



Report of Investigation  
into the fatal accident of  
a grit-blasting & painting worker  
on board floating dock “*United*”  
at West Tsing Yi  
on 13 March 2008





## **Purpose of Investigation**

This incident is investigated, and published in accordance with the IMO Code for the Investigation of Marine Casualties and Incidents promulgated under IMO Assembly Resolution A.849(20). The purpose of this investigation conducted by the Marine Accident Investigation and Shipping Security Policy Branch (MAISSPB) of Marine Department is to determine the circumstances and the causes of the incident with the aim of improving the safety of life at sea and avoiding similar incident in future.

The conclusions drawn in this report aim to identify the different factors contributing to the incident. They are not intended to apportion blame or liability towards any particular organization or individual except so far as necessary to achieve the said purpose.

The MAISSPB has no involvement in any prosecution or disciplinary action that may be taken by the Marine Department resulting from this incident.

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## **1. Summary**

- 1.1 An industrial accident happened onboard a locally licensed floating dock “*United*” at West Tsing Yi on 13 March 2008. While a grit-blasting & painting worker was on the work platform of an elevated dock arm to carry out grit-blasting to the hull plate of an ocean-going vessel, the dock arm collapsed and he fell down about 18 metres together with the dock arm to the bottom of the dock. The worker sustained fatal injuries.
- 1.2 The investigation revealed that the accident was caused by the failure of the upper coupling and lower support bush which were stress-bearing parts to support the arm.
- 1.3 The accident was also contributed by the non-compliance of the Merchant Shipping (Local Vessels) (Works) Regulation, i.e., failure of carrying out thorough examination to the dock arm.

## 2. Description of the Vessel

### 2.1 Particulars of the Vessel

Name of the Vessel	:	"United"
Certificate of Ownership No.:		B117V
Certificate Issuing Authority :		Hong Kong Marine Department
Classification Society	:	Lloyds Register
Type of Vessel	:	Class II, Floating Dock, Cat.A
Year of Build	:	1995
Built At	:	Far East Levingston Shipbuilding Limited, Singapore
Owner	:	Hong Kong United Dockyards Limited
Length	:	270.00 metres
Breadth	:	59.60 metres
Depth	:	18.51 metres
Gross Tonnage	:	80,709.00
Net Tonnage	:	46,309.00
Engine Power	:	N.A.



Fig. 1: Floating Dock "United"

"United" (hereinafter referred as the "FD") (see Fig.1), is a floating dock fitted with two cranes and four dock arms to facilitate the ship repair work.

## 2.2 Particulars of Dock Arms

Maker	:	Officina Meccanica Michielotto s.a.s., Italy
Type	:	mobile type
Safe Working Load	:	600 kilogrammes.
Length of Arm	:	20 metres
Maximum Outreach	:	25 metres
Total Weight of Arm and Platform	:	4,103 kilogrammes
Power Unit	:	3 cylinder diesel engine Deutz F3L912, 37 kW

