Tower crane incidents worldwide

Prepared by the Health and Safety Laboratory for the Health and Safety Executive 2010
Since 2000 there have been five major incidents on UK construction sites that involved the collapse of a tower crane. These five being Canary Wharf in 2000, Worthing in 2005, Battersea in 2006, Liverpool in 2007, Croydon in 2007 and Liverpool in 2009. Subsequent investigation into these incidents by HSE, assisted by HSL, showed that these collapses were due to different causes.

HSL were requested to identify tower crane incidents that had taken place around the world between 1989 to 2009 and obtain, where possible, the causes of each incident and the tower crane involved. The intention underlying the research was to use the information obtained to assist in advising and guiding the UK tower crane industry to help improve safety.

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EXECUTIVE SUMMARY

Objectives

Since 2000 there have been five major incidents on UK construction sites that involved the collapse of a tower crane.

HSL were requested by Mr Ian Simpson, HSE Principal Inspector having portfolio for lifting equipment and lifting operations, to identify tower crane incidents that had taken place around the world between 1989 to 2009 and obtain, where possible, the causes of each incident and the tower crane involved.

The intention underlying the research is to use the information obtained to assist in advising and guiding the UK tower crane industry to help improve safety.

Main Findings

A world wide total of 86 incidents involving the collapse or major structural failure of a tower crane have been identified as taking place between 1989 and 2009.

One of these incidents took place in the U.K. in 2009 and further details cannot be released until the conclusion of current investigations and any legal proceedings which might arise from the investigation. Consequently, this incident has not been included in any analysis of the causes of the incidents in this report.

Each of the remaining 85 incidents analysed has been placed in one of the following seven categories as follows:

- Erection/Dismantling/Extending of the crane – 29 Incidents (34%)
- Extreme Weather – 15 Incidents (18%)
- Foundation Issues – 2 Incidents (2%)
- Mechanical or Structural Issues – 4 Incidents (5%)
- Misuse – 6 Incidents (7%)
- Electrical/Control System Issues – 1 Incident (1%)
- Unknown Cause – 28 Incidents (33%)

10 of the world wide total of 86 incidents took place in the U.K. The causes of these were dominated by erection/dismantling/climbing and extreme weather.

No particular crane manufacturer has been identified as being more prone to incidents than any other.
1 INTRODUCTION

Since 2000 there have been five major incidents on UK construction sites that involved the collapse of a tower crane. These five being Canary Wharf in 2000, Worthing in 2005, Battersea in 2006, Liverpool in 2007, Croydon in 2007 and Liverpool in 2009.

Subsequent investigation into these incidents by HSE, assisted by HSL, showed that these collapses were due to different causes.

HSL were requested by Mr Ian Simpson, HSE Principal Inspector having portfolio for lifting equipment and lifting operations, to identify tower crane incidents that had taken place around the world between 1989 to 2009 and obtain, where possible, the causes of each incident and the tower crane involved.

The intention underlying the research is to use the information obtained to assist in advising and guiding the UK tower crane industry to help improve safety.
2 CRANE TYPES

The type of cranes considered in the research was confined to tower cranes commonly found on UK construction sites, i.e. conventional top slew tower cranes including saddle jib, flat top and luffing tower cranes.

A conventional top slew tower crane consists of a central mast or tower section mounted on a foundation, usually at ground level. The main features of the top part of the crane consist of a horizontal counterjib, horizontal main jib, cab (where fitted), counterweights and ‘A’ frame or slew turret. These are attached to the top of the mast section via a slewing ring that permits the top of the crane to rotate through 360º. The hook of this type of crane is positioned by travelling the hook along the main jib and by rotating the top of the crane via the slewing ring.

A luffing tower crane also consists of a central mast or tower section mounted on a foundation, usually at ground level. The main features of the top part of the crane consist of a horizontal counterjib, main jib, cab (where fitted), counterweights and the ‘A’ frame or tower head. The main jib is attached to the ‘A’ frame or counterjib using pivot points. The top of the crane is attached to the top of the mast section via a slewing ring that permits the top of the crane to rotate through 360º. The hook of this type of crane is suspended from the outer end of the jib and is positioned by raising and lowering the jib and by rotating the top of the crane via the slewing ring.

Only major incidents resulting in the collapse of the crane or a substantial part of its structure (e.g. the jib) have been considered in the research. Other incidents e.g. dropped loads, falls from height, trapping and crushing, fires, slips and trips and electrocutions etc have not been considered.

Not included in the research were incidents involving the following:

- Mobile Cranes
- Self Erecting Tower Cranes
- Tracked Crawler Cranes
- Dockyard Cranes (e.g. Gantry and Container Cranes)
3 SOURCES OF INFORMATION

The research was primarily conducted using the internet. During the course of the research the most useful websites that were regularly referred to were:

- [http://www.vertikal.net/en/](http://www.vertikal.net/en/)
- [http://www.cranestodaymagazine.com](http://www.cranestodaymagazine.com)
- [http://craneincidents.com](http://craneincidents.com)
- [http://towercraneincidents.blogspot.com](http://towercraneincidents.blogspot.com)

The vertikal and cranes today magazine websites are websites of trade magazines associated with the lifting and access industry. Both sites have news sections that are regularly updated and have archive sections of older news stories that can be searched.

Craneincidents.com and towercraneincidents.blogspot.com are websites of two U.S.A. based private individuals who have knowledge and connection with the lifting industry.

Craneincidents.com was launched on 27 January 1999 and is operated by a Mr Doyle Peeks who, according to his resume, on the website has been involved in the construction industry for more than half a century, as an equipment operator (including cranes), master mechanic, equipment manager, superintendent and as a business owner.

Towercraneincidents.blogspot.com is operated by a Mr Gaytor Rasmussen who, according to information on his website works as a crane erector and inspector.

In addition to the above, websites of media local to an identified incident was also referred to where possible or available. Usually this was local newspapers (e.g The New York Times) and websites of other media including local radio and television stations. In the U.K., the BBC website was also referred to.

Internet research does have limitations and due regard must be given to the accuracy and relevance of information gained from the internet. In this research the principal limitations of using the internet were found to be:

- No single source of reliable accurate information was identified.
- Not all the four websites detailed above had knowledge of all the incidents. Some incidents were given on one website but not another.
- The two “trade” websites tended to be satisfactory when initially reporting the incident. Facts were given when facts were known about the incident and logical conclusions that followed from what was known were also expressed. In addition, if further information about a particular incident became known after the event, then this was generally followed up.
- The two websites of the private individuals were sometimes prone to speculation concerning an incident.
- Local media reports concerning an incident were usually in the immediate aftermath of the incident and tended to focus on the damage caused, number of
casualties etc. Technical details, where given, tended to be vague and sometimes inconsistent when compared with knowledge from the “trade” websites.

- Geographic locations also provided limitations. Incidents in U.S.A. and Europe tended to have more information available on the internet than those from more remote and possibly less well developed countries, e.g. China, North Korea etc.

In addition to the above, the two websites of the private individuals tended to detail more incidents than on either of the two “trade” websites. In a number of cases it was not clear which type of crane was involved in a number of incidents reported on these private websites. Considering that both websites are operated from the U.S.A. I believe that a lot of incidents that have taken place in the U.S.A. reported on these two websites that do not detail the crane involved may have involved either mobile or tracked crawler cranes, rather than tower cranes.

