

INTERNATIONAL SAFETY PANEL

RESEARCH SERIES #15

Terminal Operations in High Wind Conditions

BY KATHERINE TSAI

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TERMINAL OPERATIONS IN HIGH WIND CONDITIONS

1. Introduction

- 1.1 The International Safety Panel (ISP) of ICHCA International decided that research was necessary before embarking on the development of a publication on the subject of high winds, their impact on terminal operations and practical measures that can and should be taken to minimise their effects.
- 1.2 Whilst this was being prepared, TT Club developed a publication called "WindStorm" arising from experience of a number of severe high wind damages. The guidance in the booklet was the result of incident investigations and analysis of good practice that could help prevent or minimise damage from this cause.
- 1.3 Once the ISP research had been completed and analysed, it was decided that ICHCA International and TT Club would collaborate to jointly produce a second edition of "WindStorm" and that this would utilise the outcome from the research as well as reflect further practical experiences and other information.
- 1.4 At the same time, ISP felt that the research itself should also be published as there are many aspects revealed by the study and highlighted by the commentary that will be of value to those responsible for determining how their terminal(s) should plan for high wind emergencies.
- 1.5 The second edition of "WindStorm" is being published at roughly the same time as this Research Paper and the two may be seen as complementary to each other.
- 1.6 The following summarises the various questions that were asked as part of the research and also includes a commentary on many of the revelations it highlights. From this, some simple conclusions have been reached to assist in the reviewing of terminal plans.

2. The Questions and Commentary

Q1.1 What type of terminals do you operate?

68% of the responses came from pure container terminals, 16% from general cargo and containers combined with the remainder being from terminals that a greater mix of cargoes. They came from 17 different countries spread around the globe.

Q1.2 What is considered to be a "high wind"?

NOTE: The answers quoting actual wind speeds throughout the replies used a variety of values - metres per second (m/s), miles per hour (mph), kilometres per hour (kph), knots or even a part of the Beaufort Scale. For the sake of clarity and comparison, each has been converted to m/s

Whilst many terminals take the level of high wind to which it should respond with preventative action as being that which is quoted by manufacturers of the terminal plant and machinery, particularly the quay cranes, such values could differ with the type of plant and, over it all, the wind speed at which parts of the terminal stop work and also the complete terminal work cease operations may well be different. This general question was intended to show what was considered to be a high wind and the answers showed a wide diversity. They ranged from 13.8 m/s through to 24 m/s with one indicating that a local typhoon

signal was the level. For a more detailed analysis of individual pieces of plant and also operations see Q 8/9.

Q1.3 Effect of local geographic features

42% said that they did take into account local geographic features in determining wind speeds and direction, whereas 58 said that they did not

Q1.4 Where does the terminal receive its wind readings and high wind forecasts?

Interestingly,

- 47% depended on at least the internet whereas 53% did not even subscribe to it
- 79% depended upon at least fixed anemometers
- 84% depended upon at least forecasts from local authorities
- 37% depended on all three sources
 - Of the others, 32% depended upon two sources, 5% on a different two source combination and 26% on only one source

The most popular arrangement was to have a reliable local forecast backed by on-site anemometers.

Q1.4b If a fixed anemometer, is it placed in a location that would be approved by the local meteorological service?

Of those that answered this question, 69% said that their anemometers were in positions that were approved or would be approved. The placing of anemometers can be quite important as the readings need to be reliable. A combination of placing, open/closed position, height and relationship to the plant/operation concerned are all relevant factors. An approved position is much more likely to give the accuracy desired.

Q 1.5 Over what periods are sustained wind speeds measured?

How long should a wind which is above the designated level be allowed to continue until preventative action is taken? If the wind is strong and steady, the reaction can be almost immediate, especially as the forecast will have indicated it was coming. Closing operations down is not an action to be taken lightly and, even if it is inevitable, it can be left whilst there is still sufficient time to take all the precautions before the wind takes effect. Alternatively, the wind may be variable both in strength and direction and it may not be clear as to whether it will continue, get worse or improve. It is, therefore, a matter of judgement both as regards the wind speed at which action should be taken (see Q 1.2) and how long it should be blowing before acting.

The replies to this question were very varied with no clear preference. Individual circumstances might play a part in establishing this diversity. They ranged from in two instances 4/5 seconds to 1/10/15 minutes and to several hours. One terminal reported that it had several different criteria ranging from instant wind speed, 2/5/10 second averages and a daily maximum average.

