



# Sharing on Technology for Safe Lifting Operations

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# Common Causes of Crane Incidents

- **Common Causes of Crane Related Incidents**
  - Human errors
  - Material fatigue
  - Poor planning
  - Etc.

# Technology of the Future

- **Technology of the Future**
  - Automation
  - Artificial Intelligence
  - Big Data Analytics
  - New material science technology
  - Etc.

# Human Error

- Why human error?
- Human error is involved in over 90% of all accidents and injuries in a workplace.
- Is human error a good explanation of error?
- Is this just a simple explanation to find someone to blame?
- **Poor state of mental and physical condition** due to fatigue and tight schedule.
- How technology can help?

## Crane lift

- **Crane Lift to facilitate access to tower cranes.**
- **ISO 12480-3:2016. Cranes – Safe use – Part 3: Tower cranes**
- **6.5.2. Boarding and leaving the crane**
- **Where the crane cab level is in excess of **30 m** from the ground and there is no access from a supporting building, it is **recommended** to have a crane lift or an elevating control station.**

## Crane lift

- **How many tower cranes you can climb in a day?**
- **Aging society**
- **Labor shortage**



- **In January 2019, French regulations have stipulated that every crane erected above 30m in height must be provided with a crane lift.**
- **Do we want to follow?**

# Material fatigue

- Material fatigue
- **Bolts and welds** under high cyclical loadings are prone to fatigue failure.
- Tower crane components can be interchanged with other tower cranes, like a LEGO system.
- How can we monitor the conditions of the load bearing components, take them out of service before fatigue failure? → by pen and paper, Excel sheets, bar-code system, **RFID??**



RFID (Radio-Frequency IDentification) for component identification

ISO 12480-1:1997. Cranes – Safe use – Part 1: General

9.2. Identification of components

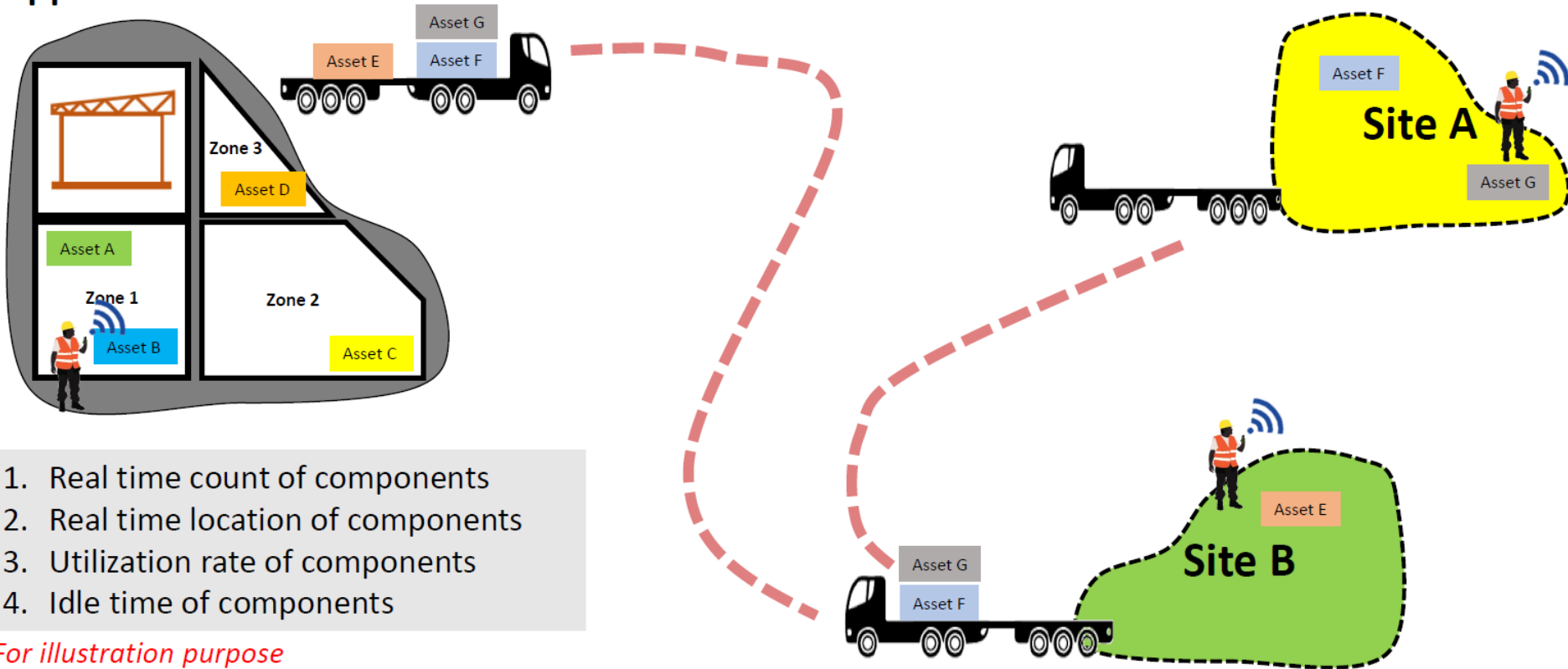
All major components that form part of a crane and are **dismantled for transportation**, particularly those that are **load-bearing** or ensure the stability of the assembled crane, should carry a clear identification mark to ensure that they can be distinguished for inspection and condition monitoring purpose

