Wind-Alarm Systems: Emerging Observing Technologies for Port Operations

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Abstract
With the rising competition in the operation of Ports and Marine facilities, new challenges are faced to create cost reductions and efficiencies, while operating in increasing challenging environments. Container offloading ports and logistic storage yards must optimise throughput while maintaining operational safety as paramount. Empty and full containers are stacked to maximum heights, for best utilisation of available land, and this creates new safety challenges when facing high wind and weather scenarios. In the context of the Blue Economy, the need to monitor high winds, and have an efficient process of informing labour in adverse events, is important in maintaining safety and productivity.

Cranes used for vessel offloading have automatic intervention to stop work. Container storage yards and logistic terminals do not, and therefore require several alarms systems and other means of communication to ensure internal and external staff can be trained to respond according to a safety plan. There are many methods of high wind detection, data retention, and alarm management available. It is my purpose to explain the various systems to choose from and how they can be designed to meet differing operation requirements.

Observator has been in the maritime instrumentation industry for 90 years in total and we have since built our business in providing terrestrial and maritime meteorological instrumentation and systems. The fact that our Synchrotac anemometer is the only one approved by the Australian Bureau of Meteorology and has recorded the highest recorded wind speed on the planet attests to our ability to accurately report wind events.

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1. Introduction

Wind-alarm systems are becoming ubiquitous to monitor wind speed and direction in a huge range of Port Operation applications. Establishing an efficient high-wind monitoring strategy requires to take into consideration a range of requirements intrinsically related to the context of the project operation. This paper will present a comprehensive methodology to design high-wind measurement systems for Port & Marine facilities.

2. Applications of wind measurement

Obtaining highly reliable and accurate wind data requires a great understanding of the project requirements. This dictates the best installation location, the types of instruments, their position and even their orientation.

Wind observations are used for a variety of applications including weather monitoring and forecasting, wind-load climatology, probability of wind damage and estimation of wind energy. Besides being used as part of a weather monitoring station there are many other situations where knowledge of the wind condition helps in decision-making such as safety of tall structures, studies on the effects of wind on manoeuvring of ships, helidecks and aircraft landing systems.

2.1 Wind monitoring system applied to the Maritime industry

Automatic instruments deployed in harsh environment must face the harshest conditions including high-wind, humidity and corrosion. New types of wind instruments and standards have been implemented to handle those specific requirements. Short term deployment strongly differs from remote permanent weather station installation (i.e., whether data is retrieved manually or via communication link). The equipment should be proven, affordable, and user-friendly.

Heavy wind gust or changes in wind speed or direction can severely impact maritime operations. Container yards rely heavily on wind-alarms to monitor wind speed and direction and avoid tipping of the containers and the outcome can become disastrous (as shown on Figure 1). All offshore operations can be highly impacted by weather conditions, especially helicopter traffic, offshore loading and helideck operations. Using real-time information, costly delays can be avoided to reduce fight interruptions and increase safety & efficiency.

Figure 1: Occupational health and safety (OHS) requirements for Port Operations, importance of wind measurement policies & regulations for Safe Work Australia (Source: Wind-Alarms website).

There are numerous applications for Maritime and Terrestrial Wind and weather warning systems including:

- Port wind and weather systems for operational control;
- Crane wind warning system & safe crane operation;
- Irrigation wind warning systems;
- Fire Fighting wind warning systems;
- Chemical hazard wind warning systems;
- Spray optimisation for agriculture;
- Plume control and warning systems for mine blasting sites;
- Overspray control for bulk on-loading;
- Container offloading Terminals and Logistics off-loading yard wind warning systems;
- Marine vessels and ships;
- Data buoy;
- Supply vessels loading/unloading;
- Offshore loading & platforms;
- Heavy-lift operations;
- Subsea operations;
- Logistics;
- Hazard warning solutions;
- Running safe workplace environment;
- Situation awareness;
- Environmental field sites.

This paper will focus on wind alarms as they apply to container off-loading ports.

2.2 Sensor Resellers & System Integrators

Observator Instruments is a manufacturer and supplier of Meteorological and Hydrological Instrumentation and key supplier to the Australian Bureau of Meteorology. The company is part of the Observator Global Group, based in the Netherlands, which has a 90-year history of supplying maritime and terrestrial wind and weather systems.
The Australian division manufactures and integrates Weather stations and Wind alarms for various applications. Observator Instruments world class scientists and engineers have developed the optimum weather observation systems for maritime observations. Observator Instruments are compliant to Maritime standards and our designs meet the harshest conditions in the world.