Q1.6 Are there written guidelines for terminal operations high wind conditions?

89% of respondents said that they had such guidelines or were working on them. With safe systems of work dependent upon such advice, it is difficult to see how such procedures can work without carefully thought out guidance which is published.

Q 1.7 Are there guidelines on ship mooring in high wind conditions?

With ships presenting quite large wind profiles, it is clearly important to consider what should be done in any of the specific wind speed/direction possibilities. Ships have been known to strike container cranes whilst berthing or leaving and being affected by the wind is an obvious possible cause. Surprisingly, 58% of respondents did not have such guidelines.

Q1.7b If you do have such guidelines can you describe them?

Three sets of guidelines have been supplied, whilst others described the basis for such advice. They have been developed variously in conjunction with the Harbour Master, Pilotage Authority, Port Control or Port Authority. In one case, extra moorings lines/tugs are on standby whilst another said that its container operations were suspended according to gantry crane instructions.

Q 1.8 Do you have guidelines on cargo work aboard vessels during high wind conditions?

What is a relevant level of wind that justifies action being taken to protect the integrity of quay cranes, for example, in a high wind situation may be very different from the wind level at which it becomes dangerous for personnel to work on the tops of decks stows for example and/or for containers to be lifted in the air. Only 42% of respondents had such guidelines.

Q 1.8b If yes, can you describe them?

One was attached. Other remarks included the use of "safety flats" and safety harnesses at all times. 21% said that they stopped such work at given wind speeds and the values quoted varied from 17m/s to 20 m/s. One terminal left the decision to Shift Managers whether to suspend operations or slow down operations when wind speeds reached 13.8 m/s. If the wind continued to grow and reached 17m/s or 20 m/s, operations were immediately stopped.

Q1.9a At what wind speed does quay equipment stop?

This series of questions are crucial. The stoppage of quay equipment varies widely from 14 m/s up to 25.2 m/s.

Q1.9b At what wind speed does quay equipment cease?

Ceasing quay equipment completely occurs at the same wind speeds as the stoppage level for 68.75%, whilst 18.75% used a higher wind speed.

Q1.9c At what wind speed does quay equipment cease trolleying?

Mostly the same wind speed levels as in previous questions were used with only 2 stopping at slightly higher speeds.

Q1.9d At what wind speed are mobile cranes moved to a safe area?

This does depend upon the type and size of mobile crane. Modern mobile cranes with typically 30t SWL at 30m radius will have substantial wind profiles whereas smaller types will not be so susceptible. The replies, therefore, varied quite widely but tended to be higher.

Q1.9e At what wind speed are other terminal operations ceased?

Only two respondents used a higher wind speed than that for mobile cranes, with another two using slighter lower levels.

Q1.10 At what wind speed do all operations cease?

This is an important issue for those terminals that are likely to/or regularly do experience very high winds. 76.9% replied with higher wind speeds which varied from 18 m/s up to 33.5 m/s.

Q1.11 How often do you experience high wind conditions?

The respondents clearly represented the full spectrum of possibilities with

- 11% almost never having such an experience
- 16% high winds occur once per year
- 37% experience it 1-5 times per year
- 21% 6-10 times per year
- for the rest it was monthly, daily during certain months and, finally, daily throughout the year

Q1.12 Do you have an arrangement to receive weather warnings from a local or national meteorological centre?

All respondents had such arrangements

Q1.12b If so, please describe the arrangements

64% relied upon daily reports, some requiring extra reporting during anticipated emergency conditions and this was the most common arrangement. 16% admitted to receiving such reports only in anticipated emergency conditions and a few used the internet for such information.

Q1.13 Who receives the reports from the meteorological centre?

Whilst the answers to this query will be bound up with the specific management arrangements at each terminal, the replies show a very wide disparity. The control room receives the report in 16% of the replies and that was the largest single arrangement. The others covered variously -

- terminal meteorologist
- operations shift superintendent
- berthing office manager
- shift manager
- operations manager
- marine manager

and in a few instances multi reports go to -

- terminal manager, operations manager and shift manager
- harbour master and control room
- terminal manager, operations manager, harbour master, shift manager and control room

This, of course, is closely linked to the next question.

Q1.14 Who decides when the terminal should be shut down?

Surprisingly, this also shows a wide diversity of arrangements with the most popular being the Shift Manager. However, elsewhere this responsibility variously lies with the terminal manager, control room, operations manager, operations shift superintendent or the terminal meteorologist. In other terminals, it is shared between terminal manager/shift manager, operations manager/managing director and terminal manager/operations manager. At one location it was said that an emergency meeting would be convened at which the decision would be made. There can be no doubt that, especially at a busy terminal, such a decision can have considerable consequences, including ships backing up at sea unable to berth and road vehicles backed up on the surrounding road system unable to access the port. Just as valid are the possible consequences if the terminal is not shut down and considerable damage and disruption results.

Q1.15 At what wind speed levels is work started again?

One respondent said that this occurred when the wind had calmed down and that this was covered by procedures. Otherwise, every respondent gave a wind value with the levels varying from 13 m/s up to 32.5 m/s.

Q 2.1 When activities are ceased on quay cranes are they secured?

It was pleasing to note that all respondents said that such securement was carried out in those circumstances. It may be thought that this should be automatic and would be carried out every time. Regretfully, experience and incidents show that this is not always so and a large company eventually went out of business by a chain of circumstances which started with 2 container quay cranes colliding under high wind conditions. One was damaged beyond repair and the other substantially damaged and this was occasioned by the cranes not being secured. However, what does securement mean?

Q 2.2 If yes, which methods are used?

Container cranes are equipped with brakes but these are on the motors and do not usually directly work on the wheels. Coupled with this, it has been known for the wind to move such cranes to the extent that the whole structure is sliding along on its track. In this situation, even brakes on the wheels will not have any appreciable effect. Movement will only be stopped if there is something placed in the way, preferably before movement starts. Once movement starts, and although not impossible, it is very much more difficult to stop. All those who responded use storm pins, apart from two terminals who said that they relied only on rail clamps. Most also supplemented the storm pins with either rail clamps or integral braking systems or both. Anchorage chains are also favoured by some terminals either in two opposite directions or, in one case, one direction only. The size and number of the storm pins, whether to have anchorage chains, and, if so, how many and what size, and whether to fit rail clamps and/or integral braking systems are decisions that will be determined by the likelihood of high wind conditions being experienced and how often. The power of the wind should never be underestimated. There is one recorded instance of a boomed up container crane being hit face on by a very intense local wind which collapsed the crane. It did not fall backwards but just collapsed in its own space. There have been many instances over the years of cranes being moved by the wind, some to the end of the rails and some to their destruction. In a minority of instances this has happened whilst the driver was still in his cab.

NOTE: The second edition of "WindStorm" has much more on the subject of tie-downs

Q2.3 When activities are ceased on other loading/unloading equipment, are they secured?

77% of those who responded did secure such other equipment. Surprisingly, 23% did not.

Q2.4 What other equipment do you have?

Those who did not secure, did not list any other terminal equipment. Those that did secure, listed variously straddle carriers, fork lift trucks, RTGs, RMGCs, RSD, side loaders, and other gantry cranes. Strangely, only one respondent referred to container stacks and that was in regard to empties. Whilst other cargo handling equipment may not have the wind profile of a quayside container crane, they can be affected if the wind is strong enough and it is a sensible precaution to have arrangements made should it be necessary. With emergencies, preparation and preparedness are everything. Equally, stacks of containers can be affected by the wind, depending upon the height, wind direction and whether the containers have loads in them or are empty. Experience has shown, however, that even containers with loads in them can be affected if the conditions are right.

Q2.5 Is every crane or item of lifting plant fitted with an anemometer?

68% said that they were.

Q2.6 If no, where are the anemometers placed?

50% of those who said no to Q2.5 said that the anemometers were on the tops of their gantry quay cranes. Other positions reported were on the tops of various buildings. Of those who replied yes to the above question, tops of buildings, apex location of each gantry quay cranes and also trolley location for each RMG were also locations that were used

Q2.7 How many anemometers in total are in place and operating within your terminal?

Of course the size and location of the terminal will determine the number of such devices but, again to emphasise the disparity of the terminals responding to this survey, the answers ranged from 1 up to 65. 69% had 10 or under, 19% had 11-50 and 12% had over 50.

Q2.8 Who makes the decision for the crane drivers to descend/stay in the cab during high wind conditions?

Although there was a variety of answers, the most popular was shift manager or leader. The rest of the answers listed various management positions with only 2 terminals saying that it was the crane drivers themselves who decided and a further 2 who said that it was a joint decision between the responsible manager and the crane driver.

Q2.9 How many incidents involving quay cranes has your terminal experienced in the past 5 years that resulted directly from high wind conditions?

74% said that they had had no incidents. Of those who said that they had, the highest number was 5.

Q2.9b If the answer was yes, what type of incidents were they?

The incidents reported ranged from gantry crane movement along the rails, structural damage to the crane and in one instance the crane toppling over.

Q2.10(a) How many incidents involving other loading/unloading equipment has been experienced in the past 5 years?

Only one terminal said that it had such experiences and listed 5 occasions.

Q2.10 (b) How many incidents involving terminal equipment has been experienced in the past 5 years?

Two terminals had experienced such events 5 times and one 6 times in the past 5 years.

Q2.10(c) How many incidents involving cargo moving has been experienced in the past 5 years?

Again, most terminals said that they had not had such experiences. However, of those that had one reported 3 incidents involving empty containers in an empty container yard, one said that it had had numerous incidents and another that it had experienced containers being blown out of position.

Q2.11 If there have been such incidents, what type were they?

Reports were received of cargo falling/toppling and equipment moving along the terminal which in some instances resulted in structural damage to the equipment.

Q2.12 What do your procedures require your employees to do in high wind conditions?

Most replies referred to boom up cranes, move to storm anchor positions and tie down. An interesting additional action mentioned by a few terminals was to move cranes not in use together to act as a buffer. One terminal said that cranes that are not in use are secured at all times - even during the period of the year when high winds were not expected.

Q3.1 Have you experienced falling container stacks due to high wind conditions?

Of those that answered, 78% said yes to empties and 18 said yes to loaded boxes.

Q3.2 Have you experienced wind damage to containers in the past 5 years?

Of those that answered, 6% said yes to loaded boxes and 59% to empties.

Q3.3 Do you have specific container stack procedures designed to minimise losses during high wind conditions?

Of those that answered, 64% said yes to loaded boxes and 84% to empties.

Q3.4 How do you secure container stacks in high wind conditions?

The methods for loaded boxes indicated involved adjusting stack levels (the most popular), securing with strops or wires and turnbuckles, compressing stacks and adjusting the number of containers per slot. For empties, the same precautions were listed plus the use of twistlocks and stipulating that empties should not be stacked in the peripheral stacks.

Q4.1 Have you experienced cargo losses in the past 5 years?

All of those responding to this question said that they did not have any such losses in the timescale specified.

Q4.2 Have you experienced damage to cargo due to high wind conditions in the past 5 years?

Of those responding, only 14% said that they had.

Q4.3 Do you have specific procedures designed to minimise losses during high wind conditions?

Of those responding, only 39% said that they did have such procedures.

Q4.4 How do you secure cargo in high wind conditions?

Of those that answered this question, lashing down or lashing to something else and covered with a tarpaulin was mentioned with the most positive being to remove to a warehouse.

Q5.1 Are workers other than your employees informed of high wind procedures at the terminal?

Of those that answered, 88% said that they were so informed.

Q5.2 Do high wind operating procedures or limiting wind speeds form an element of the safety briefing given to new employees at the terminal?

Of those that answered, 75% said that they did.

Q5.2b Are high wind operating conditions a part of safety briefings given to visitors to the terminal?

Of those that responded, only 38% said yes to this.

Q5.3 At what wind speed is evacuation planned?

77% have thought about this aspect and most of those quoted wind speeds. They varied from 18 m/s up to 30 m/s, with one respondent quoting typhoon conditions and another saying that they never would evacuate.

Q5.4 Who decides the evacuation of the employees and other workers in high wind conditions?

Of those that answered, a variety of management positions or combination made such a decision or, in two instances, the crises organisation. One terminal said that current procedures did not provide for this. Employees and others are required to stay in safe areas such as offices and covered warehouses or locker rooms. Some employees may be asked to leave the site in anticipation of winds greater than 28 m/s.

Q5.5 Do employees and other workers have a designated evacuation safe point?

Of those that answered, 67% said that they did.

3. Conclusions

3.1 Although such a survey can only be a snapshot in time and will be limited by the number of respondents, it is believed that the depth of response enables certain broad conclusions to be drawn and they are highlighted in order to assist those whose task is to ensure that emergency plans are as thorough as they should be in relation to high winds.

3.2 The conclusions are –

- There is great diversity in what is considered to be a high wind
- The most common unit used is metres per second (m/s) but miles per hour (mph), kilometers per hour (kph), knots (kts) and even the Beaufort Scale are used
- The majority did not take into account local geographical features
- Most relied upon more than one source for wind forecasts with the most popular being a local forecasting service backed by on-site anemometers
- Two thirds said that the siting of their anemometers had been approved by the local meteorological service
- There is no clear preference as to how long a wind should be experienced before preventative action is taken. Responses varied between a few seconds up to hours. One terminal reported a range of criteria depending upon the situation/forecast and that would seem to offer the most flexible approach
- 89% said that they did had or were developing written guidelines to deal with high wind situations
- Over half of respondents did not have any guidelines on mooring of ships in high wind conditions
- The basis for most high wind considerations is the crane manufacturer's recommendations regarding the operation of the crane. This, of course, is crucial as the modern quay crane has a high wind profile and can be moved by it. However, is that action level appropriate for ship work, eg working on tops of containers, and terminal operations involving other plant and container stacks generally to continue?
 - Over half of respondents did not have any specific guidelines regarding cargo work aboard ships in high winds
 - The wind level at which quay equipment would be stopped varied from 13.8 m/s up to 25.2 m/s. The mean speed was 19.2 m/s
 - The wind level at which quay equipment cease operations was in most instances the same as the stopped level
 - The wind level at which trolleying was ceased was also in most instances the same although in two instances it was slightly higher
 - The wind level at which mobile cranes were moved to a safe area was very varied and reflected differing types, size and weight of mobile cranes now available to modern terminals
 - The wind level at which other terminal operations were ceased varied between 13.8 m/s up to 23.2 m/s with the mean speed being 19 m/s
 - The wind level at which all operations were ceased ranged from 18 m/s up to 33.5 m/s with a mean speed being 22.9 m/s
- The Control Room was the most common receiver of weather reports but that was not the majority with named position holders being more usual. Such persons widely varied with many reports only being sent to one individual and, in a few instances, to a group of persons
- There was a wide diversity as to who decided when the terminal should be shut down, with the most popular being the Shift Manager

- A variety of wind speeds were quoted in relation to when work could restart. One terminal said that this occurred when the wind had calmed down and that this was covered by procedures
- All respondents said that when activities ceased on quay cranes they were secured. However, it should be noted that there have been instances where dramatic events have occurred because this most basic of precautions was not taken
- The means of securement varied and readers are encouraged to refer to WindStorm, edition 2, in which there is much advice on tie-down arrangements
- Surprisingly, almost a quarter of respondents said that they did not secure other plant and equipment when activities on them ceased.
- Approximately two thirds said that every crane and item of lifting plant was fitted with an anemometer
- The most popular person to be deciding that crane drivers should descend or stay with in the cab was the Shift Manager
- Incidents were reported involving quay equipment, terminal equipment and container stacks, including with loaded boxes
 - Over 80% said that they had container stack procedures designed to minimise losses of empty containers
 - Two thirds said they had similar procedures for loaded boxes
- Nearly 90% said that they informed workers apart from their employees of high wind procedures at the terminal
- Three quarters said that this aspect forms an element of the safety briefing given to new employees at the terminal
- Just over a third said that this aspect was part of the safety briefing given to visitors to the terminal
- With regard to the level of sustained wind speeds that would trigger the terminal being evacuated, 77% had thought about this aspect and most of those quoted specific wind speeds. They varied with one respondent quoting typhoon conditions and another saying that they never would evacuate. Windstorm, edition 2, has the details of where a terminal did evacuate and necessarily so.
- A variety of senior management positions were quoted or a combination thereof regarding making an evacuation decision. One respondent said that current procedures did not provide for this.

4. Recommendations

- 4.1 It is recommended that those responsible for the establishment, review and effectiveness of provisions relating to high winds at terminals, consider the aspects raised by this survey and study “Windstorm”, edition 2, with a view to ensuring that their preparations are as complete as possible.