For instance, craneincidents.com carries the following entry for September 1996:

“September 1996: Lexington, Kentucky — University of Kentucky
Crane collapses onto roof of bookstore | Dead Link | | Cache Copy N/A |

A crane from a construction site fell onto the roof of the Kennedy Bookstore yesterday morning, causing thousands of dollars in damage to the bookstore at 405 South Limestone Street. No one was injured.”

The link given in the article is a “dead link”, i.e. when followed it does not reveal anything of use and the phrase “cache copy N/A” indicates that the details of the incident are not held on craneincidents.com own website.

Also, craneincidents.com carries the following entry for June 2004:

6/06/04: China — 5 killed by crane jib fall
| Cache Copy |

In this case, the “cache copy” is functioning (at the time of writing this report). Unfortunately, the article from the China Daily newspaper (via Xinhua news agency) is not at all detailed and refers only to “.....incident Saturday morning in which a crane's jib fell down, killing two instantly and another three died in the hospital, local officials said.”. The type of crane is not stated so it is uncertain if it was a tower crane or not

No further details of these incidents are available from craneincidents.com, in particular the type of crane involved is not identified and no information from any other source to determine more detail was found using standard search engines such as Google, Yahoo and Ask Jeeves etc.

In such cases, where the type of crane involved has not been able to be positively identified as a tower crane the incident has not been included in the research.

Therefore, this report is likely to under estimate the actual number of tower crane incidents.
4 INCIDENTS IDENTIFIED

86 incidents resulting in the collapse or major structural damage of the tower crane involved were identified since 1999. Information concerning incidents prior to 1999 was found to be very scarce and only 1 incident was identified from 1989 to 1999.

Based on the information obtained during the research the circumstances of each incident has been categorised into seven different broad groups:

- Erection/Dismantling/Extending of the crane
- Extreme Weather
- Foundation Issues
- Mechanical or Structural Issues
- Misuse
- Electrical/Control System Issues
- Unknown Cause

The following lists all the incidents found during the research and states which of the groups above they have been categorised as.

4.1 1989 INCIDENTS

4.1.1 San Francisco

In November 1989 a Peiner luffing crane collapsed whilst being extended (or climbed). It is believed that the climbing frame was binding on the mast section resulting in out of squareness and unevenly applied loading. The collapse is reported to have occurred when the crane was slewed with the separated mast section.

This incident has been categorised in the Erection/Dismantling/Extending group.

4.2 1999 INCIDENTS

4.2.1 Salt Lake City, Utah, U.S.A.

On 11 August 1999, Salt Lake City was struck by a tornado. This caused structural damage to the jib of a saddle jib crane (manufacturer unknown), causing the jib to collapse to the ground. The mast section and counterjib remained in situ and did not fall to the ground.

This incident has been categorised in the Extreme Weather group.

The crane is shown in Figure 1

4.2.2 Frankfurt, Germany

In August 1999 a Liebherr 256 HT tower crane collapsed during erection. Reports suggest that the crane was slewed at an incorrect moment. The investigating authority was reported to be the German technical standards authority, TUV Hessen.
This incident has been categorised in the Erection/Dismantling/Extending group.

4.3 2000 INCIDENTS

4.3.1 Bangkok, Thailand

In April 2000, a tower crane located on the 17th floor of a 38 storey building project reportedly toppled and fell to the ground. No further details have been found.

This incident has been categorised in the Unknown causes group.

4.3.2 Singapore

On 11 April 2000, the jib of a luffing crane reportedly collapsed while being raised. The manufacturer of the crane is unknown and the investigating authority was the Singapore Ministry of Manpower. It is believed that the luffing hoist mechanism was “faulty” allowing the luffing rope to “unwind from the winch”. The nature of the hoist fault has not been determined in the research.

This incident has been categorised in the Mechanical or Structural group.

4.3.3 Canary Wharf, London, England

On 21 May 2000 a Wolff 320 B Luffing crane collapsed whilst the mast section was being extended. The investigating authorities were the HSE. The exact causes of the incident were not determined but issues of concern raised during the investigation included:

- Possible fatigue of the erection crew and the possibility of taking shortcuts or rushing towards the end of the working day.
- Changes in wind speed and direction whilst the crane was supported on the climbing frame.
- The securing of the single hydraulic cylinder of the climbing frame with the mast section.

This incident has been categorised in the Erection/Dismantling/Extending group.

4.4 2001 INCIDENTS

4.4.1 Tianshui, China

In December 2001 a crane reportedly collapsed at a building site in Tianshui, China. There are no further details other than the crane had reportedly just unloaded some soil.

This incident has been categorised in the Unknown causes group.

4.5 2002 INCIDENTS

4.5.1 Chicago, Illinois, U.S.A.

This incident took place on 31 January 2002 and involved a Pecco tower crane. Photographs show that the top of the crane has parted from the mast section at the slewing ring.
No further information has been found but one eyewitness is said to have reported “....the crane was spinning very fast at 01:00 am and then it started to fall down”. This may imply that the cause of the incident was extreme weather but this is not completely certain.

This incident has been categorised in the Unknown causes group.

The crane is shown in Figures 2a and 2b.

### 4.5.2 Taipei, Taiwan

An earthquake measuring 6.8 on the Richter scale struck Taipei on 31 March 2002. At the time four Favelle Favco luffing cranes were in use in constructing the building Taipei 101. Two cranes located at the 56th floor level were shaken from the foundations and fell to the ground.

This incident has been categorised in the Extreme Weather group.

The incident is shown in Figure 3 and two videos can be found at the following link [http://towercraneincidents.blogspot.com/2008/08/april-1-2002.html](http://towercraneincidents.blogspot.com/2008/08/april-1-2002.html)

### 4.5.3 Jerusalem, Israel

This incident took place in September 2002. The manufacturer of the crane is not known and details are vague. From reports it does however appear the crane was being dismantled at the time of the collapse and the collapse may be due to misuse of a mobile crane.

This incident has been categorised in the Erection/Dismantling/Extending group.

The crane is shown in Figure 4.

### 4.5.4 Cuijk, Holland

This took place on 1 November 2002. Details are vague but a single photograph, Figure 5, shows a saddle jib tower crane lying on its side.

The sign on the hand rails would indicate that the crane is a Potain. Reports indicate that the incident happened as the counterweights were being installed. However, it also appears that the concrete foundation block shown to the right of the picture has pulled out of the ground.

The exact cause of the incident is unknown, it is possible that there was a problem with the foundations such that they were not capable of sustaining the normal loads and moments applied by the crane. Alternatively, it is possible that the foundation was adequate and that the counterweights were fitted at an incorrect point during the erection sequence and too great a resultant moment was applied to the foundation.

This incident has been categorised in the Unknown causes group since no definitive explanation has been found during the research.

### 4.5.5 Kuala Lumpur, Malaysia

On 7 November 2002 the jib of a luffing crane collapsed whilst lifting a load. No cause for the incident has been identified in the research.

This incident has been categorised in the Unknown causes group.
4.6 2003 INCIDENTS

4.6.1 Singapore

It is reported that a tower crane collapsed on 17 January 2003. No further details concerning the incident have been found but a news report from “channelnewsasia.com” states that the witnesses reported that workers were “…trying to dismantle the crane when the structure gave way”.

This incident has been categorised in the Erection/Dismantling/Extending group.