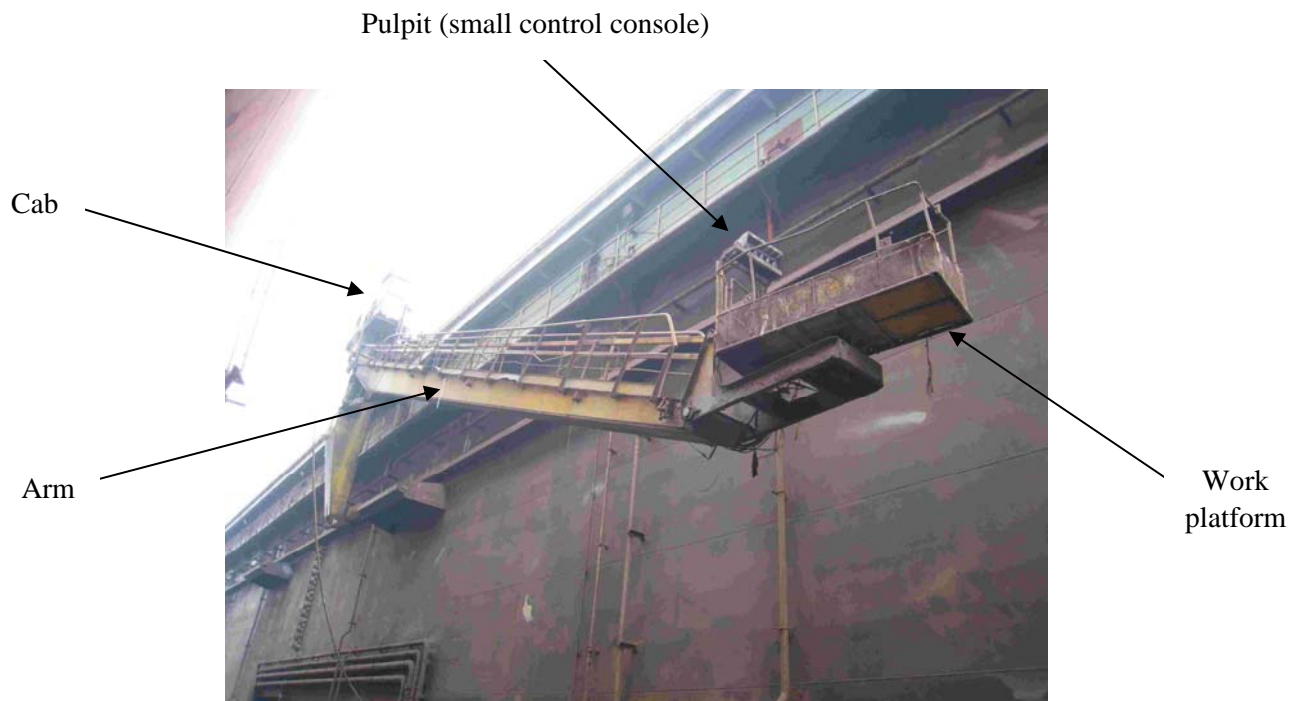


Fig. 2: The No.1 Dock Arm on board Floating Dock "United"

A dock arm is usually used for conveying workers to the vicinity of hull plates of a vessel under repair to carry out grit-blasting or painting work. There are four dock arms (Nos.1, 2, 3 & 4) (see Fig.2) fitted on the *FD*, two at port side (Nos.3 & 4) and two at starboard side (Nos.1 & 2). The dock arms are of same design and constructed of steel structures and their movements are hydraulically operated. On the extremity of the arm there is a rotating work platform which could remain horizontal at different angles of inclination.

## 2.3 Movements of Dock Arms

- Each dock arm has the following three degree of movements (see Fig.3):-

- i) the dock arm cab (see Fig.4) together with the arm moves fore and aft along the rail fitted on the top deck of *FD* (i.e., translation);
- ii) the arm slewing (i.e., rotating around the cab); and
- iii) the arm luffing (i.e., moving up above or down below the cab).

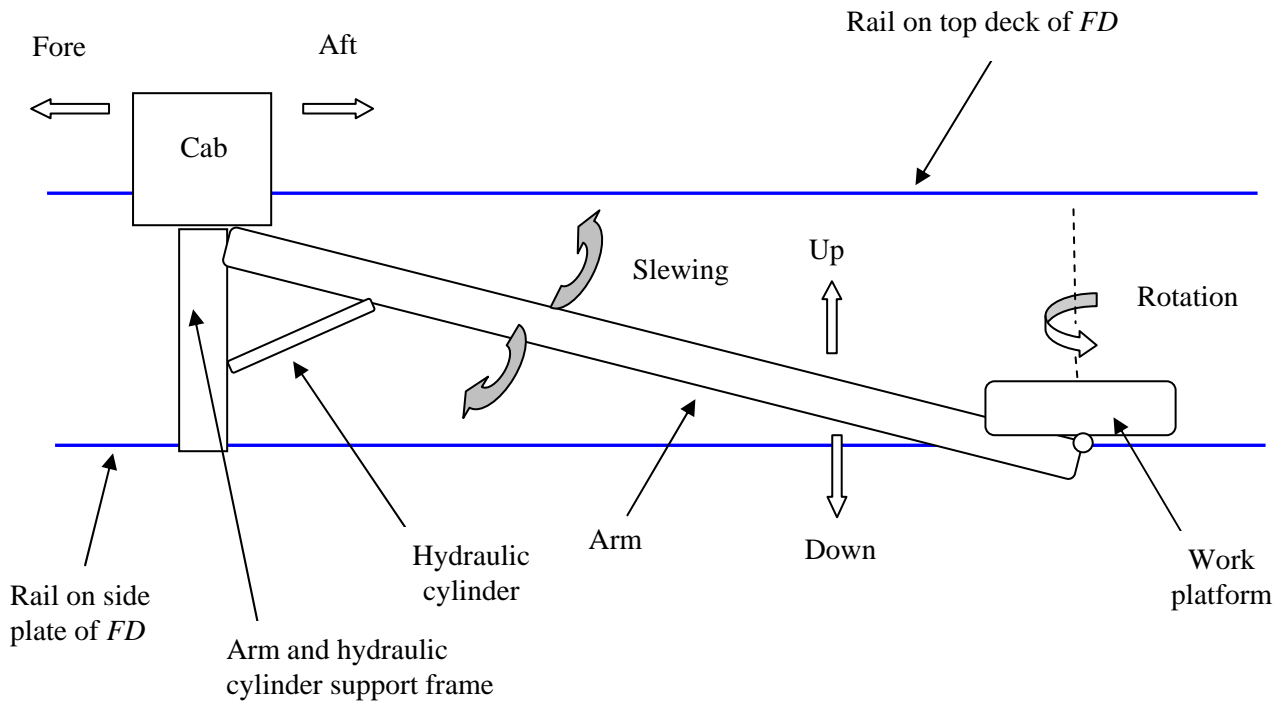


Fig. 3: Movements of a Dock Arm on board Floating Dock "United"



Fig. 4: The Cab of No.2 Dock Arm on board Floating Dock "United"

- b) The arm rotation (slewing) is carried out by a gear motor which transmits the motion by means of a pinion and a toothed wheel keyed on the transmission axle (upper rotation pin) of the arm. The upper rotation pin is keyed on the upper coupling of the arm and hydraulic cylinder support frame to make the arm slewing (see Fig.5). At the bottom of the arm and hydraulic cylinder support frame, there is a lower rotation pin and a thrust bearing is fitted inside a lower support bush. The bush is fixed on the lower structure (by M20 bolts) which moves fore and aft along a rail fitted on the side plate of *FD* during translation of the arm.
- c) The luffing of the arm is carried out by means of a hydraulic cylinder.
- d) The dock arm can be controlled either from a console located in the cab which is placed on a rail on the top deck of *FD* or from a pulpit (small control console) on the work platform.

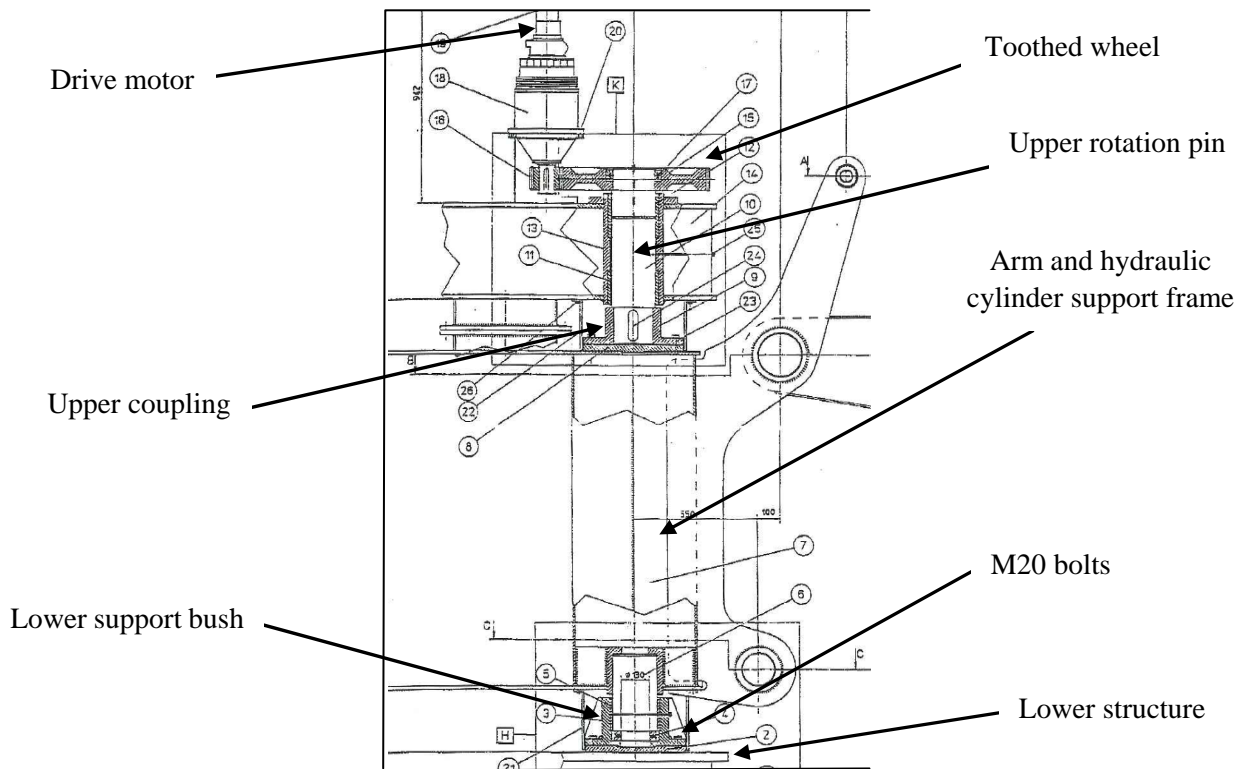


Fig. 5: Dock Arm Slewing System

### **3. Sources of Evidence**

- a) The Facility Management Engineer, Ship-repair Superintendent, Grit-blasting & Painting Superintendent and a grit-blasting & painting worker of Hongkong United Dockyards Limited
- b) Drawings and plans of the *FD*
- c) Assembly and maintenance handbook, drawings and plans of dock arm provided by Hongkong United Dockyards Limited
- d) Investigation report submitted by Michielotto Gru & Service S.p.A.
- e) Weather report from the Hong Kong Observatory
- f) Autopsy report of the deceased

**4. Outline of Events**

4.1 On the morning of 13 March 2008, an ocean-going vessel “*E. R. Perth*” (hereinafter referred as the “*OGV*”) was lying on the *FD* anchored at West Tsing Yi for ship-repairing (see Fig.6).



Fig.6: “*E. R. Perth*” Lying on Floating Dock “*United*”

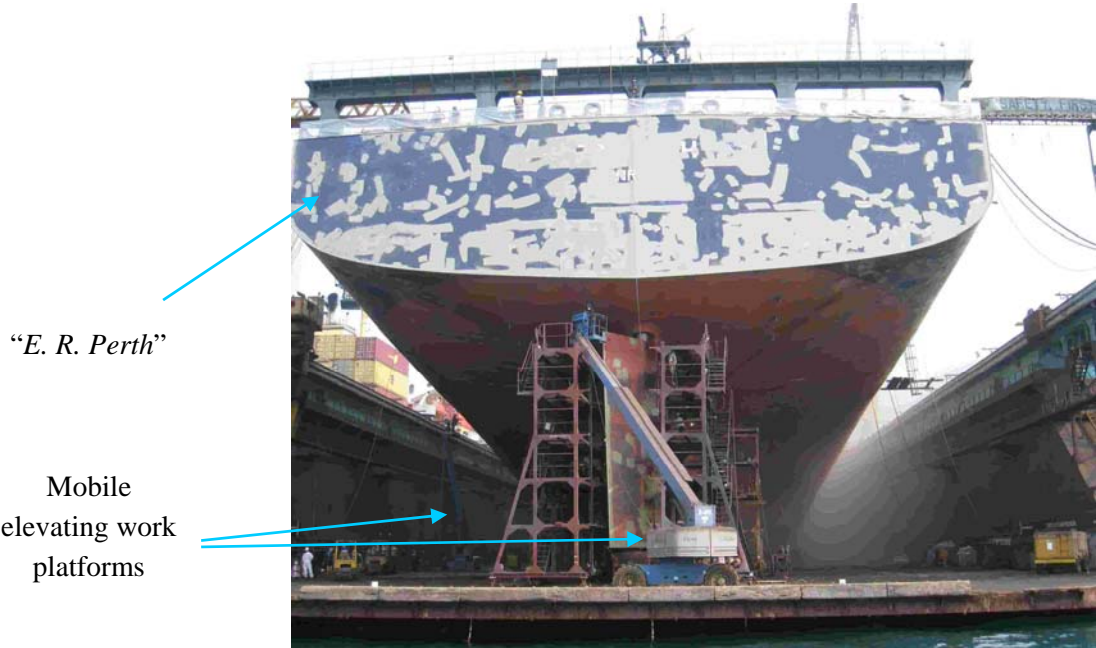


Fig.7: Mobile Elevating Work Platforms in Use on Floating Dock “*United*”

- 4.2 Grit-blasting was carried out to the hull plates of the *OGV* by several teams of grit-blasting & painting workers to remove the scales and old paint. Four teams of workers each used a dock arm to carry out the grit-blasting. Other teams used cherry pickers (mobile elevating work platforms) (see Fig.7).
- 4.3 The workers went to lunch at about 1200 and the grit-blasting work was restored after lunch at about 1245.
- 4.4 A team of two workers used No.2 dock arm at the starboard forward of *FD* to carry out grit-blasting to the hull plate at the starboard side bow of *OGV*. A worker was standing on the work platform of the dock arm at elevated height holding the grit-blasting gun to point at the hull plate and another worker provided supporting services including feeding the grits at the bottom of *FD*.
- 4.5 At about 1434, the worker on the work platform of No.2 dock arm was carrying out grit-blasting to the bow of *OGV* at an elevated height of about 18 metres above the bottom of *FD*. Suddenly the arm of No.2 dock arm detached from its support and fell off.