3. Implementing an effective wind measurement strategy

Finding the best location to install a wind alarm system is always a challenge. Fortunately, there are numerous models and tools available to optimize the installation choice of a wind sensor.

Defining clear wind measurement goals is paramount to implementing a successful wind assessment strategy. Understanding the basics, such as, the application, the location, the parameters and their range is absolutely critical prior purchasing any equipment.

3.1 Sensor Placement

The most difficult aspect of wind measurement is the exposure of the anemometer. Since it is nearly impossible to find a location where the wind speed is representative of a large area, the location of the wind alarm system requires in-depth weather monitoring knowledge. The determination of true North, and thus the site bearings, is essential for proper wind sensor orientation. It is also useful during the tower layout phase of the installation process.
The placement of the sensor should take into consideration the following guidelines:

- Start with an aerial view plan of the site;
- Get historical information on the direction of the strongest prevailing winds;
- Sensor placement is primary to achieving un-impeded wind information;
- If there is a large structure, such as a warehouse, then sensor placement should be on the structure or multiple sensors must be placed in primary and secondary high wind areas;
- Always define how high the sensors are to me mounted to achieve meaningful results. Maximum container heights must also be considered;
- Understand what the sensors will be mounted to. Most ports use light poles as a mounting structure.

3.2 Sensor Types & Sensor Parameters

Wind alarms are used to detect the changes of speed and direction of the wind [2]. Whether you wish to comply with essential OHS legal requirements, observing a meteorological phenomenon or implementing a wind alert measurement strategy, choosing the best wind sensor is capital for the success of your project.

For years, mechanical cup and vane anemometers have been used to measure wind speed and direction. There are simple but very effective tools. The past two decades have brought Ultrasonic technology into a dominant position of the market. Because sonic anemometers have no moving parts owing to their principle, they have high durability and little accuracy deterioration.

Besides wind measurement, there are many other parameters which are relevant to meteorological weather observations. Observator Instruments provides a range of meteorological sensors which are adapted to all types of weather monitoring applications [1]. Typical weather sensors include wind, rain, solar, temperature, humidity and barometric pressure parameters.

With the advent of compact wind-alarm systems, you can now choose from a range of fully integrated platforms. Implementing an 'All-In-One' solution will save a considerable amount of time, cost and effort. However, choosing the correct sensor is critical to collect successful data for specific applications.

Wind direction and wind speed are the most common form of wind data. Nevertheless, monitoring air temperature has become a standard for many basic wind assessments. Optional parameters such as solar radiation, vertical wind-speed, change of temperature with height, rain and barometric pressure can also deliver critical information about atmospheric stability.

Wind-Alarm systems can sometimes become costlier to maintain that to purchase on the first place. Investing in self-maintainable solutions or even renting a portable Wind-Alarm trailer is often much cheaper than retrieving the data yourself. Users should always take into consideration the entire lifetime of the product while budgeting for a wind sensor solution. Wind-alarm solutions are generally designed to be modular devices in order to handle complex situations and are priced differently.

Wind-alarm systems come in various shapes and solutions. With a variety of data logging and telemetry capabilities, users can remotely monitor a weather system in real-time from their desk. Performing site-visit can become extremely time-consuming. It is usually recommended to control the wind-alarm system remotely and retrieve the data on the go.

Inspection and calibration costs can be kept to a minimum using ultrasonic wind sensor with no moving parts (i.e. Figure 2). Those platforms are highly reliable and require very low maintenance [3]. However, users should keep in mind that choosing the correct wind instrument will mostly depend on the type of application.

Figure 2: Gill Instruments Wind Observer II, wind speed sensor ideal for use in extreme environments, high accuracy sensor for low maintenance maritime applications (Source: Gill-Instruments website).

4. Major design considerations: Minimum equipment required to perform high-wind measurement

Wind alarms have some basic components and many customisable features. It is critical to have a complete view of what is available in a wind alarm system, so end users can make informed decisions when designing their system. The goal is a system that consistently provides situational awareness of a potential hazard, but does not negatively impact productivity and budgetary constraints.