4.6.2 Düsseldorf, Germany

Three tower cranes collapsed on a building site on 29 April 2003. Reports state that the foundations failed on the first crane to collapse, a saddle jib Liebherr. The driver on another crane apparently saw the collapse start and positioned the jib of his crane to deflect the falling crane away from a school hall. In the process of the collapse the other cranes were brought down as well.

Two photographs of site following this incident are shown in Figure 6.

This incident has been categorised in the Foundation issues group.

4.6.3 Rotterdam, Holland

This incident took place on 2 December 2003. No details concerning the incident have been found other than photographs suggest that the crane tipped over at the lower mast section/foundation level.

One source of information I have been able to find concerning this incident is from www.craneoperator.com. This appears to be a website of an American company called “Barth Crane Inspections LLC”. On their website the incident is attributed to “…..several bolts from the Tower crane cranefoot were used and probably they were over-tightened”.

This incident has been categorised in the Unknown causes group.

The crane is shown Figures 7a and 7b.

4.7 2004 INCIDENTS

4.7.1 Dublin, Ireland

On 1 February 2004, the jib of a Wolff saddle jib tower crane failed in two places but was prevented from falling to the ground by the jib tie bar. It was reported that high winds were responsible for the incident and there was a reported possibility that the slew motor brake had either jammed on or been left applied such that free slew of the crane in the wind was prevented. The investigation authorities were the H.S.A.

This incident has been categorised in the Extreme Weather group.

The crane is shown Figures 8a and 8b.
4.7.2 Manama, Bahrain

On 15 May 2004 a tower crane collapsed. A photograph from “craneaccidents.com” shows that the mast section was short in comparison to the building and has what appears to be a climbing frame positioned at the top. An article from Gulf Daily News suggests that the crane was being dismantled at the time of collapse and had been reduced to a height of 12 m from the original 54 m. This is consistent with the photograph.

This incident has been categorised in the Erection/Dismantling/Extending group.

The photograph showing this crane is shown Figure 9.

4.7.3 Cardiff, Wales

On 9 July 2004 the jib of a Raimondi LR60 luffing crane was severely damaged by strong winds and was blown back over the ‘A’ frame.

The investigation authorities were the HSE. During the investigation it was found that the mechanical slew motor brake had two faults. The setting mechanism was faulty such that it could slip leading to the brake being unknowingly applied and that the applied braking torque was approximately ¼ of that specified.

This incident has been categorised in the Extreme Weather group.

4.8 2005 INCIDENTS

4.8.1 Guangzhou, China

Tower crane incident reported to have taken place on 28 January 2005. According to a news report from Xinhua news agency it is reported that the crane was being dismantled at the time of the incident.

Reference to the website of Jinan Jihong Machinery Co Ltd appears to give some details of this incident. (http://www.jnjhtj.com/ywxt/ShowInfo.asp?ID=19). The crane model is given as a “QTZ – 63 type jack up tower crane” (presumably of Chinese manufacture) and from pictures on the website this appears to be a saddle jib tower crane having a climbing frame fitted.

The report on the Jinan Jihong Machinery Co Ltd website has obviously been translated from Chinese (Mandarin or Cantonese) and much has been “lost in translation”. However, from the text it does appear that the information provided is consistent with a problem occurring during erection/dismantling/extending the crane.

This incident has been categorised in the Erection/Dismantling/Extending group.

4.8.2 Australia

On 3 February 2005 severe winds blew the jib of a luffing crane back over the ‘A’ frame.

No further information concerning this incident has been found. In particular it is not known at what angle the jib was raised to or if the crane was permitted to free slew correctly.

This incident has been categorised in the Extreme Weather group.

The crane is shown in Figure 10.
4.8.3 Worthing, Sussex, England

A BPR tower crane collapsed on 11 February 2005. During the collapse it struck and damaged another crane on site but this remained basically intact but suffering a buckled jib.

The investigating authorities were the HSE and it was found that the root cause of the collapse was due to mast section bolts being untightened and left “finger tight” in preparation for dismantling the crane. The crane was slewed such that the applied load stretched and ultimately fractured the loose mast section bolts causing the crane to collapse.

This incident raised issues of operator competence and training in the UK crane industry.

This incident has been categorised in the Erection/Dismantling/Extending group.

4.8.4 Hong Kong

A Potain Tower crane collapsed on 7 July 2005. Photographs would suggest that the bottom of the mast section failed or perhaps separated from the foundation. No further details of this incident have been found and the exact cause is unknown.

This incident has been categorised in the Unknown causes group.

The crane is shown in Figures 11a and 11b.

4.8.5 Drammen, Norway

The newspaper “Aftenposten” reported that the counterjib of a tower crane fell to the ground on 11 May 2005, apparently as preparations were underway to dismantle the crane. Photographs show the crane to be a Potain saddle jib tower crane. No further information has been found.

This incident has been categorised in the Erection/Dismantling/Extending group.

The crane is shown in Figures 12a and 12b.

4.8.6 Shanghai, China

Xinhua news agency reported the collapse of a “400 m Tower crane” that took place on 6 June 2005. According to the report “...a worker was testing the huge Tower crane by loosening the screws at the foot of the machine, triggering the collapse...”.

No further details of this incident have been found.

This incident has been categorised in the Erection/Dismantling/Extending group.

4.8.7 Qingyuan, China

The collapse of a Tower crane during dismantling was reported by the Beijing Times newspaper on 31 October 2005. The article gives no detail other than casualty numbers and I have not been able to find any further information.

This incident has been categorised in the Erection/Dismantling/Extending group.
4.8.8  **West Palm Beach, Florida, U.S.A.**

A tower crane collapsed on 7 November 2005. The collapse is attributed to severe storm force winds associated with hurricane “Wilma”. According to one newspaper report the crane was provided by “Morrow Equipment Hire”. Their website indicates that they supply Liebherr, Wolff, Comedil and Peiner cranes. Hence the crane involved is probably one of these makes.

One small indistinct photograph from the newspaper report would perhaps indicate that the crane was a Comedil flat top, but this is not certain. The photograph is given in Figure 13.

This incident has been categorised in the Extreme Weather group.

4.8.9  **Puchong, Kuala Lumpur, Malaysia**

The New Straits Times newspaper website reported the collapse of a Tower crane on 26 November 2005. Details of the crane concerned have not been found during the research and other details are also vague.

However, according to the newspaper report an eyewitness “…..said he saw the crane in the midst of lifting some material up when the load was stuck. Attempts to hoist the load up failed and the crane began slanting to the front. Suddenly, the cable holding the load snapped and the crane swung back and this caused it to collapse…”.

This incident has been categorised in the Misuse group.

4.8.10  **Bahrain**

A Tower crane collapse is reported by craneincidents.com to have taken place on 18 December 2005. The associated article (“cache copy”) is from the Gulf Daily News website. At first reading this incident seemed to be a duplicate of the Bahrain incident reported in Section 4.7.2, many of the details being very similar.

However, sufficient differences between the two articles exist for them to be believed to be separate incidents.

In this case the Tower crane is also reported to have collapsed during dismantling. No further details concerning this incident have been found during the research.

This incident has been categorised in the Erection/Dismantling/Extending group.

4.9  **2006 INCIDENTS**

4.9.1  **Tel Aviv, Israel**

On 6 March 2006 a tower crane collapsed. Very little detail concerning this incident has been found. However, it is reported that the building the crane was working on was 26 storeys high and the crane fell from a height of 130 m.

It is also reported that “…..the entire top of a 130 m tower crane attached to Tel Aviv’s Neveh Tzedek Tower construction site broke loose from its bearing and crashed into a building and onto the road…..”.

This incident has been categorised in the Unknown causes group.
4.9.2 Uitenhage, South Africa

A tower crane collapsed on 31 May 2006 at the site of a Volkswagen factory. It is reported that the crane was being dismantled at the time of the incident and that the “counterweight collapsed first, followed by the main jib”. No further details have been found.

This incident has been categorised in the Erection/Dismantling/Extending group.

4.9.3 Cupertino, California, U.S.A.

On 3 June 2006 a luffing crane collapsed on a shopping mall. Details are vague but a report on craneincidents.com is said to be from a reliable source. This report suggests that the crane was left parked with a steeply raised jib and was subsequently struck by severe winds associated with a storm.

This incident has been categorised in the Extreme Weather group.

4.9.4 Battersea, London, England

On 26 September 2006, failure of slewing ring bolts allowed the top part of the crane (jib, slew turret, counterjib and counterweights) to fall to the ground.

The crane involved was a BPR 222 and was approximately twenty-seven years old.

This incident has been categorised in the Mechanical or Structural group.

4.9.5 Holborn, London, England

The jib of a luffing crane buckled and collapsed on 19 October 2006. It is believed that the crane collided with another at the same site.

This incident has been categorised in the Misuse group.

The crane is shown in Figure 14.

4.9.6 Bellevue, Seattle, U.S.A.

A Liebherr saddle jib tower crane collapsed on 17 November 2006. It is reported that the mast section failed approximately 15 feet above the base. Subsequent investigation by Occupational Safety and Health Administration (OSHA) and Washington State Department Labour and Industries attributed the incident to the failure of an unusual “non standard” purpose built steel fabrication foundation consisting of steel I section cross beams supported by four concrete pillars.

The crane was rented from Morrow and erected by North West Tower Crane Service Inc.

However, it is interesting to note that during the investigation cracks in the mast section of another Liebherr crane were found. This crane was very close to the crane involved in the incident, one city block away, and had been erected by the same company (North West Tower Crane Service Inc). It is reported that this crane was located on a more conventional concrete foundation base.

This incident has been categorised in the Foundation issues group.

The crane and a sketch of the foundation are shown in Figures 15a, 15b and 15c.
4.9.7 Penang, Malaysia

On 20 December 2006, the top of a saddle jib tower crane fell from the mast section. No more details have been found concerning this incident, however vertikal.net suggested that the crane was operating in very strong wind conditions. The photograph accompanying the vertikal article is not very clear. However it does appear to show that the mast section has been tied to the building.

This incident has been categorised in the Extreme Weather group.

The crane is shown in Figure 16.

4.10 2007 INCIDENTS

4.10.1 Liverpool, Merseyside, England

On 15 January 2007 a Jaso J138PA luffing crane collapsed. The subsequent HSE investigation showed that the crane had been operating with a steeply raised jib at or close to minimum working radius. Wind speeds were approaching the maximum permitted 20 m/s and it is believed that short duration gusts in excess of this were being experienced.

It is believed that the sequence of events leading to the incident was:

- The jib was facing the wind direction and the jib was blown backwards against the spring stops on the ‘A’ frame.
- In this process the luffing rope became slack and came out of the grooves of one or more of the pulleys at the top of the ‘A’ frame.
- This caused a snag or jam such that the jib of the crane could not be lowered using the luffing system. However, the crane driver operated the controls to lower the jib and a large amount of luffing rope was payed out from the luffing winch drum and this hung down in a loop behind the crane.
- At some point the luffing rope jam at the top of the ‘A’ frame cleared and the jib was released. This is attributed to the driver slewing the crane out of the wind and the load or the hook snagging on the mast section or some lights attached to the mast section.
- Once released, the jib free fell through a large arc (calculated to be approximately 38°) and was suddenly arrested by the luffing system.
- The sudden arrest of the falling jib shock loaded the bolts attaching the top of the crane to the mast section and these failed in sudden gross bending/tensile overload and the top of the crane fell from the mast.

This incident has been categorised in the Extreme Weather group.

4.10.2 Bucharest, Romania

A saddle jib tower crane partially collapsed on 17 January 2007. It is reported that the incident took place whilst the crane was being dismantled. No further details have been found.

This incident has been categorised in the Erection/Dismantling/Extending group.
4.10.3 Utrecht, Holland

“Hurricane force” winds were reported to cause the collapse of a tower crane in Utrecht in the week of 20 January 2007. No further details have been found.

This incident has been categorised in the Extreme Weather group.

The crane is shown in Figures 17a and 17b.

4.10.4 Katowice, Poland

In the same week as 4.10.3 above, “exceptionally high winds” are reported to have caused a 25 m tall tower crane to “literally snap in half”. No further details have been found.

This incident has been categorised in the Extreme Weather group.

4.10.5 Ningbo, China

The collapse of a tower crane occurred on 30 January 2007. No further details have been found and possible causes of the collapse are not clear from photographs found.

This incident has been categorised in the Unknown causes group.

The crane is shown in Figures 18a, 18b and 18c.

4.10.6 Pearl Qatar Island, Doha, Qatar

The collapse of a tower crane occurred on 9 March 2007. Details are vague but according to vertikal.net and the Gulf Times website the incident happened during erection of the crane.

This incident has been categorised in the Erection/Dismantling/Extending group.

4.10.7 Jakarta, Indonesia

During dismantling of a crane involved in constructing the building “Pacific Place” on May 24 2007, a sling is reported to have broken and the jib and top part of the crane fell to the ground. No further details have been found.

This incident has been categorised in the Erection/Dismantling/Extending group.

4.10.8 Shanghai, China

A 100 m tower crane collapsed on 28 March 2007. According to vertikal.net “…the jib pendants apparently failed whilst the crane was being dismantled”. Other reports suggest that steel ropes used to support the jib failed (“snapped”). The mast section buckled during the incident but remained tied to the building.

This incident has been categorised in the Erection/Dismantling/Extending group.

The crane is shown in Figure 19.

4.10.9 Quezon City, Philippines

The collapse of a tower crane is reported to have taken place in April 2007. No further details have been found.
This incident has been categorised in the Unknown causes group.

4.10.10 Toronto, Canada

The jib of a Kroll luffing crane collapsed on 12 April 2007. According to the Daily Commercial News and Construction Record website the incident took place during a “wind storm”. No further details have been found concerning this incident during the research.

This incident has been categorised in the Extreme Weather group.

4.10.11 Croydon, England

On 2 June 2007 a Terex Comedil tower crane belonging to Select was being extended or climbed. The crane collapsed during the climbing operation onto the Croydon Park Hotel. Subsequent investigation by HSE revealed that bolts attaching the climbing frame to the crane structure were left loose or not used during the climb. With the climbing frame unattached to the structure the mast section was split and the crane toppled.

This incident has been categorised in the Erection/Dismantling/Extending group.

4.10.12 Boguchany Hydro Power Plant, Siberia

The collapse of a tower crane at this site is reported to have taken place in June 2007. Details are vague but it is reported that “......strong winds are being blamed although local reports seem to indicate that the crane was being worked on at the time”. No further details have been found.

This incident has been categorised in the Unknown causes group.

4.10.13 Causeway Bay, Hong Kong

A tower crane collapsed on 10 July 2007. Most reports found say that the crane was being dismantled whilst other reports suggest that it was carrying out a lift. Photographs of the collapse show a large red tower crane, which could suggest that the crane involved was either a Wolff or Wilbert.

The photographs also show what appears to be a climbing frame positioned under the slewing ring support structure and what appears to be a bent hydraulic cylinder in the climbing frame. Another photograph shows the mast section to be buckled at the edge of the building, close to a building tie.

The presence of the climbing frame would tend to confirm the reports that the crane was being dismantled at the time of the collapse.

This incident has been categorised in the Erection/Dismantling/Extending group.

The crane is shown in Figures 20a and 20b.

4.10.14 Shanxi, China

Reports state that a tower crane collapsed in September 2007 whilst the mast section was being extended. Details are vague and no further information has been found.

This incident has been categorised in the Erection/Dismantling/Extending group.
4.10.15 Prague, Czechoslovakia
A tower crane collapsed on 4 October 2007. Details are vague and no reliable information concerning this incident has been found in the research. However, one photograph of the crane after the incident would suggest that the foundation or base ballast was not correct but this has not been definitively proven.

This incident has been categorised in the Unknown causes group.

The crane is shown in Figure 21.

4.10.16 Sharjah, United Arab Emirates
The collapse of a tower crane on 23 October 2007 is reported on vertikal.net. Details are vague and no reliable information concerning this incident has been found in the research. However, according to the Gulf News website the crane was apparently being erected at the time.

This incident has been categorised in the Unknown causes group.

4.10.17 Forest Hill, London, England
The jib of a Raimondi LR 60 luffing crane buckled and collapsed to one side on 11 December 2007. No definitive cause for this incident was proved during the HSE investigation but the jib damage is consistent with an excessive side load being placed on it during operation. Another possibility is that the safety/erection ropes snagged or jammed the jib.

This incident has been categorised in the Unknown causes group.

4.10.18 Ho Chi Min City, Saigon
A tower crane collapsed on 27 December 2007 whilst being extended (climbed). No further details concerning this incident have been found.

This incident has been categorised in the Erection/Dismantling/Extending group.

4.11 2008 INCIDENTS

4.11.1 Dubai, United Arab Emirates
The jib of a Potain luffing crane collapsed over the side of the building in January 2008. No further details of this incident have been found.

This incident has been categorised in the Unknown causes group.

4.11.2 Singapore
On 22 February 2008 a tower crane collapsed. Early reports suggest that the crane was 60 m high and “…..appears to have fallen after its foundation gave way”.

A photograph of the incident from channelnewsasia.com, shown in Figure 22, suggests that the crane was fixed to its foundation using conventional ground anchors being attached to the bottom of the lower mast section legs using a large diameter pin (or pins). From the photograph it appears as if the pins have pulled through the top of the ground anchors.
No further details of this incident have been found during the research and the mechanism of the incident has not been determined from any published source.

However, sources in the U.K. industry suggest that the crane involved was manufactured by Jaso and the green colour of the mast section is consistent with a Jaso crane. The cause of the incident was said to be overloading of the crane and that the protection system had either been not correctly set up or perhaps bypassed.

This incident has been categorised in the Misuse group.

4.11.3 New York, U.S.A.

A Favelle Favco luffing crane collapsed on 15 March 2008. Investigation by Occupational Safety and Health Administration (OSHA) showed that the crane collapsed following climbing (extending) the mast section and whilst fitting a building tie in collar at the 18th floor level. It is reported that a sling failed under load allowing the unattached collar to drop and crash into a building tie in collar at the 9th floor level of the building. The two loose tie in collars then crashed into the supporting collar at the 3rd floor level. This was not ripped out but supporting braces were broken. The counterweights of the crane were facing away from the building and so were effectively pulling the crane away from the building. The loss of the tie in supports permitted the mast section to fall away from the building and lean against a building on the other side of the street. The top of the crane separated from the mast during this and fell to the ground.

This incident has been categorised in the Erection/Dismantling/Extending group.

4.11.4 Brazil

A tower crane collapsed on 13 April 2008. The location and type of crane is unknown and other details are vague. However, it appears that the incident took place when a climbing frame was in use and this slipped down and split the mast section vertically.

This incident has been categorised in the Erection/Dismantling/Extending group.

The crane is shown in Figures 23a, 23b and 23c.

4.11.5 Damascus, Syria

A crane collapse occurred on 28 April 2008. Details are vague but it has been reported that the crane was being extended or dismantled to be replaced with a larger crane. No further information has been found in the research.

This incident has been categorised in the Erection/Dismantling/Extending group.

4.11.6 Sichuan Province, China

On 12 May 2008 an earthquake measuring a reported 7.9 or 8.0 on the Richter scale is alleged to have caused the jib of a tower crane to buckle. Details of this incident are vague and no further information has been found.

This incident has been categorised in the Extreme Weather group.
4.11.7 New York, U.S.A.

On 30 May 2008 the top part of a Kodiak luffing crane, reported to be at least 24 years old separated from the mast section and fell to the ground. Investigation by OSHA showed that the incident had been caused by the failure of a welded repair that had been carried out on the slewing ring support structure.

This incident has been categorised in the Mechanical or Structural group.

4.11.8 East London, South Africa

The jib of a saddle jib tower crane, thought to be a Potain, buckled on 21 June 2008. Strong winds were originally blamed by the building contractors but the East London weather service cast doubts on this, wind speeds of only 55 km/hr were recorded at the time of the incident.

No further accurate details concerning this incident have been found but speculation on the internet exists that indicates the suspicion that the jib was side loaded, possibly by snagging a load.

This incident has been categorised in the Unknown causes group.

4.11.9 Rotterdam, Holland

A Wilbert WT 300 tower crane collapsed on 10 July 2008 and this incident was investigated/analysed by the Dutch Safety Board.

According to them, the crane was lifting and positioning a heavy load. The lift was a “blind” lift, i.e. the crane driver could not see the load and the lift was being supervised by a banksman with communication between the crane driver and banksman being achieved via radio.

The load was positioned along the jib of the crane such that the load was very close to the permitted maximum at that radius. Immediately prior to the incident, the load was stationary and under control of the mechanical brake fitted to the hook block saddle travel motor. In this condition it has been calculated that the crane would have been leaning forward.

The banksman instructed the driver to “trolley in”, i.e. bring the load closer to the mast section. The crane driver operated his controls to achieve this but instead of the load moving towards the mast it ran away to the outer end of the jib and the crane toppled forwards, in the direction of the jib.

The hook block saddle travel motor control system was a sophisticated modern PLC/Inverter system and the incident was attributed to settings within the control system. When the controls were operated the solenoid operated mechanical brake of the hook block saddle travel motor was released before sufficient current had been applied to the motor to brake the load against the downward slope of the jib. Since the crane was leaning forwards, the hook block and load started to move towards the outer end of the jib and the electric braking of the motor was not sufficient to stop it once it had gathered momentum.

This incident has been categorised in the Electrical/Control system group.

4.11.10 Manresa, Barcelona, Spain

A tower crane collapse on 20 August 2008 is reported on vertikal.net. Details are vague but a short video from the website of “El Pais” newspaper suggests that failure of the foundations or lower mast section may be a possible cause.
This incident has been categorised in the Unknown causes group.

4.11.11 Lapu Lapu City, Philippines

The collapse of a tower crane during erection on 26 August 2008 is reported on vertikal.net and elsewhere. Details are vague and no further information has been found during the research.

This incident has been categorised in the Erection/Dismantling/Extending group.

4.11.12 Zibo City, China

The collapse of a tower crane 10 October 2008 is reported on vertikal.net and elsewhere. An accompanying photograph on vertikal.net shows the top part of the crane separated from the mast section at the slewing ring and it is reported “....the cranes superstructure separated from the tower at the slew ring”.

However, another photograph of the incident from craneincidents.com shows the crane lying horizontally across a road with the slewing ring still attached to the mast. A climbing frame located underneath the slewing ring can also be seen in this photograph. However, the mast section and slewing ring support structure do not appear to have separated in the region of the climbing frame.

This would imply that the photograph on vertikal.net was taken after the incident during the recovery of the crane when the slewing ring/top part of the crane had been separated from the mast section and was being supported on the blocks that can be seen under the slew turret in the photograph from vertikal.net.

This incident has been categorised in the Unknown causes group.

The crane is shown in Figures 25a and 25b.

4.11.13 Shanghai, China

A tower crane collapsed on 14 October 2008 at a power station. Details are vague and no further information has been found during the research. However, it is reported that “....the crane is thought to have been undergoing a load test after being delivered”.

This incident has been categorised in the Unknown causes group.

4.11.14 Taizhou City, China

On 20 October 2008 a tower crane collapsed on a construction site and in the process apparently knocked another crane over. Details are vague and no accurate information about this incident has been found. However, some reports suggest that the crane was being dismantled or extended at the time of the incident.

This incident has been categorised in the Erection/Dismantling/Extending group.

4.11.15 Yongzhou City, China

On 29 December 2008 a tower crane collapsed on a construction site. Details are vague and no accurate information about this incident has been found.

This incident has been categorised in the Unknown causes group.

19
4.12 2009 INCIDENTS

4.12.1 Nelspruit, South Africa

A tower crane in use to build a new football stadium collapsed on 6 January 2009. Severe winds associated with a major storm are reported to be responsible.

This incident has been categorised in the Extreme Weather group.

4.12.2 Heidelberg, Germany

A tower crane collapsed on 23 February 2009. Details are vague and no accurate information about this incident has been found. However, it is reported that the crane was not in use at the time of the incident.

This incident has been categorised in the Unknown causes group.

4.12.3 Jeddah, Saudi Arabia

A tower crane collapsed on 2 March 2009. Details are vague and no accurate information about this incident has been found.

This incident has been categorised in the Unknown causes group.

4.12.4 Kuala Lumpur, Malaysia

A tower crane reportedly collapsed on 8 March 2009. Details are vague but it is reported that the load line snapped whilst lifting concrete at or about the 22nd – 30th floor level. No further accurate information about this incident has been found.

This incident has been categorised in the Unknown causes group.

4.12.5 Qingdao, China

A tower crane collapsed on 2 April 2009. Details of this incident are vague but photographs suggest that a climbing frame is located at the top of the mast section. In addition, the number of casualties is reported to be five which would be consistent with an erection crew either erecting, dismantling or climbing the crane. No further information has been found during the research.

This incident has been categorised in the Erection/Dismantling/Extending group.

The crane is shown in Figures 26a and 26b.

4.12.6 Manama, Bahrain

On 10 April 2009 a tower crane collapsed on a construction site. Details are vague but it is reported that the crane was being erected at the time of the incident. No further information about this incident has been found.

This incident has been categorised in the Erection/Dismantling/Extending group.

4.12.7 Singapore

Strong winds are reported to have caused structural damage to a luffing crane on 23 April 2009. Photographs and other information suggest that the crane involved was a Potain.
This incident has been categorised in the Extreme Weather group.

The crane is shown in Figures 27a and 27b.

4.12.8  Taipei, Taiwan

Vertikal.net reported that “..... the luffing jib of a tower crane broke free and falling 37 floors onto the back of a tourist bus...”. This incident occurred on 24 April 2009 and subsequently overloading and using the crane in relatively strong winds were reportedly blamed for this incident. Details are vague and no further accurate information has been found.

It should be noted that photographs of the incident show that the jib of the crane is a square lattice section and not having a walkway. It is possible that this could indicate that the crane involved was a large crawler type crane. However, this incident has been included since vertikal.net specifically identify the crane as a luffing tower crane.

This incident has been categorised in the Misuse group.

4.12.9  Amman, Jordan

The jib and counterjib of a saddle jib tower crane suffered severe structural failure and buckling on 16 May 2009. However, the top of the crane remained attached to the mast and the mast remained upright. Details are vague and no further information about this incident has been found.

This incident has been categorised in the Unknown causes group.

4.12.10  Tokyo, Japan

A luffing crane collapsed on 3 June 2009. The incident happened as the height of the crane was being reduced by climbing. It is believed that the top part of the crane was being supported on the hydraulic cylinder of the climbing frame when it suddenly fell 1 – 2 m on to the top of the mast section below. The associated impact then causing the collapse. No further information about this incident has been found, in particular the manufacturer of the crane involved or the reason(s) why the hydraulic cylinder should fail.

This incident has been categorised in the Erection/Dismantling/Extending group.

4.12.11  Liverpool, Merseyside, England

A Wolff 500 B luffing crane owned by HTC collapsed on 6 July 2009 onto a block of flats.

Further details cannot be released until the conclusion of current investigations and any legal proceedings which might arise from the investigation.

4.12.12  Seoul, Korea

A luffing tower crane collapsed on 6 July 2009. Details are vague and no further information about this incident has been found.

This incident has been categorised in the Unknown causes group.
4.12.13  Toronto, Canada

A Pecco saddle jib tower crane collapsed on 23 October 2009 on a construction site. Photographs show that the top of the crane has separated cleanly from the mast section at the slewing ring joint. It is reported that eyewitnesses state that two or three loud cracks were heard as the crane was slewing and that the top of the crane fell in the direction of the counterjib/counterweights. This is consistent with failure of the slewing ring bolts.

This incident has been categorised in the Mechanical or Structural group.

The crane is shown in Figure 28.

4.12.14  Dongguan, China

A tower crane collapsed on 5 December 2009. Details are very vague. Reports suggest that a local official blamed the incident on “quality problems with the crane” and other reports state that the incident was caused by “…a broken arm of the crane”. No further details concerning this incident have been found.

This incident has been categorised in the Unknown causes group.

4.12.15  Shenzen, China

A tower crane reported to have been manufactured by “Guangxi Construction Machinery” collapsed on 29 December 2009. Details of this incident are vague. However, according to vertikal.net a photograph shows that the mast section appears to have collapsed/buckled at the point of its last tie in with the building and the manufacturer stated that the incident was caused by “….malpractice by none specialised person”, i.e. an untrained operator overloading the crane by lifting three tonnes as against the cranes maximum capacity of two tonnes.

This incident has been categorised in the Misuse group.

The crane is shown in Figure 29.

4.13  UNKNOWN DATES AND DETAILS

4.13.1  Bogotá, Columbia

A tower crane was in use to assist in cutting down a eucalyptus tree. Apparently, a large branch had been attached to the crane prior to cutting it from the tree. When the branch was cut, its weight was found to be greater than the capacity of the crane. Hence, the crane was overloaded and fell forward.

A video of this incident can be seen at:


This incident has been categorised in the Misuse group.

4.13.2  Prague, Checkoslavakia

Photographs at http://picasaweb.google.com/c25land/JeB# show a collapsed Potain crane. Some of the information with the photographs suggests that they were taken on 17 November 2006 and other information suggests a date of 19 January 2007.
However, towercraneincidents.blogspot suggests that this incident happened on 19 January 2007 and was due to strong winds. If so, this would be consistent with the Utrecht and Katowice incidents (Sections 4.10.3 and 4.10.4).

This incident has been categorised in the Unknown causes group.

4.13.3 Germany

A tower crane leaning forwards is shown in Figure 30. No further details concerning this incident have been found and the cause of the incident is not clear from the photograph, although it might be suspected that the mobile crane shown in the picture has been removing counterweights and the crane has become unbalanced in the direction of the main jib.

This incident has been categorised in the Unknown causes group.
5 ANALYSIS OF IDENTIFIED INCIDENTS

5.1 TOTAL NUMBER OF INCIDENTS

A total of 86 incidents involving the collapse or major structural failure of a tower crane have been identified as taking place between 1989 to 2009. These occurred as follows:

1989 – 1 Incident identified
1990 to 1998 – No incidents identified
1999 – 2 Incidents identified
2000 – 3 Incidents identified
2001 – 1 Incident identified
2002 – 5 Incidents identified
2003 – 3 Incidents identified
2004 – 3 Incidents identified
2005 – 10 Incidents identified
2006 – 7 Incidents identified
2007 – 18 Incidents identified
2008 – 15 Incidents identified
2009 – 15 Incidents identified

Unknown date – 3 Incidents identified

65 out of the total of 86 incidents identified (76 %) took place between 2005 to 2009 and no incidents were found to have occurred between 1990 to 1998. This may reflect a boom in the construction industry around the world from 2005 onwards with a consequent increase in the population, use and therefore incidents of tower cranes. However, it must be remembered that the sources of information used to gather the data do not carry much historical data at all. Specifically, the archive information from the four websites principally used to conduct the research date from:

www.vertikal.net - 3 April 2001
http://towercraneincidents.blogspot.com - May 2000 except for the 1989 San Francisco incident given in Section 4.1.1

It is also difficult to believe that no incidents took place between 1990 and 1998. Consequently, it is likely that the high percentage of the total incidents recorded since 2005 is due in part to
increasing availability of reports and information on the internet since then. It is likely that a number of incidents took place before 2005 that have not been found during the research and this report is likely to under report the number of incidents.

5.2 CIRCUMSTANCES OF EACH INCIDENT

5.2.1 Total Number of Incidents

Further details of the Liverpool incident of 2009 (Section 4.12.11) cannot be released until the conclusion of current investigations and any legal proceedings which might arise from the investigation. Consequently, this incident has not been included in any analysis of the causes of the incidents in this report.

Each of the remaining 85 incidents has been placed in one of the following seven categories as follows:

- Erection/Dismantling/Extending of the crane – 29 Incidents (34%)
- Extreme Weather – 15 Incidents (18%)
- Foundation Issues – 2 Incidents (2%)
- Mechanical or Structural Issues – 4 Incidents (5%)
- Misuse – 6 Incidents (7%)
- Electrical/Control System Issues – 1 Incident (1%)
- Unknown Cause – 28 Incidents (33%)

Figure 31 summarises these figures in a pie chart.

It has been possible to place each of the 85 incidents in one of the seven groups above. However, in most cases it has not been possible to further identify and detail the exact cause. E.g., whilst an incident may have been clearly identified as happening during erection, dismantling or extending the crane it has not always been possible to accurately identify exactly what went wrong in that process to cause the collapse. Similarly, it may be clear that an incident is associated with extreme weather but the exact circumstances of what actually caused the crane to fail have not been determined.

5.2.2 Total Number of Incidents neglecting the Unknown Cause Category

If the unknown cause category is neglected the total number of incidents is 57. Each of these 57 incidents are placed in the same six categories above having identified causes or circumstances surrounding the incident so the actual numbers in each category do not change but the percentage contribution does:

- Erection/Dismantling/Extending of the crane – 29 Incidents (51%)
- Extreme Weather – 15 Incidents (26%)
- Foundation Issues – 2 Incidents (4%)
- Mechanical or Structural Issues – 4 Incidents (7%)

25
The two dominant categories are erection/dismantling/extending and extreme weather, which are associated with 77% of all the incidents having identified causes or circumstances surrounding the incident.

5.2.3 Erection/Dismantling/Extending

29 of the incidents identified occurred during erection/dismantling/extending (climbing) of the crane. This is the category having the greatest numbers of incidents and so would perhaps indicate that tower cranes are most sensitive to these procedures.

The erection/dismantling/extending of a tower crane usually involves lifting, manoeuvring and fitting together large and heavy components in a defined and sequenced order with the added complication of carrying this out at height. It is physically demanding work and personnel involved in this work often work long hours. The consequences of making a mistake during this can therefore be extremely serious.

5.2.4 Extreme Weather

15 incidents associated with extreme weather were identified. Of these 15 incidents, 2 were associated with earthquakes and so the type of crane involved in these earthquakes is not relevant.

Out of the remaining 13 incidents 6 involved luffing tower cranes, 5 saddle jib tower cranes and the type of crane involved was not identified in the remaining 2 incidents.

This implies that both types of crane, luffing and saddle jib are equally susceptible to structural damage in strong winds.

Some of these incidents, including the Liverpool incident of January 2007 (Section 4.10.1), involve operating the crane in strong winds.

In addition to operating the crane in strong winds, other factors in some of these incidents were:

- Was the crane prevented from rotating in the wind (free slewing).
- The angle the jib of a luffing crane was left at whilst unattended. This is important because if the jib is at too steep an angle the crane may not free slew correctly.

5.2.5 Foundation Issues

2 incidents attributed to foundations were identified.

The crane involved in the Seattle 2006 incident (Section 4.9.6) was erected on foundations of an uncommon design consisting of steel I beams supported by four concrete pillars.

The details of the foundation involved at Dusseldorf 2003 (Section 4.6.2), are unknown.

5.2.6 Mechanical or Structural Issues

4 incidents associated with mechanical failure or structural failure of the crane involved were identified.
In two cases, Battersea 2006, (Section 4.9.4) and New York 2008 (Section 4.11.7) the cranes involved were over twenty years old and the crane involved at New York had undergone repairs prior to its collapse. These two incidents raised numerous issues including:

- What was the authority/competence of personnel or companies evaluating, authorising and implementing the repair techniques.
- What, if any, inspection criteria were applied to the repairs at the time they were carried out and was any subsequent inspection following a period in service of the repairs planned.
- Were the repairs carried out to the specified standards (if any)

These sorts of issues are common to the use and maintenance of almost all aged plant and equipment and are not particularly confined to the tower crane industry.

The details of the other incidents associated with mechanical failure or structural failure, Singapore 2000 (Section 4.3.2) and Toronto 2009 (Section 4.12.13) have not been determined with any great accuracy. However, from Figure 28 the Toronto incident does appear to involve failure of the slewing ring bolts in a similar manner to Battersea.

### 5.2.7 Misuse

Misuse of the crane was identified as being the cause of the incident in 6 of the incidents.

This involved factors such as:

- Overloading the crane
- Snagging loads when lifting or side loading the jib
- Colliding with another crane on the same site.

These may well raise concerns about the training/competence of crane operators and banksmen and quality of site supervision.

### 5.2.8 Electrical/Control System Issues

The 2008 Rotterdam incident (Section 4.11.9) was the only identified incident that was attributed to electrical/control system issues. In this case settings of the sophisticated PLC/inverter motor drive system were found to be at fault.

Whilst not included in this report there has been an instance of a similar problem in the U.K. that fortunately did not result in the collapse or major structural failure of the crane involved. This occurred in London in August 2008 on a Raimondi LR60 luffing crane owned by City Lifting Ltd. Dr A.M. Wray of HSL’s Engineering Control Group report XS/09/04 refers. In this case it was the hoist motor drive settings at fault and the crane could drop a lifted load without warning.

In my opinion this scenario has the potential for becoming more prominent in crane incidents as newer cranes having ever more sophisticated control systems come on the market and enter service. Much depends on the training/competence of individuals setting up this type of control system during erection of the crane and replacement of spare parts once the crane is in service to ensure that the internal settings of all motor drives are correct for the application. The settings
required to properly control a cranes motor may well differ from the driver manufacturer’s
default settings and so adjustment during initial erection/commissioning and/or spare part
replacement exercises may well be required by a competent person.

5.2.9 Unknown Causes

This category has the second highest number of incidents identified, 28 incidents out of the total
of 85 (33%).

Incidents have been placed in this category where the cause or circumstances surrounding the
incident have not been able to be determined with sufficient accuracy to place them in one of
the other categories.

Some incidents in this category do have some possible suggested causes and these have been
given in the relevant section where known.

E.g. Section 4.5.4 refers to the incident in Cuijk, Holland. The information available suggests
that the incident may be associated with either something going amiss during the erection
process as the counterweights were being fitted or that the foundation was not adequate for the
crane. However, the available information is not sufficiently detailed or accurate enough to
place this incident in one of the other categories.

5.3 U.K. INCIDENTS

10 of the total of 86 identified incidents involved tower cranes in the U.K and Ireland. Only one
of these has been categorised in the unknown group and in the other cases the circumstances
surrounding eight of the incidents have been identified sufficiently accurately to include them in
one of the other categories. The remaining incident is still under investigation and details cannot
be released.

These incidents are:

- Canary Wharf (Section 4.3.3) – Erection/Dismantling/Climbing
- Dublin (Section 4.7.1) – Extreme Weather
- Cardiff (Section 4.7.3) – Extreme Weather
- Worthing (Section 4.8.3) – Erection/Dismantling/Climbing
- Battersea (Section 4.9.4) – Mechanical or Structural Issues
- Holborn (Section 4.9.5) – Misuse
- Liverpool (Section 4.10.1) – Extreme Weather
- Croydon (Section 4.10.11) – Erection/Dismantling/Climbing
- Forest Hill (Section 4.10.17) – Unknown
- Liverpool (Section 4.12.11) – Under Investigation
The total numbers for each category are:

- Erection/Dismantling/Extending of the crane – 3 Incidents (33.5%)
- Extreme Weather – 3 Incidents (33.5%)
- Mechanical or Structural Issues – 1 Incident (11%)
- Misuse – 1 Incidents (11%)
- Electrical/Control System Issues – 0 Incidents (0%)
- Unknown cause – 1 Incident (11%)

Table 1 below compares the contribution of incidents in each category (neglecting the unknown cause category) between the U.K. and the rest of the world. In Table 1, the U.K. incidents have been subtracted from the total of 57 incidents identified in Section 5.2.2. for each category.

| Table 1 – Comparison of Incidents in the U.K. with the rest of the world |
|---------------------------------|-----------------|-----------------|
| Erection/Dismantling/Extending  | 3               | 26              |
| Extreme Weather                 | 3               | 12              |
| Foundation Issues               | 0               | 2               |
| Mechanical or Structural Issues  | 1               | 3               |
| Misuse                          | 1               | 5               |
| Electrical/Control System Issues| 0               | 1               |
| Total                           | 8               | 49              |

Despite a smaller number of incidents in the U.K. and so perhaps being statistically less valid, the general trend of the circumstances surrounding each incident in the U.K. are very similar to those for the world wide incidents. i.e., the two dominant circumstances are erection/dismantling/extending and extreme weather, which are associated with 76% of these eight incidents with lesser contributions made to the overall total of incidents by the other four categories.

This would suggest that the overall experience of incidents in the U.K. is in keeping with the rest of the world.

5.4 MANUFACTURER OF CRANES INVOLVED IN INCIDENTS

Fourteen separate makes of crane have been identified as being involved in the 86 incidents. Table 2 overleaf shows the number of incidents a particular make of crane has been identified as being involved in.
### Table 2 – No of Incidents a particular make of crane has been involved in

<table>
<thead>
<tr>
<th>Crane Manufacturer</th>
<th>No of Incidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peiner</td>
<td>1</td>
</tr>
<tr>
<td>Liebherr</td>
<td>3</td>
</tr>
<tr>
<td>Wolff</td>
<td>3</td>
</tr>
<tr>
<td>Pecco</td>
<td>1</td>
</tr>
<tr>
<td>Favelle Favco</td>
<td>3</td>
</tr>
<tr>
<td>Potain</td>
<td>6</td>
</tr>
<tr>
<td>QTZ – Type 63</td>
<td>1</td>
</tr>
<tr>
<td>BPR</td>
<td>2</td>
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<tr>
<td>Comedil</td>
<td>2</td>
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<td>Jaso</td>
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<td>Kroll</td>
<td>1</td>
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<td>Wilbert</td>
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<td>Raimondi</td>
<td>1</td>
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<tr>
<td>Kodiak</td>
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</tbody>
</table>

From Table 2, it would appear that Potain cranes have been involved in the most incidents, twice that of any other manufacturer. However, it should be remembered that Potain are a very large company having a worldwide presence. I do not have information on the numbers of cranes produced by each company and it is possible that the number of incidents involving Potain cranes merely reflects a larger population of Potain cranes than other manufacturers.

In my opinion the information obtained during the research concerning the particular crane manufacturer involved in an incident is not sufficiently detailed or accurate to say for sure that any individual manufacturer’s cranes are more prone to incidents than another.
6 CONCLUSIONS

6.1 A total of 86 incidents involving the collapse or major structural damage of the tower crane involved have been identified as taking place between 1989 and 2009.

6.2 The cause or circumstances surrounding 57 of these incidents have been identified. The cause or circumstances surrounding 28 incidents have not been identified.

6.3 Where the cause or circumstances surrounding the incident have been identified the dominant categories were erection/dismantling/climbing followed by extreme weather.

6.4 10 of the 86 incidents took place in the U.K. The causes of these were similarly dominated by erection/dismantling/climbing and extreme weather.

6.5 No particular crane manufacturer has been positively identified as being more prone to incidents than any other.
7 FIGURES

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Figure 30– Crane involved in Germany (Section 4.13.3)
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Figure 31 – Total Number of Accidents Pie Chart
Since 2000 there have been five major incidents on UK construction sites that involved the collapse of a tower crane. These five being Canary Wharf in 2000, Worthing in 2005, Battersea in 2006, Liverpool in 2007, Croydon in 2007 and Liverpool in 2009. Subsequent investigation into these incidents by HSE, assisted by HSL, showed that these collapses were due to different causes.

HSL were requested to identify tower crane incidents that had taken place around the world between 1989 to 2009 and obtain, where possible, the causes of each incident and the tower crane involved. The intention underlying the research was to use the information obtained to assist in advising and guiding the UK tower crane industry to help improve safety.

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