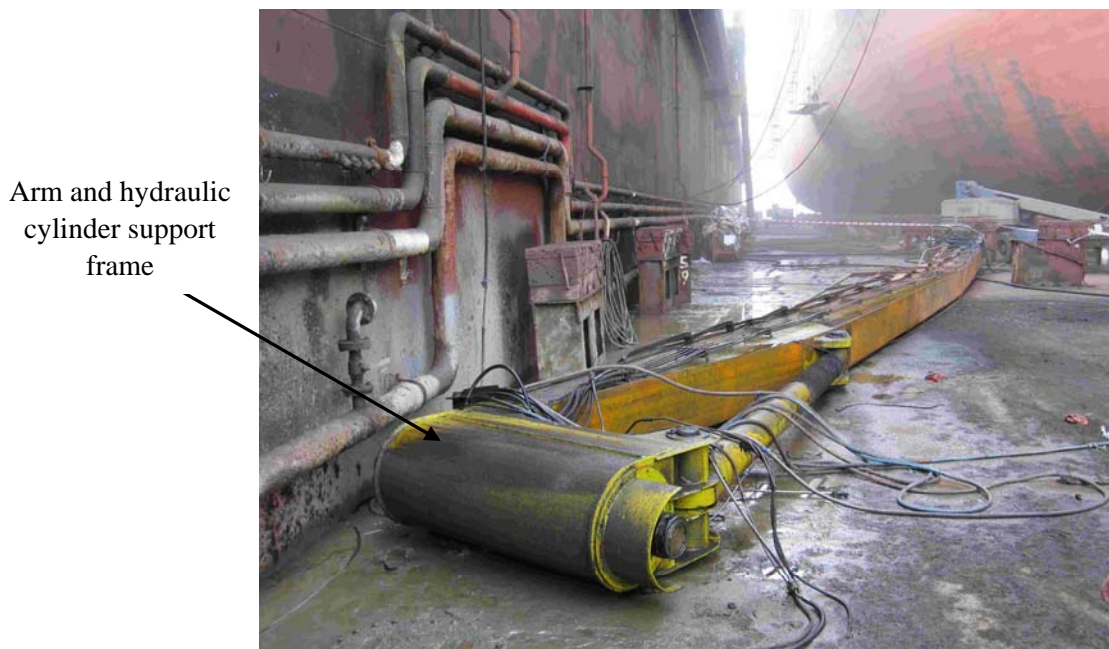
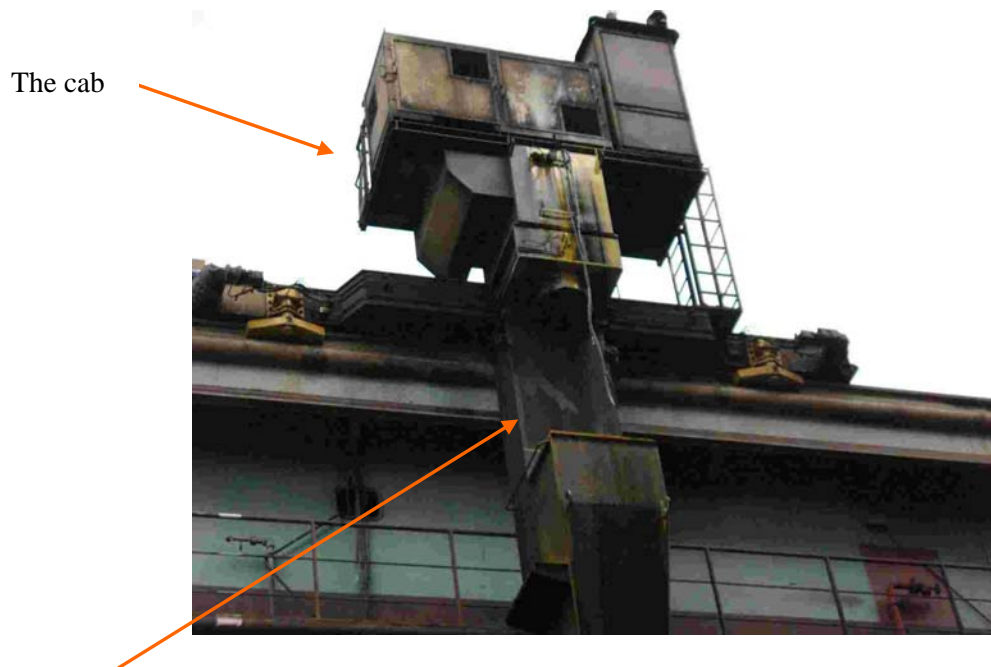


Fig.8: Broken Dock Arm Lying at the Bottom of Floating Dock “United”

- 4.6 The worker on the platform fell together with the arm to the bottom of the *FD* (see Figs.8, 9, 10 & 11).



Fig.9: Distorted Platform and Arm Lying at the Bottom of Floating Dock “United”



The cab

The arm had detached from the lower structure

Fig. 10: The Cab of No.2 Dock Arm on board Floating Dock "United"

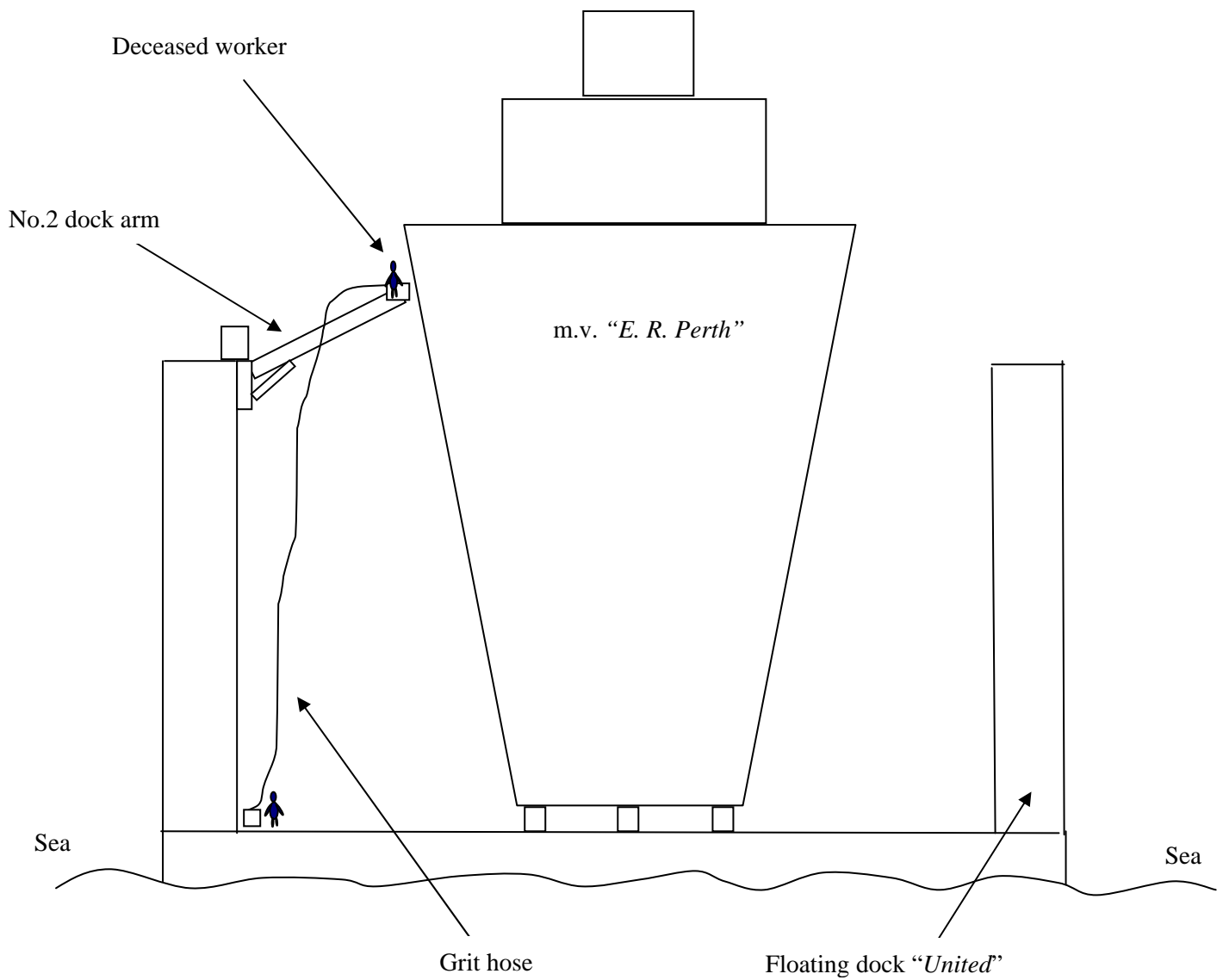


Fig.11: The Workers Carrying out Grit-blasting at the Time of Incident

4.7 The worker was found lying near the work platform of broken dock arm at the bottom of *FD*. Rescue team was summoned and the injured worker was sent to hospital. Later he was certified dead in the hospital.

## 5. Analysis of Evidence

## Damage of the No.2 dock arm

- 5.1 The fallen arm was found slightly bent and the work platform was distorted (see Figs.8 & 9). The upper coupling of the arm and hydraulic support frame was deformed with both keyways being torn apart (see Figs.12, 13 & 14).



Fig.12: The Arm and Hydraulic Support Frame of No.2 Dock Arm

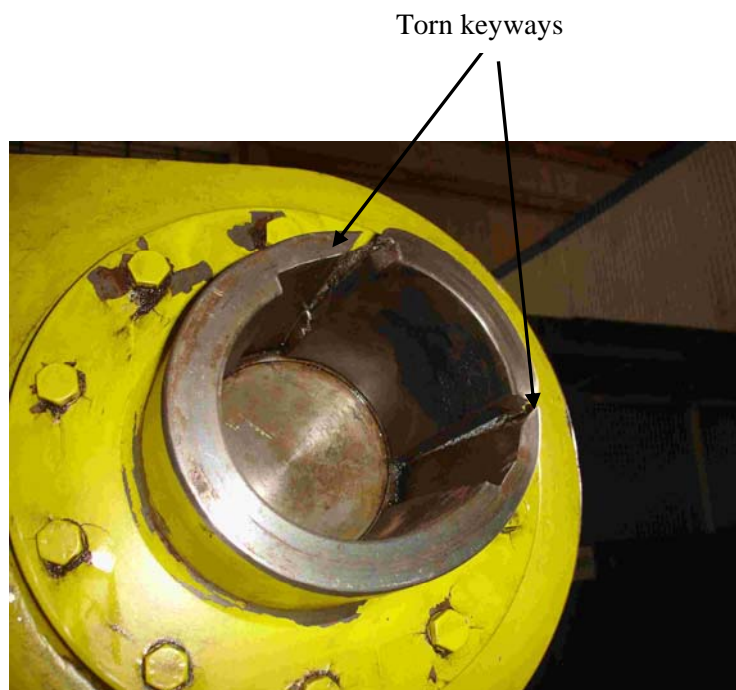


Fig.13: Deformed Upper Coupling with Both Keyways being Torn Apart



Fig.14: Keys of Upper Coupling and Upper Rotation Pin

5.2 The lower support bush for the arm and hydraulic support frame was deformed and detached from the lower structure during the accident. All 10 pieces of M20 steel bolts (diameter of bolts is 20 mm) which fixed the bush onto the lower structure were broken (see Figs.15, 16, 17 & 18).



Fig.15: Lower Support Bush for the Arm and Hydraulic Support Frame of No.2 Dock Arm



Fig.16: The Bottom Side of the Deformed Flange of Lower Support Bush



Fig.17: Nine Broken M20 Bolts of the Lower Support Bush and Parts of Thrust Bearing

The lower support bush had been detached from the lower structure



Fig.18: Lower Structure for Supporting the Arm and Hydraulic Support Frame of No.2 Dock Arm

5.3 Both the upper coupling and the lower support bush are the stress-bearing parts to hold the arm in position (see Fig.19).