The best way to approach the design of the system is to follow some basic considerations. Basic components are as follows:

- **Wind sensors** are required to measure wind speed as live, average, or gust conditions;
- **Wind displays** are required to validate sensor conditions and set alarm thresholds;
- **Visual and/or audible indications** of alarm conditions are used to provide awareness.

From these basic components the end user can begin to build framework on how to implement a system for the operational requirements and then design what is suited to the safety plan.

4.1 Wind sensor specification

In basic configurations, sensors are directly wired with a relative close proximity of a display and an alarm. Wireless communication is generally not required for basic wind-alarm operations.

The first step to designing a Wind-alarm system is to assess the needs of your application. Users may select All-In-One wind monitoring solutions or search among a range of weather sensors to suit each application requirement.

Each sensor has its own advantages: from a solid and compact mechanical wind sensor to a low-maintenance ultrasonic sensor with no moving part. Some applications may require specific requirements such as ATEX Intrinsically safe equipment. Other wind sensors may be best suited for high-speed and high-accuracy situations. In most case, the choice of the sensor always comes down to the application requirements.

Offshore Approved sensors
Marine & Offshore Applications face the most challenging environment including salt water, corrosion and humidity. In order to increase safety and assure uninterrupted offshore operations, it may be relevant to choose Lloyds Register Approved Anemometers which will guaranty the suitability of the equipment for Marine and Environmental Monitoring Systems.

Aggressive environment: Use of cup & vanes
Some Wind-Alarm installations require higher level of specifications than others (e.g. using a heavy-duty wind sensor for offshore application as showed on Figure 3). When it comes to withstand the highest wind on Earth, it becomes a trade-off between robustness and maintenance requirements [4].

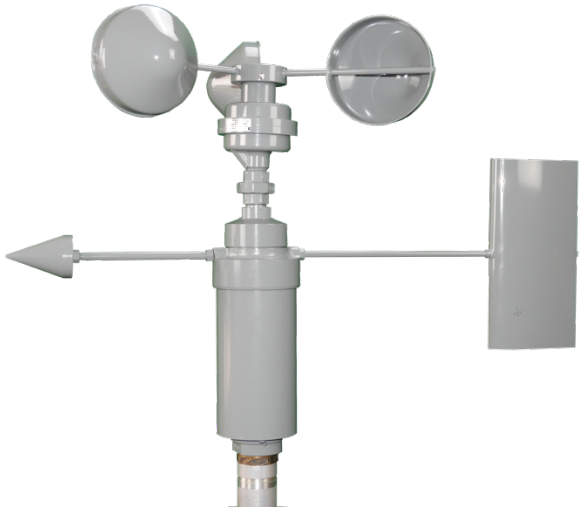

Figure 3: Synchrotac SYN-706 sensor, heavy duty high-wind sensor, replica of the instrument which has recorded the fastest surface wind on Earth in April 1996 (Source: Observator Instruments).

Extreme temperature environment
Based on the application, wind sensors may be confronted to specific environmental influences such as winter conditions, humid environment or even hot weather. High-specification anemometers are specifically designed to operate in very cold icy conditions (ice, snow). Equipped with optional heating and de-icing capabilities, those systems are designed to withstand salty and wet conditions as well as the freeze or thaw conditions.

4.2 Wind and weather displays
Observator Instruments provides users with many display solutions ranging from simple LCD/LED display to touch screen displays. Users performing wind measurement using a handheld option may prefer using a tablet or an Android device (and MET-LINK Application). Finally, high-end applications such as port terminal operations may require to use a PC or web visualisation systems.

4.3 Alarms
It is generally recommended to install both visual and audible wind-alert systems. Users can choose from a variety of sirens and flashing lights offered by Observator Instruments.

5. Additional options and considerations
Meteorological sensors are best selected based on the requirements of the application. In some cases, the integration of the system requires to take into consideration additional options such as the communication requirements, the logging options, the necessary power supply for the equipment and the range of wind alerts needed (as displayed in Figure 4).

