Best Practices for Hurricane Season Utilization of Tower Cranes and Hoisting Equipment

Interim Report

Florida Department of Business and Professional Regulation
Florida Building Commission

and

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Executive Summary

Recent crane failures due to hurricanes and other high-wind events in Florida prompted the introduction of Section 25, Section 489.1132 of Florida Senate Bill 180 in 2025. This section of the bill regulates cranes and other hoisting equipment utilized in construction during the hurricane season in Florida, with the goal of reducing the risk of crane failure due to high winds. The language in this section provides a list of actions to be taken 24 hours prior to the impact of a hurricane and directs the Florida Building Commission (FBC) to establish best practices for crane utilization during hurricanes by the end of 2026.

In response to SB 180, FBC has tasked the University of Florida (UF) with conducting a research study and convening an advisory group to inform the best practices required by the legislature. Project tasks include reviews of relevant literature, wind-induced crane failure case studies, crane safety regulations across the US, and industry safety standards.

A review of crane incidents, regardless of the cause, highlights the importance of clearly defined jobsite roles and responsibilities, effective and frequent jobsite communication, and proper training for crane operators and other site personnel. The American Society of Mechanical Engineers (ASME) B30 crane safety standard and crane safety regulations across the US also emphasize these practices. Incidents due to high-wind events make up almost one quarter of crane accidents. Many of these accidents occur due to operation during high winds; however, the focus of this study is on out-of-services failures occurring on job sites during high wind events with advance warning.

When a storm approaches, forecasts provide several days of warning to jobsite personnel, allowing them to implement safety plans in preparation for the storm's impact. Common actions in anticipation of hurricane-level winds are largely aligned with the current language in Senate Bill 180, including following manufacturer recommendations, weathervaning tower cranes, retracting and/or laying down crane booms, removing rigging, and disconnecting power. Most contractors have written hurricane preparedness plans that outline the specific actions and timelines for their implementation.

Despite manufacturer guidance and wind plans in place, failures still occur. A review of several crane failures resulting from forecasted high wind speed events shows that these failures are often the result of disregard for, or improperly following, manufacturer recommendations related to securing cranes. While unclear lines of responsibility, miscommunication, or inexperience can contribute to these lapses, it is not always evident why jobsite personnel failed to act in accordance with safety guidance in a timely manner.

Florida's vulnerability to strong hurricanes has resulted in crane failures even when manufacturer guidelines were followed, and the cranes were reportedly rated by the manufacturers to have adequate capacity for the high wind events. In three failures during Hurricane Irma (2017) and one during Hurricane Milton (2024), wind turbulence/ was cited as a contributing factor. Cranes are designed to withstand out-of-service wind loads calculated using ASCE/SEI 7; however, load reductions for temporary structures are permitted. Crane failures that occur below their rated

wind speeds warrant a careful review of design practices and manufacturer procedures for determining maximum rated wind speeds.

To aid in the development of crane safety best practices when utilized during hurricanes in Florida, a 15-member advisory group has been assembled. Group members represent crane rental companies, crane manufacturers, certification organizations, contractors, engineers, building departments, and code development organizations. The group has met monthly since October 2025 to discuss and draft the language that will be presented to FBC at the conclusion of this study. To date, the group has focused on outlining roles and responsibilities, the purpose and components of a hurricane preparedness plan, timeframes and risk considerations for various preparation actions that may be taken ahead of a storm, and the role that crane manufacturers and their guidelines have in hurricane planning. The group aims to balance public safety with reasonable requirements for contractors and jobsite personnel to ensure all stakeholder needs are addressed.

Table of Contents

1 Introduction

Minimizing the risk of crane failure and collapse during high-wind events is predicated on their proper design, construction, installation, operation, and maintenance, as well as the creation and implementation of job site safety protocols. In hurricane-prone regions, contractors often have a hurricane plan for each job site that includes practices such as lowering the crawler crane each evening, switching off power to the crane, and "weathervaning" tower cranes in response to high wind conditions (allowing the crane's arm to rotate in the wind), depending on the type of crane used. There are currently no standards in Florida for the operation and storage of cranes during strong wind conditions, although Occupational Safety and Health Administration (OSHA) directs operators to follow manufacturer recommendations. Maximum wind speeds and methods for securing cranes during windstorms are provided by the crane manufacturers, with job site personnel responsible for securing the equipment ahead of intense winds.

Florida Senate Bill (SB) 180 [1] directs the Florida Building Commission (FBC) to conduct a research project to assist with the development of minimum criteria/standards for best practices for the utilization of tower cranes and hoisting equipment on construction job sites for construction, demolition, or excavation during the hurricane season. Researchers at the University of Florida (UF) have been tasked with conducting the required research and developing hurricane crane safety recommendations with input from an industry advisory group.

2 Scope

The Florida Building Commission (FBC) has been directed to develop recommendations for minimum criteria/standards for best practices for the utilization of tower cranes and hoisting equipment on construction job sites for construction, demolition, or excavation during the hurricane season. The goal of these standards is to develop legislation that will minimize the risk of crane failures due to hurricanes or high wind events, and recommendations will be based, in part, on the results of the UF research project. Best practice recommendations will encompass activities related to crane safety in high-wind events, including qualifications of personnel, roles and responsibilities on a job site, hurricane preparedness plans, and necessary preparation for hurricanes. The scope of work conducted by UF will include:

1. Analysis of historical wind-induced crane failures, primarily focusing on failures of cranes during hurricanes or high wind events.
2. Creation of an advisory group of professionals knowledgeable of crane practices to develop relevant recommendations.
3. Analysis of crane regulations in other jurisdictions focused on crane safety during wind events.

3 Background

Historically, State of Florida has lacked legislation specifically governing crane safety during high-wind events. This lack of regulation was brought to the forefront of media coverage with

the collapse of a tower crane in St. Petersburg, Florida during Hurricane Milton (2024). Contractors responsible for the safety of tower cranes were given two days' notice by the local building department to deconstruct their cranes ahead of the impacts of Milton; however, the contractor deemed that there was not adequate time to safely complete the request. Instead, the crane was set to weathervane while it remained standing during the storm. The crane's owner stated that the cranes were designed to withstand 140 mph gusts at the height the crane was operating (550 ft). [2] Wind gusts from 80 to 100 mph were reported in St. Petersburg, with a peak gust of 101 mph recorded at 33 ft above ground level [3]. The tower crane at 400 Central collapsed into a residential building, raising questions about why the crane was left standing and whether current crane operational procedures for hurricane safety are adequate.

Contractors are generally responsible for securing cranes for high-wind events. They are recommended to use the manufacturers' guidelines and have an emergency action plan; however, the specific procedures vary from one contractor to another. OSHA is responsible for assuring worker safety but does not dictate policy or offer specific guidance to address high wind events. In the case of the collapse during Hurricane Milton, the Deputy Building Official of St. Petersburg had asked contractors to lower their cranes, but this was a request rather than an order since there is no legal authority over crane safety measures.

In response to the collapse, and others around the country, the Florida Senate signed SB 180, Section 25 into law to regulate hoisting equipment used in construction, demolition, or excavation work during a hurricane. The bill text is as follows:

- When a tower crane or mobile crane is located on a worksite, a hurricane preparedness plan for the crane must be available for inspection at the worksite.
- In preparation for a hurricane, the controlling entity must ensure that hoisting equipment is secured in the following manner no later than 24 hours before the impact of the hurricane is anticipated to begin:
    - All hoisting equipment must be secured in compliance with manufacturer recommendations relating to hurricane and high-wind events, including any recommendations relating to the placement, use, and removal of advertising banners and rigging.
    - Tower crane turntables must be lubricated before the event.
    - Fixed booms on mobile cranes must be laid down whenever feasible.
    - Booms on hydraulic cranes must be retracted and stored.
    - The counterweights of any hoists must be locked below the top tie-in.
    - Tower cranes must be set in the weathervane position.
    - All rigging must be removed from hoist blocks.
    - All power at the base of tower cranes must be disconnected.

This report summarizes the preliminary findings of the UF research to evaluate whether SB 180 addresses crane safety during high wind events to limit failures similar to the crane collapse in St Petersburg during Hurricane Milton, or whether further provisions are needed to improve public safety.

4 Literature Review

Wiethorn [4] compiled and analyzed 701 forensically evaluated crane accidents spanning over 30 years. The research assessed whether crane safety standards published by ASME B30 (2007), appropriately assigned roles and responsibilities on a construction site to prevent crane failures. It also analyzed how new risk management strategies could be developed to improve crane safety. Statistical analysis of the data compiled in this study found that ASME B30 did appropriately address roles and responsibilities. The study broke down the 701 cases by who was determined to be at fault for the accidents, and the reason for failure in the crane. Several recommendations were offered to mitigate future risks. One is for the service provider – the party responsible for bringing the crane and operator to a job and controlling crane operations – to hold pre-lift meetings to ensure all parties on the job site are aware of their roles and responsibilities. The author also lists specific components of a pre-lift meeting that would make it effective, such as confirming the qualifications of involved personnel, the load path does not pass over sit personnel, communication methods etc. Another recommendation is an increase in education for major roles on a worksite, such as the lift director, and how to carry out their stated responsibilities effectively and safely on a job site.

The U.S. Bureau of Labor Statistics reports 42 to 44 crane-related deaths per year in the United States [5]. Between 2011 and 2017, 297 crane-related fatalities were reported, an average of 42 per year. Globally, there were 1,125 tower crane accidents worldwide between 2000 and 2010 causing over 780 fatalities [6]. Wind events accounted for 23% of these failures. OSHA estimates that 90% of all crane accidents are due to human error. Texas has experienced the largest number of fatalities involving cranes, with 50 deaths. Florida ranks second with 16 fatalities [7]. Many cases of crane-related incidents are not reported, so these figures may be higher.

Neitzel et al. [8] reviewed crane-related injury data, and methods to reduce the severity and number of crane accidents. They found that 87% of crane-related fatalities involve workers other than the crane operators. While the total number of fatalities among crane operators is seemingly insignificant, the rate is high when considering the low number of operators. An OSHA report [9] calculated a death rate of 1.4 per 1,000 for crane operators over a 45-year working lifetime. Pratt et al. [10] analyzed machine-related fatalities in the construction industry and identified 306 (16.1%) deaths out of 1901 fatalities that were attributable to cranes. This statistic emphasizes the need for increased research into the causes of fatalities for both crane operators and those working around the crane. Despite the technological advancement of cranes and their safety devices, the number of injuries and fatalities associated with crane operations remain high. Neitzel et al. [6] conclude that the persistently elevated casualty and fatality rate stems from the

unrealistic number of hazards that a crane operator must manage simultaneously. Moreover, there is a notable lack of epidemiologic research on crane related injuries [11].

5 Review of Wind-Related Crane Failures

The most common practices ahead of forecasted high wind events are to weathervane tower cranes and lay down mobile crane booms, in accordance with manufacturer recommendations. Despite these practices, dangerous and often fatal failures still occur during forecasted storms. This section presents cases of crane failure attributed to high wind events with advance warning. The failures can be divided into two primary categories: 1) cases where measures were taken in preparation for the storm, but the crane remained assembled and 2) cases where the crane was being disassembled when high winds impacted the job site. The first class of failures can be further classified into those that adhered to manufacturer bracing/preparation guidance and those that did not.

It is important to note that most available information presented in this section comes from news articles that often lack reliable information on the operational status of the cranes at the time of their failure. Precise wind speeds and the braced position of cranes at the time of failure are difficult to definitively determine based on available public information. The most reliable and thorough information is from OSHA investigation reports, which exist for a few of these failures.

5.1 Failures Due to Forecasted High Winds – Mobile Cranes

5.1.1 Mobile Crane Case 1 – Mecca, Saudi Arabia (9/11/2015)

On September 11th, 2015, a Liebherr LR 11350 crawler crane collapsed because of winds between 50 to 65 mph. The crane fell onto the Great Mosque, where worshippers were gathered for a pilgrimage. The crane fell through the ceiling, killing 111 people and injuring 394.

It was reported that the Governor of Mecca ordered the Binladin group, the contractor on the project, to relocate the cranes from pedestrian areas and deploy safeguards in preparation for a pilgrimage next to the construction zone. In the week leading to the collapse, the area had been experiencing strong storms, and gusts on the day of the collapse were reported up to 25 mph. At the top of the crane, the winds would have been significantly higher, up to 50 to 65 mph. Although the company may not have had time to relocate the cranes, there may have been adequate time to properly stow the cranes given the forecasted conditions. The crane was not in operation at the time of failure, but the boom and jib were left in the working position, against manufacturer recommendations for a high wind event. Workers usually lower the boom to an angle of 60° or less and, if equipped with a luffing jib, rest the tip on a dolly on the ground in the face of incoming stores. Liebherr reported the tip-over was caused by improper stowage of the boom and luffing jib prior to the storm. As a result of the failure, the Saudi Binladin group was fined $5.3 million dollars and seven people were sentenced to prison [12-15].

Figure 5-1. Fallen crawler crane at the Great Mosque in Saudi Arabia.

5.1.2 Mobile Crane Case 2 – New York City (2/5/2016)

A 570-foot-tall Liebherr crawler crane (Model No. LR 1300) collapsed as the operator attempted to lay down the crane during a high wind event with wind speeds reported on the ground of up to 30 mph, resulting in speeds at the top of the jib estimated between 55 and 80 mph. The crane was carrying no load at the time. The crane fell onto a motorist, killing them and injuring two others [16]. The crane was owned by Bay Crane Services and was leased to Gallaso Trucking & Rigging (GTI). GTI had retained an engineering consultant, MRA Engineering, who submitted the permit for the crane to the city.

The day before the accident, the weather forecast for the following day predicted high winds. GTI expected high winds through the night and early morning of February 5th. Manufacturer and MRA recommendations both stated to brace the crane for the forecasted wind speeds; however, no action was taken to properly brace the crane against these winds. The crane was left with the boom at approximately 87 degrees and the jib at 78 degrees the previous day and overnight. When the crane was attempted to be lowered during high winds the following day, the boom was lowered to 69.4 degrees, in violation of the manufacturer's manual, which states a minimum angle of 75 degrees.

The lack of timely preparation for the forecasted high winds disregarded instructions of both the engineering consultant and the manufacturer, Liebherr. However, the engineering consultant and manufacturer offered two different guidelines for how the crane should be stowed in the event of high winds.

1. The engineering consultant, MRA, offered specifications included in their application to the state. These guidelines stated that cranes were to be stowed overnight or in severe weather conditions as "per manufacturer's recommended procedures found in the

operator's crane manual." MRA suggested that the crane be "jackknifed" to stow overnight or prevail against severe weather. A diagram of a jackknifed crawler crane is shown below. Importantly, even though MRA stated this procedure was per the manufacturer's guidelines, Liebherr suggests an entirely different guideline for stowing the crane in a high-wind event. So, MRA's guidelines were not approved by the manufacturer.

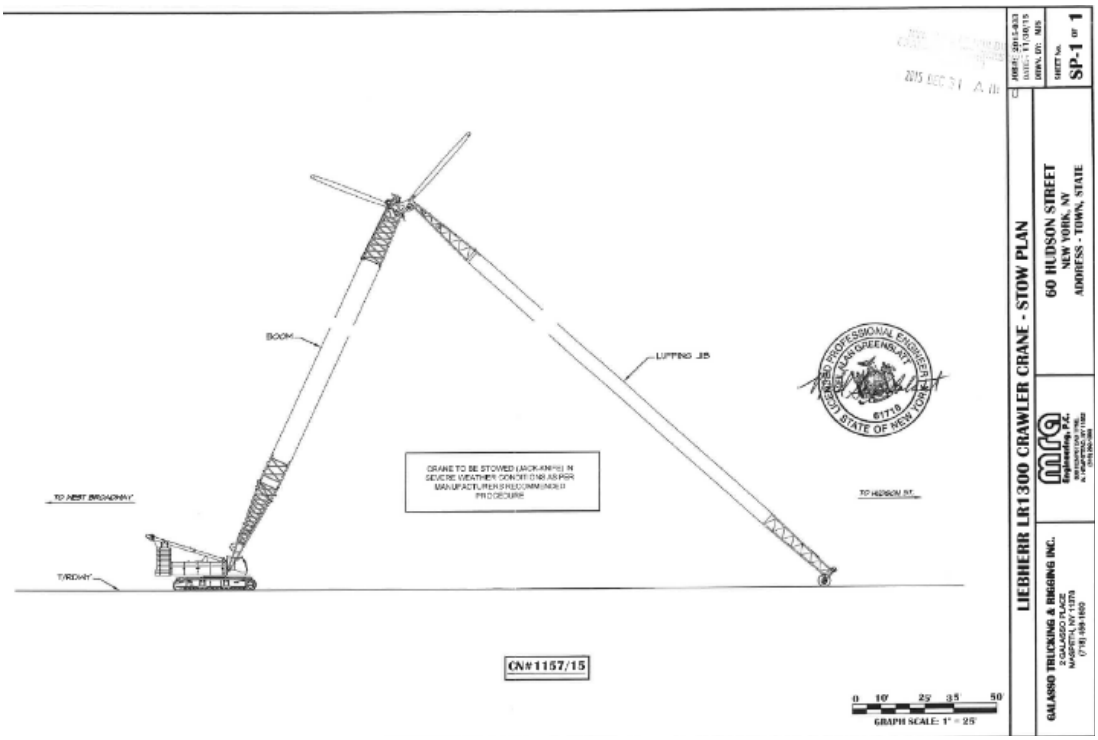

Figure 5-2. MRA's example of a "jackknifed" crawler crane. [16]

2. Liebherr's guidelines state that the crane should be laid down in winds exceeding 20 mph. After the incident, Bay Crane, which owned the crane, requested Liebherr to determine whether the subject crane could be jackknifed under severe weather conditions instead of laying it down on the ground. Liebherr stated in its email that the subject crane could be parked in a jackknife position up to a maximum wind speed of 67 mph, provided certain conditions were met. This instruction by Liebherr supersedes the instructions provided in the Liebherr manual and provides alternate options to the user and is in general agreement with MRA's instructions to Galasso. Liebherr overwrote its own manufacturer guidelines.

It is important to note that no action was taken to stow the crane in a timely manner ahead of a known high wind event, so the conflicting advice of the manufacturer and MRA did not contribute to the failure.

Figure 5-3. Overturned crawler crane in New York City. [16]

5.1.3 Mobile Crane Case 3 – Merritt Island, Florida (6/4/2025)

On June 4th, 2025, a Manitowoc crawler crane collapsed under high winds onto a hospital being built on Merritt Island, killing two workers who were pouring concrete for a column. Maxim Crane owned the crane. Gilbane Building was the contractor on the job site. Thunderstorms in the area were reported to have gusts up to 45 to 55 mph at the time of collapse. The National Weather Service office in Melbourne issued a special weather statement warning of strong winds and advising people to seek shelter in a sturdy structure as a line of storms moved through the area. A lawsuit states the workers were told to continue working even with the known weather forecast and as the conditions worsened. It was not known if the site was in the process of shutting down for safety or if operations continued as the area was caught off-guard [17, 18].

Figure 5-4. Collapsed crawler crane while constructing a hospital in Merritt Island. [17]

5.2 Failures Due to Forecasted High Winds – Tower Cranes, No Disassembly

5.2.1 Tower Crane Case 1 – New York City (10/29/2012) – Hurricane Sandy

On October 29th, 2012, Hurricane Sandy hit New York City. Of the 29 cranes standing in New York City, one tower crane failed. The crane that failed was inspected a few days before the failure, and no damage was reported. New York declared a state of emergency on October 26th, 3 days prior to the storm hitting. In response, all cranes in the area were set to weathervane in accordance with manufacturing guidelines. Gusts in the area were reported as 65 mph but may have been as high as 95 mph at the jib level, approximately 1,000 feet off the ground. The crane was in service to construct a $1.5 billion residential tower. The building's construction manager was Lend Lease, and the crane was manufactured by Favelle Falco. The crane was owned by Pinnacle Industries LLC. The crane model was reported to be Favelle Falco 440 model.

Initially, state officials and engineers stated the failure of the crane was a result of high wind speeds that overturned the crane despite adhering to best practices. An investigation by the forensic engineering company Haag Engineering found that while workers were putting the crane into weathervane mode, they tied two fall protection lanyards to the climbing frame and hooked the loose ends around the crane's slewing gear bolts. The forensic engineering company reported that the workers tasked with preparing the crane were inexperienced in the procedure. As wind speeds increased on the crane, the lanyards on both sides of the turntable prevented the crane from rotating properly. The stress incurred then caused the boom to flick backwards, collapsing the jib. No injuries were reported [19, 20] .

Figure 5-5. Tower crane destroyed during Hurricane Sandy in New York City. [20]

5.2.2 Tower Crane Case 2 – Miami/ Fort Lauderdale - Triple Crane Collapse (9/10/2017)

On Sunday, September 10, 2017, three hammerhead tower cranes collapsed within hours of each other, two in Miami and one in Fort Lauderdale, during heavy winds in the wake of Hurricane Irma. Miami and Fort Lauderdale experienced tropical storm conditions as Hurricane Irma made landfall on the west coast of Florida. All three cranes were SK-315 models, with one produced by Terex Peiner and two by Noell. In preparation for the hurricane's approach, all construction activities were terminated, and all three tower cranes were set to weathervane mode with their slewing brakes released. The cranes carried no load except their dead weight. OSHA launched a full investigation to determine why these particular models failed, when dozens of other cranes around Broward and Miami-Dade did not fail despite standing during the storm.

Figure 5-6. Locations of downed cranes in Miami and Fort Lauderdale during Hurricane Irma.

Miami and Ft. Lauderdale experienced peak gusts of 80 mph due to the storm. According to OSHA, these measurements were taken from inland measuring sites; however, since all three cranes stood on the coast, the actual wind speed may have been much higher. Anemometer data is taken from 33 ft off the ground (reference height), so wind speed at the elevation of the jibs is significantly higher. Table 5-1 gives predicted wind speeds at the jib elevation of each of the three cranes.

Table 5-1. Wind speed at the jib elevations of the three failure sites.

Site	Jib elevation, z (ft)	Wind speed at 33 ft (mph)	Wind speed at z (mph)	
			Exposure C	Exposure D
1	425	80	105	109
2	600	80	109	112
3	200	80	97	102

SK-315 cranes were designed to withstand a maximum out-of-service wind speed of 95 mph. The masts and their connections to the structure and the foundation were designed for 175 mph. Prior to the storm, the cranes were lowered by two tower sections.

OSHA reports the following from its investigation [21]:

- *"The design of the crane, model SK-315, met the U.S. and European standards. The crane was designed for a maximum wind speed of 95 mph at the jib level for the out-of-service condition. Beyond 95 mph, failure could occur as stated in the manufacturer's manual. The wind speed at different heights of the jib of the three cranes in Miami and Fort Lauderdale exceeded 95 mph.*

- *If the wind speed at the jib level exceeds 45 mph, the crane must be placed out of service and allowed to weathervane, as per the manufacturer's manual. This was done correctly.*
- *U.S. and European codes do not require that turbulent wind, suction, or vortices be considered in the design of the cranes. The failure of all three cranes was attributed to turbulent wind. Out of more than a dozen cranes in and around Miami, only the model SK-315 failed due to an inherent weakness at the connection of the jib to the turntables.*
- *The cause of the failure of the three cranes was the detachment of the crane jibs from their turntables due to turbulent wind loads. It is believed that wind gusts, at oscillation periods corresponding to the frequencies of the dominant modes of the jibs, struck the jibs. Under the turbulent wind loads in either lateral or upward direction, the forces on the turntable cradles at the jib feet potentially exceeded their capacities."*

The cranes failed despite adherence to the manufacturer's guidelines and with the cranes partially lowered and set properly to weathervane. Although these cranes failed due to their design at connections, this example demonstrates that setting cranes to weathervane may not be adequate to prevent failure during strong hurricane events.

Figure 5-7. One example of the failed cranes in South Florida during Hurricane Irma. [21]

5.2.3 Tower Crane Case 3 – Dallas, Texas (6/9/2019)

On June 9th, 2019, a Peiner SK415-20 tower crane collapsed into an apartment building in Dallas, Texas. The collapse killed one person living in the apartment and injured five others. The crane was owned by Bigge Crane and Rigging and operated by the contractor Greystar Development & Construction. The crane was being used to construct an apartment complex across the street.

The crane was designed to withstand speeds of 95 mph when properly secured. Wind gusts on the day were measured up to 70 mph. At the time of the collapse, the National Weather Service

had issued a severe thunderstorm warning in the area. There was also a ground stop at the Dallas Airport due to severe winds. It was reported that this thunderstorm had been in the forecast for several days' prior, meaning the contractor likely knew of it in advance. The crane was not put into weathervane by the operators despite the advanced warning of the storm. The crane collapsed under gusts of 70 mph. It was also reported that the crane operator had worked 84 hours during the week of the collapse. The operator of the crane during the collapse was an employee of Bigge but "essentially served Greystar," making the trial complicated.

In the trial, Greystar and Bigge Crane both denied responsibility. Greystar claimed it was Bigge's responsibility to have the crane set to weathervane, while Bigge argued that the contractor was responsible for the operators' actions. Greystar was found negligible and Bigge was found not guilty. A total of $860 million was awarded to the family of the deceased. Bigge Crane and Rigging were eventually fined by OSHA for failing to inspect and remove rusty bolts. [22-24].

Figure 5-8. Tower crane that collapsed into a building in Dallas, Texas. (Michael Santana/AP)

5.2.4 Tower Crane Case 4 – St. Petersburg, Florida (10/9/2024) – Hurricane Milton

On October 9th, 2024, Hurricane Milton passed by St Petersburg, Florida. The area had advance notice of at least several days that the storm was expected to hit the area. Contractors were asked to deconstruct or lower their cranes roughly two days before the storm hit the area. This was a request rather than an order from a Buildings Official, as they have no legal authority over the operation of cranes in incoming wind events. Contractors stated they needed at least a week's advance to deconstruct their cranes. Therefore, cranes in the area were set to weathervane.

One tower crane, owned by Liberty Companies, working to construct a building at 400 Central, collapsed during the storm. Gusts were recorded up to 100 mph but were likely between 115 and 130 mph at the height of the jib on the crane, over 500 feet off the ground. It is possible the

winds were a design-level event for the crane, causing it to topple into the building and cause significant property damage. A full-scale investigation is not yet publicly available, but the crane was properly set to weathervane and failed because of peak wind gusts. The role the turbulence or dynamic loading of the wind played is unknown [25, 26].

Figure 5-9. Tower crane collapsed into building in St. Petersburg, Florida. [25]

5.3 Failures Due to Wind During Tower Crane Disassembly

The following cases involve cranes that failed during disassembly. In these cases, responsible parties did not properly follow disassembly instructions in the manufacturer's guidelines, resulting in the cranes collapsing due to their inability to resist wind gusts in a compromised configuration.

5.3.1 Tower Crane Case 5 – Richardson, Texas (7/7/2012)

Two employees of Harrison Hoist, Inc. were in the process of dismantling a 150-foot-tall Texer Peiner (Model SK 415) tower crane when gusts of 50 mph hit the area and toppled the crane. The workers were attempting to dismantle the top portion of the crane's mast when it collapsed. The crane fell into the new Arts & Technology building on the University of Texas campus. Both workers were on the crane when it collapsed and died. The collapse occurred because mast bolts had been removed or loosened from several tower sections, leaving parts of the structure inadequately supported [27, 28]. Harrison Hoist was cited for six serious safety violations and proposed a penalty of $29,400. OSHA cited the company for failing to ensure that the "disassembly procedures positioned workers to minimize their exposure to danger and failing to ensure the procedures were developed by a qualified person, plus other violations." The

manufacturer's guidelines to take down the tower cranes were not followed, and the crane was left unsupported against wind gusts during deconstruction.

Figure 5-10. Crane failure in Richardson, Texas. (Meg Roussos / The Dallas Morning News)

5.3.2 Tower Crane Case 6 – Seattle, Washington (4/27/2019)

A 278-foot-tall tower crane was owned by Morrow Equipment Company, manufactured by Liebherr and leased to GLY construction. The crane was being used to construct a 607,000 square foot building that would serve as a campus for Google and 150 new apartment units. The crane was being dismantled at the completion of its work. After an investigation by the Washington Department of Labor and Industries, it was concluded that the crews removed "nearly all the mast bolts and sleeves that held it together…significantly undermining its integrity." This dismantling process did not follow the guidelines from Liebherr. A 45-mph gust came through and caused the crane to collapse, killing four and injuring four others. The forecast for the day was "breezy" with 15 to 25 mph winds expected.

Three companies were cited for willful serious violations of safety procedures established by the manufacturer. Morrow Equipment was fined $70,000 for "approving the premature removal of the mast bolts." GLY was fined $25,200 for "lack of qualified supervision and failure to account for hazardous wind conditions." Northwest Tower Crane was fined $12,000 for "failure to train and ensure that the ironworkers dismantling the structure were following the manufacturers procedures correctly." A $150 million settlement was awarded to the families [29, 30].

Figure 5-11. Crane failure in Seattle, Washington. (KIRO7.com)

5.4 Wind-induced Crane Failure Case Summary

The crane failures analyzed above can be split into two broad categories: 1) cases in which manufacturer guidelines were followed, and 2) cases where manufacturer guidelines were not adequately followed.

Of the nine crane failure cases examined above, seven did not take actions aligned with manufacturer's guidelines. In the cases of failures during forecasted storms, warning of the storms' impacts was provided days in advance. In five of these cases, the cranes were not correctly prepared for the storm, even when there was adequate time to take the actions recommended by the manufacturer.

One contributing factor to these failures may have been a lack of central authority on the job site, resulting in inaction or incorrect action. In ensuing lawsuits, various jobsite entities (contractor, crane owner, crane operator, etc.) point to others for responsibility for the failure. While efforts to transfer liability during litigation are expected, clear definitions of responsibility for actions ahead of the storms may reduce future failures.

Another factor in some failure cases was inexperience by those responsible for preparation actions, highlighting the importance of proper training.

Two of the reported cases involved tower crane failures during hurricanes in Florida, despite manufacturer recommendations being followed (three cranes in Tower Crane Case 2 and one in Tower Crane Case 4). While the cranes were correctly set to weathervane, failure still occurred, indicating that wind loads at the jib height exceeded the capacity of the crane. In both cases failure was partially attributed to the turbulent nature of the wind, resulting in higher loads than

anticipated. While partial disassembly of the cranes can reduce wind loads, there may not be adequate time or support equipment to take this action ahead of a storm's impacts, even with advance warning. Given the risk associated with disassembly ahead of an incoming storm, such action may not be justified in many circumstances. These crane failures highlight the need to assess the adequacy of manufacturer wind speed ratings considering the turbulent nature of tropical cyclone winds interacting with an urban environment. Furthermore, appropriate preparation actions in situations where the crane capacity is likely to be exceeded by the wind event should be evaluated.

Tower Crane Cases 5 and 6 highlight the potential dangers associated with crane disassembly when appropriate procedures are not followed. However, even when procedures are adhered to, disassembly requires time and support equipment that can introduce additional risk during a forecasted high wind event. Weighing this risk against the potential to reduce wind loads will require site-, storm- and resource-specific evaluations.

6 Crane Safety Regulations

To develop a set of informed best practices for crane safety during high wind events, crane-related regulations across several U.S. counties, cities and states were reviewed. The review includes the municipal crane codes of New York City, Chicago, Washington State, California, Miami-Dade County, and the provisions established under Florida Senate Bill 180. These regulations were selected because they represent the most comprehensive crane safety requirements in the United States. By examining the common elements, recurring requirements, and distinct approaches within these codes, this report identifies consistent components in the regulations. These components include criteria for crane permitting, wind-related operational limitations, inspection and maintenance intervals, qualifications and responsibilities of site personnel, and emergency procedures triggered by approaching severe weather.

Text in italics are taken directly from the legislation available online. Links to the legislation are included in the following section and more comprehensive excerpts are provided in Appendix A.

6.1 New York City

New York City created regulations in response to several wind-related crane failures [31]. Segments of the information from these regulations are provided in Appendix A as they pertain to wind events involving cranes.

The Cranes and Derricks Unit within New York City Buildings has many regulations regarding safety and wind hazards. New York City regulations require that crane operators, assembly/disassembly directors, and lift directors be licensed. This includes training classes of at least 30 hours and recertification every three years. New York City regulations require the hoisting machine operator to perform a frequent inspection prior to each shift and a parking/secure inspection at the end of each shift. The New York City regulations then refer to ASME B30 for the list of items to inspect. Also, hoisting machine operators, lift directors, and

assembly/disassembly directors should have a copy of the wind action plan easily accessible at the site.

The wind action plan that New York City requires is a document that contains an in-depth analysis of the crane being used, site location, and procedures. This document also contains a mixture of different load analysis and manufacturer specifications. One of the more important points of the wind action plan is the maximum in-service threshold, which says it can't exceed 30 mph (3-second gust) or the threshold specified by the manufacturer, whichever is lower.

There are also wind and weather restrictions found in New York City's regulations. Some of these restrictions include: the hoisting machine operator must follow the approved wind plan and applicable manufacturer procedures related to securing the crane when required, no work may start if wind speed exceeds the threshold specified in the approved plan, while in service the hoisting machine operator must safely stop when the wind speed exceeds the threshold approved in the plan or warranted by weather conditions, and inspections to verify the crane is secured. If any of these regulations are broken, the New York City Department of Buildings will pursue fines and penalties, which would range in value depending on the severity of the offense.

6.2 Chicago

The City of Chicago's rules regarding crane operations are reported by the city of Chicago Department of Buildings. See Appendix A for the excerpts taken from the rules manual as they pertain to crane safety in the face of high winds [32].

In summary, Chicago's crane regulations have strict safety requirements that require trained and licensed personnel to be present on the job site during key events. A construction equipment manager is required to be present whenever a crane is reconfigured in any way. A copy of the crane supplier's certification and specifications checklist must be ready to be always inspected by the department. The crane must have a functioning anemometer. The crane must be able to weathervane 360 degrees and in the event it cannot, it must be tied down according to manufacturer's recommendations. The crane must be supervised by a "qualified and competent person" whenever constructed or deconstructed.

Chicago defers to the manufacturer's recommendations when it comes to crucial safety features of the crane, such as preparing it for storms or erecting/taking down the crane. It requires the presence of qualified people on site during events, crucial for safety. Chicago states that the City may pursue penalties, fees, sanctions or remedies for breaking these rules. Penalties are set in the municipal code of Chicago, but they can be added on depending on the nature of the violation. The City of Chicago defers to the Code of Federal Regulations on Cranes and Derricks, a substantial document that includes regulations on inspection, testing, operational safety and other key aspects of crane operation. Chicago does not mention hurricanes or preparedness plans in their legislation. The Federal Code of Regulations defers to manufacturer guidelines when discussing wind operations. For design, construction and testing, the Code of Federal Regulations defers to ASME B30. The Code of Federal Regulations does not require a wind action plan.

6.3 California

Appendix A includes excerpts from the State of California Department of Industrial Relations [33]. The regulations have been edited to only contain those relevant to this project.

The regulations in California do not require hurricane action plans but fall back on manufacturer procedures in the event of high wind events. If manufacturers' procedures are unavailable, the employer shall develop one in compliance with safe operating procedures. If wind speeds exceed the speed threshold recommended by manufacturers, operation must stop. During storm warnings, the competent person shall determine whether it's necessary to follow the manufacturer's guidelines to secure the equipment. California does not specifically mention hurricane preparedness or wind action plans as they pertain to crane safety. During assembly or disassembly, the A/D director shall determine the procedure during a high wind event. This may be either following the manufacturer's guidelines or a written employer procedure. California's guidelines expect cranes to be visually inspected daily by a qualified person or the operator. California's regulations defer to the manufacturer guidelines and relevant ASME chapters.

6.4 Washington

Excerpts taken from Washington State Department of Labor and Industries Cranes, Rigging and Personnel Lifting is provided in Appendix A [34]. The regulations have been edited to only contain those relevant to this project.

Washington does not specifically call for hurricane action plans but does give some direction for safety in the face of expected or unexpected high winds. In the face of expected high winds. Washington directs the lift director and operator to determine whether they should take action to utilize the manufacturer's guidelines. In the presence of unexpected high winds, the crane operations should be stopped and taken out of service safely. All assigned personnel are directed to stop operations when they feel unsafe and not resume until a qualified person addresses the concerns. Washington's guidelines call for cranes to be inspected daily by a qualified individual. Washington's regulations fall back on the manufacturer guidelines and relevant ASME chapters.

6.5 Miami-Dade County

Excerpts taken from Miami-Dade County's Code of Ordinances are provided in Appendix A – only parts relevant to this project are included. This code is not currently enforceable due to legal authority, but the statements are helpful in analyzing most efficient potential legislation.

Miami-Dade regulations defer to several codes and governing bodies when setting safety standards for cranes. These regulations state to adhere to the manufacturer, OSHA, ASME, and ASCE (for wind loads) to follow the most up-to-date guidelines. Therefore, these regulations mostly defer action to those regulations and do not state specific action for the erection, use or deconstruction of these cranes.

Miami-Dade does set specific information in their ordinance regarding inspections, permits, qualifications and punishments for breaking said rules. For tower cranes, a full inspection

schedule that sets specific events in which a tower crane should be inspected, including after initial erection, after each time top climbing is completed, each time a hurricane has passed and several other crucial events. This schedule makes it so the tower cranes are inspected by a special crane inspector on a regular basis.

A permit is required to be submitted for review by a building's official. This permit will include sufficient information for the official to determine if the hoisting equipment fits the standards.

Specific qualifications are set for what individuals can inspect cranes or hoisting equipment. They include a proof of licensing and a minimum years of experience. Qualifications are also set for who can operate tower cranes. They are thorough and include tests such as emergency control skills, characteristic and performance questions, knowledge of the legislation, "hands-on" tests and others. These tests are included in ASME B30.

These regulations include a section specifically on hurricane preparedness that sets guidelines to prepare for incoming hurricanes in the area. They defer to the manufacturers' regulations for preparation. They also added some additional guidelines that state tower crane turntables must be lubricated, mobile crane booms should be laid down if feasible, tower cranes should be set to weathervane, and a preparedness plan should be ready for inspection.

The regulations give power to the Building Commission to enforce the legislation by issuing civil violations fines and potentially taking action in court if there is damage to public health and safety.

6.6 Senate Bill 180 Section 25

Senate Bill 180 Section 25 Section 489.1132 [1] was created in response to the St. Petersburg crane collapse as discussed earlier in this document. This bill specifically outlines measures for the use of cranes in Florida in preparation for incoming hurricanes. The information from SB 180 is taken directly from https://www.flsenate.gov/Session/Bill/2025/180/BillText/er/HTML and given below and the text was provided in Section 3 of this report.

This bill is similar to the Miami-Dade County crane ordinance and includes requirements intended to improve public safety during hurricanes. It once again states for tower cranes to be set to weathervane and the booms of mobile cranes to be laid down. The bill adds that these actions must be completed 24 hours before the anticipated impact of the hurricane, a timeline which was not set by Miami-Dade's regulations. This legislation does not give details about the anticipation of hurricanes, such as how soon work should begin to take these measures once a hurricane has formed and could potentially impact an area.

6.7 Regulation Summary

In general, New York City, Miami-Dade and SB 180 are the only regulations reviewed that offer specific policy of interest to this project. Other regulations do not have provisions for hurricanes or high wind events, likely because they do not experience such events and do not have a

historical record of crane failures due to wind. These other regulations instead focus on testing, qualification, roles, enforcement and permitting.

The only regulations that specifically require hurricane preparedness procedures are Miami-Dade and SB 180, with SB 180 drawing heavily on Miami-Dade's language. These regulations direct that cranes on jobsites must be braced or stowed properly in the event of high winds but do not provide specific provisions for when wind speeds are predicted to be above design level wind speeds. Tower cranes are directed to be set to weathervane ahead of hurricanes and booms of mobile cranes laid down. New York regulations outline the requirements for a wind action plan, which can be utilized similarly for hurricane preparedness. This wind action plan must be site specific and be approved by the city. The plan must be available on the job site at all times and includes the procedure in cases when high winds are forecast. The wind action plan includes manufacturer requirements and an emergency action plan.

For testing, inspections and qualifications of job site users, the most regulations reference ASME B30. That document, summarized in a subsequent section, covers in depth procedures for the design, qualifications of significant positions on a jobsite, their roles and responsibilities and a thorough inspection procedure for the cranes.

7 Manufacturer Guidelines

Most crane regulations around the United States defer to manufacturer guidelines for maximum operational and out-of-service wind speeds as well as crane configurations and procedures to ensure safety during high wind events. This section provides some limited examples of publicly available operating manuals for commonly used cranes. Additional research is underway to learn more about guidance manufacturers provide to their users and will be included in the final report.

7.1 Tower Cranes

7.1.1 JOST

JOST is a crane manufacturer founded in 2000 and serves as one of Germany's leading crane manufacturers. JOST provides a wide variety of tower cranes to countries around the world. The operating manual for JOST luffing crane JL 616.32 provides recommended procedures for taking the crane out of operation when a strong wind (gale) is approaching.

In Section 6.9: Taking the Crane out of Operation when a Gale is Approaching, JOST gives a graph that relates wind speed versus time required to carry out safety measures to inform crane users of the speed at which cranes should be taken out of operation, as shown in Figure 7-1 . This method provides that JOST cranes can be utilized in higher wind speeds if the safety measures to properly secure them for high winds can be completed in less time. For example, if safety measures take 12 minutes to complete, the maximum wind speed a crane can operate in is 55 kilometers per hour, or 34.2 miles per hour [34]. If the time to complete safety measures is one minute, the crane must be taken out of operation at 67.5 kilometers per hour or 41.9 miles per hour. These limits come from DIN 15019 - part 1, a European crane standard [35].

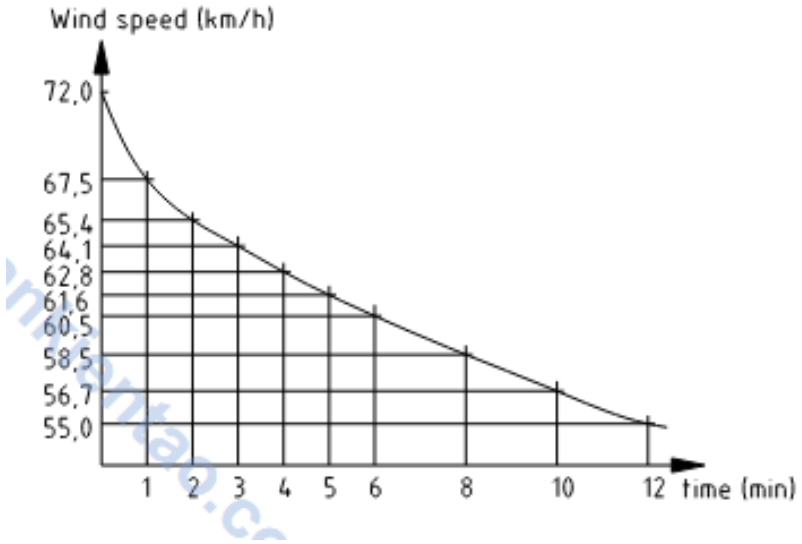

Figure 7-1. Wind speed versus time to carry out safety measures as recommended by JOST.

The safety measures outline the process of putting a crane into weathervane mode:

"When taking the crane out of operation, the following measures must be taken:

- *All lifting elements (including ropes and chains) must be let down and the empty hook pulled up.*
- *Lift the jib in out of service position.*
- *Slew the jib in wind direction (with the wind).*
- *Release the slewing brake and provide for free slewability of the crane, or observe corresponding prescriptions.*
- *Insert all track plinch bars or secure the crane by way of other tying means."* [34]

7.1.2 Liebherr

The following guidelines are written for one of Liebherr's most popular tower crane models, the 316 EC-H. Liebherr is an international manufacturer of various types of cranes that are used in several economic sectors. They are the world's largest manufacturer of tower cranes.

Liebherr offers the maximum permissible wind speed in which this crane may operate, as seen in Figure 7-2. 72 km/h is equivalent to 44.7 mph. The manual states this wind speed can occur as a peak gust under wind speeds of between 43 to 47 km/h (26.7 to 29.2 mph).

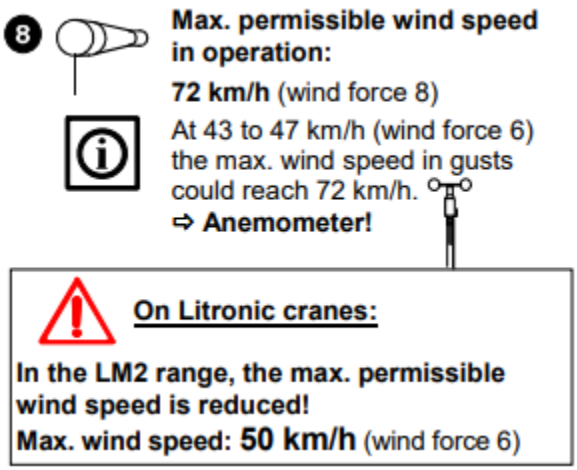

Figure 7-2. Maximum operational wind speed taken from Liebherr operations manual.

The operational guidelines offer maximum wind speeds that the crane can be jumped erected in, as seen in Figure 7-3.

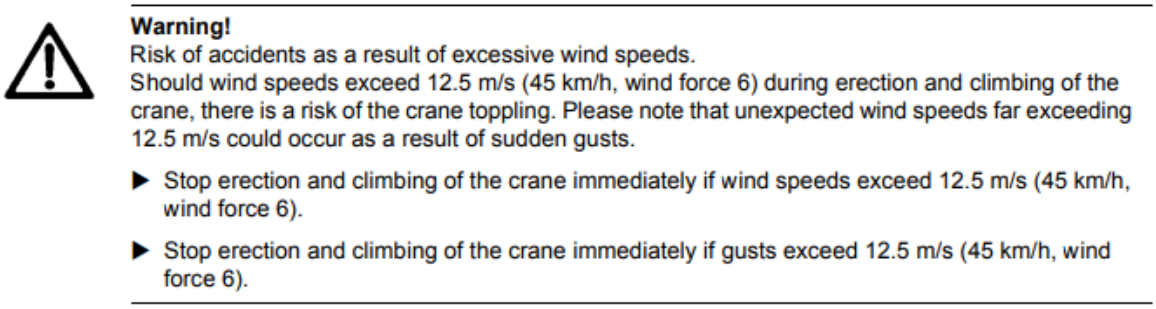

Figure 7-3. Maximum wind speed requirements for erecting a crane.

The operations manual provides detail in the operation section of how to set the crane into weathervane mode, which it recommends when wind speeds exceed operational values. The crane is to be set to weathervane whenever the crane is shut down at end of the workday as well.

7.2 Crawler Cranes

7.2.1 Terex

Terex is a large manufacturer of cranes based in Fontanafredda, Italy. Their cranes are used worldwide in a variety of models and sizes. This operation manual was made for the HC110 Terex crawler crane [38]. The manual gives wind speed limitations for operation of the crane based on the boom size or boom plus job size. For example, if the boom size is 37 inches and the boom plus jib is between 0 to140 feet, the maximum wind operation speed is 30 mph. This same chart gives the wind speeds that the crane must lower its boom in, as well as speeds in which the boom must be lowered completely or secured. For example, in the same category, a boom size of 37” and boom plus jib, the boom must be lowered to 50-60 degrees and no operation allowed at wind speeds of between 30 to 50 mph. Additionally, in this same category, at wind speeds over

50 mph, the boom must be lowered or secured. The full wind speed limitations form this manual can be seen in Figure 7-4.

WIND SPEED LIMITATIONS

Boom Size	Boom or Boom Plus Jib	Operation	No operation. Lower boom to 50-60 degrees. Position rear of crane into wind.	Lower or secure boom
37"	0-140' (0-42.3m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
37"	Over 140' (0-42.3m)	0-20 mph (0-8.9 mps)	20-30 mph (8.9-13.4 mps)	Over 30 mph (13.4 mps)
46"-47"	0-170' (0-51.8m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
46"-47"	Over 170' (51.8m)	0-20 mph (0-8.9 mps)	20-30 mph (8.9-13.4 mps)	Over 30 mph (13.4 mps)
1K 1400	0-170' (0-51.8m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
1K 1400	Over 170' (51.8m)	0-20 mph (0-8.9 mps)	20-30 mph (8.9-13.4 mps)	Over 30 mph (13.4 mps)
58"-59"	0-220' (0-67.1m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
58"-59"	Over 220' (67.1m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
77"	0-290' (0-88.4m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
77"	Over 290' (88.4m)	0-20 mph (0-8.9 mps)	20-30 mph (8.9-13.4 mps)	Over 30 mph (13.4 mps)
92"-94"-118"	0-360' (0-109.8m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
92"-94"-118"	Over 360' (109.8m)	0-20 mph (0-8.9 mps)	20-30 mph (8.9-13.4 mps)	Over 30 mph (13.4 mps)
130"	0-400' (0-122m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
130'	Over 400' (122m)	0-20 mph (0-8.9 mps)	20-30 mph (8.9-13.4 mps)	Over 30 mph (13.4 mps)

Figure 7-4. Ranges of wind speed of operation for HC110 Terex crawler crane with their necessary safety steps to prevent failure from wind loading.

These guidelines offer different ranges of wind speeds, each with their associated necessary steps to keep the crawler crane from overturning.

8 ASME B30.3

8.1 Overview

The American Society of Mechanical Engineers provides safety standards for cranes, hoists and lifting equipment through their ASME B30 standard series. A summary of the tower crane requirements outlined in ASME B30.3 is provided below, with additional summaries and excerpts are provided in Appendix B. ASME B30.3 provides detailed guidance on equipment configuration, installation, climbing, load ratings, operational limitations, and wind-related considerations for tower cranes. ASME B30.3 also establishes overarching roles, responsibilities, and personnel qualifications for the crane owner, user, lift director, operator, rigger, and signalperson.

This review focuses only on the components of the ASME B30.3 standard that are relevant to the scope of this project, such as design wind speed considerations for tower crane operation, site responsibilities, and warnings related to wind conditions during crane climbing and disassembly.

ASME B30 defines the terms qualified person and competent person as follows:

- A qualified person, according to OSHA 1926.1401, is "a person who, by possession of a recognized degree, certificate or professional standing, or who by extensive knowledge, training and experience successfully demonstrates the ability to solve/resolve problems relating to the subject matter, the work or the project."
- A competent person, according to OSHA 1926.1401, is "one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them [39]."

ASME B30.3 is split into four chapters. Chapter 3-0 is Scope, Definitions, References and Personnel Competence, 3-1 is Erection, Climbing and Dismantling, Characteristics and Construction, 3-2 is Inspection, Testing, and Maintenance and 3-3 is Operation [38].

8.2 Standards and Guidance for Out-of-Service Wind Velocities

For tower cranes, out-of-service wind velocities used in site planning and design are to be determined using ASCE/SEI 7, specific to the geographical region. Load reductions are permitted according to ASCE/SEI 37 for cranes in service less than five years. Stabilizers and ballast are permitted to meet the out-of-service wind requirements.

ASME B30.3 suggests a reduction in freestanding height for cranes erected during the hurricane season in high wind zones.

Climbing is prohibited when wind speeds exceed 20 mph, including the effects of wind gusts, unless allowed by the manufacturer or a qualified person.

8.3 Roles and Responsibilities

ASME B30.3 lays out the roles and responsibilities for best practice on a job site. Some of the responsibilities listed in this chapter describe responsibilities related to the technical operations of the crane. Responsibilities related to wind procedures, inspections, assembly, and disassembly and enforcement of rules are provided here, with full excerpts on their responsibilities provided in Appendix B. The standard assigns responsibilities to five roles and states a single individual may perform one or more of these roles:

- Crane Owner – Has control of the crane by virtue of lease or ownership.
- Crane User – Arranges the crane presence on a work site and controls its use.
- Site Supervisor – Exercises supervisory control over the work site on which the crane is being used and over the work that is being performed on that site.

- Lift Director – Oversees the work being performed by the crane and the associated rigging crew.
- Crane Operator – Directly controls the crane functions.

9 Advisory Group

The advisory group formed to inform opinions about future legislation is made up of crane owners, contractors, building officials, and certification representatives. Virtual meetings are held once per month with the first meeting in October 2025. Meeting notes are generated and distributed following each meeting. The primary objective is the development of language for hurricane crane safety recommendations in Florida. Members are encouraged to provide input on the recommendations beyond the meetings, which are then considered for inclusion in future draft iterations. Members of the advisory group are listed in Table 9-1.

Table 9-1. Advisory group members

Name	Role	Organization
Brian Bleakly	Owner	Bleakly Engineering Consulting
Lundy Clark	Chief Code Officer	Miami-Dade Board and Code Administration
Jaime Gascon	Board and Code Administration Director	Miami-Dade Board and Code Administration
Derek Sather	VP Risk Management	Sims Crane and Equipment
George Fernandez	Director QA/QC	Coastal Construction
Mo Madani	Technical Director	Florida Building Commission
JR Moran	Director of Crane Operations	Brasfield and Gorrie
Ashraf Omran	Executive Director	NYC Buildings, Cranes & Derricks Division
Jim Schock	Vice Chair	Florida Building Commission
Garret Schra	Engineering Manager	Morrow
Charles Shelhamer	Code Development	NYC Buildings
Thom Sicklesteel	CEO of Certification	Nat. Commission for the Certification of Crane Operators
Chris Smith	VP of Service	Morrow
Brian Trusky	VP Loss Prevention	Coastal Construction
Seamus Turnbull	Superintendent, FL	PCL Florida Buildings Group

10 Conclusions

Recent crane failures during high wind events in Florida have motivated new legislation aimed at improving safety of crane utilization during hurricanes. An initial set of requirements has been established in Senate Bill 180, with a focus on specific actions to be taken 24 hours ahead of the

impact of a storm. FBC is to provide recommendations to the legislature on additions or modifications to this language at the conclusion of a UF-led study.

A review of crane safety literature shows that wind accounts for almost one quarter of crane accidents. An analysis of over 700 crane failures concludes that that clearly identifying roles and responsibilities related to crane safety, effective jobsite communication practices, and personnel training are critical to avoid crane failures. These importance of these practices are emphasized in both ASME B30 standards and in crane safety regulations across the US.

This report presented several crane failures caused by forecasted high wind events, with many attributable to a lack of adherence to manufacturer guidelines or jobsite safety procedures. In some cases, these oversights were caused by miscommunication or personnel inexperience, while in others it seems that action or in action were simply taken without regard for manufacturer recommended procedures, even when adequate advance warning of high wind events was provided.

Even when all procedures and guidelines are followed, crane failures still have the potential to occur. This is especially the case during hurricanes when the wind loads on weathervaned tower cranes exceed their capacity. Such occurrences call into question whether cranes being used in hurricane prone regions have adequate resistance to design-level, turbulent wind events or whether there should be provisions requiring them to be partially disassembled (lowered to reduce wind loads) ahead of design level storms. The challenge in creating such provisions lies in the inherent risk associated with crane disassembly and the fact that it requires additional equipment – both of which become more challenging as a storm approaches.

An advisory group has been assembled to develop recommendations aimed at ensuring the safety of cranes during the hurricane season in Florida. In the first four meetings, the group has built on and modified the original SB 180 crane safety recommendations. This effort is ongoing as the group addresses issues related to jobsite roles, adherence to manufacturer requirements, and the creation and documentation of a hurricane preparedness plan. With at least two more meetings planned, the output of this group will be a final set of recommendations to be presented to FBC.

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APPENDIX A – Crane Safety Regulations Excerpts

A.1. New York City

1 RCNY SS3319-01, Chapter 3300

SS3319-01 Cranes and Derricks

(d) Certificate of approval. Certificates of approval must comply with the requirements of Section 3319.4 of the New York City Building Code and the following.

(5) Manufacturer supplements to the certificate of approval.

(iv) Site specific wind analysis for a tower crane. For a tower crane, other than a self-erecting tower crane, the manufacturer must submit a site-specific wind analysis to the department prior to the approval of the crane or derrick notice application. Such analysis must:

(A) Cover each configuration for which crane or derrick notice application approval is sought;

(B) Be based upon the following information, with such information submitted to the manufacturer by the engineer who files the crane or derrick notice application:

1. Project address;

2. Crane make and model;

3. Maximum lifting capacity;

4. Distance of the crane from the building;

5. Proposed tie-in spacing;

6. Elevations and sections detailing the location and configuration of the crane at the site, in both plan view and elevation view, with dimensions indicated;

8. New York City wind load conditions, including exposure category and height distribution of the wind. Such information must be in accordance with Chapter 16 of the New York City Building Code, and based on the following:

8.1. An in-service wind speed of at least 45 mph;

8.2. An out-of-service wind speed that is not less than that allowed by Chapter 16 of the New York City Building Code; and

(C) Contain the following information from the manufacturer for the given in-service, out-of-service, and, where applicable, full, unreduced, design wind speed at the center of the tower:

1. Wind load base shear.

2. Wind load overturning moment at the base.

3. Vertical loads at the base.

4. Overturning moment at the base center due to vertical loads.

5. Maximum tower and boom displacements due to wind.

6. The slewing moment.

(D) Contain a certification from the manufacturer that the information provided per clause (C) above is based on the information provided by the engineer per clause (B) above;

(E) Contain a certification from the manufacturer that, in accordance with the requirements of the standard listed in the certificate of approval for the design and construction of the crane (e.g. ASME B30-3 or EN 14439), the boom, mast, jib, attachments, and working deck of the crane will sustain the wind loads specified in (B)(8) above; and

(v) Wind action plan. The application must be accompanied by a wind action plan.

(A) Content. The wind action plan must include the following information:

1. Load reductions, if any, due to wind;

2. The maximum in-service wind threshold;

3. Wind thresholds, configurations, and procedures, including angles and sequencing, for parking and securing the crane in each applicable out-of-service position (e.g. retracted, parked, jackknifed, laid down, and/or other special protective measures for wind); and

4. The communication protocol for safeguarding the crane or derrick in the event of changes of forecasts over weekends or longer stoppage periods.

(B) Self-contained document. The wind action plan must be a complete, self-contained document.

(C) Maximum in-service threshold. The maximum in-service wind threshold listed in the wind action plan cannot exceed 30 mph (3-second gust) or the threshold specified by the manufacturer, whichever is lower. Exceptions: The 30 mph (3-second gust) criterion does not apply to:

1. A mobile crane where the crane is set up and operated entirely within a safety zone, provided:

1.1 The distance from the crane to the boundary of the safety zone is equal to or greater than the length of the boom, jib, and any other attachments; and

1.2 All areas and structures within the safety zone are closed to the public.

2. A tower crane, where the crane is set up and operated entirely within a safety zone, provided:

2.1 The distance from the crane to the boundary of the safety zone is equal to or greater than the height of the mast and the length of the boom, jib, and any other attachments; and

2.2 All areas and structures within the safety zone are closed to the public.

(D) Specific to configurations. The wind action plan must include all applicable thresholds and procedures for each configuration for which crane or derrick notice application approval is sought. Where multiple configurations are included, the wind action plan must clearly identify the applicable thresholds and procedures for each configuration.

(E) Able to be fully implemented based upon site conditions. The wind action plan must account for all site conditions and be able to be fully implemented based upon site conditions. Where the manufacturer's specifications can be fully implemented at the site, the plan must incorporate this information. Where site conditions prevent full implementation of the manufacturer's specifications (e.g. site conditions make it impossible to point the boom into the wind), the engineer must contact the manufacturer and develop alternate procedures and/or thresholds, as appropriate, and incorporate them into the wind action plan.

(F) Emergency action plan. Where load reductions are utilized in accordance with Section 1618 of the Building Code, the emergency action plan required by Section 1618.3 of the Building Code must also be included in the wind action plan.

(t) Wind and weather. Cranes and derricks are subject to the following wind and weather restrictions.

(1) Wind action plan and manufacturer procedures. The hoisting machine operator must follow the approved wind action plan, where a wind action plan is required, and the applicable manufacturer procedures related securing the crane or derrick against wind and weather.

(2) Hoisting machine operator to review wind action plan and manufacturer procedures. The hoisting machine operator must review the approved wind action plan, where a wind action plan is required, and the applicable manufacturer procedures related to securing the crane or derrick against wind and weather prior to the operator's initial commencement of work with the crane or derrick at the job, each time the crane or derrick enters into a new phase, and each time the wind action plan is amended. It is the responsibility of the equipment user to verify that the hoisting machine operator has reviewed the approved wind action plan and the applicable manufacturer procedures, as required above, and to notify the hoisting machine operator each time the wind action plan is amended.

(3) Start of work. No hoisting machine operator may start a pick when:

> *(i) The wind speed exceeds the threshold specified in the approved wind action plan, or where such a plan is not required, 30 mph (3-second gust) or the threshold specified by the manufacturer, whichever is lower; or*
>
> *(ii) As otherwise warranted by weather conditions or weather forecasts.*

(4) In-service. The following must be observed at all times the crane or derrick is in service.

> *(i) During picks, it is the responsibility of the hoisting machine operator to safely bring the pick to a stop and safely land the load:*
>
> > *(A) When the wind speed exceeds the threshold specified in the approved wind action plan, or where such a plan is not required, 30 mph (3-second gust) or the threshold specified by the manufacturer, whichever is lower; or*
> >
> > *(B) As otherwise warranted by weather conditions or weather forecasts.*
>
> *(ii) At the end of the shift, or as weather conditions otherwise warrant, the hoisting machine operator must properly park or secure the crane or derrick for occurring or forecasted winds in accordance with the approved wind action plan, or where such plan is not required, in accordance with the manufacturer's specifications.*

(5) Assembly/disassembly operations. Assembly/disassembly operations may not begin if the wind speed exceeds the thresholds specified in the approved assembly/disassembly plan, or if winds are forecast to exceed the thresholds specified in the approved assembly/disassembly plan before the crane or derrick that is to assembled/disassembled, and all assist cranes or derricks involved in such operation, can be parked or secured. The provisions of paragraphs (3) and (4) of this subdivision above also apply to all hoisting machine operators engaged in the assembly/disassembly operation; except that the term "approved wind action plan" means "approved assembly/disassembly plan."

Exception: Where an assembly/disassembly plan is not required, the thresholds established by the manufacturer will govern.

(7) Measuring wind. For the purposes of this subdivision, wind speed must be determined in accordance with one of the options listed in subparagraphs (i) through (iii) of this paragraph.

Exceptions:

1. For a crane, other than a pile driver or clamshell, that requires a certificate of on-site inspection and that utilizes a lattice boom, lattice jib, or lattice mast at the site, only the option listed in subparagraph (i) of this paragraph may be utilized; except, however, should the anemometer on the crane malfunction, the option listed in subparagraph (ii) of this paragraph may be utilized.

2. For a derrick that requires a certificate of on-site inspection, only the options listed in subparagraphs (i) or (ii) of this paragraph may be utilized.

(i) Anemometer on the crane or derrick. An anemometer provided by the crane or derrick manufacturer, or an entity acceptable to the manufacturer, and installed at the top of the boom or other location specified by the manufacturer. The anemometer must measure a 3-second gust wind. A real-time display of the anemometer must be available to the hoisting machine operator at the operator's station.

(ii) Anemometer at the site. An anemometer located at a high point of the site approximate to the height and location of the crane or derrick boom/jib, freely exposed to the wind, and calibrated in accordance with ASTM D5096-02. The anemometer must measure a 3-second gust wind. A real time display of the anemometer must be available to the hoisting machine operator at the operator's station, or a person designated by the hoisting machine operator must be provided to monitor the display and alert the hoisting machine operator when measurements near, meet, or exceed the thresholds specified in the approved wind action plan.

(iii) Nearest weather station. The most recent gust wind speed reported at the nearest National Weather Service weather station. The equipment user must establish a system to ensure the hoisting machine operator is notified when reported wind gusts near, meet, or exceed the thresholds specified in the approved wind action plan. An acceptable system may include engaging a metrological service to provide a text or similar alert to a person designated by the equipment user when wind thresholds are neared, met, or exceeded, and have such designated person notify the hoisting machine operator.

(iv) Anemometer as operational aid. The anemometer required by subparagraphs (i) and (ii) of this paragraph is to be considered an operational aid and must be checked prior to each shift as part of the frequent inspection required by paragraph (1) of subdivision (k) of this section.

A.2 Chicago

Rule No. 2. The following requirements apply to the operation of any and all cranes when they are required to be operated by a licensed crane operator under Chapter 4-388 of the Code:

- *Replacement parts for either the hoisting or operational stabilization structural components of a crane shall be supplied from the crane manufacturer, and the installation of any replacement part shall be performed per the manufacturer's specifications.*
- *The hoisting or operational stabilization structural components of a crane shall not be modified without the prior written consent of the manufacturer.*
- *If the bolts of the hoisting or operational stabilization structural connection components of a crane are cracked, damaged or otherwise compromised, then all of the bolts in that structural connection shall be replaced.*
- *Comply with any other applicable provisions of Title 29 Section 1926.CC of the Code of Federal Regulations (29 CFR 1926.CC) (Cranes and Derricks)*

Rule No. 4. The following requirements apply to the operation of any and all tower cranes when they are required to be operated by a licensed crane operator under Chapter 4-288 of the Code. A tower crane or derrick shall:

- *Have a Construction Equipment Inspector from the department present whenever a tower crane or derrick is erected, tied-in, jumped or otherwise reconfigured.*
- *Have on-site and available for inspection by the department, a copy of the crane supplier's written certification and check-list with all crane specifications signed by the crane supplier.*
- *Be erected, tied-in, jumped, reconfigured or dismantled in accordance with the manufacturer's recommendations and only under the direct supervision of a qualified and competent person.*
- *Comply with any other applicable provisions of Title 29 Section 1926.CC of the Code of Federal Regulations (29 CFR 1926.CC) (Cranes and Derricks)*
- *Have a functioning anemometer with the read-out positioned for operator accessibility.*

Rule No. 5. The following requirements apply to the operation of any and all tower cranes when they are required to be operated by a licensed crane operator under Chapter 4-288 of the Code. A tower crane not in operation shall:

- *Be able to weathervane a full 360 degrees without obstruction or in the event that the crane is unable to weathervane fully, it shall be tied-down and secured according to the manufacturer's specifications or shall be staffed full-time by a licensed crane operator.*
- *If not operational for a period of 30 or more days, be inspected by the supplier and have the slewing ring greased in accordance with the manufacturer's specifications.*

Rule No.6

- *Shall not be jumped if the wind velocity exceeds 20 mph at the tower crane superstructure.*

A.3. California

Article 96. Tower Cranes (Sections 4965 - 4969)

4966. Erection, Dismantling, and Operation

(j) Addressing specific hazards. In addition to the requirements in Section 5010.1(h)(1) through (9), the A/D director shall confirm the following:

> *(3) Wind speed. Operations shall not be conducted when wind speed exceeds the speed tolerance recommended by the manufacturer or, where the manufacturer does not specify this information, the speed tolerance shall be determined by a qualified person.*

4968.2. Operational Aids

(b) The devices listed in this section ("operational aids") are required on all tower cranes covered by Group 13, unless otherwise specified.

(c) Operations shall not begin unless the operational aids are in proper working order. If a listed operational aid stops working properly during operations, the operator shall safely stop operations until the device is repaired, or the device is again working properly.

(d) Operational aids and alternative measures. Operational aids listed in this section that are not working properly shall be repaired no later than 7 calendar days after the deficiency occurs subject to the provisions of subsection (c).

> *(2) Wind speed indicator. A device shall be provided to display the wind speed and shall be mounted above the upper rotating structure on tower cranes. On self-erecting cranes, it shall be mounted at or above the jib level.*

Temporary alternative measures: Use of wind speed information from a properly functioning indicating device on another tower crane on the same site, or a qualified person estimates the wind speed.

Article 98. Operating Rules

5004. Crane or Derrick Suspended Personnel Platforms

(k) Work Practices

> *(5) Environmental conditions.*
>
> > *(A) Wind. When wind speed (sustained or gusts) exceeds 20 mph at the personnel platform, a competent person shall determine if, in light of the wind conditions, it is safe to lift personnel. If it is not safe, the lifting operation shall not begin (or, if already in progress, shall be terminated).*

5006.1. Mobile cranes and Tower cranes – Operator qualifications and certificate

5008.1. Operation

(a) The employer shall comply with all manufacturer procedures applicable to the operational functions of equipment, including its use with attachments.

(b) Accessibility of procedures.

> *(1) The procedures applicable to the operation of the equipment, including rated capacities (load charts), recommended operating speeds, special hazard warnings, instructions, and operator's manual, shall be readily available in the cab at all times for use by the operator.*

(d) Unavailable operation procedures.

> *(1) Where the manufacturer procedures are unavailable, the employer shall develop and ensure compliance with all procedures necessary for the safe operation of the equipment and attachments.*
>
> *(2) Procedures for the operational controls shall be developed by a certified agent.*
>
> *(3) Procedures related to the capacity of the equipment shall be developed and signed by a certified agent.*

(f) Storm warning. When a local storm warning has been issued, the competent person shall determine whether it is necessary to implement manufacturer recommendations for securing the equipment.

(h) Safety devices and operational aids shall not be used as a substitute for the exercise of professional judgment by the operator.

(i) The competent person shall adjust the equipment and/or operations to address the effect of wind, ice, and snow on equipment stability and rated capacity.

5010.1 Assembly/Disassembly – General requirements

(h) Addressing specific hazards. The A/D director supervising the assembly/disassembly operation shall address the hazards associated with the operation, which include:

> *(12) Wind speed and weather. The effect of wind speed and weather on the equipment.*

A.4. Washington

General requirements.

(3) Cranes and equipment must meet the requirements for design, construction, installation, and testing as prescribed in the applicable ASME standard at the time the crane or equipment was manufactured.

> *(a) Where manufacturer's specifications are not available, the limitations assigned to the crane and equipment must be based on the determinations of a RPE competent in this field, and such determinations must be appropriately documented and recorded.*

(b) Attachments used with cranes and equipment must not exceed the capacity, rating, or scope recommended by the manufacturer or RPE.

(4) Unavailable operation procedures.

(a) Where the manufacturer procedures are unavailable, the employer must develop and ensure compliance with all procedures necessary for the safe operation of the crane/equipment and attachments.

(b) Procedures for the operational controls must be developed by a qualified person.

(c) Procedures related to the capacity of the crane/equipment must be developed and signed by an RPE familiar with this equipment.

(8) All manufacturer procedures applicable to the operational functions of cranes/equipment, including its use with attachments must be complied with.

(15) A competent person must be designated, who must inspect the cranes and components daily when used, and periodically during use to make sure it is in safe operating condition. Any deficiencies that effect the safe operation of the crane must be repaired, or defective parts replaced, before continued use.

(36) The site supervisor must:

(a) Ensure that ground preparations necessary to meet the requirements in subsection of this section are provided.

(b) Inform the user of the crane/equipment and the operator of the location of hazards beneath the crane/equipment set-up area (such as voids, tanks, utilities).

(57) Modifications or additions which affect the capacity or safe operation of the crane/equipment are prohibited, except where the requirements of (a) or (b) of this subsection are met. For recertification requirements, see WAC 296-155-53214 (1)(c).

(a) Manufacturer review and approval.

(i) The manufacturer approves the modifications/additions in writing.

(ii) The load charts, procedures, instruction manuals and instruction plates/tags/decals are modified as necessary to accord with the modification/addition.

(iii) The original safety factor of the crane/equipment is not reduced.

(b) Where manufacturer is unavailable or has refused to review a request. The manufacturer is provided a detailed description of the proposed modification/addition, and is asked to approve the modification/addition, but it declines to review the technical merits of the proposal or fails, within 30 days, to acknowledge the request or initiate the review, and all of the following are met:

(i) A RPE who is a qualified person with respect to the crane/equipment involved:

(A) Approves the modification/addition and specifies the crane/equipment configurations to which that approval applies; and

(B) Modifies load charts, procedures, instruction manuals and instruction plates/tags/decals as necessary to accord with the modification/addition.

(ii) The original safety factor of the crane/equipment is not reduced.

(c) Manufacturer does not complete the review within 120 days of the request. The manufacturer is provided a detailed description of the proposed modification/addition, is asked to approve the modification/addition, agrees to review the technical merits of the proposal, but fails to complete the review of the proposal within 120 days of the date it was provided the detailed description of the proposed modification/addition, and the requirements of subsection (57) (b)(i) and (ii) of this section are met.

(d) Multiple manufacturers of equipment designed for use on marine job sites. The equipment is designed for marine job sites, contains major structural components from more than one manufacturer, and the requirements of subsection (57) (b)(i) and (ii) of this section are met.

(58) Modifications or additions which affect the capacity or safe operation of the crane must not be made without the manufacturers' written approval. If components of more than one crane manufacturer are being combined, written approval from all manufacturers must be obtained prior to use. If the manufacturer(s) is/are not available, RPSE written approval must be obtained. If such modifications or changes are made, the capacity, operation, and maintenance instruction plates, tags, or decals, must be changed accordingly. In no case must the original safety factor of the crane be reduced.

(65) Storm warning. When a local storm warning has been issued, the site supervisor and lift director must determine whether it is necessary to implement manufacturer recommendations for securing the crane/equipment.

(66) Whenever there is a concern as to safety, all assigned personnel have the authority to stop crane operations until a qualified person has determined that safety has been assured.

(74) A preventative maintenance program must be established based on the recommendation of the crane/equipment manufacturer. If manufacturers' recommendations are not available, then those of a qualified person must be followed. Dated records must be kept available.

(78) No crane/equipment shall begin a hoisting operation when the wind speed exceeds the maximum wind speed limitation.

(79) If unpredicted wind speed occurs while using the crane/equipment, and that wind speed exceeds the crane/equipment's maximum wind speed limitations, the operator must safely stop operations. The crane/equipment must be taken out of service, and not resume operations, until the wind is predicted to stay below the maximum wind speed limitations.

A.5. Miami-Dade

Chapter 8E - CRANES AND HOISTING EQUIPMENT

Sec. 8E-4. - Tower crane manufacture, installation and use.

The following standards shall be applicable to tower cranes proposed to be installed and used within the incorporated and unincorporated areas of Miami-Dade County:

(a) The equipment manufacturers' (O.E.M.) specifications;

(b) The mandatory rules contained within the applicable ASME B30 standard of the American Society of Mechanical Engineers made applicable to construction Tower Cranes (ASME B30.3);

(c) The most current standards of the U.S. Department of Labor, Occupational Safety and Health Administration ("OSHA") applicable to cranes including 29 CFR 1926.550;

(d) The wind load standards contained within SEI/ASCE-7 for High Velocity Hurricane Zones as applied to the crane base foundation, the tie-ins to the building, the freestanding height and the height above the top tie-in. In applying the provisions of SEI/ASCE-7 for temporary installations, the design velocity reduction factors contained in SEI/ASCE 37-02 may be considered in factoring the wind speed at the discretion of the Building Official. The decision shall be made by the Building Official on a site-by-site basis. Factors to be considered include, but are not limited to, proximity to other structures, density, swing radius of the crane, hoist location and other safety requirements.

Sec. 8E-5. - Standards for mobile crane manufacture, installation and use.

The following standards shall be applicable to mobile cranes proposed to be installed and used within the incorporated and unincorporated areas of Miami-Dade County:

(a) The equipment manufacturers' (O.E.M.) specifications;

(b) The mandatory rules contained within the applicable standard of the American Society of Mechanical Engineers made applicable to construction Mobile Cranes (ASME B30.5);

(c) The most current standards of the U.S. Department of Labor, Occupational Safety and Health Administration ("OSHA") applicable to cranes including 29 CFR 1926.550 and 29 CFR 1910.80.

Sec. 8E-6. - Standards for personnel/material hoist manufacture, installation and use.

The following standards shall be applicable to personnel/material hoists proposed to be installed and used within the incorporated and unincorporated areas of Miami-Dade County:

(a) The equipment manufacturers' (O.E.M.) specifications;

(b) The mandatory rules contained within the applicable ANSI standard (ANSI A10.4). Bridging devices may be used provided they meet manufacturers' specifications;

(c) The most current standards of the U.S. Department of Labor, Occupational Safety and Health Administration ("OSHA") applicable to cranes including 29 CFR 1926.552;

(d) The wind load standards contained within SEI/ASCE-7 for High Velocity Hurricane Zones as applied to the hoist tie-ins and the floor shoe connections. In applying the provisions of SEI/ASCE-7 for temporary installations, the design velocity reduction factors contained in SEI/ASCE 37-02 may be considered in factoring the wind speed at the discretion of the Building Official. The decision shall be made by the Building Official on a site-by-site basis. Factors to be considered include, but are not limited to, proximity to other structures, density, hoist location and other safety requirements.

Sec. 8E-7. - Crane siting.

Together with the permit documents, the permit applicant shall submit to the Building Official all required applications and/or approvals related to the operation of the crane on site, including, but not limited to, any required by the Federal Aviation Administration pursuant to 14 CFR Part 77 and FAA Advisory Circular AC70/7460-2K and the Miami-Dade County Transit Adjacent Construction Manual.

Sec. 8E-8. - Building permits and inspections.

(a) Permits. In addition to the requirements of the Florida Building Code, and of Section 8-10 of this Code, the following shall apply to any construction involving the placement or erection of Hoisting Equipment regulated by this chapter. The structural building plan for any threshold building shall contain sufficient information for the Building Official to determine whether the Hoisting Equipment to be used in the construction complies with the standards set forth in this section. In the event that the complete fabrication, including the connection to the foundation, base structural support and attachment to the building structure, requires the preparation and approval of shop drawings, the Building Official may issue the building permit subject to permit holds. The permit holds shall be released upon completion and approval of all required information.

(b) Inspections. In the event that any construction involves the use of Hoisting Equipment regulated by this chapter, the Building Official shall require the use of a Special Hoisting Equipment Inspector. The Special Crane Inspector shall perform the inspections set forth in the approved inspection plan and report to the Building Official the results of the inspections in forms designed for that purpose. The Building Official shall be authorized to suspend or revoke the building permit relating to any construction for gross negligence, gross incompetence, failures to correct any identified failures to comply with the applicable standards, or willful or repeated disregard of any occupational safety standard or order involving the crane. Decisions of the Building Official may be appealed to the Board of Rules and Appeals in the manner set forth in this Code.

(c) Schedule. The inspection plan shall provide for crane inspection which shall occur at a minimum as follows:

Tower Cranes

** After initial erection of crane*

** After each time top-climbing is completed on the crane and/or after each period of 6 months the crane has been erected on a construction project*

** After the passage of a hurricane or catastrophic wind event in the area of installation of the crane*

** After a major incident/accident involving the tower crane*

Mobile Cranes

** Annual inspection with a rated load test within the configuration of the crane and the manufacturer's recommended load chart*

** After a major incident/accident involving the mobile crane*

** After the passage of a hurricane or catastrophic wind event in the area of an assembled and erected mobile crane*

Personnel/Material Hoists

** After initial erection of personnel/material hoist, including a full rated load drop test*

** Every 90 days, including a full load drop test*

** After a hurricane*

** After a major incident/accident involving the personnel/material hoist*

(d) Hoisting equipment inspection companies. To perform inspections of Hoisting Equipment, companies and/or individuals shall comply at a minimum with the following requirements:

** Incorporated or registered in the State of Florida conducting third party inspections on cranes and/or personnel/material hoists.*

** Cannot be wholly or partly owned by an Equipment Owner or Equipment Manufacturer in the crane and hoisting industry.*

** Cannot be receiving financial support from an equipment Owner or Equipment Manufacturer in the crane and hoisting industry.*

** Must carry a minimal of $1,000,000 professional liability insurance.*

** Must carry a minimal of $1,000,000 general liability insurance.*

** Must have in its full-time employment an individual who is qualified to perform inspections as set forth in subpart (e) below.*

(e) Qualification of individuals performing crane inspections. To perform the requisite crane inspections, individuals must possess the following qualifications:

** Minimal five (5) years of work experience in the crane industry specifically erecting, operating, maintaining, inspecting and supervising equipment. Two (2) of the five (5) years of documented work experience must be in the capacity of conducting inspections of cranes.*

** Must provide proof, reasonably satisfactory to the Certifying Entity, of completion of at least one (1) factory-sponsored or approved technical course to inspect the subject equipment.*

** Cannot be an employee of an Equipment Owner or Equipment Manufacturer in the crane and hoisting industry.*

(f) Qualifications of personnel/material hoist employee inspector. To perform the requisite inspections, an individual must possess the following qualifications:

** Minimal five (5) years of work experience in the personnel/material hoisting industry, specifically erecting, operating, maintaining, inspecting and supervising of equipment. Two (2) years of the five (5) years of documented work experience must be in the capacity of conducting inspections of personnel/material hoists and following all applicable codes and standards.*

** Must provide proof, reasonably satisfactory to the Certifying Entity, of completion of at least one (1) factory-sponsored or approved technical course to inspect the subject equipment.*

Sec. 8E-9. - Tower crane and mobile crane operator qualifications and certifications.

(a) Tower cranes and mobile cranes shall only be operated by individuals certified in accordance with this Section. Certificates shall be issued by the Accredited Certifying Entity and shall be valid for five years. Certificates shall be issued to operators who:

> *a. Operational characteristics and controls, including characteristic and performance questions appropriate to the crane type for which qualification is sought;*
>
> *b. Emergency control skills, such as a response to fire, power line contact, loss of stability, or control malfunction;*
>
> *c. A demonstration of basic arithmetic skills necessary for crane operation and the ability to read and comprehend the crane manufacturer's operation and maintenance instruction materials, including load capacity information (load charts) for the crane for which certification is sought;*
>
> *d. Knowledge of the requirements of this chapter, chapters 5-0 through 5-3 of The American Society of Mechanical Engineers (ASME) B30.5-2000 and B30.5a-2002 Addenda to the standard for mobile and locomotive cranes or chapters 4-0 through 4-3 of the ASME B30.4-1996 standard for portal, tower, and pedestal cranes or Chapter 3-3 of the ASME B30.3-1993 standard for Construction Tower Cranes, depending on the type of crane(s) the operator intends to operate.*
>
> *e. Pass a "hands-on" examination to demonstrate proficiency in operating the specific type of crane, which at a minimum shall include pre-start and post-start inspection, maneuvering skills, shutdown, and securing procedures.*

(b) Recertification. Crane operators shall recertify every five (5) years and shall be required to meet all of the qualifications set forth in subsection (a). Operators with at least one thousand (1,000) hours of documented experience operating the specific type of crane for which recertification is sought as covered by this section during the immediately preceding certification period and who meet the physical examination, substance abuse, and written examination requirements set forth in subsections (a)(1), (a)(2) and (a)(3) of this section shall not be required to take the "hands-on" examination specified in subsection (a)(4) to recertify.

(c) Trainees may be authorized to operate mobile or tower cranes provided they are under the direct supervision of an operator possessing a valid certificate of competency for the type of crane operated by the trainee. The term "direct supervision" means the supervising operator is in the immediate area of the trainee and within visual sighting distance and able to effectively communicate with the trainee. When performing direct supervision, the supervising operator shall have no other duties other than to observe the operation of the crane by the trainee.

(d) Existing Operators. For the period commencing on the effective date and ending one year thereafter, the certification requirements of this Section shall be deemed satisfied by any individual who satisfies the waiver requirements of this subsection. To be certified by waiver an individual must: (a) make written application for waiver from the Accredited Certifying Entity; (b) demonstrate to the Accredited Certifying Entity three years' experience in the operation of tower cranes and mobile cranes and (c) pass a hands-on examination to demonstrate proficiency in operating the specific type of crane. Only active performance of the tasks and skills required to operate the equipment for which the applicant is seeking certification throughout the applicant's career shall be counted toward the experience requirements. A certification obtained by waiver shall be valid only for five years and shall be subject to recertification in the same manner provided for in subsection (b) above.

Sec. 8E-11. - Hurricane preparedness.

General Hoisting Equipment shall abide by the following hurricane precautions:

(1) Hoisting Equipment shall abide by all manufacturers' recommendations relating to hurricane preparedness including any relating to the placement and removal of advertisement banners, the use and removal of rigging.

(2) Tower crane turntable must be lubricated prior to the event.

(3) Mobile cranes with fixed booms must be laid down whenever feasible.

(4) Hydraulic cranes must have booms retracted and stored.

(5) Any counterweighted hoist must have the counterweight locked below the top tie-in.

(6) Tower crane must be set in the weathervane position.

(7) All rigging must be removed from the hoist block.

(8) All power at base of tower shall be disconnected by a general contractor.

(9) A hurricane preparedness plan which conforms with the requirements of this section shall be available at the site for inspection.

APPENDIX B – Summary and Excerpts of Relevant ASME B30.3 Content

ASME B30.3 specifically applies to the operation, inspection and roles and responsibilities of tower cranes. This standard is split into four chapters. Chapter 3-0 being Scope, Definitions, References and Personnel Competence, 3-1 is Erection, Climbing and Dismantling, Characteristics and Construction, 3-2 is Inspection, Testing, and Maintenance and 3-3 is Operation. Chapter 3-1 through 3-3 will be discussed, with the definitions in Chapter 3-0 being used as needed [38]. Much of the information given below is taken directly from ASME B30.3 to give accurate information as to what is provided in these guidelines.

B.1 Chapter 3-1: Erection, Climbing and Dismantling, Characteristics and Construction

Section 3-1.1: Design Requirements for the Load Bearing Structure

Where Stability Governs Lifting Procedure (Para. 3-1.1.2)

(b) Wind forces shall be determined using the maximum in-service wind velocity, as specified by the manufacturer or by a qualified person, and shall be applied in the direction least favorable to stability.

Where Structural Competence Governs Lifting Performance (Para. 3-1.1.3)

(a) For each stipulated operating radius, the manufacturer or a qualified person shall ascertain that the crane is capable of supporting the rated loads without stresses exceeding predetermined acceptable values. Dynamic effects associated with hoisting and slewing shall be considered. Wind shall be taken in the least favorable direction and at the maximum in service velocity, as specified by the manufacturer or a qualified person.

Out-of-Service Stability Requirements for Rail-Mounted Cranes (Para. 3-1.1.4)

(a) Stability. The manufacturer or a qualified person shall demonstrate by calculation that in each permitted configuration, traveling cranes shall not become unstable when exposed to out-of-service wind forces.

(b) Sliding. Cranes shall be evaluated for resistance to sliding along rails by the manufacturer or a qualified person with wind acting in the least favorable direction. Calculations shall demonstrate crane traveling resistance sufficient to forestall sliding. Rail clamps or other wind anchorage mechanisms may be provided to forestall sliding.

Design Wind Velocity (Para. 3-1.1.5)

(a) Temporary Construction Cranes (Less than 5 yr)

> *(1) The design out-of-service wind velocity shall be appropriate to the installation site as given in ASCE/SEI 7. Reductions for the short-term duration of temporary installation can be taken into account per ASCE/SEI 37.*
>
> *(2) The manufacturer shall furnish recommendations on permitted crane configurations at the various wind velocity levels specified in ASCE/SEI 7 for the geographical region.*

(3) Out-of-service requirements may be satisfied using stabilizers or ballast when necessary, but rail clamps shall not be used for the purpose on rail traveling cranes.

(b) Permanently Mounted Tower Cranes (Longer than 5 yr)

(1) The design out-of-service wind velocity shall be appropriate to the installation site as given in ASCE/SEI 7.

(2) The manufacturer shall furnish recommendations on permitted crane configurations at the various wind velocity levels specified in ASCE/SEI 7 for the geographical region.

(3) Out-of-service stability requirements may be satisfied by using stabilizers or ballast when necessary, but rail clamps shall not be used for this purpose on rail traveling cranes.

Section 3-1:2 Site Planning

(b) Consideration shall be given to the geographical location at which the crane is to be erected with regards to

(1) wind in accordance with para. 3-1.1.5

Section 3-1.4: General Erection and Dismantling Requirements

(l). Prior to and during erection and dismantling operations, consideration shall be given to conditions that may adversely affect the operation. These conditions include but are not limited to the following:

(2) wind velocity and gusting winds

(n) Unless provisions to secure the crane's swing are provided ad approved by the manufacturer or a qualified person, the crane shall be configured to weathervane when placed out-of-service. The freely rotating crane shall be able to swing through a complete 360-deg arc with a minimum clearance from obstructions of 6ft, 6 in. (2 m)

Section 3-1:5: Freestanding Cranes

(k) Cranes shall be erected to a freestanding height no greater than that specified by the crane manufacturer or a qualified person. A reduction in freestanding height should be considered when erected in a seasonal high wind zones as specified by ASCE/SEI 7. The manufacturer or qualified person shall determine acceptable heights that conform to codified wind loads as prescribed in para. 3-1.1.5.

Section 3-1.6: Climbing Cranes

(d) At the time of climbing, the maximum wind velocity above the highest tower section shall not exceed 20 mph (9 m/s), or as recommended by the manufacturer or a qualified person. The effects of wind gusts on climbing operations shall be considered.

(e) Before climbing operations commence, the weather forecast shall be considered by a designated person and a determination made as to the advisability of starting operations.

(f) Where specified measures are needed to protect the crane from extreme adverse weather, such as hurricanes, the manufacturer or a qualified person shall prepare detailed written instructions as part of the erection plan. This plan shall be on the jobsite and shall address the time and personnel requirements needed to carry out specified protection measures.

Top Climbing Cranes (Para. 3-1.6.1)

(a) A climbing and tie-in schedule shall be prepared prior to the crane's installation and shall be in accordance with the crane manufacturers or a qualified person's instructions. This schedule shall indicate

(7) the in-service and out-of-service wind conditions.

Section 3-1.8: Documentation

Informational Literature (Para. 3-1.8.1)

Each crane shall be provided with information literature in accordance with Section 3-1.8 including the following:

(a) installation preparation instructions, which shall provide

(2) maximum wind velocity for which traveling cranes possess adequate resistance to sliding in each permitted configuration and precautions that must be taken to secure cranes installed in geographical areas of higher wind velocity.

Section 3-1.8: General Requirements

Wind Velocity Device (Para. 3-1.23.7)

A wind velocity measuring device shall be mounted at or near the top of the crane. A velocity readout shall be provided at the operator's station in the cab, and a visible or audible alarm shall be triggered in the cab and at remote control stations when a present wind velocity has been exceeded.

B.2 Chapter 3-2: Inspection, Testing and Maintenance

Section 3-2.1: Inspection

This section states that if any of the following information differs from the manufacturer's criteria, the manufacturers guidelines should take precedence. All inspections state must be performed by a qualified person, and deficiencies should be evaluated by the manufacturer or qualified person to analyze hazards.

Inspection Classification (Para. 3-2.1.2):

(a). Initial Inspection – Tower cranes should undergo a periodic or major inspection (defined in para. 3-2.1.4. and 3-2.1.5) prior to being used.

(b) Regular Inspection – Inspection occurrences for in service cranes are divided into three classifications, based on the time intervals when the inspections occur and the level of inspection. Time intervals are dependent on the service required and the degree of wear the crane experiences on the jobsite. The three classifications of inspection are frequent, periodic and major inspections. The types are inspection are defined as:

(1) Frequent Inspections should be conducted prior to each day, or at intervals recommended by the manufacturer or by a qualified person

(2) Periodic inspections shall be conducted annually, or at intervals recommended by the manufacturer or by a qualified person

(3) Major inspections should be conducted at 60-month intervals, or as recommended by the manufacturer or qualified person

Frequent Inspections (Para. 3-2.1.3)

Para. 3-2.1.3 gives a detailed list of what should be inspected during a frequent inspection. This lists contains all elements of the crane and its control systems, indicating devices, crane motion operating systems, documentation, limiting system and others.

Periodic Inspection (Para. 3-2.1.4)

Para. 3-2.1.4 lists requirements of a periodic inspection. This includes inspecting for deformed, cracked or corroded members in the crane structure, loose, worn or cracked parts lie bolts, pins, shafts or gears, load, wind, radius and other indicators for inaccuracies outside the tolerances recommended by manufacturer, and others. Cranes that have been idle for a month or more should undergo a periodic inspection before going back into service. A crane with over five years of service should undergo periodic inspections at more frequent intervals unless the manufacturer recommends different intervals.

Major Inspection (Para. 3-2.1.5)

The requirements for a major inspection are given in paragraph 3-2.1.5. All items listed in frequent and periodic inspections should be inspected. Any safety upgrades recommended by the manufacturer should be verified as completed, the most recent published documentation by the manufacturer should be verified, nondestructive testing of the tower and slewing ring's connection material should be considered or replaced according to the manufacturer, disassemble and inspect drive systems, motors, sheaves and gear boxes, test all electrical components, inspect and clean the slewing ring according to manufacturer requirements and other requirements are given. For permanently mounted tower cranes with 10 or more years of service, this inspection should take place every year.

Section 3-2.2: Testing

When testing requirements differ in the manufacturer's guidelines, they should take precedence. Tests should be performed by a designated person.

Operational Tests (Para. 3-2.2.1)

After each erection, climbing, or reconfiguration, operational tests should be performed before putting the crane back into service.

(a) If unsatisfactory performance is observed during operational testing, further testing should be paused until a qualified person has found the crane's condition acceptable.

(d) If any part of the support structure becomes displaced or distressed during testing, all crane operations should stop until an evaluation is made by a qualified person.

Testing After Installation or Reconfiguration (Para. 3-2.2.1.1)

This paragraph lists specific parts and functions for a crane that must be tested before operation begins. This includes mechanical motion, brakes, rated capacity limiting devices and others.

Testing Following a Climb (Para. 3-2.2.1.2)

This paragraph lists parts of a crane that must be tested after it has been climbed. This includes mechanical motion, brakes and others.

Section 3-2.3: Maintenance

Parts used in the repair or maintenance of the crane should be acquired from the manufacturer.

Preventative Maintenance (para. 3-2.3.1)

A preventative maintenance program should be obtained from the manufacturer.

Maintenance, Adjustments, and Repair Procedures (para. 3-2.3.2)

Maintenance or repair requirements found during inspection should be completed before operation can resume. This section lists several requirements for a crane's position and status before repairs can be made.

B.3 Chapter 3-3: Operation

Section 3-3.1: Qualification for Conduct of Operators and Operating Practices

This section first lays out the qualifications and conduct of crane operators.

Operators (Para. 3-3.1.1)

(a) Cranes should be operated by the following qualified personnel

(1) designated persons

(2) trainees who are under the supervision of a designated person

(3) maintenance and test personnel

(4) inspectors

(b) No one, other than those specified to operate a crane, should enter a crane cab except supervisors whose responsibilities require them to.

Qualification for Operators (Para. 3-3.1.2)

Operators should meet the following requirements for the specific type of crane they are operating.

(a) Operator or trainee should meet the following physical requirements

(1) vision of at least 20/30 Snellen in one eye and 20/50 in the other, with or without corrective lenses

(2) ability to distinguish colors, regardless of position, if color differentiation is required

(3) adequate hearing to meet operational demands, with or without hearing aid.

(4) sufficient strength, endurance, agility, coordination and speed of reaction to meet the operational demands.

(5) depth perception, field of vision, reaction time, manual dexterity, coordination, and no tendencies to dizziness or similar undesirable characteristics to meet operational demands

(6) a negative result for substance abuse test. The level of testing will be determined by the standard practice for the industry where the crane is employed and this test should be confirmed in a recognized lab.

(7) no evidence of having physical defects or emotional instability that could render a hazard to the operator or others, or that in the opinion of the medical authority could interfere with the operator's performance. If evidence of this nature is found, it may be sufficient cause for disqualification.

(8) no evidence of being subject to seizures or loss of physical control that cannot be controlled with medication; such evidence is sufficient reason for disqualification. Specialized medical tests may be required to determine these conditions.

(b) Operator requirements include, but not be limited to:

(1) evidence of successfully passing the physical exam stated.

(2) satisfactory completion of a written examination covering operational characteristics, controls and emergency control skills, such as response to fire, power line contact or control malfunction, as well as characteristic and performance questions appropriate to the crane types. Type of crane means a crane with any combination of the applicable characteristics from each of the four group types in para. 3-0.2.1.

(3) demonstrated ability to read, write and comprehend the crane manufacturers documentation.

(4) satisfactory completion of a combination written and verbal test on load/capacity chart usage skills that covers a selection of the configurations (the crane may be equipped to handle) for the crane type for which the qualifications is being sought.

(5) satisfactory completion of an operation test demonstrating proficiency in performing lifting, lowering, trolleying or luffing, swinging, and travel (when so equipped) functions at various radii as well as taking the crane out of service. Testing shall also include proficiency in prestart and post-start inspection, and securing procedures by appropriate written, oral or practical methods.

(6) demonstrated understanding of the applicable Sections of the B30.3 Standard and applicable regulatory requirements.

(c) Operators who have successfully qualified for a specific crane type shall be required to be requalified every 5 yr, or sooner if supervisions deems it necessary

(d) Trainee qualification requirements shall include, but not limited to, the requirements of (b)(1) through (b)(4) above.

(e) Trainee qualification, operator qualification, and operator requalification shall be performed by a qualified person

(f) Operator physical examinations shall be required every 3 yr as in defined in (a) above, or more frequently if site supervision deems it necessary.

Conduct of Operators (Para. 3-3.1.3)

This paragraph gives an extensive list of proper conduct of operators. The list includes properly testing equipment at the start of a new shift, not diverting attention while operating a crane, properly supervising other crane operators under their direct control, not operating the crane when mentally or physically unfit.

Point (j) states *cranes shall not be operated when wind speeds exceed the maximum velocity recommended by the manufacturer.*

Crane Owner (Para. 3-3.1.4.1.1) – On some worksites, the crane owner and user may be the same person, therefore if the same person holds these roles, that person is responsible for all job duties listed. The owners' responsibilities include:

(e) providing field erection, dismantling, operation, maintenance, warning decals and placards, installed as prescribed by the crane manufacturer and regulatory bodies

(f) establishing an inspection, testing and maintenance program in accordance with Chapter 3-2 and informing the crane user of the requirements of this program

(g) using personnel that meet the requirements for a designated person for the purposes of maintenance, repair, transport, erection, climbing, and dismantling

(h) using personnel that meet the requirements of a qualified or designated person where required within the provisions of this Volume.

Crane User (Para. 3-3.1.4.1.2) – The crane user's responsibilities include:

(a) Complying with the requirements of this Volume, manufacturer's requirements, and those regulations applicable at the work site

(b) using supervisors for crane activities that meet the requirements of a qualified person

(c) ensuring that the crane is in proper operating condition prior to initial use at the work site by

(2) verifying that a frequent inspection has been performed as defined in para. 3-2.1.3

(e) using operators that meet the requirements of paras. 3-3.1.1 and 3-3.1.2 and are qualified to perform the tasks that are required with the crane that they are assigned to operate

(g) using personnel that meet the requirements for inspections in Section 3-2.1

(h) using personnel that meet the requirements of a designated person for the purposes of maintenance, repair, transport erection, climbing and dismantling

(i) ensuring that all personnel involved with maintenance, repair, transport, erection, climbing, dismantling, and inspection are aware of their responsibilities, assigned duties and associated hazards.

(j) ensuring that the inspection, testing, and maintenance programs specified by the crane owner are followed

(k) ensuring wind restriction, when climbing, are in accordance with para. 3-1.6(d)

(l) ensuring the crane operator is present during climbing operations

(m) ensuring climbing operations are not commenced until all support provisions are required at the new support level are in place and as specified by a qualified person.

Site Supervisor (Para. 3-3.1.4.2.1) – On some worksites the site supervisor and lift director may be the same person. That person is responsible for the duties of both positions if they fill both positions. The duties of the Site Supervisor include:

(c) ensuring that a qualified person is designated as the lift director

(f) ensuring that work involving the erection, dismantling, climbing, and reconfiguring of a crane s supervised by a qualified person

(g) ensuring that work involving the erection, dismantling, climbing, and reconfiguring of a crane is supervised by a qualified person

(h) ensuring that crane operators meet the requirement of para. 3-3.1.2

(i) ensuring that conditions which may adversely affect crane operations are addressed. Such conditions include, but are not limited to, the following:

1. Poor support conditions
2. Wind velocity or gusting winds
3. Rain
4. Fog
5. Cold
6. Artificial lighting

(m) ensuring that crane maintenance is performed by a designate person."

Lift Director (Para. 3-3.1.4.2.2) – the Lift Director's responsibilities include:

(a) being present during lifting operations

(b) stopping crane operations if alerted to an unsafe condition affecting these operations

(e) ensuring that personnel involved with crane operations understand their responsibilities, assigned duties, and the associated hazards

(f) addressing safety concerns raised by the operator or other personnel, ad being responsible if they decide to overrule those concerns and direct crane operations o continue. In all cases, the manufacturer's criteria for safe operation and the requirements of this Volume shall be met.

Crane Operator (Para. 3-3.1.4.3.1) – the Crane Operator's responsibilities include:

(b) knowing what types of site conditions could adversely affect the operation of the crane and consulting with the lift director concerning the possible presence of these conditions.

(c) understanding and applying the information contained in the crane manufacturer's operating manual

(g) performing frequent inspection as specified in para. 3-2.1.3

(j) not operating the crane when physically or mentally unfit

(o) knowing and following the procedures specified by the manufacturer or approved by a qualified person, for erection, climbing and dismantling