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Tornado incident at the Freeport Container Port Grand Bahamas on 29 March 2010

Independent Investigation

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Introduction

1. Following a tornado incident at the Freeport Container Port (FCP) on 29 March 2010 an independent investigation was commissioned by the Ministry of Labour and Social Affairs of the Bahamas to review the incident in the light of existing information gathered by the FCP and by the Freeport Department of Labour Inspectors. This investigation was carried out during the period 10 to 14 May 2010 by Mr. Jacques Obadia, former official of the International Labour Office (ILO) and expert in occupational safety and health (the Expert). His services were provided graciously to the Government of the Bahamas.

2. The general terms of reference for the investigation were to review the different aspects of the incident that resulted in three occupational fatalities and six injuries, two of them serious. This included an analysis of the sequence of events, factors that might have affected the outcome of the storm passage through the port and the level of emergency response preparedness prior to the incident. The management and staff of FCP cooperated fully during the investigation by arranging meetings, making available all the information and documents requested by the Expert, and opening the whole Terminal for inspection. The Expert was provided with an office with telephone and computer facilities. A list of the references provided by the FCP and the Ministry of Labour is provided in Annex 1.

3. All employees were given the opportunity to arrange for a private interview with the Expert and a few took advantage of this possibility. Due to time limitations, the interviews were carried out in an office at the FCP site. The Expert declined to meet and interview the two seriously injured employees. He considered that, in the light of possible legal implications, such questioning would be best conducted in the context of a coroner's inquiry.

4. The signed interviews of 35 employees and docked vessel crew members who witnessed the incident, carried out by the FCP in the days following the event, were made available to the Expert. It is assumed that these employees made their statements freely and in good faith, and without any pressure. The table in Annex 2 summarizes the information provided in the signed employee statements as well as the interviews conducted by the Expert. The observations in the table focus on the sequence of events related to the passage of the storm formation through the Terminal and on other safety and health aspects

5. Freeport Container Port (FCP) is a privately owned and operated port of Hutchison Port Holdings (HPH), a subsidiary of Hutchison-Whampoa Limited. HPH operates 49 ports in 25 countries throughout Asia, the Pacific, the Middle East, Africa, Europe and the Americas. Freeport Container Port is located on Grand Bahamas Island. The FCP was officially opened in July 1997 and presently comprises a total land area of 3,400 ft (1,036m of berths) with 15.5m depth alongside; 10 Super Post Panamax Quayside Gantry Cranes and 2 Gottwald Mobile Harbour Cranes; 3 Empty Container Handlers; 75 Straddle Carriers; 1 Megaport Straddle Carrier (Radiation Detection Unit); A Navis Computerized Port Operating System; and 49 Hectares/118 acres of

Stacking Area. It has an annual capacity of 1.5 Million TEU[1]. The total workforce at the FCP is 713, with 490 involved in Terminal operations and 109 in engineering (maintenance activities). The port operates on a 24 hrs basis (3 x 8 hr shift rotation).

FCP OSH programme

6. The main elements of the current FCP OSH management structure include a trained Safety and Security Manager reporting to the Operations Manager, a Safety Committee comprising representatives from all departments and disciplines, an Accident Investigation Committee, and the Safety Committee of the Employee Council. References concerning the FCP Safety, emergency response and operational manuals are provided in Annex 1.

7. The FCP started in 2007 an OHS improvement programme aimed at reducing drastically the Lost Time Injury Frequency Rate and bring the Terminal at a higher level of emergency response preparedness. A good part of the OHS improvement activities, particularly the training of employees, were implemented in 2009 with the technical assistance of the Health and Safety Department of the container port of Felixstowe (United Kingdom), the FCP's sister port. The main measures and actions taken as part of the programme, prior to the incident, include:

    - The revision and distribution of the Safety manual to all employees in 2007.
    - The recruitment in 2009 of a trained Safety and Security Manager who reports directly to the Container Port Director.
    - The establishment of a Safety Committee comprising representatives from all departments and disciplines. The Committee meets on a monthly basis. The Safety Committee has attended a two day training course on accident investigation and emergency response procedures.
    - The setting up of an Accident Investigation Committee composed of representatives of the Safety, Operations Engineering and Human Resources departments, as well as an instructor from each of these Departments. The Committee meets with the employee(s) involved in an incident to understand all aspects of the event and take corrective action to prevent a reoccurrence.
    - The implementation of a new traffic management system.
    - Upgrading the Crane Operator Training Program in 2009 through the installation and use of a new Ship-to-Shore and Mobile Harbour Crane Simulator. Operating much like an aircraft flight simulator, the simulator produces a realistic 'virtual offshore environment' and moving sensation in which the crane operator uses standard crane controls to move various simulated loads between offshore installations and supply vessels, as well as train and test operators on their reaction to emergency situations in ways which are not feasible in a real crane.

[1] The ISO 20 ft equivalent unit (TEU) is the dimensional building block for expressing container shipping capacity.

- The review and updating in 2009 of the FCP Emergency Response Manual in consultation with the Government of the Bahamas.
- Training and certification of ten Supervisors by the Institution of Occupational Safety and Health[2] (IOSH) in Managing Safety in Ports.
- Attendance by all Supervisors of a two day safety seminar on causes of accidents, accident prevention, the Health and safety at Work Act, and reasons why employees may neglect safety.
- Safety Orientation provided to all new employees and contractors.
- Giving Safety refresher classes to operations personnel (discipline specific).
- Training groups of employees in First Aid and CPR.
- Participation of a number of employees in training on Environmental Responsibility.
- Attendance of approximately 150 employees in a one-day training course on Causes and Costs of Accidents and on Accident Prevention.
- Training of groups of employees in the use of fire extinguishers. This included how to inspect, classes of fire, types of extinguishers, and practical exercises. Employees participated also in a two week training course on basic fire fighting, hose handling, chemistry of fires, tactics and techniques, internal fires response (demonstration and practical) etc…..
- A Radiological/Nuclear Awareness Hazardous Material Training Course given to employees from the safety, security, operations and engineering departments.
- Sponsoring by the FCP of a Health and Safety Fair for all employees with participation from the local fire department, public hospitals authority, and the Royal Bahamas Police Force.
- Implementation of a procedure for the boarding and inspection by Safety Officers of vessels calling at FCP. This includes completion of vessel condition, any areas of concern addressed with vessel captain/chief officer and contents relayed to operations supervision and communicated to FCP ship working personnel.
- All departments must carry out monthly safety drills. A monthly "Safety Hour" has been established during which the Terminal shuts down for one hour to allow safety meetings to be held in all departments in order to bring safety information to employees and to address employee concerns and suggestions.
- Production and implementation of a revised safe system of work for straddle carriers/berth operators working under cranes (push/pull twist lock bins in tire lanes).
- A number of employees went to the United Kingdom for training and certification from the National Examination Board for Occupational Safety and Health

[2] IOHS is a chartered professional OHS organisation located in the UK, with over 37,000 individual members and is specialized in training in all aspect of OHS. http://www.iosh.co.uk

(NEBOSH). Certifications were received in occupational health and safety, controlling workplace hazards, practical application of health and safety measures, and the management of health and safety at work.

- The installation of a terminal air quality monitoring system with several monitors placed at critical locations around the site.
- Working towards the British Standards Institution (BSI) Occupational Health and Safety Audit System (OHSAS) certification for the FCP facility. This certification ensures that the FCP implements a systems approach to the management of OHS.

The tornado incident

8. The incident at issue occurred on the 29 of March 2010 in the FCP. A number of videos[3] and photographs[4] taken close to the harbour and available on the internet show clearly a funnel cloud moving towards the port. These and the employee statements confirm that the FCP was struck by a tornado. The Williams Town, Fortune Bay and Port Lucaya areas also sustained tornado damage to property but fortunately without loss of life.

9. Based on employee statements and available meteorological data[5], it is established that the weather on 29 March 2010 in the Grand Bahamas area was very bad all day, with rain and thunderstorms with intermittent wind gusts and even some hail. There is a good consensus on the fact that a serious worsening of the weather with very heavy rain and increasingly high winds started at about 11:00 hrs. Lifting operations had been stopped a few times because of low visibility. From all accounts the first cranes on the south side of the quay started being pushed by high winds at about 11:20 hrs and by 11:30 hrs the tornado had swept the quay at full force and vanished in no more than two to three minutes.

10. Within those few minutes, one crane was pushed over a 100 m and four other 1000 ton cranes were sent crashing together into the last crane at the end of the gantry tracks, toppling it to the ground. This very short duration was confirmed by the Captain of the vessel MSC Diego who also estimated it at no more than 3 minutes with wind speeds at over 90 mph. The impact of the tornado was strong enough to break the stern mooring lines of two of the docked ships and push them in a near perpendicular position to the quay. Apart from broken stern mooring lines, the docked vessels did not sustain any damage.

11. The report written by the FCP Safety and Security Manager following the incident provides a concise description of the aftermath following the tornado passage over the Terminal, including rescue operations and a preliminary inventory of damages sustained by the cranes, a straddle carrier and containers. A diagram made by the FCP shows very clearly the positions of the 10 gantry cranes; the Gottwald crane and the two vessels before and after the tornado passage (see Annex 4).

[3] See at http://www.youtube.com . Search with key words “Bahamas tornado”
[4] Bahamasislandinfo.com , Monday 29 March 2010 . Photos Mike Stafford/Bradford Marine Bahamas.
[5] See Annexes 2 and 5.

Preparedness issues

12. A number of issues raised by employees concerning the level of emergency preparedness at the FCP prior to the incident and their possible influence on the outcome of the incident are reviewed below. This includes access to meteorological information at the FCP, rescue operations, high wind procedures, sound alarms, radio communication systems and lifting operations.

Meteorology

13. Based on employee statements, work started very early in the morning under intermittent heavy rain and winds. According to News reports, the Bahamas Department of Meteorology (BDM) was aware that day of thunderstorms moving across the island. It seems however that the risk of tornado activity was detected only very shortly after the Department issued a severe weather alert for Grand Bahamas. The FCP report on the incident indicates that news of possible tornado activity on the island reached the port at approximately 11:17 hrs. Information about the sighting over the sea near the harbour of a cloud formation resembling a tornado was radioed at approximately 11:15 hrs to the Quay Office by a number of employees working at the South side of the Terminal. A general call to stop all operations was sent shortly after. It seems that there was just enough time to secure the two most southerly cranes (C1 and C2) before the full force of the tornado swept the Terminal.

14. The Expert visited the Freeport airport meteorological facilities[6] on 10 May 2010. The airport has a recently installed an Aviation Automated Weather Observing System (AWOS 900 3) with one meteorologist on site. The system meets the requirements of the US Federal Aviation Administration (FAA), the International Civil Aviation Organisation (ICAO) and the World Meteorological Organisation (WMO) for use at airports[7]. On the day of the incident, the airport station was aware early in the morning of severe storm activity susceptible to reach Grand Bahamas. The information was seemingly transmitted to the BDM in Nassau but not directly to the FCP or any other facility. The Expert was told that only the BDM had the authority to issue public severe weather advisories and alerts.

15. Prior to the incident, the FCP did not have any onsite weather monitoring system that might have provided advance information on the nature of the incoming storm, and possibly more time to prepare for its impact. However, based on the current level of related technology and science, tornado forecasting is still very difficult. According to the US National Oceanic and Atmospheric Administration (NOAA) the current average lead-time for tornado warnings is 13 minutes[8]. Research has shown that it is also extremely

[6] Both the FCP and the airport are owned by Hutchison Whampoa Limited.
[7] See system specifications and other technical aspects at http://www.allweatherinc.com/aviation/awos_dom.html
[8] http://www.noaa.gov/features/protecting/tornados101.html

difficult to predict whether a detected storm formation will spawn tornadoes or not. These can form, land and disappear in a few minutes[9].

16. The emergency preparedness and response systems in the Caribbean region, and thus the Bahamas, are rather geared to hurricanes than to tornadoes. A strong "hurricane safety culture" exist at all levels in the country and sensitive facilities such as ports and airports have sufficient lead time – in terms of days – to get prepared. The FCP Emergency Response Manual, prepared in consultation with government authorities, provides a very comprehensive procedure defining specific responsibilities and measures to be taken in case of a hurricane to ensure the safety and health of personnel and property[10]. Terminal work during relatively bad weather and fluctuating wind speeds is a common occurrence. The presence of a weather monitoring system at the FCP at the time of the incident might have detected an incoming storm system but not necessarily its capacity to generate tornadoes.

17. The Freeport (Airport) historical weather data[11] for 29 March 2010 in Annex 5 indicates that the weather was overcast all day with thunderstorms, rain showers and even hail but with fluctuating wind speeds below the limit for triggering crane shutdown and terminal operations. This information concurs with that given by employees in their statements. The data indicates also that the tornado was a much localized event as the maximum wind speed at the airport was 23 km/h. The airport is located only one or two miles from the Terminal.

Rescue operations

18. Emergency response after the incident was rapid and coordination of rescue efforts was efficient. External services were contacted immediately and responded very rapidly (hospital ambulances, Fire department, Freeport Harbour Control, Airport Crash team, etc.). Several of the employees who were working on the Quay at the time of the incident were the first to reach the injured and provide first aid where possible. Assistance was also provided by companies nearby. Following a Terminal evacuation order, a head count was conducted at the Staff Cafeteria and all personnel not involved in emergency operations sent home.

19. It should be noted that the Company ambulance had a flat tire when it arrived on the quay and thus could not be used. However a sufficient number of external ambulances reached the Terminal rapidly. The very detailed description of the rescue in the FCP Incident Report is corroborated by the employee statements.

[9] Vortex2 tornado research project http://www.vortex2.org/home/
[10] FCP Emergency Response Manual, 2009, p.51-63.
[11] Weather Underground Internet service: http://www.wunderground.com/history/airport/MYGF/2010/3/29

Alarm and communication systems

High wind procedures

20. Sections 13 and 14 of the Safety Manual define high wind procedures for securing cranes and straddle carriers. Terminal superintendents are the nominated competent persons with the responsibility of starting the process of securing the cranes, terminating lifting operations, arranging for the cranes to be secured at their anchor positions (13.1.1-13.1.3) and keeping Terminal Management advised as to the decisions taken.

21. Each gantry crane must be fitted with its own wind speed indicator in the operator's cab. The indicator may comprise two light signals, amber and red, and a repeater light panel fitted to the external structure of the crane (13.2.1). The amber light illumination indicates that the wind has reached a speed 5 mph below the recommended maximum operating speed for the crane (45 mph). It requires the Superintendent to monitor closely wind speed levels to determine if they are reaching a stable level allowing continuation of activities, or increasing towards maximum operating speed. In this case, crane securing procedures should be started.

22. A red light illumination indicates that wind speed has reached the maximum operating speed for the crane (50 mph). The superintendent should order cargo operations to cease and to bring ship working personnel ashore. In addition, in wind conditions in excess of 55 mph, the crane rail clamps are set automatically to disable the gantry motion. This can be overridden by the driver to allow moving the crane to a pin down position[12]. The clamps are also triggered by a power loss. The heavy damage observed on the gantry drive boogies of a number of cranes may have resulted from the triggering of the rail clamps by wind speeds exceeding the 55 mph limit or by the Terminal power outage, or by both. In any case, the winds were definitely higher than the braking capacity of the rail clamps.

23. As described in Section 14 of the FCP Safety Handbook, straddle carriers do not have wind speed indicators on board and drivers must rely on information and instructions provided to them by the Terminal Superintendent and their own assessment of the difficulty in controlling the vehicle. High wind operational limits are the same as for the cranes.

24. These safety rules are evidently designed for situations where average winds are increasing steadily, thus giving the decision maker sufficient time to have the cranes secured properly and personnel brought back to safe areas. This was not the case at the time of the incident where decision making time was much shorter. It is noted that Section 13 of the FCP Safety Handbook does not specify nominally the amber and red light wind speed limits for Quay cranes while Section 14 specifies them for straddle carriers. In the same way the wind speed limits are not mentioned in the Crane Operator's Manual (see Annex 1).

[12] Operator's Reference Manual for the OMG and HHI Cranes, Quayside Gantry Cranes, Freeport Container Port, Version 3.0, 2006, p.11.

25. A Memo sent by the Terminal Coordinator to the Duty Operations Manager, dated 30 March 2010, states that the wind meter in the Quay office was out of order. The 26 April 2010 Ministry of Labour Report on the incident, indicates also that a number of operators, speaking on the condition of anonymity, alleged that wind meters on cranes had been disconnected to prevent stopping work when high winds reached the alarm and shut down levels. The FCP denied these allegations and gave instructions to determine whether the safety mechanisms had been tampered with. It should be noted that if the crane rail clamps were triggered by wind speeds in excess of 55 mph and not by the power outage, this would indicate that the wind speed indicators were functioning.

26. Two employees mentioned in their statements taking readings from a wind speed indicator at their job station. A speed of 23.7 mph was read in the machinery house of C 6 by a painter after 07:00 hrs. A speed reading of 61 mph was observed after 11:00 hrs by a welder at the Engineering building. While the Captain of the MSC Diego estimated the peak wind to be well over 90 mph at the time of the tornado passage, he and his crew were too busy responding to the emergency created by the breaking of the vessel's stern mooring ropes to take a wind speed reading. None of the employees who were on the cranes reported any wind speed readings or visual warnings prior or during to the tornado passage. It appears therefore that some wind meters were operational, at least on one crane and the Engineering Building. It should be noted that the power outage at the Terminal at the time of the incident may have affected the crane wind speed indicators.

Sound Alarms

27. Section 3.8.1 of the Safety Manual indicates that fixed sound alarms systems are installed throughout the Terminal. The alarm sounds three types of warning tones: Wail (Stay alert listen to instructions), Steady (Evacuate the Terminal) and Westminster chimes (All Clear). The available information indicates that at the time of the incident the alarm system was not triggered. There were indications from the interviews that the terminal alarm system was not operational. The system seems to be intended for specific situations such as hazardous materials leaks requiring rapid evacuation rather than weather related emergencies.

Radio Communication systems

28. The FCP uses a multi channel radio communication system that links crane operators and personnel on the Quay, straddle drivers, maintenance personnel and duty personnel the Quay Office. The use of radio communication units, particularly in the case of emergencies, is defined in Section 3.10 of the Safety Manual. In addition, the Shipworkers Training Manual details the "Speak Code" rules for effective Radio communications for work and for emergencies.

29. Radio warnings of the incoming tornado were sent by employees on specific channels but seemingly not relayed on all channels. Although one of the channels is reserved for emergencies, it seems that there is no comprehensive overriding mechanism to transmit emergency warnings, instructions or alert codes on all channels to all personnel working on the Quay at the same time.

Lifting operations

30. At the time of the incident four cranes were operating (C1, C2, C7 and C9) and were thus not pinned down. According to available information C1 and C2 had been pinned down just before the tornado hit the quay with full force. However, the pin down status of C3, C4, C5, C6, C8 and C10 at that time of the incident remains unclear. A table indicating the pin down status of the cranes and their movement prior to and during the incident is provided in Annex 3. Based on the FCP Damage report and the diagram in Annex 4 it seems that the path of the tornado was such that wind pressure on cranes C1-C4 was not as high as on the other cranes. The employee statements indicate that all cranes were affected by the winds and moved northward, but some stopped rapidly afterwards while the others continued on a collision course toward the next cranes. This seems to confirm the evaluation in the FCP report.

31. It is probable that cranes C1- C4 were subjected to lower wind pressures and only for a very short duration, while cranes C5 to C10 sustained the full force of the tornado. The fact that C5 was pushed with the rail clamps set down close to 100 m before stopping is a good indication of the force of the winds. In a Memo appended to the FCP incident report, the Terminal Coordinator states that a number of crane repositioning was made before 6:00 hrs in preparation for the morning shift work. Cranes C3 to C6 were not scheduled for use, C10 was being prepared for maintenance work and C8 was out of service. In order to free access for C9 to the holds of the MSC Bahamas, C6 and C7 were positioned further back south near the MSC Diego, and C8 was positioned between MSC Bahamas and MSC Diego.

General OHS

32. The FCP Safety, Emergency and equipment operations Manuals (See References in Annex 1) were reviewed and, apart from the sections relevant to high wind procedures, found to be clear, comprehensive and maintained up to date. However, comments were made that the safety training over the past two or three years was insufficient. Improvements made in this area following the incident are described below.

33. In the employee statements, a number of specific OHS aspects were raised, such as the difficulties in communication between employees and management, deficiencies in the checking and maintenance of emergency response equipment such as the company ambulance (flat tire) and fire truck, and lack of safety and health related training and drills in the past two or three years.

OSH improvements following the incident

34. Following the incident, the FCP has decided to undertake a number of improvements related to OSH. These include:

    - Counselling sessions related to the psychological impact of the incident are offered to all employees, and will continue to be offered as long as needed.

- Employees have now the possibility, through a Suggestion Box installed in the Cafeteria, to voice their concerns anonymously and directly to the Chief Executive Officer.
- Safety briefings are being held with team members prior to the start of each shift led by Supervisors to reinforce safe working practices.
- A general meeting dedicated to safety issues is held monthly to communicate updates and discuss safety initiatives with all team members.
- The high-wind amber alarm threshold has been lowered to 35 mph from 45 mph to improve capacity to secure cranes and straddle carriers before reaching the Terminal shut down level.
- The Terminal's general alarm system is now located in the quay office, and all duty managers have been instructed in the use of the system.
- A TELVENT weather monitoring system dedicated to the forecast and tracking of weather systems has been installed with displays at engineering, quay, safety, and planning offices. A large video monitor was placed in the cafeteria for all employees to view weather information. Familiarization and training in the use of the system was conducted by a local meteorologist.
- Tie down drills for quay cranes and straddle carriers are being held more regularly.

Conclusions

35. The following elements have been retained by the Expert as a basis for formulating conclusions regarding the consequences of the incident:

a) **The extreme brevity of the tornado incident**.There is a good consensus that on the day of the incident a serious worsening of the weather with very heavy rain and increasing winds started at about 11:00 hrs and that lifting operations were stopped a few times because of low visibility. From all accounts cranes on the south side of the quay started being pushed at various speeds by high winds at about 11:20 hrs and by 11:30 hrs the tornado had swept the quay at full force and vanished in no more than two to three minutes.

b) **The lack of experience with tornado incidents** The FCP report on the incident indicates that news of possible tornado activity on the island reached the port at approximately 11:17 hrs and that a general call to stop all operations was sent shortly after. The fact that Terminal work during relatively bad weather and fluctuating winds is a common occurrence may have affected the time taken to assess the seriousness of the situation.

c) **The absence of an on-site weather monitoring system.** At the time of the incident, the FCP did not have in place an internal weather monitoring system and had to rely on external information sources. The presence of such a system might have helped in detecting an incoming storm system but not necessarily its capacity to generate

tornadoes. The available weather historical data indicates that winds for that day were below the lifting plants operational limits and that the tornado was a much localized event. This information concurs with that given by employees in their statements.

d) **Post incident emergency response.** Emergency response after the incident was rapid, efficient and carried out according to rules. Coordination of rescue efforts was good and external services were contacted immediately and responded very rapidly. The Terminal was evacuated rapidly after a head count.

e) **Deficiencies in the maintenance of the emergency equipment.** It is noted that the company ambulance arrived on site with a flat tire and that a number of employees alleged that checking and maintenance of emergency response equipment were not effective. However, as multiple ambulances reached very rapidly the Terminal, these issues did not seem to have had a significant impact on the rapidity of the assistance provided to the injured.

f) **The extremely high level of wind speeds at the time of the incident.** While it cannot be conclusively determined whether wind speed indicators were operational at the time of the incident**,** it probable that at their highest point, wind speeds exceeded the operating limits of the gantry cranes and straddle carriers. The fact that C5 was pushed with the rail clamps set down close to 100 m before stopping is an indication of the force of the winds. It could not be determined that all wind speed indicators were operational. However, at least two wind speeds were read, one on a crane early in the morning and the other at the Engineering building at the time of the incident. Given the brevity and severity of the incident, it is probable that crane operators were not in a position to think about reading wind speeds. It is also possible that wind speed indicators were affected by the power outage. In response to wind speed indicator tampering allegations, it is understood that the FCP intends to investigate the operational status of all wind speed indicators at the time of the incident.

g) **The safety rules were not designed to cater for brief and violent events such as tornadoes.** The safety rules related to wind speed alarms and limits are evidently designed for situations where average winds are increasing slowly and steadily, thus giving the decision maker sufficient time to have the cranes secured properly and personnel brought back to safe areas. This was not the case at the time of the incident where decision making time regarding the ceasing of lifting operations was much shorter. It is noted that the amber alarm threshold has been lowered to from 45 mph to 35 mph to improve capacity to secure cranes and straddle carriers and allow personnel to descend from the cranes safely before the red alarm is triggered.

h) **There was no overriding mechanism to communicate radio alerts on all channels.** Radio warnings of the incoming tornado were sent by employees on specific channels but not relayed automatically on all channels. Although one of the channels is reserved for emergencies, it seems that there is no comprehensive overriding mechanism to transmit emergency warnings, instructions or alert codes on all channels to all personnel working on the Quay at the same time.

i) **The apparent practice to leave cranes unpinned appears to be related to a concomitant need for efficiency and lack of awareness of the seriousness of certain storms and the potential they may have to develop into tornadoes.** Based on the fact that several cranes were repositioned before 6:00 hrs on incident day in preparation for the morning shift in order to allow working cranes to service a berthed vessel and be repositioned rapidly according to needs. The Expert concludes that in all probability, none of the cranes were actually pinned down at the time of the incident. Lack of knowledge about the seriousness of the storm and productivity constraints may have played a role in the decision to keep the cranes unpinned during the shift so that they could be moved to service the berthed vessels. This is particularly the case for crane C8.

j) **Tornado trajectory**. It is probable that cranes C1 to C4 moved only a short distance because they were subjected to lower wind pressures and only for a very short time, while cranes C5 to C10 sustained the full force of the tornado. This may be explained by the trajectory of the tornado when it swept the Quay.

k) **The FCP Safety, Emergency and equipment operations Manuals** were reviewed and, apart from the sections relevant to high wind procedures, found to be clear, comprehensive and maintained up to date. However, comments were made by some employees that in actual practice, the safety training over the past two or three years was insufficient

36. In conclusion the Expert notes that,

a) While hurricanes and thunderstorms are not infrequent in the region, the formation of tornadoes such as the one at issue appears to be a comparatively rare event. Furthermore, according to current meteorological knowledge it is apparently extremely difficult, if not impossible, to determine the capacity of thunderstorms to spawn tornadoes and to detect and predict their strength and path. Moreover, as demonstrated by the incident on 29 of March 2010, the formation of tornadoes is typically a suddenly occurring event during which wind speeds of extreme levels may develop and pass by in the span of a few minutes. In the case at issue, the emergency preparedness and the FCPs safety organization were geared to cater for extreme weather conditions in the form of hurricanes and other storms and not for sudden events such as the tornado incident at issue. Among the facts that the Experts has been able to determine as a result of the investigation, reference is made to the absence of an efficient system for detecting and relaying adequate and appropriate information to the workers in the FCP regarding the relevant weather conditions. This is regrettable and should be remedied. However, and due to the unpredictable nature of the tornadoes in question, it is the view of the Expert that it is improbable that the existence of a more efficient weather relaying system could have had a significant impact to prevent the events on the 29 of March 2010 in the FCP port.

b) The Expert has determined that according to prescribed safety procedures, the conditions were such that the cranes should have been pinned down. It has not been possible conclusively to determine whether in fact the required pinning down

procedure had been followed. With the possible exception of C1 and C2 (who in any event do not appear to have been hit with the full blast of the tornado) it is probable that none of the cranes at issue had been pinned down. Several reasons related to convenience and required efficiency of operations, as well as lack of awareness of the seriousness of the weather conditions were noted as to why this requirement may not have been adhered to. However, given the unpredictability of tornadoes, the Expert considers that it is impossible to determine whether the outcome of the incident would have been less or more severe in terms of injuries to employees and property damage if all or at least cranes C8 and C10 had been pinned down.

c) The Expert has determined that: there were certain shortcomings in the communications systems, the emergency response equipment was partially deficient, and all required safety training apparently had not been carried out. These shortcomings need to be addressed as a matter of urgency, as they may have an incidence on the general level of emergency preparedness in the port. In the case at issue, however, it is the view of the Expert that, due to the brevity of the incident, these shortcomings did not have any significant impact on the outcome.

37. The Expert notes that the above conclusions are based on the information that was gathered during the investigation at the FCP in Grand Bahamas and from the other referenced sources. Other investigations, such as engineering investigations that may have been or are being carried out by the FCP and possibly other bodies such as insurance companies may identify other issues related to and relevant for the incident. These should be taken into account in any overall evaluation of the preparedness and response to the incident.

Recommendations

38. Although it may be difficult to increase significantly the level of preparedness for a tornado passage and to mitigate its impact, a strong emphasis on prevention may significantly improve the Terminal's safety level under normal or less extreme weather conditions. The availability of a focused and well promoted regulatory framework, as well as the establishment of effective social dialogue, the provision and effective carrying out of OSH training, the development of skills, and timely access to reliable knowledge are critical elements in a successful management of OHS and the building of a safety culture, both at the national and enterprise levels. The following recommendations, which reflect the basic principles in relevant ILO instruments, are focused on areas which, in the view of the Expert, could benefit from improvements to enhance the enterprise and national OHS systems and to maintain the incidence of occupational accidents and diseases at the lowest possible level.

At the enterprise level

39. These recommendations address principally the operational and general OSH issues identified by the Expert. A number of these recommendations have already been or are in the process of being implemented by FCP.

Operational issues

a) It seems that reliable information on the nature and severity of the incoming thunderstorm reached the FCP with insufficient time to fully secure the Terminal. While it is noted that a full **weather monitoring** system was installed shortly after the incident, the FCP should seek to further improve its communication channels with the Bahamas Department of Meteorology and, to the extent possible, with other key Meteorological Centres in the region.

b) The general maintenance schedules of **wind speed indicators** should be further investigated. All appropriate measures should be taken to ensure that these instruments are not disabled by power failures and work at all times. One possible solution is the installation of alternative emergency power sources such as rechargeable batteries. It might also be useful if wind speed data could be transmitted and pooled in a central location such as the Quay Office to monitor and map speeds, as well as indicator functionality. In the same way, if not already done, the Terminal's **sound alarm systems** should be modified to run on batteries or other independent power sources in case of a general power outage. In the event the procedure is not already in place, a record of functionality checks and maintenance work should be established and kept up to date for all equipment that are critical to the safety and health of workers.

c) Instructions in the **Safety Handbook** and the crane and straddle carrier operator's manuals regarding high wind procedures should be clarified regarding limited response time emergencies and harmonized. In the same way, the **Emergency response manual** should also include a specific section on high wind and eventually other limited response time emergency procedures. Moreover, the procedures in Section 3.8 of the Safety Manual should be reviewed and clarified as to its uses. The feasibility of using the Sound alarm systems in the case of very short lead time emergencies should be considered, and the logical decision steps and responsibilities for triggering the system should be defined.

d) The **radio communication system** and its use should be re-evaluated and the necessary improvements made to ensure that alerts and instructions regarding serious emergency situations can be transmitted immediately on all channels and to all personnel using radio units. It is understood that the FCP is addressing this matter.

e) **Pin down procedures** should be reviewed and clarified particularly in relation to rapidly developing emergency situations such as rapidly increasing winds. The rules under which the crane's automatic rail clamping system can be overridden should also be reviewed and clarified in relation to emergency situations.

General OSH issues

f) Effective **social dialogue**, including **communication and cooperation** between management and employees regarding safety and health at work is an essential tool in reducing significantly occupational accidents as well as property loss. It is also an

effective basis for improving labour relations within the enterprise. This is even more essential in high hazard operations such as container ports. Workers should feel that they can raise genuine safety and health issues to their management without fear of undue consequences and that their concerns are acted upon rapidly. The establishment and effectiveness of communication and consultation mechanisms is the best and most practical means to build over time a preventative safety and health culture in the enterprise. While the human losses and injuries are incalculable, the cost of implementing a good occupational health and safety programme is orders of magnitude lower than the costs of property losses sustained by the Terminal.

g) The **sharing of information, best practices and technical expertise in the area of OSH** are essential to the management of OSH and the building of a safety culture at the enterprise level. The Hutchison Port Holdings Company should consider establishing a global OHS network linking its different sites to facilitate the exchange of technical information and best practices between its OSH specialists. Given the size of the company and the number of ports it manages, it should also consider establishing its own **auditing team** to ensure periodic evaluation of the sites as to effectiveness of OHS implementation and maintain the global OSH performance of the company as a whole at the best possible level.

h) In relation to comments made concerning the insufficient level of **health and safety training** over the past two or three years, a well organized and continuous training and skills certification programme is essential for ensuring maintenance of skills at the level necessary to understand and address effectively the ever changing occupational hazards and working conditions and environment. Given the hazardous nature of port work, particular emphasis is needed on emergency response training and the handling of hazardous materials. It is noted that the FCP has started a promising programme of training in the area of OHS.

At the national level

40. In relation to the problem of timely public communication of severe weather related alerts, the process and rules for issuing such alerts should be reviewed and to the extent possible improved.

41. Occupational safety and health in the Bahamas is legislated under the 2002 Health and Safety at Work Act. While the Act provides a good general framework and defines all the important principles and responsibilities in this area, its full implementation could be strengthened and facilitated by the development of regulations, codes of practice and technical standards designed to address the specific needs of different economic sectors. Consideration should be given to the strengthening of the National OHS system and more particularly its Labour Inspection capacities in the area of occupational safety and health. In order to ensure an effective application at the enterprise level of the provisions in the Act, consideration should be given to the strengthening of the national OHS system by:

a) Giving consideration to amending the Act in a number of areas to in order to reflect more closely the provisions of the ILO Occupational Safety and Health Convention

(No. 155), 1981, particularly those concerning the protection of workers removing themselves from a work situation presenting an imminent danger to their life or health.

b) Initiating the formal process leading to the ratification of the main ILO OSH standards, including the OSH Convention (No. 155), 1981 and its Protocol of 2002 related to the recording and notification of occupational accidents and diseases, and the Promotional Framework for Occupational Safety and Health Convention (No. 187), 2006.

c) Developing and endorsing at the highest level of government an OSH policy as well as a time bound strategy defining objectives aimed at strengthening the national OHS system.

d) Developing a set of technical regulations defining OHS requirements for specific undertakings, occupations and hazards.

e) Endorsing and promoting the use by enterprises of OHS related internationally recognized Codes of practice such as those of the ILO, and technical standards such as those developed by international, regional and national standardization bodies that are relevant to the various aspects of OHS.

f) Strengthening and expanding the OHS training of the labour inspectorate so it may provide guidance to enterprises in implementing effectively the requirements of the national OHS regulatory system.

g) Promoting the establishment and implementation at the enterprise level of a systems approach to the management of OHS, based on the principles of the 2001 ILO Guidelines on OSH Management Systems, or other similar internationally recognized technical standards.

h) Participating in regional OHS networking systems designed to facilitate exchange of information and best practices.

i) Promoting the professional certification of OHS practitioners in order to ensure that skills and experience in this area are updated periodically through recognized evaluation mechanisms. The provision of diplomas and degrees in the area of OSH by the National education system should also be considered.

j) Preparing a national OHS profile designed to assess the strengths and weaknesses of the national OHS system, identifying areas, and serve as a baseline for measuring future improvements made through national programmes developed to address these areas.

Annexes

Annex 1. References

1. Freeport Container Port Safety Department - Tornado Incident Summary, March 29, 2010
2. Freeport Container Port Safety Handbook. Amended June 2007
3. Freeport Container Port Emergency Response Manual, 2009.
4. Freeport Container Port Shipmaster Information and Emergency Procedures Guide, November 2006
5. Freeport Container Port, Operator's Reference Manual for the OMG and HHI Cranes, Quayside Gantry Cranes, Version 3.0, 2006.
6. Freeport Container Port, Straddle Operator Handbook
7. Shipworker Training Manual, amended December 2007
8. Memorandum by the investigating Labour inspector to the Deputy Director of Labour, Department of Labour, Freeport, Bahamas, concerning the Tornado incident, 26 April 2010.
9. Act to make provisions relating to health and safety at work and for connected purposes, Enacted by the Parliament of the Bahamas, 2002.

Annex 2. Summary of employee statements and interviews

Employee	Work Post	Time line	Key Visuals
All			– Morning shift starts work at around 4:30-6:00, and there is one break before returning to work at approximately 11:00. – The majority of workers reported overcast sky and steady rain in early morning. – Also consensus about seriously worsening weather conditions starting at about 11:00
Crane Super intendent		04:30 11:30	– C10 scheduled for maintenance (60 day PMC) – C8 out of service with mechanical issues – All other cranes operational – Work assigned to various teams and no contact made with them until 11:30 – C1 requests assistance to pin down the crane – High winds and rain observed while walking to truck outside – Visual of cranes moving north and colliding with each other – Radio call indicating that cranes are moving and vessels moving away from quay – Rushed to North side of Quay – Visual of SC66 down near C6 – Rescue operations on C10 already started
Tower Super visor		11:15 11:20 11:25 ~11:30-11:35	– C1 call that it is stopping operation because of heavy rain and lack of visibility – C2 crane checker call that it is also stopping – Give order to stop all operations on quay – C7 driver only one who responded that he had stopped operations – Message from SC drivers warning that something very bad is building at the mouth of the harbour – C1 warns that his crane is moving on its own despite activation of E.stop. C1 pinned down – Visual of very bad weather moving toward Quay Office – Call to pin down C2 – Assumed tornado hit quay and cranes: visual of very high wind moving barricades, C5 moving North very fast and 2 vessels moving away from Quay after breaking stern mooring ropes

			– A few minutes later, wind abated joined rescue operations – **Stated that C9 and C10 were pinned down by Melvin Dickson before Engineering took over (no time given time?)**
Crane operator	Crane No.1 (C1)	11:00-11:20 (approx)	– Worsening weather conditions. – No visibility – Decision to stop crane operations. – Crane operator advises (radio) Quay Office that crane is moving very slowly on its own – Crane is moved back in place and pinned down – Visual of a dark cloud at mouth of canal (end south quay) raises suspicion of tornado – The crew of three is taken by truck to the quay Office. Get refuge in Store room. – Strong winds and rain for 3 minutes – Visual of rescue operations ongoing on quay and participation in efforts removal of injured before being ordered to go to cafeteria for head count
Crane Checker	C1	11:15	– Heavy rain and low visibility – C1 observed moving North fast – Quay office notified of worsening weather conditions and visibility – C1 driver moves crane and has it pinned down – Visual of very dark clouds at sea and wind rotation – Crew taken back to shelter in Quay Office – Strong winds for 3 minutes – Visual of one crane missing and straddle carrier down – Rescue operations initiated and 911 called immediately – Visual of FCP ambulance with flat tire. – Visual of berthed ships moving away from Quay.
Crane Operator	C1	11:00	– Heavy rain and clouds – C1 started moving North fast – E.stop mechanism activated failed to stop crane – Strong winds and dark clouds over ocean – C1 moved to pin down position and pinned down – C1 crew taken to Quay Office for shelter – After heavy rain and wind stopped, visual of one straddle down – Employees evacuated to cafeteria
Crane Driver	C2	11:15	– C2 operation stopped because of visibility too low. – C1 operator voiced same problem on radio – Quay office informed of stoppage – Radio message from C1 requesting pin down of crane to stop it moving – C2 moved south to pin down position and pinned

			during a lull in weather. – Berth operator, checker and crane operator find shelter in checker's cab – Visual of containers falling, stern mooring ropes breaking and vessel moving away from Quay – Very strong winds and rain for about 3 minutes – Visual of C10 down while going back to Quay Office
Crane Checker	C2	11:20	– Operations stopped due to poor visibility – Message that C1 moving despite E.stop engaged – C1 finally pinned down – C2 pinned down – Message from straddle driver indicating visual of waterspout forming South at sea – Shelter taken in Checkers Cab – Visual of damage after weather calmed down
Crane Checker	C2	06:00 11:00	– Assigned Berth Operator duties – Returned to Quay side to get rain gear following weather worsening – Another employee coming from outside indicated that a tornado was forming on the water – Shelter taken by all until wind and rain abated – Visual of SC66 toppled near C6
Crane Checker	C2	05:50 11:00	– Assigned berth operator duties – Heavy rain becoming intermittent then heavy again – Visual of C2 moving to park up position – At radio request went to C2 and dropped a pin – Took refuge in Cab of C3 and radioed over Channel 1 to all SCs to lock onto a container due to increasing winds. – SC driver announced arrival of a tornado – Visual of Hanford Bain pass on golf cart checking cranes. Stopped at C3 to attempt moving crane over pin down position but power was out. – Shelter taken in Cab of C3 – C3 pushed north by wind toward C4 (situated a bollard apart) – C3 collided in C4 and stopped – C4 pushed again north by winds, then C3 moved again and collided with C4 and stopped. – Both cranes started moving north. – Visual of MSC Scandinavia stern mooring ropes snapped loose – Quay Office informed via radio re situation of vessel. – Wind abated and visual of SC66 down and ongoing rescue operations
Crane Operator			– Problem of cranes C10 C9, C8, C7 in relation to

		~11:15	servicing the vessel “Bahamas” – Gottwald crane taken off quay, parked north of C10 and cordoned off (~30 min) – C8 moved to the South between the Bahamas and the MSC Diego. – Heavy winds and rain – Call from C1 to help pin down crane. Done – Shelter taken in C3 which after moving 10 ft, was pinned down – Following weather clear up, visual of straddle and crane down – Rescue operation started
Lead Crane driver	C5	04:30	– C5 boomed up and pinned. – Not known if it was to be used later in the day
Crane Checker	C7	5:30 10:00-11:00 11:20-11:30 (approx)	– Assigned to work as berth operator – Weather worsening steadily and visibility poor – Shortly before 11:00 operations stopped because of poor visibility – Took refuge in Checkers cab of C8 (out of service and pinned down) – Radio message indicating a visual of water spouts at sea on the south side not taken seriously at first. – Visual confirmed by straddle driver – Strong impact sustained by C8 from C7 – C8 starts moving North very fast – Visual of parts falling off and electrical sparks from crane, Cab window blown off – Visual of C10 boom beginning to fall in water – Drivers of C6 and C7 responded to calls – Joins rescue operations
Dispatcher	Quay office	06:00 11:18 11:22 11:24	– 4 cranes operating that day. In charge of C1 and C2 – C1 operator message that visibility is very poor – Told to stop work – Pier supervisor orders everybody by radio to stop work – Visual of very dark clouds at the mouth of canal and over the ocean and what seemed to be two water spouts – C2 operator requested assistance to pin down crane – Announcement made to Engineering and Charged Hand to pin down cranes – Radio message that cranes are moving – Visual of 3 barricades moving on the quay – Visual of C5 passing quay office going North at about 30 mph – Radio warning sent to C7 and C8 operators to gantry north to avoid collision. – Visual of C10 and SC66 down – Radio message that vessel stern mooring lines snapped

			– Rescue operations ongoing – Ambulance with flat tire
Dispatcher	Quay office	11:20	– Crane operations stopped by Tower Supervisor (TS) because of low visibility – Radio request by TS to help pin down C1. Done – Visual of sky turning very dark over ocean – Visual of strong winds and C5 starting to move North, then same for C6 and C7 – After wind died down, visual of C10 down – Radio call for an ambulance and SC66 down – FCP ambulance with flat tire – Stated that C5 was not manned and that only C1, C2, C6 and C7 were operated – Stated that no heed was given to crane operator to pin down C6 and C7 because the crane were not moving at the time of the request
Straddle Driver	RDSC	11:15 11:20 **11:32**	– Scanning row C234: Heavy rain but visibility acceptable – Radiation Detection Straddle Carrier (RDSC) parked up after radio call to secure Straddles – Visual of dark cloud formation outside of harbour resembling a tornado – Sent radio warning on channel1 – Visual of C5 moving north faster than normal – RDSC shaken violently – Driver climbs down from SC after wind abated
Straddle driver	SC74	Before noon	– Weather worsening and high wind gusts – Radio warnings from other SC drivers of incoming bad weather – Visual of containers overturned: radio warning to Park supervisor – Visual of 2 or 3 water spouts developing and sky growing darker – Radio warning sent again on radio channels 1 and 2 with no immediate response – Several calls to Quay Office for directions as weather deteriorated rapidly – SC locked on container while radio instructions finally came to do so – Visual of damage after storm passed
Straddle Driver	SC50	11:15-11:30	– Rapidly worsening wind and weather conditions – C6 ceased operations – Winds becoming very high and hard rain, no visibility – Executing container discharge job just behind C9 and C10 – Decided to lock down on container

			– C7 had also stopped operations – Quay office instructed all to cease operation and to lock straddles down – Weather calmed down after 10 minutes – Then sudden huge gusts of wind and rain and started pushing all cranes from C6 into each other and toward C10 which collapsed and went over the quay into water – Empty containers around the SC blown over – The entire event lasted about 2 minutes – Rescue operations under way
Straddle Driver	SC42	11:20-11:30	– Visual of heavy rain and squalls coming from south of the quay – Visual of empty SC34 moving – Moved SC42 to a safer area – Visual of C6 moving – Call made on channel 1 to warn of tornado – Exited SC and ran to car, called family and then ran to gatehouse
Mechanic	Eng. Workshop	11:15	– Dark and heavy rain followed by strong winds – Visual of C5 moving north at high speed, then C6 also – Visual of cranes hitting each other and finally pushing C10 down – Ken Smith tried to contact C10 via radio – People running toward C10
Mechanic	Eng. Work shop	11:30	– Engineering employees running for shelter – Visual of debris flying around – Visual of C5 moving north very fast then stopping while other cranes continued to move – Then C10 down – SD66 down – Assisted at C10 scene – Rain started again
Trainee Technician.	Eng. Work shop	11:00	– At Lunchroom – Worsening weather and winds becoming stronger – Radio message re C6 moving and C10 not visible – Trucked to the North Quay and see C10 down – Mike Young put on truck bed and accompanied to hospital.
Trainee Technician.	Eng. Work shop	11:00	– Weather worsening, then abating for 10 minutes and then starting again – Radio message: vessel by C4 broke stern mooring ropes and pivoting away from quay – Loud noise at North end of Quay: C10 down – Join rescue operations
Technician II	Eng.	11:45	– Engineering building Lunch Room: full electrical power

			outage – Company generators quick in – Announcement that C10 is down and Cranes have collided – Visual of C6 to C9 together at end of Quay – Group driven to North End of quay (including captain of one of vessels) – Visual of SC66 down near C6 and assistance given to SC driver – Joins in rescue operations around C10
Welder III	Eng.	11:00	– Weather worsening, rain and wind – Wind gust speed measurement read at 61 MPH – Second strong gust of wind and decision to take shelter in ICam office – Third strong gust of wind and visual of C5 moving fast – C10 down – Wind abated after 2 minutes – Joins rescue operations around C10
Technician III	Eng.	8:00 ~11:00-11:15	– Heavy rain and wind – Completed brake check on C9 – Carry out various checks on cranes – Working on C2 – C1 pinned down following request for assistance – C1 and C2 stop operations – Containers in Alpha Dock fall to ground – Visual of a tornado at mouth of the canal – All crew, except C2 driver, driven to Quay office and proceed to Engineering workshop – Visual of C5 hitting C6 and C6 starting to move and then hit C7 – Visual of C10 collapsing – Joins rescue operations
Painter	Eng.	Early morning (after ~7:00) 11:00 11:15 11:25	– Resume paint job at C6 in machinery house – Visual of wind gauge reading 23.7 mph – Stated that morning news reported possibility of a tornado hitting Florida – Return to work in C6 machinery house after break – Weather worsening – Radio message re C1 moving – Radio message from engineering superintendent for all to stay put where they are – C6 starting to move very fast – C6 hits C7 twice and then comes to stop – Winds die down a little and employees come down – Visual of C10 and SC down – Rescue operations ongoing

Technician II	Eng.	6:20 11:05 11:15	– Bad weather – Carry out minor repairs to C6, then to C1 – Weather worsening – Rain becoming heavier – Power outage – Call for help from C1 for pin down – Very heavy bout of rain and wind (30 sec) – Visual of cranes starting to move and collide and C10 go down – Joins rescue operations
Tech nician.III	Eng.	6:15 11:00 11:25	– Heavy rain – Back at C6 machinery house, weather worsening and thought of pushing Emergency button but not done immediately – C6 starts to move North very fast – Crane collision sequence started – Exit C6 after it stops – Visual of C10 down – Join rescue operations
Technician	Eng.	6:25 ~11:00 11:15	– Assigned to do brake checks on C6, C7, C9 – At C1 machine house. C1 operational – C1 makes sudden jolt from side to side – C1 pushed 10 ft by a gust of wind – Engage E.stop after waiting for driver to do so – C1 stopped and call made to pin down crane – C1 pinned down during a short lull in weather – While exiting C1, visual of dark band of clouds coming from sea – Radio warning sent of incoming storm – All C1 staff taken to Quay office – Visual of Crane collision sequence and C10 down – Join in rescue operations
Painter	Engineering	6:30 11:15 11:25	– Assigned to paint C5 boom – Shelter taken in machinery house because of rain and strong winds – Ask for directives re lunch break and told to stay put because of the weather – Very strong winds and C5 starts moving very fast at about 30 mph – C5 stops near Quay office – Exit C5 – Visual of 2 vessels moving away from Quay and C10 down – Asked to clear the area
Tower Super visor		04:50	– Three vessels on berth: MSC Diego and MSC Scandinavia both nearing completion, and MSC

		9:05 10:20 No time given	Bahamas as next inbound vessel – Noted that positions of cranes at North end of Quay (C8, C9, C10 and Gottwald) would not allow access to bays 02 and 06 of MSC Bahamas – Cranes and ship are repositioned to allow access to the two ship bays – Gottwald moved out of quay and next to Fence, C10 moved to end of quay, and C8 positioned between Bahamas and Diego (**this possibly means that these cranes were not pinned down anymore when the tornado hit the quay area**) – Return to Quay office – Visual of C5 moving North very fast and stopping 10 seconds later – Rain and wind stopped and visual of damage – Debris falling from cranes – Assisted in re-docking vessels – Joins rescue operations
Fitter	Vessel M/VHalcyon	~11:50	– Heavy rain and high winds – Visual of C10 moving fast and then falling over quay in water – Visual of man lying on the ground – Bleeding man put on stretcher and taken away
Able Seaman	Vessel M/V Halcyon	~11:45	– Heavy rain and very strong winds – While on way to take refuge in store room, visual of big electrical sparks coming from top of cranes – Notice increase in wind and noise from outside and ship moving abnormally – Winds abated after 3 minutes – On coming out of store room, visual of damage – Visual of man lying down on ground – Man put on stretcher
Persons interviewed by the Expert 10 to 14 May 2010			
Engineering Manager	FCP		– Day with hard rain not unusual – C10 slated for standard preventive maintenance that day – Starting time of event was about 11:30 – From office saw a large white mass moving through the port – Emergency response and rescue operations were immediate after winds died down – C10 moved a whole crane length out of rails before collapsing
OHS Manager	FCP		– Re Question on radio communications system: complex system with several channels but Emergency channel not set to override all other channels. Communication channel with docked ships available. Updating of

			system under consideration – No onsite weather monitoring system at FCP site but one installed one week after event. – FCP OSHMS certification under way – A site power outage occurred during event but had no impact on rescue operations – Increased efforts in area of safety in last 3 years after detecting increase in incidents – Internal OSH drills have started to be conducted on monthly basis – A Standing Safety Committee was established in January 2010 – The independent Employee Council has also an OHS committee – Psychological counselling made available to all workers
Chair of Employee Council	FCP		– Only key Visuals provided are that there was a power outage during the storm and wind meters did not go to alarm status
Manager and meteoro logist			– Airport is also owned by Hutchison – Airport has an AWOS 900 3 semi automated meteorological system with one meteorologist – On 29.03.2010 Station was aware early in morning of storm activity susceptible to reach Grand Bahamas. Info was passed on to the Bahamas Department of Meteorology (BDM) – Not authorized to broadcast public advisories directly. Serves only airport – Understood that BDM broadcasted public advisory on storm too late to allow preventive action to be taken. –
Berth Operator			– Assigned to twist locks removal at C6 – There were several work stops because of bad weather – Indicated there might have been a communication problem because of the different radio channels in relation to understanding how fast the weather situation was worsening – No instructions came from Quay office re high winds. Decision had to be made by Crane driver – Indicated that TV Channel 7 gave a warning of possible tornado at 9:00 hrs – Recognized that safety improvements have been made since accident – Problem with management response in case of high winds
Straddle Driver Trainer	FCP		– Alarm system was not operational – Lack of safety culture and experience – Not enough first aid training

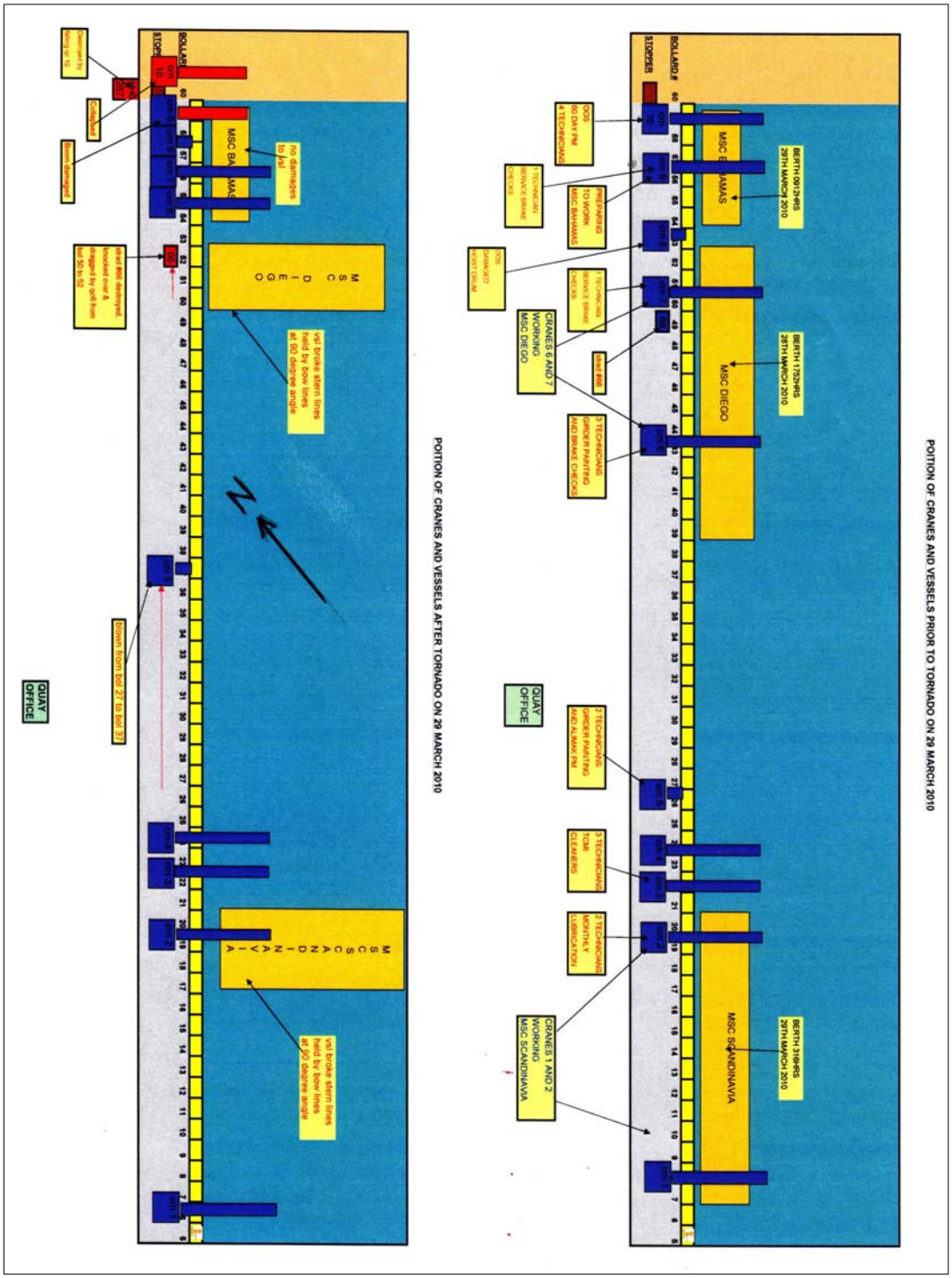
Operations Manager	FCP		– Indicated that the wind speed limit for crane operation had been lowered to 35 mph from 45
Crane driver Trainer	FCP		– Crane drivers are certified through training lasting about 4-5 weeks on computerised crane simulator and hands on – Training includes all relevant safety aspects of crane operation – Driver's licence required – Licence is renewable every 3 years through retesting with a refresher course every 6 months – C6 and C7 travelled about 100 metres at about 30 mph before hitting C8 – C6 had a container handling problem because of high wind and loss of power – Whole event lasted only 2-3 minutes
Captain	MSC Diego		– Was on deck when tornado hit without any warning – Event did not last more than 2-3 minutes – All were on deck because of broken aft mooring lines and no one had time to look at wind meter as ship was rotated perpendicular to quay around bow lines – Wind must have been greater than 90 mph – Some cranes moved about 100 m North very fast
Berth Operator			– Training is minimal at operator level – PPE not readily available – Incident reporting problematic – Often no info or warning on leaking containers – Need better Hazmat training for operators – OHS management needs to be strengthened to ensure round the clock presence on site – Workers have been ill from exposure to chemical leaks – General problem with communication between employees and management.
Crane Checker			– Communication to employees is not optimal, usually one way – Generally labour relations need to be improved, particularly in the area of health and safety – High level of near accidents – Provided copy of a letter sent to management detailing grievances

Annex 3. Crane pin down status and movements on 29 March 2010

Crane	Status	Remarks
C01	SFW PD	– Pinned down after moving north
C02	SFW PD	– Pinned down after moving north
C03	NSFW NPD	– Attempt to bring it to Pin Down position failed because of power failure. – C03 pushed 10 ft before it stopped
C04	NSFW NPD	– Pushed by C03 – C03 and C04 are then pushed north together and then stop.
C05	NSFW NPD	– Was Pinned Down and boomed up at 04:30 but was observed being pushed North by winds. Must assume that it was unpinned later, possibly to move it to allow servicing of berthed ships. – Seen hitting C06 then stopping near Quay Office. – Must assume it stopped afterward because of derailment and heavy damage to gantry drive motors and gear boxes.
C06	NSFW NPD	– C06 spreader hits SC66, topples it and derails – Continues moving North fast, then hits C07 and stops – Sustained serious damage to north side gantry drive systems bogies from derailment possibly caused by spreader in low position hitting and toppling SC66.
C07	SFW NPD	– Seen moving North fast at 11:20 – Serious damage to all gantry drives and bogies from collision with C8 and being struck by C06
C08	NPD Out of service	– Morning: C08 moved South to between the Bahamas and MS Diego – At 11:00: C07 Crane checker takes refuge in out of service C08 Cab. – 11:25: C07 hits C08 which starts moving north very fast and collides with C09. – Serious gantry drive and bogie damage
C09	SFW NPD	– Pinned Down early morning at shift change time. – Put in operation later to service Bahamas – 11:25-30: Hit by C08 and C07 together before hitting C10 – Serious gantry drive and bogie, and boom damage
C10	NSFW NPD	– Pinned Down early morning at shift change time. Crane moved later to North end of quay to give room to C7 and C9 to service MSC Bahamas. – 11:30: hit by C09 and collapses after breaking through rail end buffers.
Gottwald	Parked North of C10	– In morning , to make room for servicing of Bahamas by C07 and C09 – Main boom destroyed by collapsing C10.

Legend: PD: Pinned Down; NPD: Not Pinned Down; SFW: Scheduled for work; NSFW: Not scheduled for work.

Annex 4. Terminal situation before and after the tornado passage



Annex 5. Historical Weather data for 29 March 2010.

Hourly observations at Freeport Airport

Time EDT	Temp. °C	Dew Point °C	Humidity %	Sea Level Pressure hPa	Visibily Km	Wind Direction	Wind Speed Km/h	Gust Speed Km/h	Precip. Cm	Events	Conditions
7:00 AM	23.0	21.0	88	1010.4	-9999.0	SSW	11.5	-	N/A	Rain	Rain Showers
8:00 AM	23.0	22.0	94	1009.7	6.0	South	13.8	-	N/A		Overcast
9:00 AM	23.0	21.0	88	1009.7	6.0	South	16.1	-	N/A		Overcast
9:18 AM	23.0	21.0	88	1010.0	6.0	SSW	15.0	-	N/A	Thunderstorm	Thunderstorm
10:00 AM	23.0	22.0	94	1010.0	-9999.0	SSW	15.0	-	N/A	Rain-Thunderstorm	Light Thunderstorms and Rain
11:00 AM	23	22	92	1014	1.6	SSW	15.0			Hail-Thunderstorm	Thunderstorms with Hail
11:00 AM	23.0	22.0	94	1010.0	-9999.0	SSW	15.0	-	N/A	Rain-Thunderstorm	Heavy Thunderstorms and Rain
11:05 AM	22.0	21.0	94	1010.0	0.4	South	16.1	32.2	N/A	Rain-Thunderstorm	Heavy Thunderstorms and Rain
11:45 AM	24.0	23.0	94	1008.7	-9999.0	SW	12.7	23.0	N/A	Rain-Thunderstorm-Tornado	Funnel Cloud
2:00 PM	24	23	100	1007	7	SSW	17.3			Rain-Thunderstorm	Thunderstorms and Rain
2:00 PM	24.0	23.0	94	1007.0	6.0	SSW	17.3	-	N/A	Rain-Thunderstorm	Light Thunderstorms and Rain
3:35 PM	24.0	23.0	94	1006.0	0.4	SW	16.1	28.8	N/A	Rain-Thunderstorm	Heavy Thunderstorms and Rain
4:00 PM	23.0	23.0	100	1006.0	-9999.0	SW	20.7	35.7	N/A	Rain-Thunderstorm	Light Thunderstorms and Rain
Source: Weather Underground Internet Service: http://www.wunderground.com/about/background.asp											