The arm

Location of upper coupling

Rail on side plate

Location of lower support bush



Fig. 19: The No.3 Dock Arm on board Floating Dock "United"

- 5.4 The nominal outside diameter of the cylindrical section of the steel upper coupling is about 250 mm. After the accident, it is found that it has been enlarged to a maximum of 285 mm (see Fig.13).
- 5.5 The thickness of metal of the cylindrical section of the coupling is about 35 mm. The depth of each keyway at the coupling is about 12.5 mm. Hence the thickness of metal in way of each keyway is 22.5 mm. The keyway located at the tangent line parallel to the arm (tangent to the cylindrical section of the coupling) (see Fig.20). The keyways would be the stress concentrated areas at the upper coupling and would easily be torn apart when the coupling was under excessive stress.

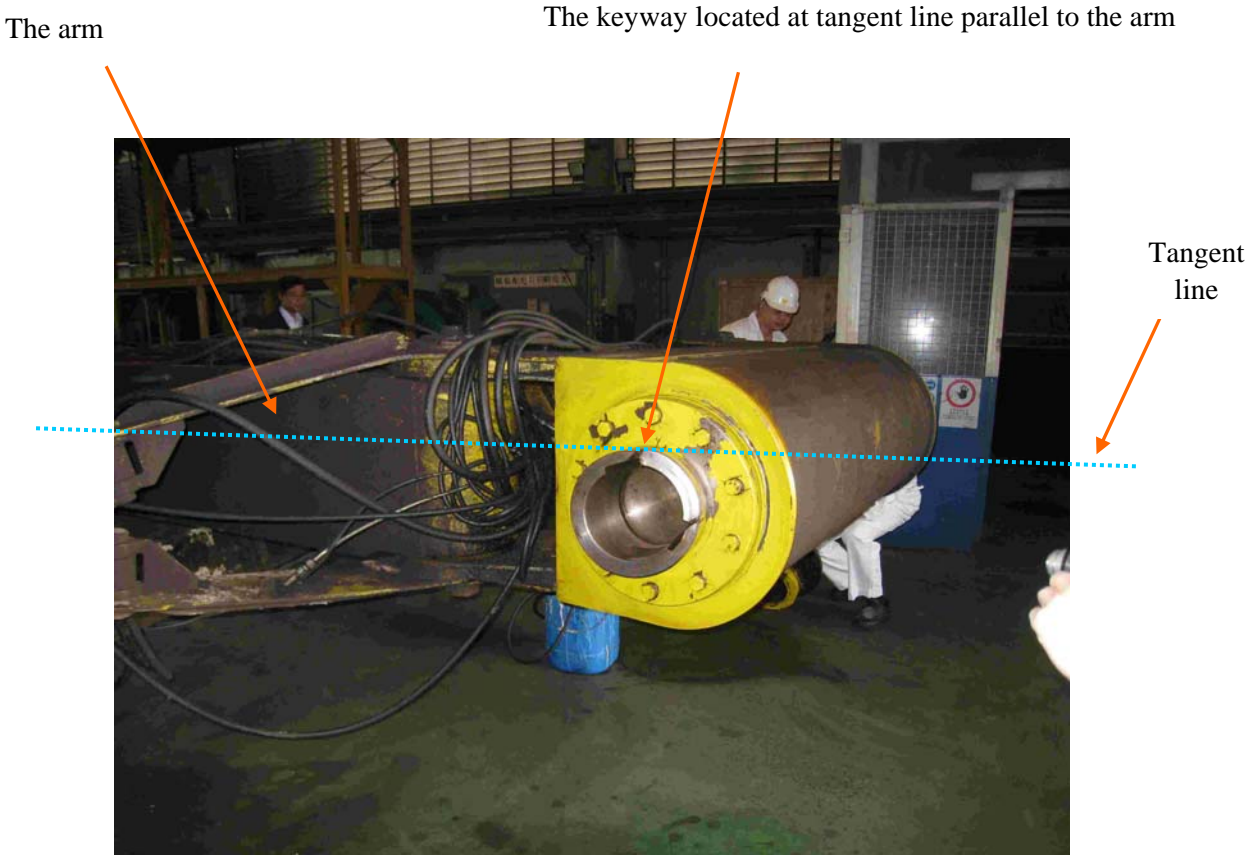


Fig.20: The Arm and Hydraulic Support Frame of No.2 Dock Arm

- 5.6 The maximum outreach of the dock arm is 25 metres. At the time of accident the outreach the dock arm was about 22.5 metres, i.e., it was at a position close to maximum stress sustained.
- 5.7 It is probable that tiny cracks had been developed and propagated in the keyway of the upper coupling which in line with the arm at the time of service before the accident. The

cracks developed rapidly at the time of accident leading to the failure of the coupling at the keyways (see Figs. 21 & 22).