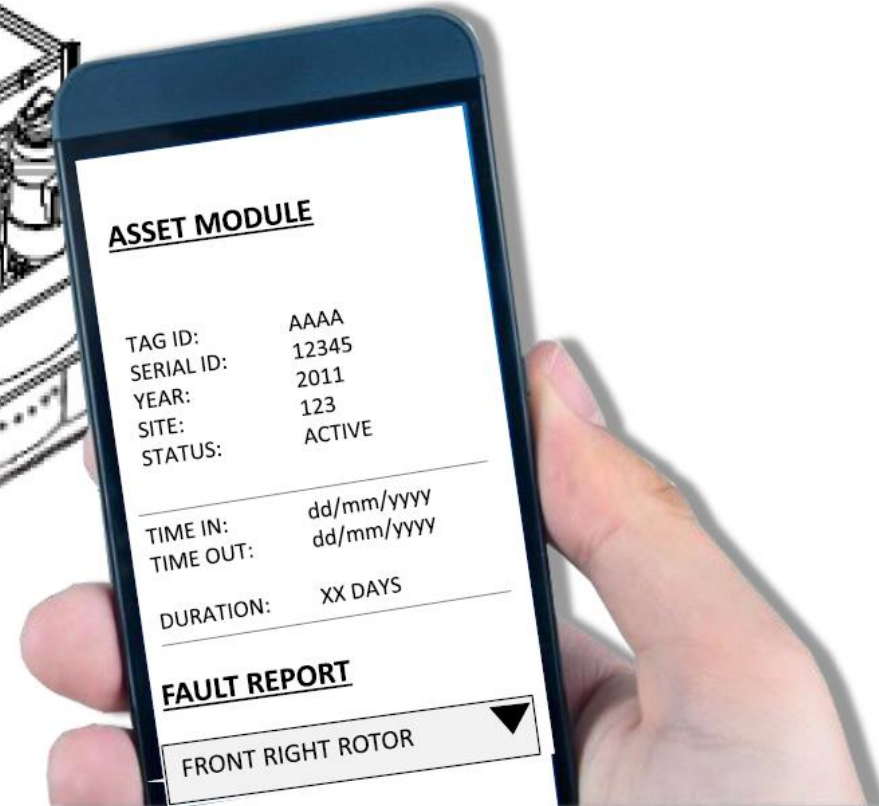
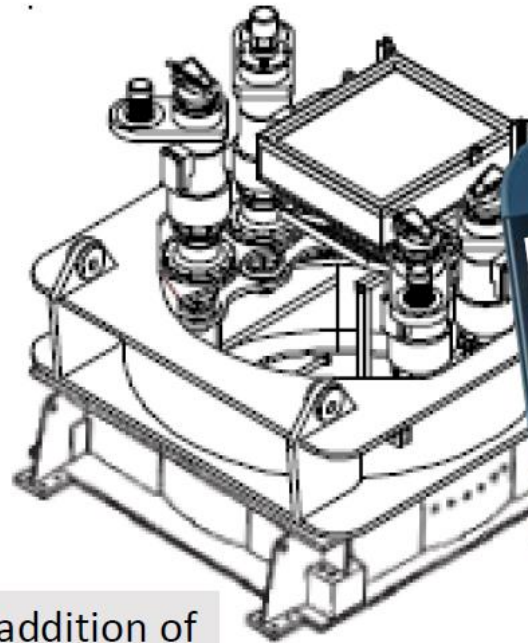
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**With RFID, the following information can be traced:**

- **Part No.**
- **Serial No.**
- **Year of manufacture**
- **Location (No. of days at warehouse, no. of days at job sites)**

## Supplier warehouse





1. Real time onsite retrieval/addition of information
2. Pre-emptive asset maintenance
3. Fast access to information onsite

*For illustration purpose*

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- **Accurate inventory information in every site.**
  - **Available information all the time, real time.**
  - **Accessible information anytime, anywhere with web based application.**
  - **Never lose or misplace a high value asset.**
  - **Increased visibility and better predictability of supply and demand.**
  - **Improved safety from tracking aging and serviceability of components**

## Useful life of crane

- What is the useful life of a crane, from **regulation perspective**?
- **MOM Guideline:**
  - Tower cranes which are **15 or more years old** (from the date of manufacture) will not be allowed to use unless the occupier or owner obtained a letter from the manufacturer certifying that the tower crane can be safely used for a longer period. Tower cranes of **20 or more years old** (from the date of manufacture) will not be allowed for use.

## Useful life of crane

- **For mobile crane**

Table A

Design Safe Working Load (Maximum Capacity)	Maximum allowable years of service from the year of manufacture
50 tons and below	20
Above 50 tons but not more than 100 tons	25
100 tons and above	30

- **Is this one-size-fits-all approach still good?**

## Useful life of crane

- What is the useful life of a crane, from **engineering perspective**?
- ISO 12482:2014. Cranes – Monitoring for crane design working period.
- **Cranes are designed for a finite lifetime duty**, which is specified in **load cycles and load spectrum** and is **not principally related to calendar working time**.
- A specified crane classification may be related to any calendar time depending on the application, e.g. **5 to 10 years for a special limited use or 40 years for a long-term investment**.



## Useful life of crane

- **Load cycle: How many liftings have been performed?**
- **Load spectrum: How heavy you are lifting in every lift?**
- **Scenario 1: A 10T crane is only lifting 1T, one time a day. With proper maintenance, the crane may be useful for 40 years or more.**
- **Scenario 2: A 10T crane is lifting 10T, ten time a day. Without proper maintenance, the crane may be KOYAK after two years.**
- **If we can capture the usage of the crane more accurately, with proper technology, we can determine the optimal useful life of the crane, and its components without sacrificing safety → more economical, more environmental friendly....**

## Condition monitoring

- Can data logger be used for more meaningful condition monitoring
- ISO 9927-3:2005. Cranes – Inspection – Part 3: Tower cranes
- 6. Periodic inspections
- 6.1 General
- The competent person shall be in possession of
  - The **automatic registered data**, where available, (cycles, hours, days, loads, etc.) permitting knowledge of the service time of the components for which data exists



All owners of tower or mobile cranes,  
Authorised Examiners (Lifting Equipment)  
and other interested parties

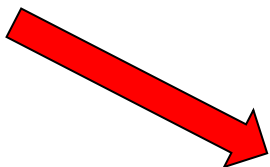
### **LOAD CHARTS, OPERATION MANUALS AND SAFEKEEPING OF MAINTENANCE AND OPERATIONAL LOGS**

From the recent spate of accidents and dangerous occurrences involving mobile or tower cranes, it was observed that many mobile cranes are provided with load charts and manufacturer's operation manuals that are in a language not understood by the persons involved in the lifting operation. It is critical that lifting personnel, such as the lifting supervisors and crane operators, are able to read and understand the load charts and operation manuals to ensure proper planning and safety in lifting operation.

2. Owners of mobile or tower cranes are reminded that every mobile or tower crane must be provided with the load chart(s) and operation manual (both written in English) and these are kept in the operator's cabin. An owner has also to arrange for the load chart(s) and operation manual to be in other language understood by the crane operator if he/she does not understand English.

3. The Ministry has also observed that some owners do not have properly documented maintenance and operation logs/records for their mobile or tower cranes. Regn 21(16)(b) of WSH (General Provisions) Regulations requires the owner of a mobile or tower crane to ensure that it is properly maintained. In addition, regns 16(g) and 16(h) of the Factories (Operation of Cranes) Regulations require the crane operator to record operational tests and incidents of failures or malfunctions in the crane's log book or sheet.

4. To comply with these requirements, all owners must have such maintenance and operation logs<sup>1</sup> for every mobile or tower crane and keep them available for inspection. The maintenance carried out on a mobile or tower crane must be in accordance with manufacturer's instructions and properly documented in the log. Operation logs shall indicate the heaviest load lifted, cycles of lift and hours of operation of the crane on a daily basis. (see attached Annex for an example of an operation log)



# Condition monitoring

## Sample Operation Logs

Daily (To be kept for a minimum of 6 months)

Year	Month	Day	Load, kg	Cycles	Crane Operating Hours	Crane Operator	IC / WP no.
2009	Sept	25	500-1000	12	9am – 10am, 2pm-4pm	ABC	S7654321A
		26	300-1000	6	9am – 11am	ABC	S7654321A
		27	600-1000	7	2pm-4pm	DEF	S7891011D
		28	500-1200	13	9am – 10am, 2pm-4pm	ABC	S7654321A
		29	500-1200	13	9am – 11am, 2pm-5pm	ABC	S7654321A
		30	500-1000	13	9am – 11am, 2pm-5pm	ABC	S7654321A
	Oct	1	300-3000	11	9am – 10am, 2pm-4pm	DEF	S7891011D
		2	300-3000	10	9am – 10am, 2pm-4pm	DEF	S7891011D
		3	600-1000	5	2pm-4pm	DEF	S7891011D
	<b>Total</b>				<b>90</b>		

# Condition monitoring

Cumulative Monthly (To be kept for Life Extension)

Year	Month	Load, kg	Cycles
2009	June	100-1100	373
	July	200-2000	287
	Aug	300-3000	176
	Sep	300-1200	322
	Oct	300-3000	26

- **Can data logger be used with RFID to monitor the usage of crane components, combined with big data analytics and artificial intelligence, to predict the useful life of load bearing components of tower cranes?**

# Condition monitoring

- **Jack Ma, founder of Alibaba:**
- **“The new wave is coming. Jobs will be taken away. Some people who catch up with the wave, will be rich. But for those who fall behind, the future will be painful.”**
- **“The world is going to be data. I think this is just the beginning of the data period.”**
- **“We think data is going to be so important to human life in the future. Tomorrow, everything will be connected.”**
- **“I think a basic understanding of data analytics is incredibly important for this next generation of young people. That’s the world you are going into.”**

## Poor Planning

- **Poor planning**
- **Key role of tower cranes at construction sites: Transporting a variety of materials vertically and horizontally.**
- **Cannot reach the load you want to lift.**
- **Cannot place the load at the intended location.**
- **Cannot find suitable location for tower crane tie back.**
- **Cannot dismantle the tower crane.**

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- **BIM (Building Information Modelling)**
  - **BIM to facilitate construction planning.**
  - **Can BIM be used to optimize location of tower cranes on construction sites?**
  - **Can BIM be shared with the Approved Crane Contractors (ACC) for tower crane planning?**



## Variable outriggers

- **Variable outriggers for mobile cranes**
- **SS 536:2008. Code of practice for the safe use of mobile crane.**
- **9.3.1.2 The person authorized to operate the crane:**
  - f) Shall ensure that any outrigger when it is required is fully extended and secured.**

**The space conditions are far from perfect for many crane jobs – it is often not possible to extend all the supports evenly on constricted job sites → Variable outriggers for mobile cranes.**

# Remote control cranes

- **Remote control cranes**
- **ISO 12480-3:2016. Cranes – Safe use – Part 3: Tower cranes**
- **7. Selection of tower cranes**
- **Where cranes are available with remote control, care shall be taken in their selection for the following reasons:**
  - **The crane operator has no “feel” for the machine and could, under certain circumstances, be tempted to handle the machine more dangerously than if the crane were operated via cabin control;**
  - **Infrared remote control may be unreliable on tower cranes if the receiving sensors rotates with crane and thus loses alignment with transmitter.**
- **Radio control → any interference from similar radio frequency nearby?**
- **Ensure battery of remote control sufficiently charged before use.**

# Autonomous cranes

- **Autonomous cranes / driverless cranes**
- There are challenges, but this might be coming sooner than you think.
- Algorithms to ensure that cranes operate efficiently, intelligently, and substantially shortening the project timeline.
- Challenges in the construction industry:
  - Growing shortage of skilled workers
  - Lack of standardization
  - Downturn in productivity and profitability



# Synthetic / fibre ropes

- **Synthetic / fibre ropes** (high-performance fibre ropes, HPFR)



# Synthetic / fibre ropes

- **Synthetic / fibre ropes (high-performance fibre ropes, HPFR)**
  - Comparable strength to steel wire ropes
  - Reduction in weight → safer and easier to handle.
  - Not require as much maintenance in terms of greasing or lubricating
  - Increased tolerance for spooling failures
  - No international standards regarding design and discard criteria
  - **FEM 5.024: 2017. Guideline – Safe Use of High Performance Fibre Ropes in Mobile Crane Applications**
  - Recent tests shows that fibre rope not only weighs around one-fifth of a conventional steel rope, but also lasts four times as long and is significantly easier to handle.

- **“Everything changes and nothing stands still.”. Plato, