiefs (IAFC) also recommends that crews consider the calm period during the eye of the hurricane. “Operations during the period the eye of the hurricane passes by should be limited to re-securing the fire station. No companies will be dispatched during the eye of the hurricane. All operations during the eye of the hurricane should only be performed if they can be done safely” (IAFC, 2008).

In 2008, the IAFC put out a guide on preparing for and responding to hurricanes. This guide titled ‘Model procedures for response of emergency vehicles during hurricanes and tropical storms,’ guides departments on planning, response, and mitigation of hurricanes. The model procedures put an emphasis on ensuring a plan is in place for resuming response. Some of these recommendations for resuming response include:

1) “The chief of department or designee shall make the determination when the department can resume response operations. This decision will be announced by dispatch as a resume response order.
2) Chief officers and company officers who believe it is safe to resume operations before receiving this order shall contact command and state the conditions at their location and their need to begin operations. Command shall order accordingly.

3) If these officers are unable to contact command, the decision to begin operations will be the responsibility of the highest-ranking officer on scene. Operations shall be undertaken only if such operations can be performed in a safe manner.
4) Personnel conducting emergency operations must realize that their own safety and wellbeing is their first priority. Many hazards will be encountered after a hurricane, including but not limited to live wires down, gas leaks, building fires, unsafe structures, flooding, hazardous materials, heat stress, traumatized victims, civil disturbance and displaced animals" (International Association of Fire Chiefs [IAFC], 2008, p.11).

Miami-Dade for example has a system that resumes response when winds reduce below a certain threshold and send out incidents that have been triaged and are awaiting dispatch. "After Hurricane Irma passes and sustained winds drop to less than 35 miles per hour—which could take a day—the Miami-Dade County Office of Emergency Response's Command Center will begin sending first responders to the places of greatest need" (Edwards, 2017, para. 18).

Criteria used in determining response

Through much research on his Applied Research Project (ARP) at the National Fire Academy (NFA), Carl Weaver found that the commonly accepted industry standard for ceasing response during tropical cyclones is 50 mph sustained winds. He also noted that sustained winds were the only identifiable parameter that was utilized to determine when to cease response during this time (Weaver, 1997).

Weaver proposed that while response thresholds have focused primarily on sustained winds, they should include wind gusts as well. This is due to the fact that though sustained winds may be within normal response thresholds, wind gusts may exceed the thresholds and cause failure of structural components as well as cause debris to become wind borne, thus endangering operational personnel. Further research indicated that the criteria utilized for ceasing response should also include the effects of wind on vehicles, operational crews, and debris (Weaver, 1997). The difference between sustained winds and wind gusts has been looked at throughout the year, but one study by Powell, Houston, and Reinhold (1996) found that wind gusts can be 1.3 times (or 30% higher) than sustained winds.

Elaine Fisher found during research for her ARP at the NFA that while most agencies used the 50 mph sustained winds response threshold, after experiences with previous storms, several agencies have changed their response and even lowered the point at which they cease response (Fisher, 2004).

Future research found similar results, ". . . wind will be a limiting factor in their (ambulances) operation. Other hazards must be considered, of course, including debris on the highway, flooded highways, debris in the air, the difficulties of working outdoors in severe winds, and impacts of the driver's reactions while operating an ambulance in high winds" (Schmidlin et al., n.d., p.2).

With more information, better decisions can be made regarding when to stop responding, but overall people are drawn to the simplicity of the Saffir-Simpson wind scale. Recently, many groups have looked to categorize hurricanes in a new manner to more accurately portray the damage potential of a tropical cyclone. Over the years, many groups have proposed new scales, including the "Hurricane Severity Index, the Cyclone Damage Potential Index and the Integrated Kinetic Energy Index." All of these scales consider that there are factors other than wind speed which can dictate how catastrophic a storm can be. The main idea behind these scales is that the more variables, the more valuable it will be (Rice, 2017).

For years fire service agencies have had to determine if and when they would respond during tropical cyclones with little research conducted on the topic and no standardized approach. In 2002, after Hurricane Andrew, Helene Wetherington, the assistant director for the Palm Beach County Emergency Operations Center, said that “The rescue vehicle study is needed because manufacturers can’t give accurate data on how their vehicles will do in high winds, and cities and agencies often have to make an educated guess” (Kleinberg, 2002, para. 20). She noted that if triggers for amending, or halting response are too conservative, lives can be lost and if they are too liberal, the responders are put in jeopardy.

Another significant finding after Hurricane Andrew was that blanket decisions which are applied over large areas can have a detrimental effect on the response efforts. Wind speeds and other factors used to determine when to respond and when not to can be drastically different from one area to another. In this case, the south end of Miami-Dade County had 40 mph winds and the north end had nothing. Units could have been responding in most of the county if the blanket decision to stop responding at 39 mph winds was not applied (Kleinberg, 2002).

Hurricane Andrew was one of the contributing factors that led to Florida Institute of Technology (FIT) conducting a study regarding Wind Effects on Emergency Vehicles (Pinelli & Subramanian, 2003). Due to the fire department and law enforcements active role in helping with the preparation, evacuation, and response during a hurricane, where operating vehicles in situations when the wind speeds are so high that safety might be compromised, Pinelli and Subramanian (2003, p. 10) explained that “it is therefore important to define the threshold wind speed beyond which vehicles should not be allowed to operate.”

The Wind Effects on Emergency Vehicles study looked at three distinct vehicle types: Cyclone model fire truck, type I ambulance, and Suburban SUV and the possibilities of two types of vehicle accidents: course deviation and overturning of vehicles due to high winds in these vehicles. The study showed that wind speeds required to overturn emergency vehicles depends on a variety of factors including the surface area, weight, weight distribution, and wind direction, among other factors. Tests on scale models showed that ambulances are the most susceptible to overturning, and will occur starting at 90 mph. Fire engines and SUV's require much greater wind speeds (160 mph and 138 mph respectively) due to the factors listed. However, it was also found that much lower wind speeds can cause course deviation on these vehicles (Pinelli & Subramanian, 2003).

In 2004, after Hurricanes Francis and Jeanne, Palm Beach County updated their hurricane response model so that after the winds reached 45 mph the dispatch center would only dispatch life-threatening calls and place the other calls in a wait-list. The alarm office would screen the calls with a fire officer being present in the dispatch area for consultation. After the dispatch screened the calls, the call would be forwarded to the area battalion chief who would make the decision of whether or not to respond, but the station officer had the discretion not to respond if they felt it was unsafe. The personal experience of the researcher found that while the idea was good in principle, there were issues with leaving discretion to not respond to the individual stations. In one case, a structure fire was dispatched and one of the stations dispatched responded while the other did not. This confusion led to an inconsistent delivery model (Madigan, 2005).

The US Fire Administration issued a technical report on Fire Department Preparedness for Extreme Weather Emergencies and Natural Disasters. One key recommendation is that "Winds above storm force (above 39 mph) will cause debris and any other objects not secured to move or become airborne, posing serious hazards to personnel, vehicles, and structures. Departments that have hurricane plans should include a provision for the cessation of response operations at a given wind threshold. According to this particular research, sustained winds of 39 mph generally are the accepted threshold. This “no-go” period will last until the sustained winds once again drop below the threshold. During this time, procedures should be in place to put calls “on hold” until conditions warrant a safe response” (USFA, 2008, p. 22-23).

To help create a standardized approach to tropical cyclone response, the IAFC “Model procedures for response of emergency vehicles during hurricanes and tropical storms” was published in 2008, and recommends the following guidelines to assist in the department’s response during these types of storms:

1. No member shall ride alone during a storm. All members will operate in pairs.
2. All members are to wear full bunker gear, including eye protection, for all responses in order to protect from flying debris.
3. Aerial devices should not be operated when sustained winds are 35 mph or per department policy.
4. Prior to sustained wind speeds reaching 50 mph, or wind gusts over 65 mph, any chief officer or company officer who feels the situations encountered are sufficiently dangerous to the safety of personnel may cease operations and return to quarters. The officer must advise the incident commander and the dispatch center.
5. For the safety of the members, the fire department should discontinue response to all fire/EMS calls when sustained wind speeds reach 50 mph or wind gusts are over 65 mph. When the order to cease response is given due to hazardous wind conditions:
    a. Units responding to or on the scene of an emergency shall continue their work until completed, at which time the units will return to their assigned stations.

b. Units out of station, but not on a call, should return to their stations as soon as possible" (IAFC, 2008, p. 8).

In an interview for a news article, Zephyr Penoyre, a PhD student at Columbia University, New York, related that "the heavier the truck is and the larger the force, and then higher the wind speed is needed before you topple over. . . if you increase the weight with cargo then you can manage much higher winds" ("What wind speed will blow my truck over," 2015, para. 12). The weight and size of a fire engine make the likelihood of it toppling rare, it is more likely that an ambulance would overturn due to the larger surface area, but lighter weight.

Previous researchers have proposed that wind speeds affect human performance, which should also be taken into consideration for ceasing response. Penwarden (1973) provided some of the first in depth looks at the effects of wind on the human body. The rule of thumb provided by his previous research is that: 11 mph is the onset of discomfort, 22 mph is definitely unpleasant, and 45 mph is dangerous. More recently, Murakami, Iwasa, and Morikawa (1986) defined the hazardous threshold for wind speed at 52 mph. Yet Chaston (1996) in his book Hurricanes!, related that in a personal experience he went to the top of Mt. Washington, New Hampshire and "tried to stand in sustained winds over 100mph. It was impossible." He further states that in 70 mph winds you would have to lean at a 45-degree angle to not be blown to the ground, while between 80-100 mph it is impossible to walk unassisted. (Chaston, 1996, p. 119)

Recent research has looked into the impact that high wind speeds have on drivers, and not just the vehicles as in the past. A study by Jose Rodriguez (2014) titled "Modeling the effect of gusty hurricane wind force on vehicles using the LSU driving simulator," looked at the impact that different strength winds had on drivers of 3 distinct vehicle types: passenger vehicles, buses, and ambulances. He found that long before the vehicle becomes unstable, the limiting factor is the ability of the vehicle to maintain a straight path and the driver's ability to control the vehicle. It was found that a majority of the participants found it more tasking to control heavier vehicle types.

The findings throughout the Literature Review led the researcher to consider not only the measurable criteria in determining response thresholds, like sustained winds, wind gusts, and storm surge, but other factors as well like debris, driver's skill level, and risk/benefit.

Threshold measurement tools/technology

In the 17th century, Robert Hooke developed a tool to measure wind speed called the anemometer. This tool has been improved upon over the years, but the basic design has remained the same (Tufty, 1987). Anemometers can be either handheld devices, or attached to a weather monitoring station. These devices are still commonly used in determining weather conditions at a given location.

Some organizations such as the National Oceanic and Atmospheric Administration (NOAA) and the Royal Meteorological Society (RMetS) have included land-based components with the Beaufort scale to show typical land-based conditions at various wind speeds (Appendix D). By comparing conditions outside with the land-based conditions associated with the Beaufort scale, a rough estimate of wind conditions can be obtained.

Local, National, and International news/weather stations utilize a variety of satellite, radar, and local monitoring stations to collect and analyze weather conditions. This data is then disseminated, providing a valuable source of current and projected weather conditions that emergency managers can utilize in decision making.

Newer technology, such as Hurricane Imaging Radiometer (HIRAD) and Stepped Frequency Microwave Radiometer (SFMR) allow for more “accurate forecasts and warnings for the maximum wind speed, wind field structure, and related impacts” (Cecil & Biswas, 2017, p.1837). This gives Emergency Managers and responders a better picture of what can occur and allow for greater preparation as well as decision making capabilities.

In 2017, an arrival of Tropical-Storm-Force Winds Graphic was recently placed in service in an experimental status. The following year, the National Hurricane Center (NHC) fully implemented this to show when tropical storm winds can be expected to arrive (National Hurricane Center [NHC], 2018).

While offshore, weather buoys are utilized to “measure wind and air pressure, water and air temperatures as well as wind direction with anemometers, and they can measure sustained wind speeds in one-minute increments” (Whetzel, 2018, p. 4). This information allows for forecasters to track where the storms are going as well as the intensity, which allows for pre-landfall planning, but is only a reliable source of information for determining when to cease response in coastal communities.

Another measurement tool that is commonly utilized for long term forecasting is hurricane reconnaissance aircraft. These planes fly into hurricanes to measure wind speeds and barometric pressure and visually inspect the ocean surface (Whetzel, 2018). The reports on the hurricanes conditions primarily come from two organizations: the U.S. Air Force’s Hurricane Hunters and the Aircraft Operations Center (AOC) of the National Oceanic and Atmospheric Administration (NOAA) (University of Rhode Island, n.d.).

While some methods of data collection such as the reconnaissance aircraft and weather buoys are helpful in providing advance notice of weather conditions for the upcoming storm, these are most beneficial in determining when to cease response in coastal communities as the weather conditions can dramatically change within a few km of landfall.

Procedures

While attending the National Emergency Training Center (NETC), information on the topics of hurricanes and their dangers, emergency response during hurricanes, and emergency vehicles was collected from the Learning Resource Center (LRC). Periodicals, trade journals, course materials, textbooks, and prior ARP's were researched for the topics listed.

After returning from the NFA and discussing the information gathered at the LRC as well as departmental procedures for emergency response during a tropical cyclone with Oviedo Fire Department Fire Chief, Lars White, an applied research project (ARP) proposal was developed. The proposal was sent to Bruce Evans, the assigned ARP evaluator. The proposal was emailed on August 6, 2018, and approved on August 15, 2018, with a suggestion to include the Coast Guard in the research.

Between August 17, 2018 and August 21, 2018, Dr. Tom Owens, Director of Research at the University of Central Florida (UCF), was contacted to discuss the research topic and research questions. Over several phone calls, and a few emails, survey questions that targeted two of the research questions were developed. A survey was created for external agencies to look at the following research questions: (1) What criteria are used in determining when emergency response should cease when tropical cyclones approach? (2) What tools/technology are other Fire/EMS agencies utilizing to identify when to cease emergency response when tropical cyclones approach?

Qualtrics survey instrument was utilized through UCF to develop the surveys. The survey data was then distributed, collected, and analyzed through this survey tool to ensure respondent anonymity. Dillman, Smyth, & Christian (2014, ch.2) have several recommendations for improving respondent participation in surveys. Some of the methods utilized to improve the response rate include:

1. Specifying how the survey results will be used
2. Making it convenient to respond
3. Reducing the length and complexity
4. Assuring confidentiality
5. Being available if respondents need help

An introductory letter (Appendix E) was distributed through the state Fire Chiefs associations on August 27, 2018. The email explained what was trying to be accomplished with the survey (Appendix F), asked for the respondents help, and contained different methods to access the survey (a weblink and quick response code (QR code)). The survey instrument was distributed to the Fire Chiefs Associations of the 5 states most commonly hit by hurricanes: Florida, Texas, Louisiana, South Carolina, and North Carolina. Associations that indicated they distributed members the survey include: Florida, Louisiana, & Texas. The survey was closed on September 17, 2018, so the results could be analyzed (Appendix G).

Approximately 1,050 agencies had surveys distributed to them. According to the secretary of the Florida Fire Chiefs Associations (FFCA), Bonnie Scott, approximately 350 departments are members of the FFCA (B. Scott, personal communication, August 27, 2018). The Texas Fire Chiefs Associations (TFCA) contains 500 departments who are members according to Tanya Childs, Director of Operations (T. Childs, personal communication, September 17, 2018). While the Louisiana Fire Chiefs Associations (LFCA), consists of approximately 200 departments, according to Jamie Freeman, account manager for the LFCA (J. Freeman, personal communication, August, 2018).

On September 17, 2018, the survey was closed with 108 responses received. If all 1,050 members of the Fire Chief's associations that participated received a survey, this would amount to a 10.3% response rate. External surveys can typically expect a response rate of approximately 10-15%, making this fall within the normal range (Fryrear, 2015). One limitation on receiving responses was that Hurricane Florence hit South and North Carolina during the time the survey went out. Many states that surveys were sent to deployed resources to assist, and could be one reason for the results being at the lower end of the range. A second limitation of the research was that some municipalities have their spam filters set very strict and some agencies indicated that they did not see the survey until after the date the survey closed. At this time, the survey data was analyzed and interpreted.

Requests for information were sent to several of the major manufacturers of fire apparatus and ambulances on when they recommend to stop responding in their specific apparatus. These manufacturers include: E-One, Ferrara, Pierce, Braun, REV Group, & Wheeled Coach. Responses were only received from 2 of the manufacturers, E-One and Pierce.

According to Daniel Kerr from E-One, "Due to the fact that we make custom trucks and the weight of each truck along with the overall profile of the truck can be different each time. We have never done a study. we [sic]recommend that the AHJ make that determination using NFPA and DOT as a reference." Similarly, a response was received from Pierce stating "Due to the fact that our trucks are all custom built, we are only able to provide that level of information if we have the Job Number (which is a 5-digit number posted on the inside of the cab) or the full VIN" (Linda Pagel, personal communication, August 2018). With our fleet of apparatus being manufactured by Pierce, the VIN was provided and a response was received stating “your Pierce dealer will be able to help you with these questions. Their contact will be Ten-8 Fire” (Fred Willes, personal communication, August 2018). No response was received from Ten-8.

While awaiting survey responses, further literature review was conducted on the topics of: weather monitoring services, hurricanes and their dangers, emergency response during hurricanes, emergency management law, and emergency vehicles was conducted utilizing the National Emergency Training Center (NETC) Learning Resource Center (LRC) website, EBSCOhost, and the UCF main campus library. An electronic search was also conducted on weather monitoring services and sites.

Fire Operations Chief Jeff Buchanan was interviewed on August 27, 2018 to determine what the current policy is regarding when to cease response. He advised that there is no specific department policy regarding when to cease response, but Seminole County (who dispatches for all agencies in the Seminole County first response agreement) utilizes an Operational Guideline in deciding when to cease response that dates back to 2005 (Appendix H). He further related that during Hurricane Irma, the dispatch center would take the calls and ask each agencies Operations Chief what they would like to do, thus leaving the decision-making up to each individual agency.

On August 27, 2018, the district 7 (southeast US and Caribbean) public affairs department for the United States Coast Guard (USCG) was contacted and Jonathan Lally was asked how they determine when to cease response during tropical cyclones, or other major wind events. A follow up email was sent so that the proper contact could answer two questions: what are the thresholds at which you cease operations during Tropical Cyclones (sustained winds, wind gusts, storm surge, debris, or other criteria that you may use which could affect when you would respond during these events) and what instrumentation, technology, tools, or methods do you utilize to measure the criteria of when to cease response (weather monitoring stations, weather subscription services, news stations, etc.). No response was heard, but this could be due to the involvement of the 7th district of the US Coast Guard in Hurricanes Florence and Michael recovery efforts.

On September 14, 2018, Soren J. Rose, LT, Military Aide to USCG Vice Admiral Daniel Abel Deputy Commandant for Operations was contacted. He reached out to his contacts in an attempt to get a response and felt that this was something that would be better answered at the administrative level than through the district public affairs office and put the researcher in contact with Commander Ben Maule, executive assistant to Rear Admiral Anthony “Jack” Vogt, assistant commandant in the Response Policy (CG-5R) division of the United States Coast Guard (USCG). A telephone interview was conducted on Oct 4, 2018 to determine how the USCG determines when they will cease responding to incidents.

On September 21, 2018, Dr Michael Brennan, Branch Chief of the Hurricane Specialist Unit at the NWS was interviewed via telephone regarding collecting weather data during storms. In regards to any new technology that could be utilized to measure wind speed, he advised that there is a newly implemented “arrival of tropical-storm-force winds graphic” that shows when tropical storm force winds can be expected in an area. Additional insight into monitoring system capabilities was collected, and he suggested contacting Scott Spratt, Warning Coordinator Meteorologist at the NWS in Melbourne. Scott Spratt was contacted, and was interviewed via telephone on September 26, 2018, regarding the weather data collection systems in Central Florida.

Jimmy Guzman, Emergency Preparedness Manager for Duke Energy Florida, was contacted via telephone on September 26, 2018, to understand the local power company's emergency response plan during tropical cyclones.

One limitation that this research does not consider is specialty response types, or specialty apparatus such as high angle rescue, structural collapse rescue, boats, or air operations. Certain aerial apparatus could still potentially be utilized in response, though elevated operations may have to be halted or modified. Another area this research does not look at specifically, but has a great impact on the debris generated during the storm is the local building codes and construction methods. Florida is one example of a state that has enacted more stringent building codes. In Florida, during the post 2000 year of construction, the windstorm losses were reduced by up to 72%. It is possible that enacting newer codes in hurricane prone states could reduce debris, thus minimizing that danger and aiding in recovery (Simmons, Czajkowski, & Done, 2017).

Results

Current Operational Response

Through interviews, it was found that the Oviedo Fire Department does not have a specific policy in place as to when response should cease, but Seminole County Fire Department that is part of the first response agreement has an operational guideline dated September 21, 2005 that includes conditions units should use to determine response capabilities. Some of these criteria include:

1. Engines, Towers, Squads, and water tenders consider: the officer's confidence in response ability, winds ranging from 50-70 mph, enclosed crew compartments, and road conditions.

2. Ambulances consider: the officer's confidence in response ability, winds ranging from 30-50 mph, and road conditions.
3. Command Vehicles consider: the officer's confidence in response ability and winds ranging from 60-70 mph.
4. When units should "go/no-go" and risk vs benefit will be determined based on the threat to emergency personnel, and the final decision to respond or not will be determined by the company officer.
5. This guideline also indicates that a pocket weather meter, as well as remote weather stations, and the National Weather Service (NWS) should be utilized in decision making.

During recent storms, the Seminole County Fire Department dispatch center would take the calls and ask the Operations Chief for each agency that they dispatch for if they would like to: hold the call, send a normal response, or send a single unit to investigate. The 2005 guidelines were not really utilized, and the final decision rested with a chief level officer of each organization.

Criteria used in Determining Response

Literature review

The inability of apparatus manufacturers to identify specific criteria when response should cease appears to be consistent with previous research. Carl Weaver (1997) in his Applied Research Project (ARP) found "numerous studies and tests have been conducted by civil and automotive engineers on the effects of wind on vehicles and pedestrians. While there has been no identifiable research on such effects with fire apparatus and firefighters. . .). Elaine Fisher (2004) found during personal interviews at Fire Rescue East that to their knowledge they "did not know of any research specifically addressing wind effects on fire apparatus handling." This appears to be a consistent trend, and when asked the few apparatus manufacturers who responded either claimed that there were too many variables and could not answer, or tried to push the question off to someone else.

Weaver (1997) and Fischer (2004) found at the time that 50 mph sustained winds was the most commonly used threshold for ceasing response to emergency incidents. Fisher (2004), however included a 35-mph cut off for ambulances, due to the findings of Pinelli and Subramanian (2003). Newer data has led to recommendations from the IAFC to maintain the 50 mph /35 mph sustained winds thresholds, but also include 65 mph wind gusts as a threshold. They also allow for officer discretion in determining if response is appropriate. (IAFC, 2008)

Weaver determined through his research that not only does wind have an impact on emergency vehicles, but the can also have effects on people and structures through decreased mobility or capacity to work as well as debris generation (Weaver, 1997). It was recommended that careful consideration should be given to operating in high wind conditions due to the dangers that debris can have on individuals. Olson's findings through his surveys showed that almost all of the respondents who indicated they experienced a near-miss incident had encountered threats from debris (Olson, 2008). Due to these dangers, the IAFC also recommended that when responding in these incidents, all members wear full bunker gear, including eye protection, for all responses in order to protect from flying debris (IAFC, 2008).

Madigan (2005) found that Palm Beach County, FL implemented a policy when the winds reached 45 mph the dispatch center would only dispatch life threatening calls and place the other calls in a wait-list. Calls were screened by the alarm office with a fire officer being present in the dispatch area for consultation. The call then gets forwarded to the area battalion chief who decides whether or not units should respond. There is an opportunity for the station officer to decide not to respond if they felt it was unsafe.

The Pinelli and Subramanian (2003) WHIRL study "Wind effects on emergency vehicles" found:

1. In the fire truck simulated, overturning is unlikely to happen from wind speeds alone.
2. Critical wind speeds for the fire truck fall between 64-70 mph.
3. In the type I ambulance simulated, they are at risk of overturning in wind speeds above 90 mph.
4. Critical wind speeds for the type I ambulance fall between 35-50 mph.
5. In the Suburban SUV simulated, they are at risk of overturning in wind speeds above 138 mph.
6. Critical wind speeds for the Suburban SUV is above 77 mph.

Pinelli and Subramanian (2003) acknowledged a few limitations in the experiments that could influence the results and implemented a safety factor to compensate. Some of these limitations include: vehicle weight, profile, varying tire condition, wind gusts, and wind speed in the field varying from announced weather. Considering these limitations, they presented the following table (Table 1) as recommended response thresholds.

	Critical	Seek Shelter
Fire Truck	**50**-70 mph	70+ mph
Ambulance	**30**-50 mph	50+ mph
Suburban (SUV)	**60**-70 mph	70+ mph

Table 1: Classification of wind speed driving conditions for each vehicle

According to Fisher (2004), these recommendations coincide with various departments' experiences in past tropical cyclones, but along with Weaver (1997) feel that debris and wind effects on personnel are equally as important in determining when to cease response.

In 2014, LSU student Jose Rodriguez found that long before the vehicle becomes unstable, the limiting factor is the ability of the vehicle to maintain a straight path. He tested individuals in a driving simulator that was programmed to mimic the effects of different categories of hurricane. Some of the key findings in his research include:

1. 52% of drivers of the ambulance simulations felt unsafe driving the vehicles, and the participants "generally found it more tasking to control heavier vehicle types"
2. In all vehicle types tested, the results of the test indicated that beginning in category 1 hurricane conditions, a loss of control and complete lane departure were found.

According to the Rodriguez, this confirms how dangerous driving in hurricane force winds is regardless of the vehicle type that is being driven.

Due to the dangers associated with response during hurricanes, the IAFC developed some model procedures that departments can modify and implement to enhance their response capabilities. Some key recommendations from the IAFC model procedures include a cut off point for response, but also give the leeway to station officers to suspend response if they are concerned about the crew safety.

1. The fire department should discontinue response to all fire/EMS calls when sustained wind speeds reach 50 mph or wind gusts are over 65 mph.
2. Before sustained winds reach 50 mph, or wind gusts exceed 65 mph, any chief officer or company officer who feels the situations encountered are sufficiently dangerous to the safety of personnel may cease operations and return to quarters.

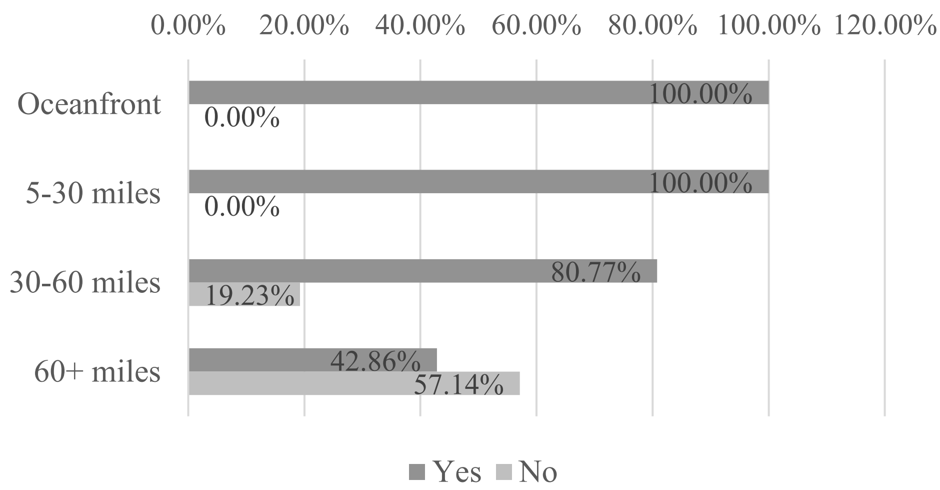
3. When responding during tropical cyclones, all members should wear full bunker gear, including eye protection, for all responses in order to protect from flying debris.

In the USFA report "Fire Department Preparedness for Extreme Weather Emergencies and Natural Disasters," it is recommended that hurricane plans are in place and include a cessation of response operations provision. The recommendation given for ceasing response is when sustained winds reach 39 mph, and will last until the sustained winds drop below the threshold (USFA, 2008). It should be noted that this is lower than the recommendations given by the IAFC and the findings of previous researchers.

It is important that whatever plan the agency has in place that it be followed. Madigan found in her interviews that the majority of departments that had criteria in place did not follow them, but improvised leading to confusion (Madigan, 2005).

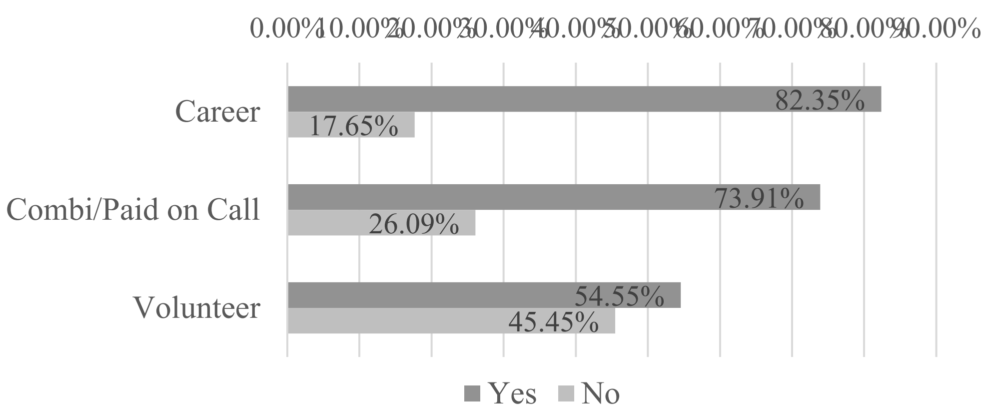
Research survey

Reviewing the research surveys, a wide variety of criteria were identified that determine when to cease response during a tropical cyclone. Overall, 77.45% of agencies that responded to the survey stated they have a written policy on when to cease response. It was found that the further you get from the shoreline, the less likely it is to have a plan in place to cease response. 100% of departments surveyed that are less than 30 miles from the ocean have a written policy in place, while 80.77% of departments surveyed within 30-60 miles of the ocean, and 42.86% of departments surveyed over 60 miles from the ocean have a written policy in place regarding when to cease response during tropical cyclones.



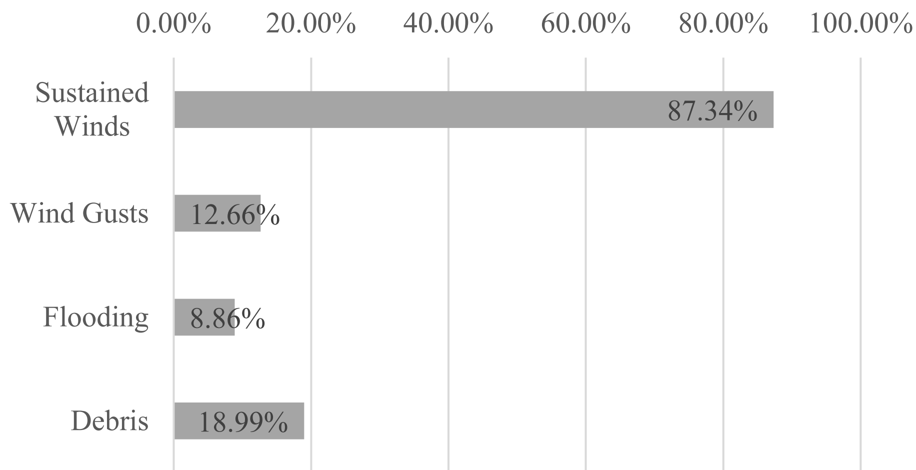
Graph 1: Response plan by distance from ocean

Similarly, 82.35% of career departments surveyed have a written policy in place, while 73.91% of paid on call, or combination departments surveyed, and 54.55% of volunteer departments surveyed have a written policy in place regarding when to cease response during tropical cyclones.



Graph 2: Response plan by department type

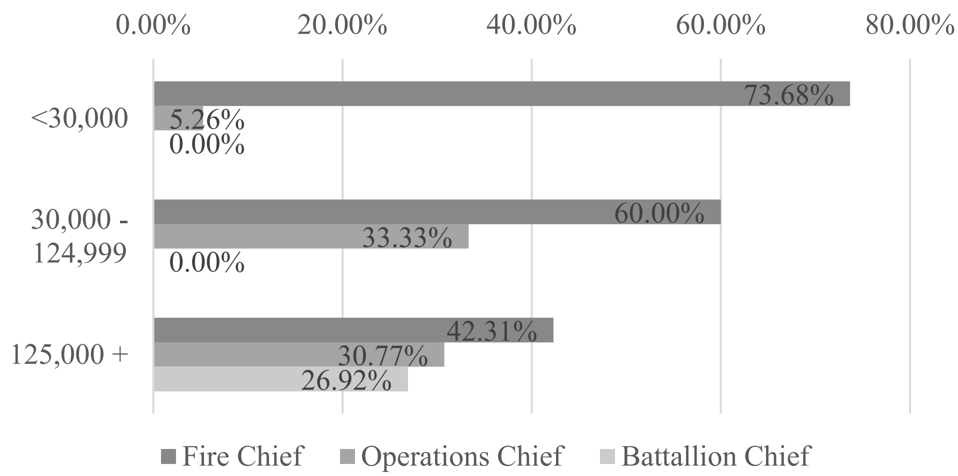
The surveyed departments indicated that of the criteria used to determine when to stop responding 87.34% of agencies that responded indicate sustained winds are utilized, while 18.99% of written policies identified include debris in their criteria to stop response. Additionally, only 8.86% of identified response plans utilize flooding/storm surge and 12.66% of identified response plans utilize wind gusts. The identified threshold limits for ceasing response through the survey varied significantly, with sustained winds ranging from 30-74 mph, wind gusts ranging from 35-80 mph, and of the few written policies identified including flooding/storm surge or debris utilizing officer discretion.



Graph 3: Response plan criteria

Survey results also indicated that departments that serve smaller populations typically leave the decision of when to stop responding to the fire chief, while agencies serving larger populations delegate that decision down. In 73.68% of departments serving a population <30,000 surveyed, the fire chief makes the decision to cease response. This changes as the size of the population increases. In 60.00% of departments serving a population between 30,000 and 124,999, the fire chief makes the decision of when to stop responding, while 33.33% of the surveyed departments serving this population same population size leave the decision to the operations chief. The departments serving a population 125,000 and up surveyed indicated that in 42.31% of departments, the fire chief makes the decision of when to stop responding, 30.77% of the departments serving the same population leave the decision to the operations chief, and

26.92% of the departments serving populations 125,000 and up leave the decision to the battalion chief or company officer.



Graph 4: Response ceasation decision maker

Respondents had varying opinions when asked what they felt should be the criteria for ceasing response. The main ideas mentioned include having clear, measurable thresholds, weighing the risk/reward, implementing an industry wide standard, and allowing discretion to override thresholds when appropriate.

Risk/Reward should be included as an opportunity to determine the necessity of response during risky situations. Some of the comments mentioned indicate the importance of include risk/reward in decision-making. “If you have a better understanding of your own capabilities (personnel/equipment), then your executive leadership need to be in harmony with risk vs. benefit of sending a Rescue or a Fire Engine/other apparatus to calls... .” “Responses during storms should weigh the cost/benefit of the emergency and let the situation dictate the tactics.” “You should take situations on an individual basis and determine risk/reward.” “Using some sort of risk/benefit scale for when the instance of responding becomes too dangerous for the emergency responders.”

The common theme of having an industry-wide standard was echoed by several agencies. "I strongly believe there should be a standard go/no go policy based on a commonly adopted wind speed... ." "Would like to see a 'standard' for all to follow - would help with the general public, admin personnel, everyone on the same page." While others felt that "any criteria the Authority Having Jurisdiction (AHJ) see appropriate with a stopgap of the units in the field exercising independent judgment during life threatening situations" should be utilized.

One respondent gave a personal instance their department faced during a hurricane. "One of our newer rescue units was dispatched out to 'find a resident who decided at the last minute he wanted to go to the shelter.' This was absolutely in the height of the storm at night. The crew was proceeding to meet with the caller when they struck a very large downed pine tree. The entire cab was demolished, causing $50,000 damage and several months of down time for the unit. The crew was injured, but only minor injuries. The caller was never found, as he just took himself to the shelter."

Chief Mike Burton from the Pinellas Suncoast Fire & Rescue District has been working on a county wide policy with the other fire chiefs from neighboring agencies and sent a copy of their draft policy after receiving a survey request.

Key point from the Pinellas County draft policy (Appendix I) include:

1. Utilization of a wind speed detection device, or if on is unavailable then the wind speed at the communication center is utilized to determine wind speed conditions.
2. If sustained winds are greater than 35 mph, aerial operations are suspended, and type 2 ambulances cease response.

3. When sustained winds are between 50 and 75 mph, each agencies incident commander makes the “GO or NO GO” call based upon available information. Only fire apparatus may respond.
4. No responses are permitted when winds are over 75 mph.
5. In emergency situations, fire apparatus or alternate means may be used to transport patients.
6. The incident commander for each agency will determine when their unit may resume response.

Interviews

Jimmy Guzman, Emergency Preparedness Manager for Duke Energy Florida, related that the power company has 2 different thresholds that they utilize in ceasing response during tropical cyclones, or other high wind speed events. At 30mph, following the vehicle manufacturers’ recommendations, all aerial operations are discontinued. The crews are still able to respond to verify that power is secured, or perform functions towards restoration that do not require aerial operations. The second threshold that is utilized is at 39mph, where all operations cease until cleared to return to work from the Emergency Operations Center (EOC) (J. Guzman, personal communication, September 26, 2018).

If crews are operating in conditions outside these thresholds and are trapped due to downed power lines, they may be stranded in an area with deteriorating conditions and no one able to respond for assistance. Fisher found evidence of individuals being trapped during her research when Chesterfield, VA law enforcement continued response even after fire department sought shelter. Several times, patrol vehicles became trapped by fallen trees and power lines.

This necessitated a fire department response outside its threshold levels, thus endangering personnel (Fisher, 2004).

Commander (CDR) Maule of the United States Coast Guard (USCG) policy division stated that the USCG has statutory policy that dictates when they have to respond and when they have to be on scene, but there are situations that arise where they are unable to utilize some tools or technology. One example he gave of this is during thunderstorms, the helicopters are not allowed to operate, but they can operate water-based vehicles, or wait until the storms clear the area. That call is made at the unit level.

He advised that there are set policies in place for certain conditions that would warrant ceasing response, but all conditions are waivable. The commanders set the objectives while the unit officers set the tactics. In the example he gave, there may be someone that needs to be rescued offshore, but how that rescue is performed, or if can be done safely is left to the unit officer who relays the decision to the commanders.

The risk/gain determines how much danger the crews are willing to take for a mission objective. CDR Maule stated that "no unnecessary risk shall be taken." The unit officers have the flexibility to override certain trigger points and can respond if there is an extenuating circumstance. They are also afforded some protection in their decision making in that asset damage is absolved. This was described as "if in the event of an extenuating circumstance an officer felt the reward outweighed the risk and an asset was damaged, they would not be charged with the damages." They are not absolved of their responsibility of injuries, or loss of crew members.

Threshold measurement tools/technology

The Oviedo Fire Department currently relies on local and national weather station updates regarding storm conditions for a generalized view of current conditions. The department also subscribes to the WeatherTap weather service (https://www.weathertap.com/) and utilizes free sites such as the NWS (http://www.weather.gov) and weather underground (https://www.wunderground.com/). For more localized conditions, the department utilizes a local monitoring station located at the EOC that is currently inoperable. This monitoring station is scheduled to be replaced in 2018. This station has been inoperable due to damage sustained during Hurricane Irma in 2017.

The research survey found that 59.85% of departments surveyed utilize weather stations (either at individual sites or a centrally monitored location), while 40.15% of departments surveyed utilize news, media, or subscription weather service. Respondents to the survey also indicated that their departments utilize sites such as Ventursky (https://www.ventusky.com/), WeatherBug (https://www.weatherbug.com/), and NOAA weather station current conditions (http://tgftp.nws.noaa.gov/weather/current/).

Responses also indicated that some departments utilize the Hurrevac storm tracking and decision-making tool which is administered by FEMA, the USACE, and the NOAA National Hurricane Center and is provided at no cost to government emergency management teams. After researching the Hurrevac software, some users indicated the tool is helpful for determining wind speeds, but not as useful as monitoring stations.

After the surveys were distributed, Thomas R. Wood, Fire Chief of the Boca Raton Fire Department emailed the researcher and indicated that they recently had Columbia weather stations installed at each of their facilities to monitor weather conditions at each station.

Locally monitored weather stations have long been a source of data, but the capabilities of them can vary greatly. “Your basic store-bought weather stations are attractive for their low price but often suffer from the most significant errors in accuracy due to their low-quality construction and longer recording intervals.” These consumer grade weather stations are designed to work at lower wind speeds and the accuracy can be off by +/- 5mph (Oswald, 2017). Another factor that can affect the accuracy of the readings is the placement of the weather station. These weather stations should be placed at 10 meters (33 feet) off the ground, and away from obstructions if possible (Oswald, 2017).

The National Hurricane Center (NHC) was contacted to ask if there was any new technology that could be utilized to determine when to cease response during tropical cyclones. The spokesperson there advised that there is a newly operational product that demonstrates the arrival of tropical storm winds in two versions: earliest reasonable arrival time (the period of time individual locations “can safely assume will be free from tropical-storm-force winds”) and most likely arrival time (“the time before or after which the onset of tropical-storm-force winds is equally likely”)” (NHC, 2018).

Dr. Michael Brennan, branch chief of the Hurricane Specialist Unit at the National Weather Service (NWS), stated that for large wind events like tropical cyclones, having weather monitoring stations within 5 miles of each other would provide a good representation of current weather conditions through large geographic areas (M. Brennan, personal communication, September 21, 2018).

Scott Spratt, Warning Coordinator Meteorologist for the NWS in Melbourne, FL, stated in an interview that the MesoWest weather system that is hosted by the University of Utah Department of Atmospheric Sciences (https://mesowest.utah.edu/cgibin/droman/mesomap.cgi?state=FL&rawsflag=3) could give a good picture of current weather conditions. By using the drop-down box and changing the network to 'all networks' it gives access to not only the NWS data, but to other data collection sites that are reliable as well (S. Spratt, personal communication. September 26, 2018).

Scott Spratt agreed with Dr. Brennan that the 5-mile spacing could give a fairly accurate picture of the current conditions experienced, however he warned that depending on the storm cells and vertical mixing of air, conditions can change by a factor of 2, 3, or 4 very rapidly. Careful consideration needs to be given to the current and future conditions crews are sent out in as deteriorating or changing conditions can impact crews that initiated response during a period between cells that fall within the response thresholds departments may have in place. He also felt that organizations that have criteria in place for not responding such as emergency response, utility companies, and the NWS rely heavily on sustained wind speeds in their decision making and should consider wind gusts, and other factors in their decision making (S. Spratt, personal communication, September 26, 2018).

Discussion

It is important to notify the community of what will occur. By advising them ahead of time when crews will not be able to respond, it will hopefully prompt upfront planning for individuals that may need additional assistance. Under mandatory evacuations, it should be relayed to citizens that if they stay in mandatory evacuation zones that responders will not be coming to their aid.

By having a plan in place, it can aid in the decision-making process for operational response during these highly chaotic times. While no policy will be able to cover every aspect, or possible scenario that could be encountered, establishing criteria but allowing flexibility to deviate when necessity dictates is important.

Current Operational Response

The lack of a current department policy should be a point of emphasis that needs to be addressed. The Seminole County Fire Department (SCFD) has an operational guide that was developed in 2005, but past experience indicates that this plan was not implemented as it was developed. This could be due to changes in recommendations, changes in the administration, or lack of awareness by officers who had not utilized it in years. While the Oviedo Fire Department (OFD) does operate under a First Response Agreement with other jurisdictions in Seminole County, the operational guide that they developed does not automatically apply to the OFD.

Criteria used in Determining Response

As was found in most previous research, sustained winds and wind gusts are commonly utilized as thresholds for ceasing response as they are easily measurable criteria. However, through the research it was also found that there are many other factors that can contribute to the danger crews face while responding, including flooding, storm surge, debris, vehicle condition, and driving ability.

Most agencies break the apparatus into 3 groups when defining when to cease response. These include: ambulance, fire truck, and fire SUV. The most commonly recognized sustained wind speed threshold varies depending on vehicle type, but previous research has been upheld with more recent findings in supporting Pinelli and Subramanian’s findings. Ambulances should be the first vehicle type to cease response as they are the most susceptible to wind effects. Previous research recommends a threshold of 30-50 mph for ambulances. Fire engines and SUV’s are better able to withstand high wind conditions. Thresholds for these 2 vehicle types are commonly accepted as 50-70 mph and 60-70 mph respectively. With most of the destruction, death, and injury that is caused by the wind being due to flying debris, wind speed and wind gusts should be a major factor in determining response capability.

In areas where storm surge and flooding present a great risk, resources that are at risk of being affected by the rising water levels should consider relocating these to a more strategic area. Flooding also presents a significant risk to response as the apparatus may not be able to reach certain areas, and if responding during a storm could potentially isolate crews in the field.

Jose Rodriguez, through his research recognized how dangerous driving in hurricane force winds is regardless of the vehicle type that is being driven. Though vehicles can withstand high wind speed conditions, issues with driver's ability diminish as the outside conditions worsen.

Another finding on response procedures was through interviews with the Coast Guard. The USCG advised that an established set of criteria is used as a baseline, but they allow the officers the discretion to amend response, increasing the safety of the responding crews. By having an intimate knowledge of the immediate area, hazards, and equipment, local crews can make educated decisions on what response would be appropriate to ensure mission success while reducing the danger to the crews.

Through the research surveys, it was noted that there is a wide range of response thresholds as well as opinions of when responses should cease. While no one plan is correct, research regarding Emergency Management Law shows that it is important for some system to be established and in place prior to the incidents.

Overall, it was found that the 2005 Seminole County Operational guidelines fall mostly in line with research conducted and could easily be modified to fit the organizations desired response procedures. Taking into consideration Jose Rodriguez's research on vehicle operators' ability to operate vehicles during tropical cyclone conditions, thresholds for ceasing response could potentially be lowered slightly, but by allowing discretion in ceasing response this may not be necessary.

Another consideration is who should be the one making the go/no-go decision. Madigan found that in her agency officers responding to the same incident from different stations each had different interpretations of if the weather conditions were safe to respond. If the decision was left to the Battalion Chief (area commander) there would not be a question, however they may not be fully aware of how different the conditions are even a few miles away.

Threshold Measurement Tools/Technology

Research and past practice have shown that the ideal means of acquiring information regarding outside conditions in a specific area is localized weather stations. By utilizing a centralized weather station, or relying on weather broadcasts, varying weather conditions over a large area are not being considered. Conditions in a certain geographic region can vary drastically over the course of a few miles and in large geographic areas this practice of utilizing a centralized weather station can cause unnecessary risk to crews, or potentially cause crews to not respond when conditions potentially allow them to.

While news sources and online services are good at planning for upcoming weather conditions and giving a rough idea of the present conditions in a given area, they are not always the most accurate. However, some agencies may need to rely on these due to factors outside their control such as budget constraints, power outages, or equipment damage. In these cases, crews may need to rely on their judgement, or tools such as the Land Beaufort Scale (Appendix D) and not allowing discretion could be detrimental.

Care should also be taken to plan for future weather conditions. In the eye of the storm, all of the criteria to allow response may be present, but these conditions will not last long. Crews are in significant danger if they are caught outside attempting to respond when conditions change suddenly. Rain bands also cause quickly changing conditions during tropical cyclones. These tightly wound storm cells that surround the center of tropical cyclones circulation cause strong bands of weather that can quickly change weather conditions. By looking not only at the present weather conditions, but the future, agencies can make informed decisions to keep crews safe. Utilizing all of the tools and technology available is great, but there should also be flexibility when these systems fail, or do not consider all of the factors that are experienced.

Recommendations

With all of the dangers associated with a tropical cyclone, it is important to develop a plan of when to cease response at a point where it is too dangerous to continue to aid those needing assistance. The Oviedo Fire Department should act to ensure that a plan is in place to determine what thresholds should be utilized, which tools and technology will be utilized, and how the department should consider outside weather conditions in their decision-making. After the collection of research and data, the following recommendations can be made regarding when the Oviedo Fire Department should cease response during tropical cyclones.

I. Develop an organizational policy (or system wide policy that all First Response participants utilize) regarding what thresholds will trigger varying unit types to cease response (Literature Review & Appendix H & I). It is recommended that the policy contains the following:

    a. Thresholds to cease response or ambulance, SUV, and fire engine:

        i. Ambulance: sustained winds 35 mph; wind gusts 50 mph

ii. SUV: sustained winds 50 mph; wind gusts 70 mph

iii. Fire engine: sustained winds 50 mph; wind gusts 70 mph

iv. Flying debris, flooding, or downed power lines/trees should be taken into consideration when determining ability to respond.

b. Ensure incident commander, or shift commander has the ability to override the thresholds and cease response prior to targets if conditions warrant, or allow crews to respond outside thresholds if risk/benefit warrants.

c. Utilization of full PPE when responding during high wind conditions.

d. Ensure that a plan is in place to resume operations when conditions allow.

II. If a system wide policy is not in place, coordinate with partnering agencies (first response fire departments, law enforcement, and dispatch) to coordinate efforts and ensure a consistent delivery model (Literature Review).

III. Provide local weather monitoring stations within a 5-mile radius of each other to allow commanders to evaluate changing weather conditions (Literature Review & Interviews).

IV. Ensure decision makers at the Emergency Operations Center (EOC) have access to subscription web services, local/national news networks, and can view the status of the different local monitoring sites to aid in decision-making (Literature Review & Appendix H).

V. Provide training on an annual basis (prior to the hurricane season) to command staff that will make decisions of when to cease response, and to crews that will be operating in tropical cyclone conditions. Dangers of hurricanes, criteria for ceasing response, basic weather data interpretation, and risk/benefit topics should be covered (Literature Review & Appendix H).

VI. Develop an After-Action Report (AAR) at the conclusion of each incident so that any lessons learned can be applied. Modify the departmental policy to fit the recommended changes from the AAR (Literature Review & Appendix H).

The Oviedo Fire Department needs to develop a plan and key stake holders from the agency (and if possible partnering agencies) should have input into the policy. Research identified should take part in any criteria developed in response policy, specifically that of Pinelli and Subramanian, as well as that of Jose Rodriguez. With these few recommended changes, we can help ensure that crews have the tools and knowledge necessary to determine when to halt response during these difficult to manage incidents, and contribute to a safer community.

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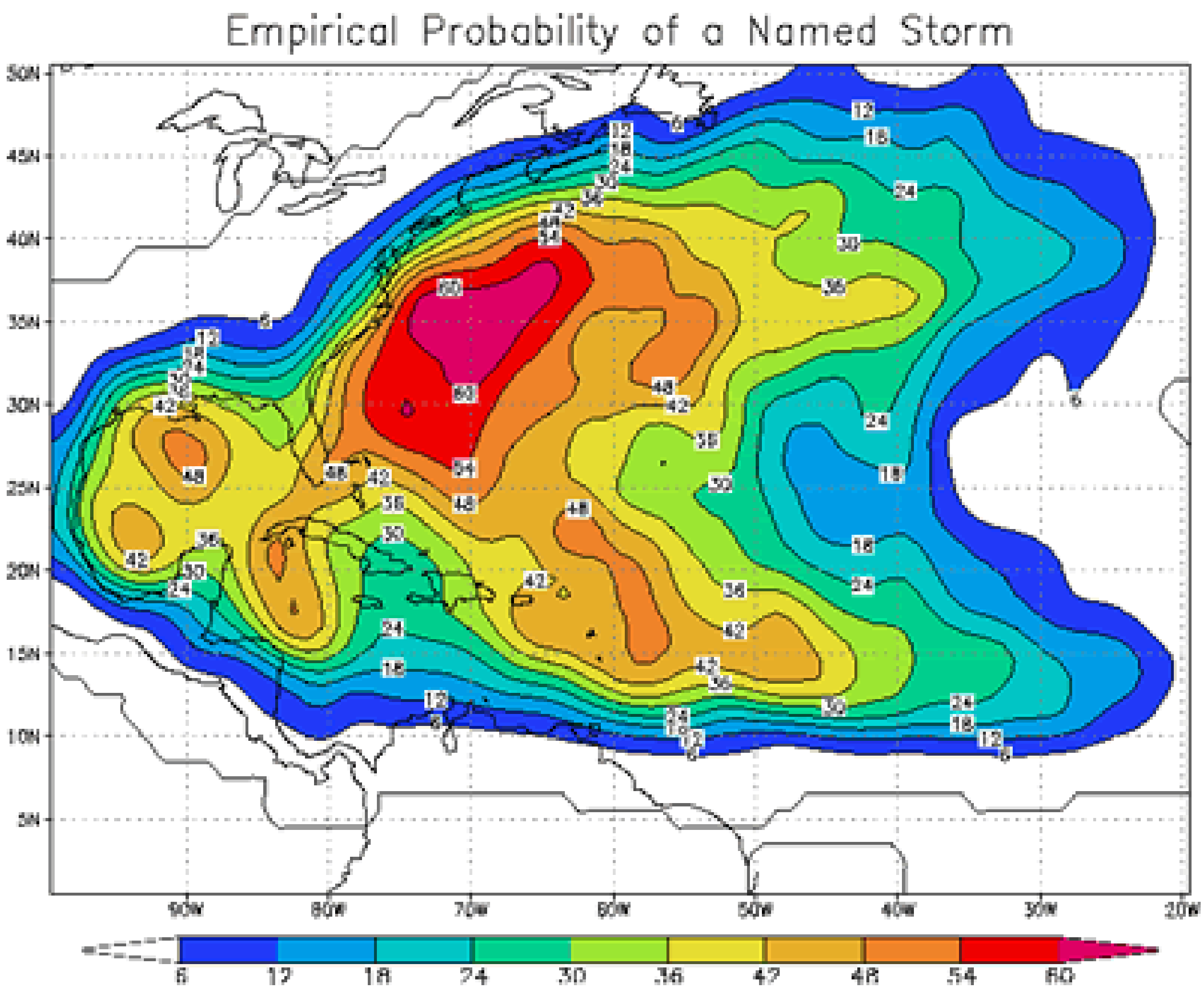
Appendix A: Probability of Named Storm



Appendix B: Beaufort Scale

Force	Description	Specification for use at sea*	Equivalent speed at 10 metres above sea level				Description in forecast	State of sea	Probable height of waves* /metres
			Mean		Limits				
			/knots	/ms^{-1}	/knots	/ms^{-1}			
0	Calm	Sea like a mirror	0	0.0	<1	0.0 to 0.2	Calm	Calm	0.0
1	Light air	Ripples with the appearance of scales are formed, but without foam crests	2	0.8	1 to 3	0.3 to 1.5	Light	Calm	0.1 (0.1)
2	Light breeze	Small wavelets, still short but more pronounced. Crests have a glassy appearance and do not break	5	2.4	4 to 6	1.6 to 3.3	Light	Smooth	0.2 (0.3)
3	Gentle breeze	Large wavelets. Crests begin to break. Foam of glassy appearance. Perhaps scattered white horses	9	4.3	7 to 10	3.4 to 5.4	Light	Smooth	0.6 (1.0)
4	Moderate breeze	Small waves, becoming longer, fairly frequent white horses	13	6.7	11 to 16	5.5 to 7.9	Moderate	Slight	1.0 (1.5)
5	Fresh breeze	Moderate waves, taking a more pronounced long form; many white horses are formed. Chance of some spray	19	9.3	17 to 21	8.0 to 10.7	Fresh	Moderate	2.0 (2.5)
6	Strong breeze	Large waves begin to form; the white foam crests are more extensive everywhere. Probably some spray	24	12.3	22 to 27	10.8 to 13.8	Strong	Rough	3.0 (4.0)
7	Near gale	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind	30	15.5	28 to 33	13.9 to 17.1	Strong	Very rough	4.0 (5.5)
8	Gale	Moderate high waves of greater length; edges of crests begin to break into spindrift. The foam is blown in well-marked streaks along the direction of the wind	37	18.9	34 to 40	17.2 to 20.7	Gale	High	5.5 (7.5)

*These columns are a guide to show roughly what may be expected in the open sea, remote from land. Figures in brackets indicate the probable maximum height of waves. In enclosed waters, or when near land with an offshore wind, wave heights will be smaller and the waves steeper.

Appendix C: Saffir-Simpson Wind Scale

Category	Sustained Winds	Types of Damage Due to Hurricane Winds
1	74-95 mph 64-82 kt 119-153 km/h	**Very dangerous winds will produce some damage:** Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph 83-95 kt 154-177 km/h	**Extremely dangerous winds will cause extensive damage:** Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 major	111-129 mph 96-112 kt 178-208 km/h	**Devastating damage will occur:** Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 major	130-156 mph 113-136 kt 209-251 km/h	**Catastrophic damage will occur:** Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 major	157 mph or higher 137 kt or higher 252 km/h or higher	**Catastrophic damage will occur:** A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Appendix D: Land Beaufort Scale

Land Beaufort Scale

Force	Speed		Land Conditions
	knots	mph	
0	<1	<1	Calm, smoke rises vertically
1	1-3	1-3	Light air, direction of wind shown by smoke drift only
2	4-6	4-7	Light breeze, wind felt on face, leaves rustle, vanes moved by wind
3	7-10	8-12	Gentle breeze, leaves and small twigs in constant motion, wind extends light flag
4	11-16	13-18	Moderate breeze, raises dust, loose paper, small branches move
5	17-21	19-24	Fresh breeze, small trees in leaf begin to sway
6	22-27	25-31	Strong breeze, large branches in motion, umbrellas used with difficulty
7	28-33	32-38	Near gale, whole trees in motion, inconvenience felt walking against the wind
8	34-40	39-46	Gale, breaks twigs off trees, impedes progress
9	41-47	47-54	Strong gale, slight structural damage occurs
10	48-55	55-63	Storm, trees uprooted, considerable damage occurs
11	56-63	64-73	Violent storm, widespread damage
12	64+	74+	Hurricane, extreme destruction

Appendix E: Research Question Survey Results Table

	External Survey
Demographic Questions	Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q13,
Research Question #2: What criteria are used in determining when emergency response should cease when tropical cyclones approach?	Q9, Q10, Q11, Q12, Q14, Q15, Q16
Research Question #3: What tools/technology are other Fire/EMS agencies utilizing to identify when to cease emergency response when tropical cyclones approach?	Q11, Q15, Q17, Q18

Appendix F: Letter to Agencies Regarding Survey

City of Oviedo Fire/Rescue
Training/EMS Division

400 Alexandria Blvd □ Oviedo, Florida 32765 □ (407) 971-5614
Physical Address: 1934 CR 419 W Oviedo FL 32766

November 27, 2018

I have recently completed the third year of the Executive Fire Officer Program, Executive Analysis of Fire Service Operations in Emergency Management (EAFSOEM). One of the requirements of this course is to complete an Applied Research Project (ARP) that is specific to the sponsoring agency. With this research project, I intend to look at the response thresholds at which emergency operations cease during Tropical Cyclones.

In order to get a good look at what other agencies are doing, a survey instrument was created. This survey is designed to look at thoughts, as well as common industry practices. If you could please take a few minutes to complete the following survey, it would be greatly appreciated. Responses are anonymous, but should you desire to get a copy of the results, or send a copy of your policy you can reach out to me at my email below.

If you could please complete the survey by **September 17, 2018**, to give me time to analyze the data and interpret it, I would greatly appreciate it. Should you have any questions on the survey, you can reach me at ndorey@cityofoviedo.net.

The survey can be found here: http://ucf.qualtrics.com/jfe/form/SV_1NOXXi2g0JDTmu1 or by scanning the following QR code on your mobile device:

Thanks,

Nichlaus Dorey
Division Chief Training & EMS, Oviedo Fire Department
ndorey@cityofoviedo.net
Phone: 407-971-5614

Appendix G: Survey to External Agencies

Response Thresholds for Emergency Vehicles in Tropical Cyclones

Survey Flow

Block: Default Question Block (7 Questions)
Standard: Block 1 (8 Questions)
Standard: Block 2 (3 Questions)

Page Break

Start of Block: Default Question Block

Q1 What is the approximate geographic size of your departments jurisdiction?

- ◯ 0-15 sq miles (1)
- ◯ 15-30 sq miles (2)
- ◯ 30-50 sq miles (3)
- ◯ 50-100 sq miles (4)
- ◯ >100 sq miles (5)

Q2 What is the approximate population that your departments jurisdiction protects?

- ◯ 0-30,000 (1)
- ◯ 30,001-60,000 (2)
- ◯ 60,001-125,000 (3)
- ◯ 125,001-250,000 (4)
- ◯ >250,000 (5)

Q3 How many personnel are employed by your agency?

____

Q4 What is your department make-up?

- ○ Career (1)
- ○ Volunteer (2)
- ○ Paid on Call (3)
- ○ Combination (4)

Page Break

Q5 Does your response area cover any oceanfront?

- Yes (1)
- No (2)

Display This Question:

If Q5 = Yes

Q6 Approximately how many miles of oceanfront do you cover?

- 0-5 miles (1)
- 5-15 miles (2)
- 15-30 miles (3)
- 30-50 miles (4)
- >50 miles (5)

Display This Question:

If Q5 = No

Q7 Approximately how far from the ocean is the closest part of your response zone? (as the crow flies)

- 5-15 miles (1)
- 15-30 miles (2)
- 30-60 miles (3)
- 60-125 miles (4)
- >125 miles (5)

End of Block: Default Question Block

Start of Block: Block 1

Q8 Does your department have a written policy on when to cease response during a tropical cyclone?

○ Yes (1)

○ No (2)

Skip To: Q9 If Q8 = Yes

Skip To: Q13 If Q8 = No

Page Break

Q9 What criteria are used in determining when to stop responding? (select all that apply)

- ☐ Sustained winds (1)
- ☐ Wind gusts (2)
- ☐ Flooding/Storm surge (3)
- ☐ Debris (4)

Q10 What are the thresholds for ceasing response?

- ○ Sustained Winds (1) ____
- ○ Wind Gusts (2) ____
- ○ Flooding/Storm Surge (3) ____
- ○ Debris (4) ____

Q11 How do you determine/measure the criteria of when to stop responding? (select all that apply)

- ☐ Weather Gauges at individual stations (1)
- ☐ Weather Gauges at a central monitoring site (2)
- ☐ Subscription Weather Services (ie. Accuweather, Weatherbug, etc) (3)
- ☐ Local/National News (4)
- ☐ n/a (5)

Q12 Who makes the final decision of when to stop responding?

- ○ Emergency dispatcher (1)
- ○ Fire Chief (2)
- ○ Operations Chief (3)
- ○ Battalion Chief/District Commander (4)
- ○ Station Officer (5)

Skip To: End of Block If Q12(Emergency dispatcher) Is Displayed

Page Break

Q13 Is there a “common practice” your agency uses to determine when to cease response in a tropical cyclone?

○ Yes (1)

○ No (2)

Q14 Please describe this practice

____

____

____

____

____

Q15 How do you determine/measure the criteria of when to stop responding? (select all that apply)

▢ Weather Gauges at individual stations (1)

▢ Weather Gauges at a central monitoring site (2)

▢ Subscription Weather Services (ie. Accuweather, Weatherbug, etc) (3)

▢ Local/National News (4)

▢ n/a (5)

End of Block: Block 1

Start of Block: Block 2

Q16 In your opinion when should fire departments stop responding? (List criteria and thresholds that you believe should be used)

____

____

____

____

____

Q17 Are you aware of any tools/technology available to aid in determining when to cease emergency response?

- Yes (1)
- No (2)

Skip To: Q18 If Q17 = Yes

Skip To: End of Survey If Q17 = No

Q18 Please list any tools/technology available to aid in determining when to cease emergency response

____

____

____

____

____

Page Break

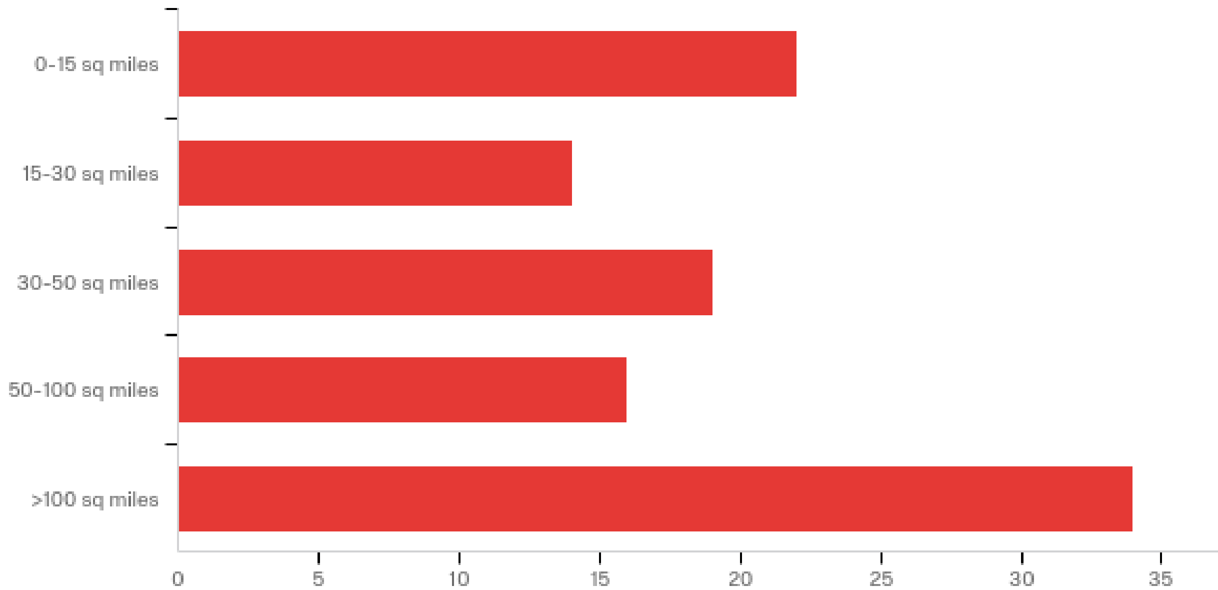
Appendix H: Survey Responses

Default Report

Response Thresholds for Emergency Vehicles in Tropical Cyclones

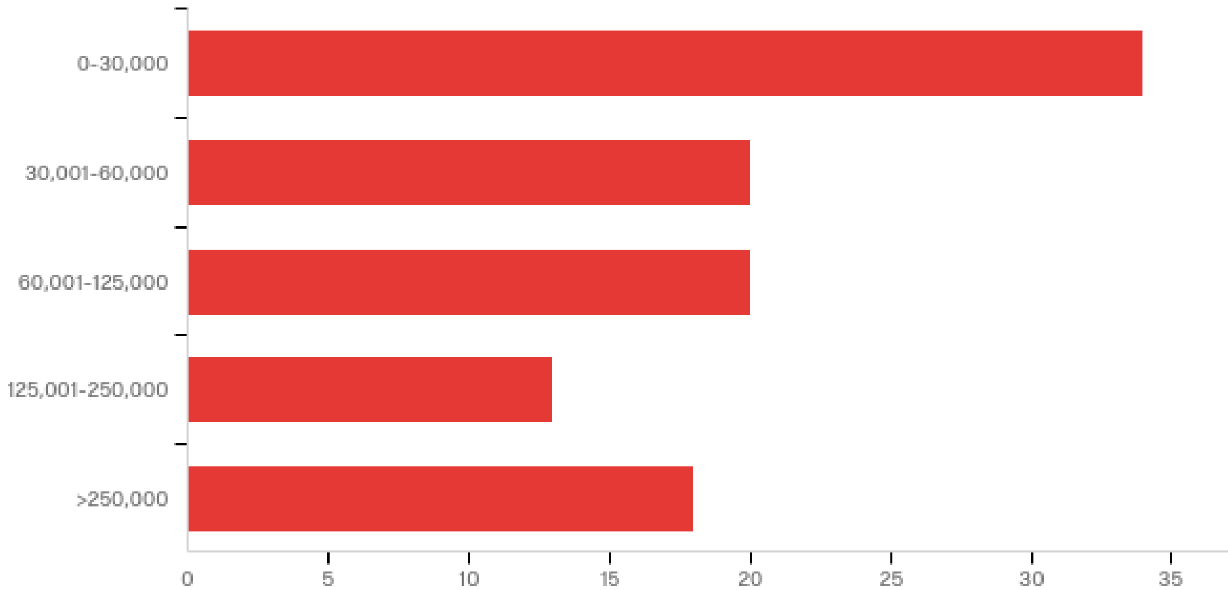
September 18th 2018, 10:28 am EDT

Q1 - What is the approximate geographic size of your departments jurisdiction?



#	Answer	%	Count
1	0-15 sq miles	20.95%	22
2	15-30 sq miles	13.33%	14
3	30-50 sq miles	18.10%	19
4	50-100 sq miles	15.24%	16
5	>100 sq miles	32.38%	34
	Total	100%	105

Q2 - What is the approximate population that your departments jurisdiction protects?

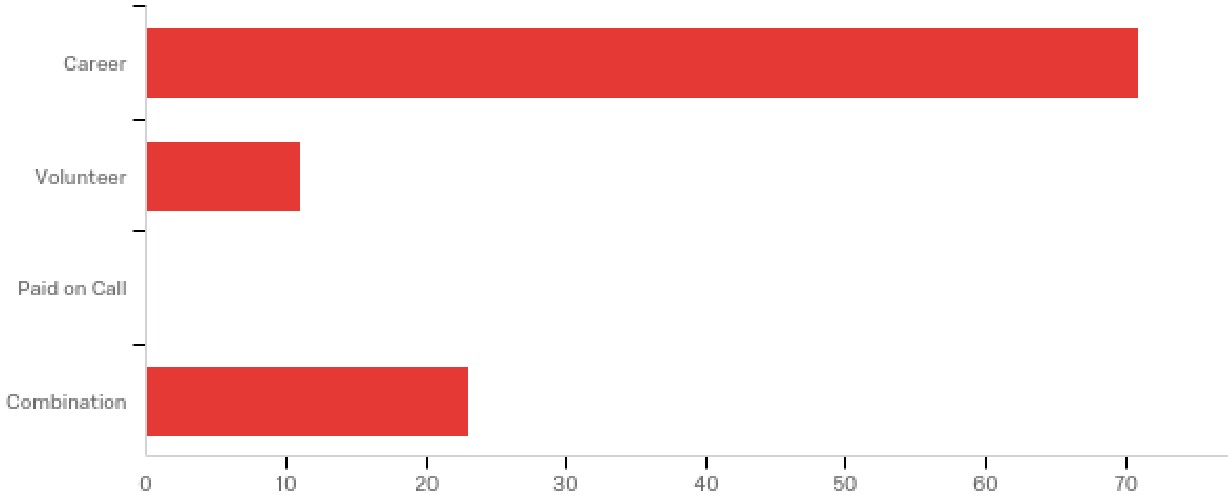


#	Answer	%	Count
1	0-30,000	32.38%	34
2	30,001-60,000	19.05%	20
3	60,001-125,000	19.05%	20
4	125,001-250,000	12.38%	13
5	>250,000	17.14%	18
	Total	100%	105

Q3 - How many personnel are employed by your agency?

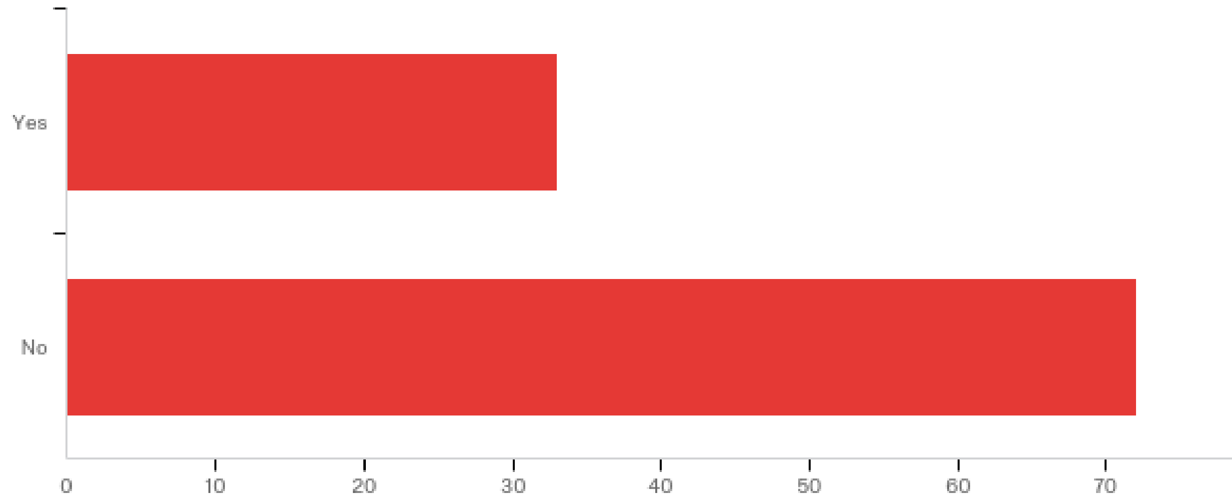
#	Answer	%	Count
1	0-25	22.85%	24
2	26-50	15.24%	16
3	51-125	22.85%	24
4	126-250	20.00%	21
5	250-500	8.57%	9
6	>500	10.48%	11
	Total	100%	105

Q4 - What is your department make-up?



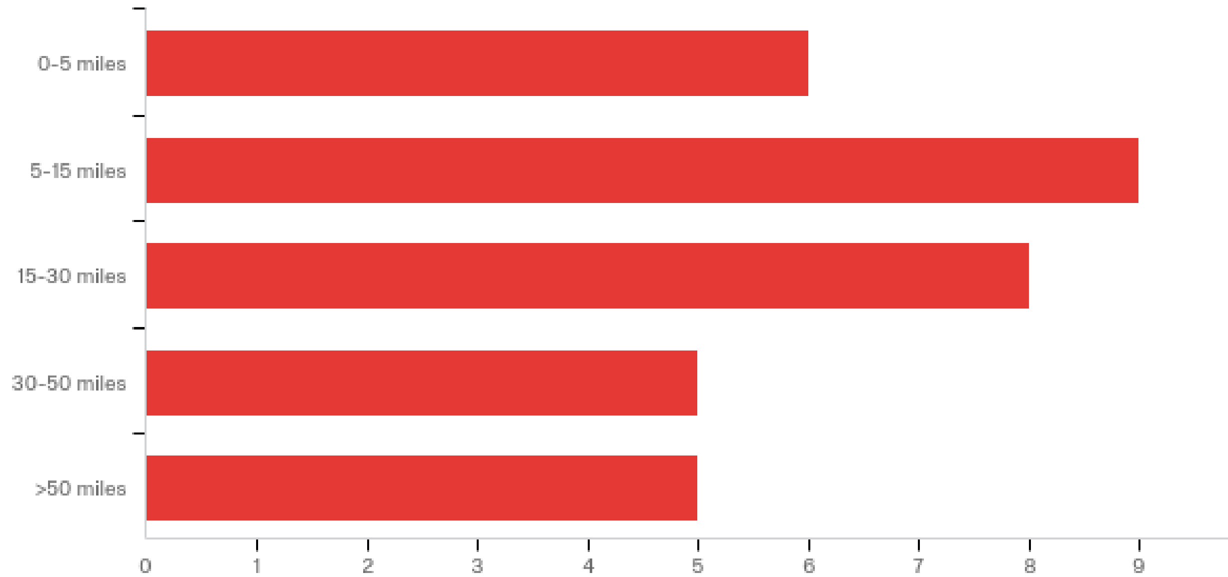
#	Answer	%	Count
1	Career	67.62%	71
2	Volunteer	10.48%	11
3	Paid on Call	0.00%	0
4	Combination	21.90%	23
	Total	100%	105

Q5 - Does your response area cover any oceanfront?



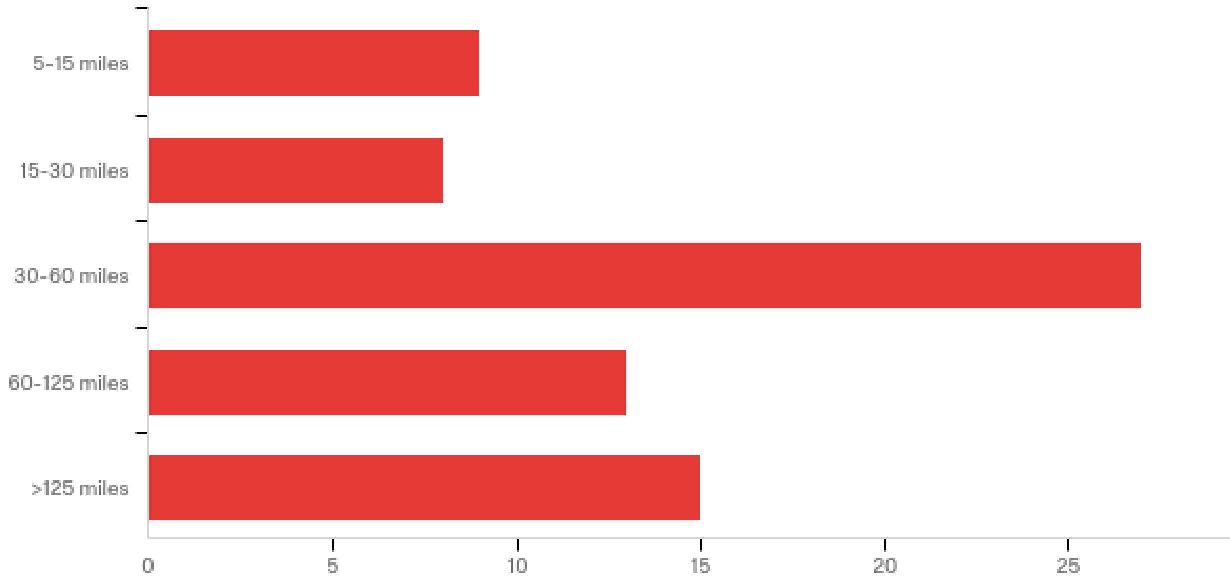
#	Answer	%	Count
1	Yes	31.43%	33
2	No	68.57%	72
	Total	100%	105

Q6 - Approximately how many miles of oceanfront do you cover?



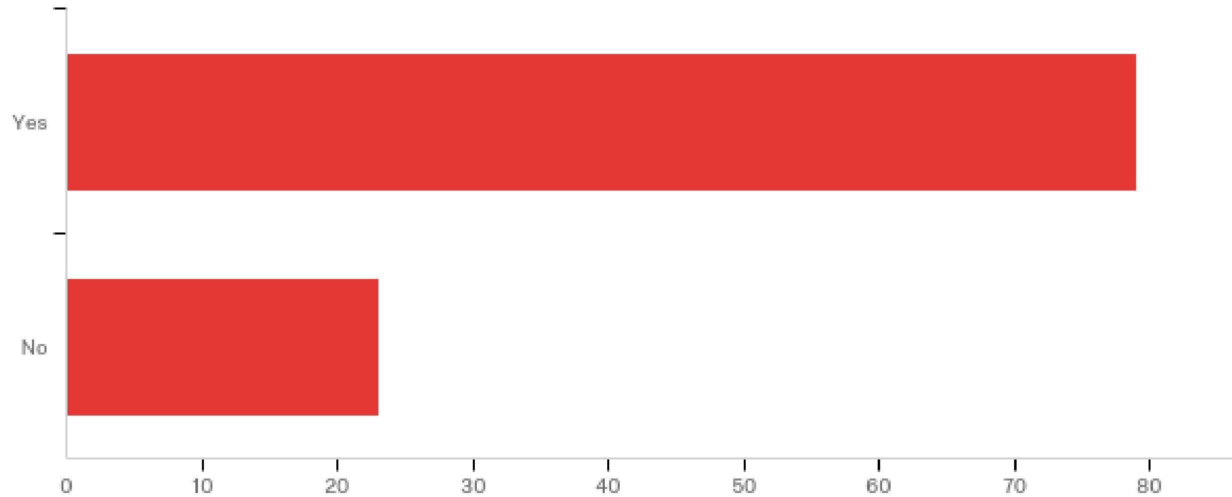
#	Answer	%	Count
1	0-5 miles	18.18%	6
2	5-15 miles	27.27%	9
3	15-30 miles	24.24%	8
4	30-50 miles	15.15%	5
5	>50 miles	15.15%	5
	Total	100%	33

Q7 - Approximately how far from the ocean is the closest part of your response zone? (as the crow flies)



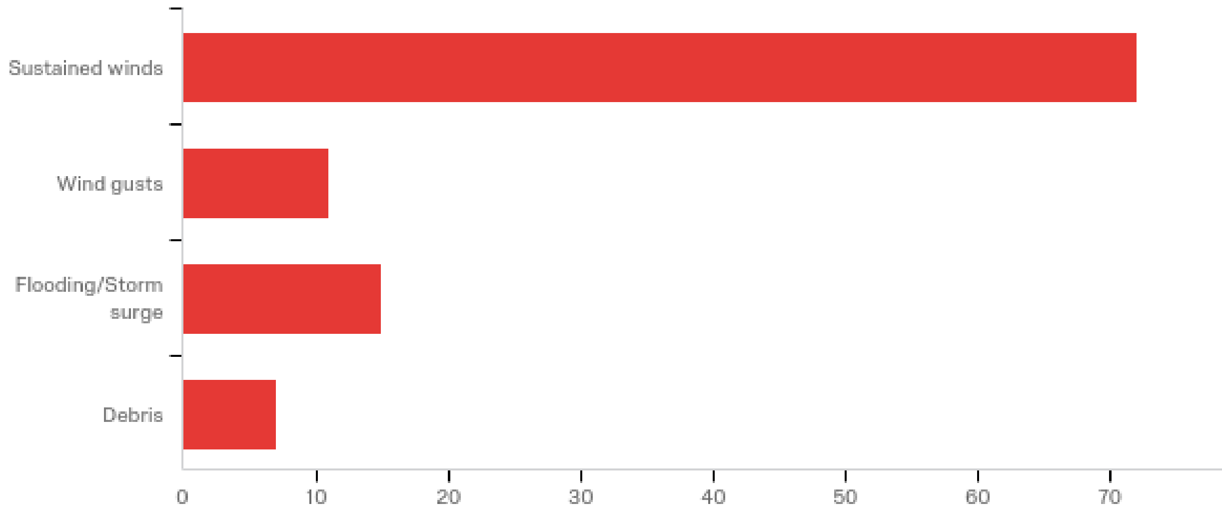
#	Answer	%	Count
1	5-15 miles	12.50%	9
2	15-30 miles	11.11%	8
3	30-60 miles	37.50%	27
4	60-125 miles	18.06%	13
5	>125 miles	20.83%	15
	Total	100%	72

Q8 - Does your department have a written policy on when to cease response during a tropical cyclone?



#	Answer	%	Count
1	Yes	77.45%	79
2	No	22.55%	23
	Total	100%	102

Q9 - What criteria are used in determining when to stop responding? (select all that apply)



#	Answer	%	Count
1	Sustained winds	68.57%	72
2	Wind gusts	10.48%	11
3	Flooding/Storm surge	14.29%	15
4	Debris	6.67%	7
	Total	100%	105

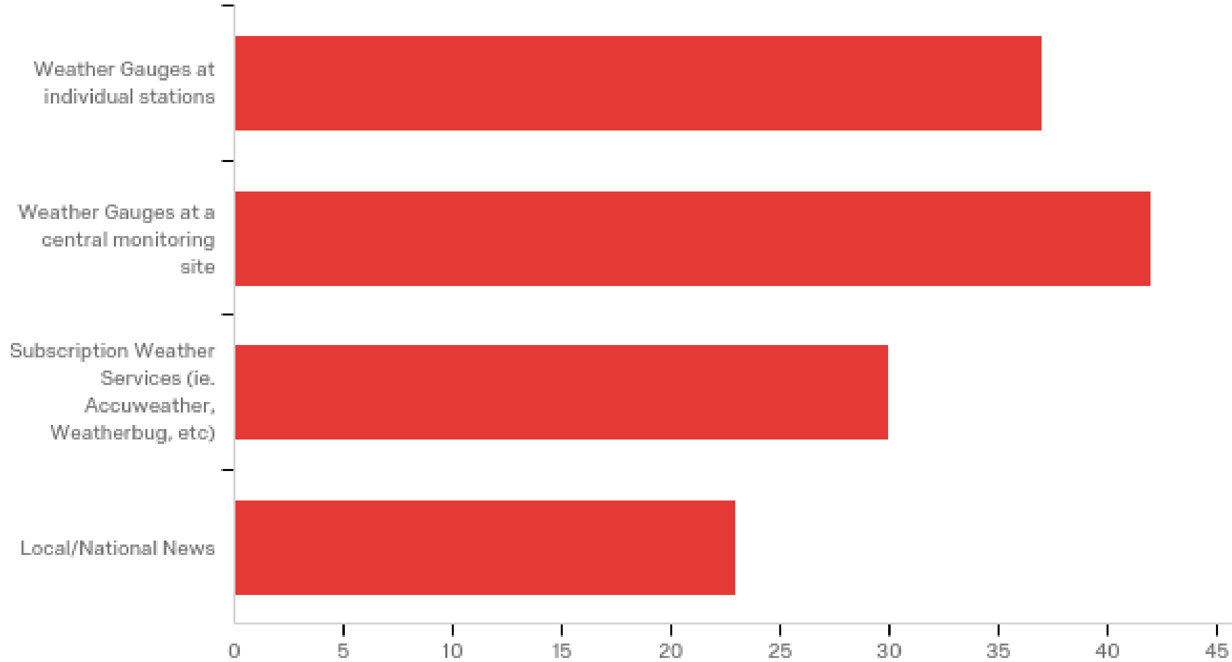
Q10 - What are the thresholds for ceasing response?

Sustained Winds	Wind Gusts	Flooding/Storm Surge	Debris
45			
74	80		
65			
55			
45	45		
40	40	Bumper height/ moving water	Flying debris of any kind
52 kph / 59.88 mph	52 kph / 63.34 mph	OICs call	OICs call
50	65		
45 mph		2ft	
70			
60 mph			
60 mph	80 mph	N/A	N/A
30	45		
50 miles per hour			
50 mph			
45 mph		We don't allow front line trucks in water past the wheel hubs	
50mph			
35 mph		Water to middle of hub on apparatus.	
35	50	Depends	Downed trees
35			
35			
40		Impassable Roads	
60			
50			

65		Storm Surge predicted in Low Lying areas Station relocated Six During Irma	
50			
50	80	None	None
50			
40mph			
+55	+55	Depends on anticipated rainfall and water rise	Depends on windfield impacts 24 hours prior on NWS/NHC Melbourne
45	65		
45			
45mph	60 mph		
50			
55	35		
50			
55			
45		2 feet	
40			
50		6’	
45			
45			
40			
50			
45	50	as deemed unsafe by officer on specific apparatus	as deemed per officer
55	55		
50 mph			
45	60	area dependent	based on wind speed
50 mph	n/a	n/a	n/a
50			Large amount of flying debris

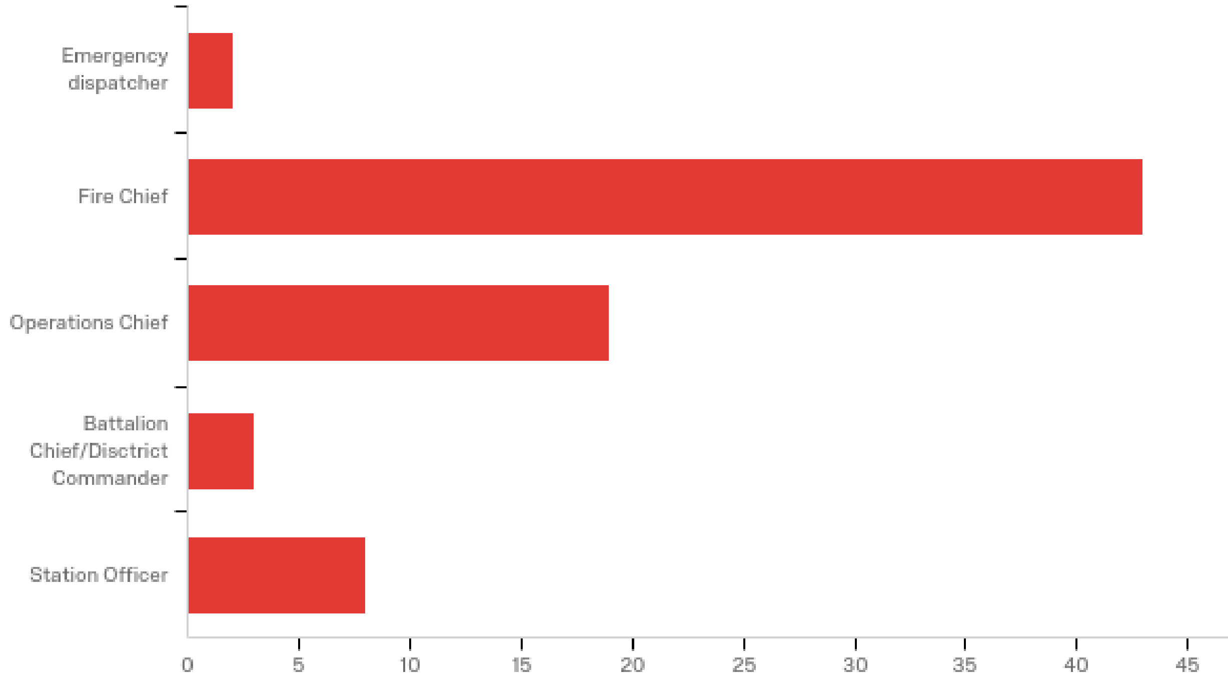
45			
40 to 45			
45			
60 mph			
40			
50			
60	80	n/a	n/a
45	65		
45			
35			
50 mph			
45			
50	65		
45			
45			
50	75	0	0
45			
45 and over			
45 mph			
35			
40			
35	50		
45	60	N/A	N/A
45 mph			

Q11 - How do you determine/measure the criteria of when to stop responding? (select all that apply)



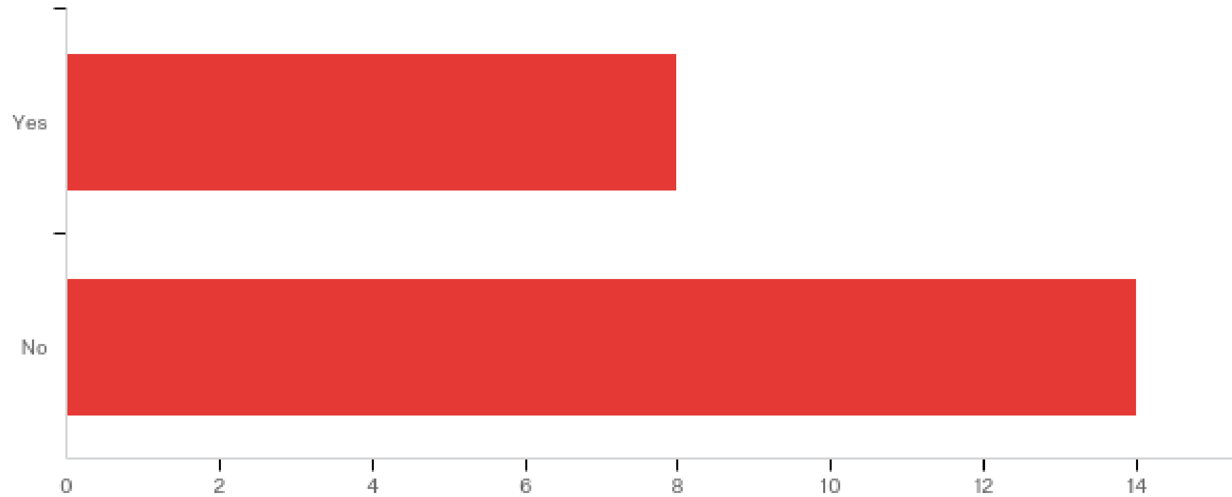
#	Answer	%	Count
1	Weather Gauges at individual stations	28.03%	37
2	Weather Gauges at a central monitoring site	31.82%	42
3	Subscription Weather Services (ie. Accuweather, Weatherbug, etc)	22.73%	30
4	Local/National News	17.42%	23
	Total	100%	132

Q12 - Who makes the final decision of when to stop responding?



#	Answer	%	Count
1	Emergency dispatcher	2.67%	2
2	Fire Chief	57.33%	43
3	Operations Chief	25.33%	19
4	Battalion Chief/District Commander	4.00%	3
5	Station Officer	10.67%	8
	Total	100%	75

Q13 - Is there a "common practice" your agency uses to determine when to cease response in a tropical cyclone?

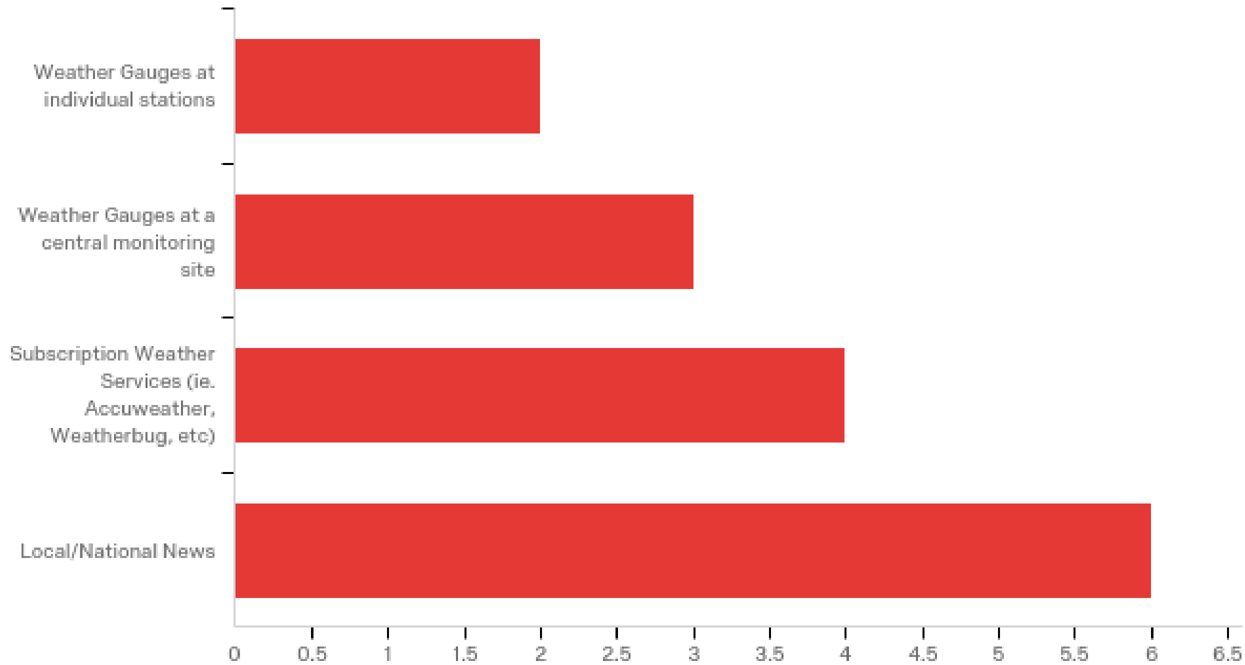


#	Answer	%	Count
1	Yes	36.36%	8
2	No	63.64%	14
	Total	100%	22

Q14 - Please describe this practice

Please describe this practice
If winds are greater than 15 mph, we will not response to calls.
sustained winds of greater than 45 mph. All life threatening emergencies are handle on an individual bases.
After winds reach 45 mph
Wind speed over sustained 45 mph, after that case by case basis
It is left to the station officers discretion as to when it is unsafe to response based on sustained winds and the nature of the incident.
We use the idea of sustained winds of 45 mph or above - cease responses
We cease response at a sustained wind speed of 40 mph - during a HURRICANE, (or other wind event)
We use the same indicators that EMS use for ambulances, any sustained wind over 40 mph

Q15 - How do you determine/measure the criteria of when to stop responding? (select all that apply)



#	Answer	%	Count
1	Weather Gauges at individual stations	13.33%	2
2	Weather Gauges at a central monitoring site	20.00%	3
3	Subscription Weather Services (ie. Accuweather, Weatherbug, etc)	26.67%	4
4	Local/National News	40.00%	6
	Total	100%	15

Q16 - In your opinion when should fire departments stop responding? (List criteria and thresholds that you believe should be used)

In your opinion when should fire departments stop responding? (List criteria and thresholds that you believe should be used)
See above.
I’m not involved with this type of response from my dept, but I would feel there would be a set of parameters such as the wind speed and water level predictions (or actual) where our personnel and apparatus should be put in safe areas or structures.
Using some sort of risk/benefit scale for when the instance of responding becomes too dangerous for the emergency responders based on things such as Visibility, Flood Water Depth, Scattered Debris, Damage to Infrastructure, etc.
60 mph sustained, or if the on scene crew decides an operation is unsafe, return to quarters.
55 mph winds sustained or 45mph when combined with rain and or debris.
At the time when it become too dangerous for our personnel to be out in the weather. Personnel safety is paramount.
15 mph or greater
emergency situation (risk vs reward) condition become unsafe for apparatus to be on roadway
When it becomes unsafe for normal operations. Wind, debris, surge, street status, point of the storm you are located. Would like to see a “standard” for all to follow - would help with the general public, admin personnel, everyone on the same page.
Anytime the amount of wind, debris, or water excides the safety you can provide balanced against the amount of possible harm.
we normally stop when hurricane force winds are blowing, but that is left to fire chief call at the time depending on the nature of the call and threat to life of citizens. we have hospitals and university in response area that may require help to prevent many lives lost
High wind posing a threat on Firemen.
When it is unsafe to be out side. High winds, heavy rains and none or limited visibility.
When no longer safe for personnel to respond without making more casualties. Wind gusts above 45 Sustained wind above 30 Any storm surge that would cover the response zone
50 mile per hour winds and as long as it is safe to roll otherwise
What I listed in the one of the last few questions. We have used this for several storms but we constantly monitor the situation in each still district
There was a study done on wind velocities and its affect on vehicles - SUV’s, ambulances, and fire trucks. I can’t remember where I found it on the internet
sustained wind of 35 mph; water levels at 4-5 inches or swift moving; debris is “mobile”
35 mph on the way up and resume at 40 mph on the way down (post storm)
Departments should stop responding when it becomes too dangerous for anyone to be on the roads

When wind gust begins to topple trees. response should cease.

We stop at 39 knots per SOG

At the very last time possible. You should take situations on an individual basis and determine risk/reward. Will I go remove a tree from a car in 30 mph winds, no. Will I go extricate someone from a flooding situation or a collapse situation in 50 mph winds? Probably, I will choose what I can do to best perform mission.

WHEN THE WIND SPEED IS GREATER THAN 45MPH

Sustained winds of 45 mph

Localized conditions based on wind speeds within the jurisdiction

Our hi-rise bridges may be closed by FHP at 40 mph sustained so that is one factor we consider but primarily we look at individual conditions at the time of the call in the district the call is received.

No. As long as officers use common sense and due regard, response should continue. Utilize more stable vehicles.

When determined unsafe by the FD

Tornado warning-imminent Winds post 55 mph sustained Water rise, current Flooding NHC Melbourne NWS Bulletins & Local EOC Cresting of St. Johns River and ICW et al

35+ Sustained or close proximity cloud to ground lightning [Halt all aerial operations] 45+ sustained and/or 65+ gusts in coordination with EOC Our policy also permits any chief officer or company officer to “Cease and Desist” when field conditions warrant such immediate safety actions when notifications made to duty battalion chief and dispatch.

sustained high winds

50 mph sustained. Winds

In conjunction with wind speeds how the community is reacting to the weather, like debris on the ground.

Yes. At sustained winds above 35 MPH aerial operations are halted and only critical fire/rescue operations are conducted. In addition, high profile and light weight vehicles (HazMat units, Ambulances, Rescues, etc.) are not used during these scenarios. When sustained winds reach 50 MPH all operations cease until wind speeds subside.

60 mph

Our current criteria or 45 mph sustained winds is effective in keeping our personnel safe.

wind and sustained gusts of 50 mph

Rescues are top heavy and can blow over at winds over 45 mph Engines and Ladders may respond for fires if the winds are above 45 mph but not higher than 55 mph

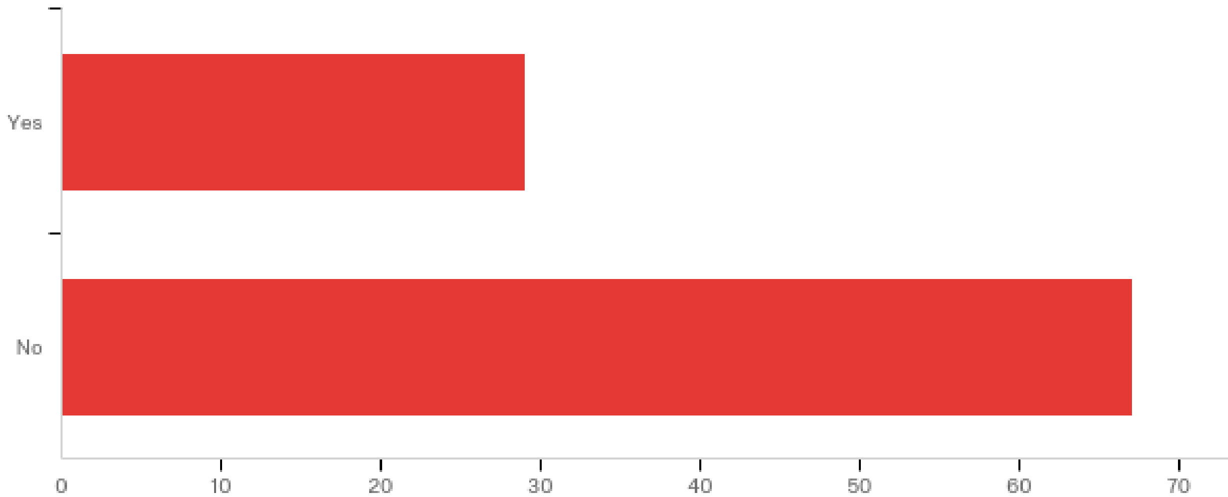
Responses during storms should weigh the cost/benefit of the emergency and let the situation dictate the tactics.

Pasco County Fire Rescue has a sustained wind of 40 mph. The decision to terminate responses is based on a several factors. the EOC Ops Section Chief in conjunction with EOC

Safety Officer will meet to discuss the current situation. Do to the size of Pasco County a sustained wind on the Tampa Bay side might not be the same on the inland side. In these type of events our communications center will contact the station captain to see if a response is allowable. when the sustained winds hit county wide, all operations will cease until it is determined that it is safe to resume emergency operations.
50 mph sustained wind
Our department covers 644 sq. miles, with 12 stations. Weather conditions may differ drastically from station to station. No official guidance was provided to us for the two past storms, even though weather conditions were very dire. One of our newer rescue units was dispatched out to “find a resident who decided at the last minute he wanted to go to the shelter”. This was absolutely in the height of the storm at night. The crew was proceeding to meet with the caller when they struck a very large downed pine tree. The entire cab was demolished, causing $50,000 damage and several months of down time for the unit. The crew was injured, but only minor injuries. The caller was never found, as he just took himself to the shelter. I am very much against leaving discretion up to the officers, as many of our officers are new, and the idea that a chief might “second guess” your judgment call, and ridicule you had these guys believing that if no order was given to shelter in, that they had better keep responding. A VERY poor lack of direction from upper management. I am of the belief we had alerted the dangers for days prior; lack of action to relocate to shelters at the last moment does not qualify as a life-threatening event during the height of the storm. We have (since those storms), placed weather stations at fire stations, so that conditions might be evaluated and reported back to the persons in charge. Not sure if they will take a stronger stance on response, but we will see.
sustained winds 55mph or greater
Determined based on sustained winds, type of apparatus, and the judgment of the officer.
the weather in each response area has to be evaluated on a case by case call. Our county is so large, the weather could be fine in one area or FMZ and be very dangerous in another. So, the ability to quickly evaluate the weather and what type of emergency is at hand (fire, ems, power out, etc.) as to who responds or not.
Really depends upon the circumstances of each incident. Sustained wind speeds of 50mph.
Sustained winds that risk the safety and stability of the apparatus being used, this causes some to stop operations (i.e. aerials at 35 mph). When the loose debris becomes hazardous to the operations being performed.
At 40 mph sustained winds. Gusts haven’t been a reliable indicator for us in the past.
anytime that physical responses conditions place a high likely hood of danger to responders.
I believe the sustained 45 mph standard is a safe and reasonable cut off.
The decision must be based on many variables. Although sustained wind speeds can set a bench mark, the ultimate no go/go decision should be made by the OSC in consideration of several factors to include crew capability, nature of emergency event, deployed vehicle, night or day time, etc.

Yes, the 40 MPH threshold is based on a study that was Commissioned by FDEM. But we give company officers the ability to use their own experience and insight to respond based on the call type and actual conditions that are being encountered.
Each fire department knows the geography and infrastructure of their response areas; If you have a better understanding of your own capabilities (personnel/equipment), then your executive leadership need to be in harmony with risk vs. benefit of sending a Rescue or a Fire Engine/other apparatus to calls (Communications Team/911 plays a bigger role in determining through EFD/EMD). I believe sustained wind at roughly 50-55 should be considered, also delineate the low vs. high profile vehicles. I also believe debris in the roadway poses a greater risk to personnel drive over them or having those airborne.
Safety of Personnel
Sustained winds of 70 or gusts greater than 75 with a geographical location.
Yes
Really depends on Vehicle Manufacturer recommendations, especially if vehicle has been modified.
The 45 mph sustained wind is a good bench mark, but I think some other conditions should be taken into account.
Sustained winds
I strongly believe there should be a standard go/no go policy based on a commonly adopted wind speed, the wind speed report should come from a pre-approved site (accurate and reliable source). Should also have some parameters regarding response into flooding/flooded areas, and responses during nightfall (or otherwise unlighted areas after darkness)
I have put together 2 SWAT “Armored Vehicles” with my SWAT Medics to be able to respond on real threats and medical emergencies during the height of the storm. it will be the extent of the type of call, location and ability to arrive on scene. These vehicles have a wide wheel frames and are heavy vehicles.
Sustained winds blocked roadways of bridges Flooded roadways
As stated
Whenever the situation is too dangerous, whether flooding, wind speeds, debris, etc. There is no sense in putting responders life at risk when the weather is too bad to safely respond.
Sustained winds is a great stopping point. It needs to be monitored closely and once the decision is made it stays until after the storm.
around 40 MPH. Coastal roads and bridges are dangerous and not protected.
Any criteria the Authority Having Jurisdiction see appropriate with a stop gap of the units in the field exercising independent judgment during life threatening situations.
Yes, for the issue of flying debris at a steady pace and increasing winds.
The above wind speed has worked well so far.

Q17 - Are you aware of any tools/technology available to aid in determining when to cease emergency response?



#	Answer	%	Count
1	Yes	30.21%	29
2	No	69.79%	67
	Total	100%	96

Q18 - Please list any tools/technology available to aid in determining when to cease emergency response

Please list any tools/technology available to aid in determining when to cease emergency response
A weather monitoring station.
National Weather Service
NWS
Local weather stations mounted at a main station
Weather Stations
The best option is individual weather stations at the stations
Weatherbug
Radar, cameras, eyes on
Weather stations and wind meters
We spent close to $35,000 equipping all 8 of our fire stations with wind speed measuring devices that record up to 160mph. The wind speed of all 8 locations is then displayed on a single dash board, so we can determine the wind speeds in the various areas of the City and determine when it is not safe to respond. We purchased this from Columbia Weather Systems.
Accurate Weather/Radar app NHC app HurrTracker app NWS app Local EOC directives/plan
GPS current location Weather Radar/Lightning Detector/Winds Apps are numerous and mostly at no charge.
NOAA Weather Stations Current Conditions http://tgftp.nws.noaa.gov/weather/current/ http://tgftp.nws.noaa.gov/weather/current/KSRQ.html
Hurrevac and assorted tools located at the EOC.
WeatherBug, weather stations, local storm reports from media.
Individual weather stations at each fire station. Weather Channel, local weather, EMA monitoring, bridge closure by the Sheriffs Office.
Hurrevac and Ventusky
Weather service and various forecasting and radar tools.
Weather gauges that can be used in real time.
Computer Programs, Hurrtrack, weather station and mainly 43 years on the job.
Hurevac
Traffic cameras

weather stations at fire stations	
Senior Command Officers.........Experience "Been there- Done That"	

Appendix I: Seminole County Operational Guide for Major Wind Response (2005)

EMS/Fire/Rescue Section: Disaster Operations #9006

Title: Responses during Major Wind Events

Controller: Norm Miller Division Chief
Origination Date: Revision Date:
Approved by Effective Date 9/21/05

Purpose
To identify criteria and establish a recognized standard to follow for ceasing responses during significant wind events (hurricanes). This standard will be using officer judgment and Pocket Weather Meters. The purpose of this document is to provide guidelines towards a uniform standard when conditions have reached a specific "trigger point".

History
Historically the Seminole County Fire Department has based judgments relating to continued response during significant wind events on several factors. These have ranged from personal observations, remote weather stations, and Doppler radar reports from the National Weather Service. Due to variances in locations and the nature of emergencies there is a need to better define when responses should be terminated.
Reviews of safety standards and improved technology have mandated that guidelines relating to a uniform standard be set to insure that both responder safety and citizen safety remain the highest priority. When conditions reach a critical point it becomes too dangerous for these personnel to continue to respond to emergencies. Current research has raised the following question:

At what wind speed does it become unsafe for emergency workers to respond?

To answer this question at least two areas must be addressed:

1) at what wind speed does it become unsafe to operate response apparatus and
2) at what wind speed does it become unsafe for people to be exposed to the threat of flying debris.

The type of vehicles used to respond has a direct impact on the decision making process. The three type of primary response vehicle are the standard fire truck, ambulances, and command sport utility vehicles. Research has shown that each vehicle has specific parameters that define response capabilities. Also important is the need for emergency personnel to seek shelter during critical time periods. The table listed below defines the ranges determined by both field tests and numerical evaluations:

Vehicle Type	Critical Limit	Seek Shelter
Fire Truck	50-70 mph	70+ mph
Ambulance	30-50 mph	50+ mph
Suburban (SUV)	60-70 mph	70+ mph

As a result of the above information the following procedures will be implemented.

EMS/Fire/Rescue	#9006
Title: **Responses during Major Wind Events**	Page 2 of 3

Procedure

The Seminole County Fire Department will continue to use all available resources to determine response limits due to significant wind events. These resources will include personal assessment using experience, Pocket Weather Meters, remote weather stations, and the National Weather Service. Each Fire Station has been assigned a Pocket Weather Meter to serve as a tool in decision making. (These units will be stored in the Lieutenants office and checked each day consistent with the pagers, radios, and Knox box keys.) Due to variances in conditions, personnel safety will be the ultimate responsibility of the assigned company officer on the responding units.

When the potential for a wind event is determined, the company officer will familiarize themselves and the crew with the proper use of the Pocket Weather Meter assigned to the station. (Instructions attached)

When a significant wind event occurs personnel will follow updated Division guidelines

Based on conditions in the immediate area and information received from the communications center units will assess their ability to respond.

- Engines, Towers, Squads and Water Tenders responses will be based on several factors:
  Officer confidence in response ability
  Winds including gusts 50-70 mph
  Enclosed crew compartments
  Road conditions—debris, obstructions

  Wind speeds exceeding 70 mph units will immediately seek shelter

  Ambulance (high profile transport units) responses will be based on several factors:
  Officer confidence in response ability
  Winds, including gusts 30-50 mph
  Road conditions—debris, obstructions

  Wind speeds exceeding 50 mph units will immediately seek shelter.

  Command Staff (SUV's) responses will be based on officer discretion.
  Recommended wind speeds including gusts 60-70 mph

  Winds exceeding 70 mph units will immediately seek shelter.

  The use of trailers during significant wind events will be determined by command staff. Use in wind speeds greater than 35 mph will require careful consideration.

EMS/Fire/Rescue	#9006
Title: **Responses during Major Wind Events**	Page 3 of 3

If units are in a response mode and it is determined that an eminent threat is present officers will immediately seek a suitable location to safe up personnel and apparatus. This may be on the down wind side of a sturdy structure, protecting both personnel and the unit.

Decisions relating to life & death, go/no-go responses will be determined based on the threat to emergency response personnel. Risk versus benefit will be determined by the company officer or the assigned command officer.
High winds create dangerous debris. Personnel must watch for flying debris as well as debris on the ground. Personal protective gear will provide limited protection from flying debris.

Considerations:
As with any decisions, responses during significant wind events will require company officers to include modifications to normal operating procedures. Listed below are recommended areas to consider:

Parking of apparatus—use the unit as a wind shield to reduce the impact from the wind and flying debris.

- All power lines are considered energized until proven otherwise.

Plan your routes to allow for the least side impact from the wind as possible.

Know your response area well and be aware of where debris will be a problem.

Limit the type of equipment you remove from your apparatus. Reduce the potential for things becoming a sail. Even ladders are difficult in high wind situations.

Remove items from stretcher to reduce them being blown away.

Keep personnel close together to prevent falls.

Watch for flying debris prior to exiting the unit. *Look up, look down, and look around.*

Kestrel® 3000 Pocket Weather™ Meter

with Backlight

Thank you for purchasing the Kestrel 3000 Pocket Weather Meter. This instrument will measure the following environmental conditions:

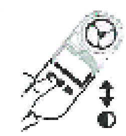
- wind speed
- maximum wind gust
- average wind speed
- temperature
- wind chill
- relative humidity
- heat stress
- dewpoint

This instrument also features a data hold function, a backlight, and an automatic power-down function. Every unit is fully tested at our factory for measurement accuracy and waterproof integrity.

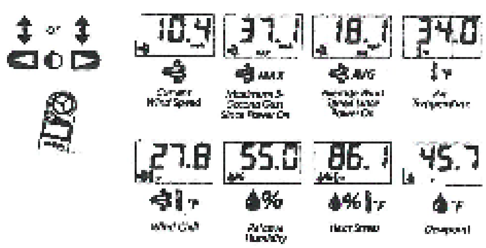
OPERATION

1) **Slide off cover.**

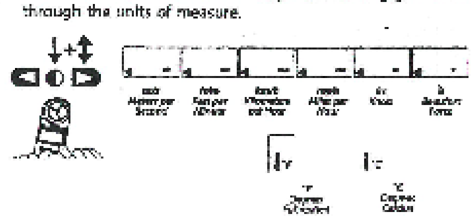
2) **Turn on:** Press the center button (◐) to turn on the unit.



3) **Select operating mode.** Press the right arrow (▶) to scroll through the measurements listed below. Press the left arrow (◀) to scroll through the measurements in reverse order. The instantaneous measurements will be displayed. (See *Understanding the Measurements* section for more information.)



4) **Select the units of measure.** Press ▶ while holding ◐ to scroll through the units of measure.



5) **Hold mode.** Press ◀ while holding ◐ to hold the measured value on the display. The word "HOLD" will blink to indicate the Hold Mode. Press ◀ or ▶ to view the other measurements in Hold Mode. Press ◀ while holding ◐ to exit the Hold Mode. This mode can be useful for taking measurements when unable to view the display, as within a duct. The Max and Avg Wind Speed Modes will continue to work as usual.

6) **Turn on the backlight.** Press ◐ to activate the backlight for 10 seconds. If ◀ or ▶ are pressed while the backlight is illuminated, the backlight will remain illuminated for another 10 seconds. Press ◐ while the backlight is illuminated to manually turn off the backlight.

7) **Turn off.** Hold ◐ for 2 seconds to manually turn off the unit. The unit will automatically turn off if no buttons have been pressed for 45 minutes.

UNDERSTANDING THE MEASUREMENTS

Wind Speed - average over the previous three seconds. The measurement will be accurate for air flow through the front or rear of the unit.

Maximum Wind Gust - maximum 3 - second wind speed since the unit was turned on.

Average Wind Speed - average wind speed since the unit was turned on.

Temperature - Instantaneous temperature of the thermistor, which is located at the end of the long coiled leads in the open cavity below the impeller. The exposed thermistor will respond quickly to changes in temperature when air flows past it. For fastest response, either hold the unit into the wind or wave the unit side to side for 15 seconds. Readings should be taken in the shade.

Wind Chill - combination of wind speed and temperature, as defined by the US National Weather Service. Wind chill is the effective temperature on a human or animal at low temperatures due to wind speed. Wind chill readings will be the same as the temperature readings above 45°F or below 3 mph.

Relative Humidity - amount of moisture in the air compared to the amount of moisture the air can hold for the given temperature, represented as a percent. Because relative humidity is also a function of the temperature, the response time will be dependent on the temperature response time (see temperature section above). Readings should be taken in the shade.

Heat Stress – combination of temperature and humidity, as defined by the US National Weather Service. Heat stress is the effective temperature on a human or animal at high temperatures due to humidity. Heat stress readings will be the same as the temperature readings below 70°F.

Dewpoint – calculated based on temperature and humidity measurements, as a measure of moisture content in the air. If the dewpoint is very close to the temperature, the air is humid. If the temperature and dewpoint are the same, dew will form. If this happens below freezing, frost will form.

MAINTENANCE & TROUBLESHOOTING

Storing Your Kestrel

Avoid storing your Kestrel where it will be exposed to temperatures below -30°C [-22°F] or above 80° C [176° F] for extended periods of time. Doing so may cause permanent damage. (Note that the inside of a car parked in the hot sun can reach very high temperatures.)

Use of the Lanyard and Cover

The cover can be captured on the lanyard to avoid loss. First, remove the cord poplock. Then feed the lanyard end through the large opening in the cover and out the slot. Replace the poplock on the lanyard.

Replacing the Battery

When your display flashes the low battery indicator (▯), replace the battery. Use a large coin to open the battery compartment. Insert a new CR2032 coin cell (available where watch batteries are sold), positive (+) pole up. When replacing the battery door, be sure to keep the black rubber o-ring seated in the groove on the case back.

Appendix J: Pinellas County Draft Policy

PINELLAS COUNTY FIRE CHIEFS' ASSOCIATION

SUBJECT: Emergency Responses during Tropical Storms & Hurricanes

DATE OF ISSUE:

APPROVED:

REFERENCES:

- International Association of Fire Chiefs' Model Procedures for Response of Emergency Vehicles during Hurricane and Tropical Storms
- Bergen County Fire Chiefs' Association Wind Tests for Rescue Vehicles
- Research Based Guidelines for Decision Making in Hurricane Conditions: When Do We Stop Responding? Elaine Fisher, Orange County FL Fire Rescue
- Model Procedures for Response of Emergency Vehicles During Hurricanes and Tropical Storms – State of Connecticut
- Wind Speeds Required to Upset Vehicles – Schmidlin & Hammer, Kent State, King – Boyce Thompson Institute, Miller – Wichita State
- Emergency Vehicle Responses During Tropical Storms and Hurricanes – Fire Chief's Association of Broward County, FL
- Pinellas County Standard Operating Procedure #600-05 – Adverse Weather Conditions
- Pinellas County Standard Operating Procedure #900-07 – Communications and Dispatch

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1) PURPOSE/ INTENT:

The purpose of this procedure is to:

a) Provide clear guidelines for the response of emergency vehicles and crews during high winds and other dangerous conditions related to storm events.
b) Provide guidance to communications professionals regarding receipt and dispatch of 911 calls for service.
c) Provide guidance to EOC staff members and public information officers.
d) Provide a consistent Countywide approach to provide routine weather and system updates to Fire and EMS services during all phases of a storm event.
e) To recognize each agency's ability to modify their response upon their local conditions and/or an imminent life/fire loss incident.
f) To keep fire rescue and EMS crews safe during the event.

2) DEFINITIONS:

a) ***Severe Weather Event-*** Any occurrence of strong winds, heavy rain, tornados, hail, lightening, or combination thereof creating a potential for moderate to severe damage to a location. Severe weather events can be planned (2 or more days' notice), or unplanned (less than a few hours' notice, or no notice at all). This will include all tropical storms and hurricanes without regard to the category.

b) ***Sustained Wind Speed -*** The National Weather Service uses the "average observed values of wind over a two-minute period" to determine the sustained wind speed.

c) ***Incident Commander-*** For the consistency of this procedure during severe storm events, the Incident Commander or his/her designee shall be considered the Incident Commander and the one ultimately making operational decisions for that agency within that agency's Emergency Operations Center.

d) ***Imminent Life/Property Loss Incident-*** An incident where no response from Fire/EMS would in the Incident Commander's determination cause a loss of life, catastrophic property damage, or a conflagration.

e) ***Fire Apparatus:*** Engines, pumpers, squads, and trucks.

f) ***Medic Units/SUVs****:* Sport utility vehicles, non-transport medic units, district chief vehicles, and utility units.

g) ***Transport Units****:* All fire-based transport units.

h) ***Ambulances and Typing****: Type 2 units are a van style unit; Type 3 units have a square patient compartment mounted on a heavy van-style chassis (typical Sunstar emergency unit).*

i) ***High Water Units:*** *Units either designed for high-water driving or capable of such actions, including the Pinellas Sheriff's Mine Resistant Ambush Protected (MRAP) vehicles.*

j) ***Dispatch Regions: Sout****h = Gulfport, Lealman, Madeira Beach, South Pasadena, St. Pete Beach, St. Petersburg, and Treasure Island;* ***Mid*** *= Largo (includes Belleair and Belleair Bluffs), Pinellas Park, Pinellas Suncoast, and Seminole;* **North** *= Clearwater, Dunedin, East Lake, Oldsmar, Palm Harbor, Safety Harbor, and Tarpon Springs.*

3) **WIND SPEEDS:** Within the EOC environment, wind speed will not be estimated; only a wind speed detection device shall be used. If a wind speed device is not available the wind speed shall be determined by the communications center. Units in the field may make on-scene estimations for their own use by referring to the Beaufort Scale Chart (Appendix A). Currently (2018) wind speed and direction provided by Pinellas County Communications is based upon conditions at the 911 center in Largo. If a wind speed detection device is available, the device may be used to detect wind speed in a specific location. The Communication Center's wind speed determination shall be considered accurate across all areas of the County unless an agency has specific weather instruments at their locale. The agency's Incident Commander shall decide which determination will be used.

4) **POLICY/PROCEDURES:**

a) The following wind speed guidelines will be used to determine vehicle responses during a severe weather event.
b) When these conditions are reached, units will be placed out of service based upon their unit type.

- Sustained wind speed of **greater than 35 MPH** = No use of aerial ladders or extension ladders and no roof operations; Type 2 ambulances no longer responding; If Pinellas County Communications has not already done so by this point, Dispatch will place the system in Condition 6 by one or more regions.
- Sustained wind speed of **less than 50 MPH** = Normal Response for fire apparatus, medic units, fire-based transport units, and Type 3 ambulances.
- Sustained wind speed **between 50 MPH and 75 MPH** = The Incident Commander (IC) for each agency will make the "GO or NO GO" decisions based upon the available information. The IC may consider available risk versus benefit information. Based upon the IC, responses may be limited to those with imminent life safety issues, catastrophic property loss or conflagration, or whatever criteria they deem appropriate. These responses will only be by means of fire apparatus.
- Sustained wind speeds **greater than 75 MPH** = No Responses

c) During the event, no individual shall respond alone.

d) No units will respond to any incident with sustained wind speeds above 75 MPH.
   i) In the event units are out on location when the wind speed changes to sustained winds of **greater than 50 MPH**, the unit shall finish their assignment and return to the closest secured operating fire station or place of refuge. This may include refuge at another agency.
   ii) In the event units are out on location when the sustained wind speed changes to 75 MPH, the units shall immediately seek direction from their Incident Commander as to finishing assignments, hunkering down in place, or return to a closest operating fire station or place of refuge.
   iii) **When winds reach 50 MPH**, Sunstar units will be assigned to designated safe locations, but based upon the conditions, may need to seek shelter and safety and the nearest operational fire station without regard to whether the ambulance can be parked inside.

e) **Patient Transport:**
   i) When wind speeds are expected to exceed the operational thresholds at a given point in the future, Sunstar units will complete any transport they may be committed to and begin measures toward safe refuge ahead of the winds reaching the thresholds.
   ii) All agencies should work with their receiving hospitals to assure measures are in place to allow acceptance of new patients.
   iii) When transport units and ambulances are not available, or no longer responding, patients may be transported in fire apparatus or other makeshift means.

5) **STORM CONDITION CONSIDERATIONS:**

a) Studies have shown that there is very low risk of fire apparatus being overturned by wind conditions below 95 MPH, however, the conditions still present challenges for responders. Drivers must reduce their speed to account for poor visibility due to rain, winds, and debris.

b) When responding in sustained winds of greater than 40 MPH, all responders should be wearing eye protection, even when responding. Upon exiting the apparatus, all responders should be wearing full turnout gear with helmet and eye protection to protect themselves from airborne debris.
c) Responders should pay particular attention to the possibility of downed power lines in locations where they not normally be expected.
d) If the option to seek a place of refuge is exercised and the apparatus or vehicle can't be placed inside the building, make every effort to protect the windshield by "nosing" up toward a secure structure.
e) Walking may be challenging in winds greater than 40 MPH. This may be made more difficult when carry objects such as backboards.
f) Use extreme caution when walking through water. Six inches of moving water can knock a person off of their feet.
g) Be alert to displaced wildlife, especially snakes.
h) Fire scene operational efforts in high wind or storm conditions may compel tactical approaches that are inconsistent with day to day operations. This may involve the use of rapid knockdown with no overhaul, limited use of fire hydrants, exposure protection only, and leaving some equipment on scene for later retrieval.
i) When agencies or field units find the reported wind conditions by Pinellas County Communications to be inconsistent with what they are observing they may consider and report their own findings. In the absence of instrumentation, responders may consider using the Beaufort Scale (attachment A) to estimate local wind conditions.

5. **RESTORATION OF OPERATIONS:**

a) When weather conditions begin to improve to a level that responders may safely resume incident responses, consideration will be given to taking regions out of Condition 6, likely to Condition 5. Coordination must take place between Sunstar, 911 Communications Staff, Pinellas County EOC staff, and each agency's Incident Commander within the given region to assure that all parties are prepared for the change in dispatch condition levels. The IC will determine when units under their command go back into service. The IC may opt to gain damage assessment information prior to the resumption of responses.
b) Each agency's IC will make the determination as to how and when the backlog of calls within the Company Journal account is to be addressed. The IC may elect to keep certain units out of service to address such.
c) All parties should be prepared for higher than normal call volume in the hours and days following the storm event and staff accordingly.