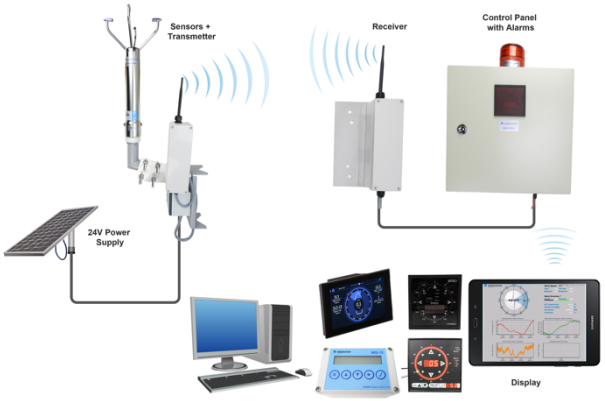

Figure 4: High wind-alarm solutions, advanced options for port operations, technology includes communication, multi-level alarms, data-logging, and power configuration (Source: Wind-Alarms website).

Overall, a typical wind monitoring system entails major components (the sensor, a meteorological display and an alarm), as well as peripherals (a tower or support, a smart logging choice, the software, connectivity to the logger and sensor, an appropriate power supply, wiring, earth grounding, IP rated enclosures and multiple alarm solutions able to provide immediate wind alerts).

5.1 Multiple sensor
Implementing redundant sensors can provide good data substitution when required. Generally, it is less expensive to provide sensor redundancy than to conduct an unscheduled site visit to replace or repair a failed sensor.

5.2 Alarm options

Alarms, data display and reporting tools provide real-time solutions to optimise operations and support efficient decision-making. Alarms can be visible and audible in a number of colours.

Preferred alert choices includes:

- Visual: Generally, a visible flashing beacon indicates an alarm condition;
- Audible: Sirens go off when the wind speed hits a set value on the dashboard;
- Text: SMS alarms limited to multiple phone numbers and would require a SIM card;
- E-Mail: Directly sent to the user's mailbox;
- Or a combination of the above.

5.3 Multi-level alarm indication

Multiple alarm levels can be requested for a same system including:

- Wind-speed (m/s, knots, mph, km/h and Beaufort);
- Wind direction;
- Wind-speed & Wind direction (combination);
- Multi-levels Alarms (low, medium and high).

5.4 Wireless telemetric inter-connection (radio, Wi-Fi, GPRS)

In order to connect and control your wind installation, you can choose among various methods of connectivity available. The advantage of choosing multiple methods is to maintain communication redundancy for your application. Whenever Wi-Fi or LAN communication is not available, GPRS/GSM may be better suited. Radio-link or Satellite communication could also be used whenever other communication channels are not available.

5.5 Data-logging, data-collection and modelling

The logging choice depends on the application. On its simplest form, a SD card is good enough to perform manual data extraction. A more complex telemetry logger would capture real-time data within an online database (available remotely). Alternatively, smart nodes could be used to send data to a controlled database.

5.6 Systems integration

The choice of enclosure entirely depends on the application and the level of IP rating required for the system. Enclosure systems would vary depending on their mounting location (indoors or outdoors).

5.7 Autonomous Power (solar, diesel generator)

Based on the application, and depending on the instrument power requirements, multiple solutions exist to power a wind installation. With no access to a wired connection, it may be preferable to keep the power requirements to a minimum. Installations such as, solar panel, or diesel generators are ideal for this type of applications. Observator Instruments provides an entire range of power solutions including low-power trailer systems (i.e. Figure 5).

Figure 5: Quick deployment wind-alarm trailer, used to comply with OH&S requirements, ideal for up to 12-month port operation wind measurement without external power supply (Source: Wind-Alarms Website).

5.8 Mounting & portable quick-deployment option (trailer, MET-LINK)

The best support hardware for a sensor may include handheld, masts (vertical extensions), mounting booms (horizontal extensions) or other sensor brackets.

The objective of mounting a sensor away from the support is to minimize any influence on the measured parameter caused by the the mounting hardware itself.

5.9 Data & Web-visualisation

Web Visualisation Systems provides the ability to monitor wind-alarm measurements from anywhere on the planet. Online dashboard can be fully customised to support end-user real-time monitoring.

6. Summary

The purpose of the paper was to provide a framework to implement wind-alarms for safe operation at container offloading ports and terminals.

High-wind alarms have many applications for harbour and port operations. Implementing a successful wind-measurement strategy requires a tremendous understanding of the application requirements. Sensors should be adapted to the environment, and supporting systems should be in place to trigger alerts.

Observator Instruments have built a worldwide reputation in delivering tailored wind alarm system for maritime applications. The fact that our technology has sustained the harshest weather conditions recorded on Earth make our systems ideal for future directions from 40°S and beyond.

7. References

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