Fig.21: Deformed Upper Coupling with Keyway being Torn Apart



Fig.22: Inside View of the Deformed Upper Coupling

5.8 After the failure of the keyways of the upper coupling, the arm and hydraulic support frame would then be misaligned. The M20 steel bolts which holding the lower support

bush as well as the arm assembly onto the lower structure would subject to excessive stress. Under such excessive stress, the bolts would start to break and consequently the arm lost its support and fell off.

- 5.9 The outside diameter of the steel flange of the lower support bush was about 450 mm. Its surface was found bent by about 11 mm. Such deformation might occur before or during the accident. There were no lock washers fitted to the M20 bolts.
- 5.10 On the other hand, it is also probable that at the time of service before the accident, some of the M20 bolts became loosened and the lower support bush shifted aside. The arm and hydraulic support frame would then become misaligned as well as the flange became bent. Such misalignment would impose excessive stress on the flawless upper coupling resulting the failure of the keyways.
- 5.11 After the accident, the upper couplings and lower support bushes of the remaining three dock arms of the *Vessel* were opened up for inspection. No defect had been found.

#### **Damage to bottom of *FD***

- 5.12 The falling of the No.2 dock arm had also caused two small holes on the bottom steel plates of *FD* (see Fig.23).



Fig.23: Two Holes were Repaired by Doublers on the Bottom Plate of Floating Dock “*United*”

#### **Maintenance of the dock arms**

- 5.13 In the maintenance handbook of the dock arms, the manufacturer recommends users to check possible loosening of the M20 bolts of the lower support bush and upper coupling periodically. However, there is no recommendation on the open-up inspection of the upper couplings and lower support bushes during the service life of dock arms.
- 5.14 All dock arms are lifting appliances with a safe working load of 600 kilogrammes. Under Merchant Shipping (Local Vessels) (Works) Regulation, Cap.548 subsidiary legislation, the lifting appliances have to be thoroughly examined once a year and load tested in every four years by competent examiners.
- 5.15 Running tests to the dock arms had been carried out in the manufacturer's workshop with test load of 750 kilogrammes before they were installed and put into use on the *FD* in 1995. Since then, there is no record to show that the dock arms had been thoroughly examined or load tested in the past 13 years before the accident.
- 5.16 No open-up inspection had been carried out to the upper couplings and lower support bushes in the past 13 years. Only external visual inspections and tightening of bolts had been done. The last external inspection to the No.2 dock arm before the accident was carried out in December 2006, i.e., 15 months before the accident, by staff of the dockyard.
- 5.17 Had the upper coupling and lower support bush of the dock arm been thoroughly examined (i.e., open-up inspected) before the accident, any cracks developed in the keyways or any loosened bolts could have been found and remedied, and thus the accident could have been prevented.

### **Working experience & training**

- 5.18 The deceased had worked as a grit-blasting & painting worker for two years. He had been trained and was competent to operate the dock arms and cherry pickers.

### **The environment**

- 5.19 At the time of the accident, the state of weather was normal. The weather condition was not considered to be a contributory factor of the accident.

### **Autopsy report**

- 5.20 According to the autopsy report of the deceased furnished by the Department of Health, he died of multiple injuries. The nature and pattern of the injuries were compatible with being caused by falling from height.

## **Fatigue**

5.21 The deceased commenced the grit-blasting work at about 0800 and the accident occurred after the lunch break. There was no evidence to show that the deceased had suffered from fatigue.

## **6. Conclusions**

- 6.1 An industrial accident happened onboard a locally licensed floating dock “*United*” at West Tsing Yi on 13 March 2008. While a grit-blasting & painting worker was on the work platform of an elevated dock arm to carry out grit-blasting to the hull plate of an ocean-going vessel, the dock arm collapsed and he fell down about 18 metres together with the dock arm to the bottom of the dock. The worker sustained fatal injuries.
- 6.2 The investigation revealed that the accident was caused by the failure of the upper coupling and lower support bush which were stress-bearing parts to support the arm.
- 6.3 The accident was also contributed by the non-compliance of the Merchant Shipping (Local Vessels) (Works) Regulation, i.e., failure of carrying out thorough examination to the dock arm.

## **7. Recommendations**

- 7.1 A copy of this report should be sent to the dockyard advising them the findings of this accident, instructing them to comply with the requirements of the legislation and the need to develop a preventive maintenance plan for the dock arms with the manufacturer in order to prevent recurrence of similar accidents.
- 7.2 A Marine Department Notice should be issued to promulgate the lessons learnt from this accident, drawing the industry's attention on the findings of this accident and urging them to carry out open-up inspections to the stress-bearing parts of lifting appliances every four years in order to prevent recurrence of similar accidents.

## **8. Submissions**

- 8.1 In the event that the conduct of any person or organization is criticized in a casualty investigation report, it is the policy of the Hong Kong Marine Department that a copy of the draft report is given to that person or organization so that they have the opportunity to rebut the criticism or offer evidence not previously available to the investigating officer.
- 8.2 The draft report was forwarded to the following:  
Hongkong United Dockyards Limited  
Michielotto Gru & Service S.p.A.
- 8.3 No submission was received from the above-mentioned parties.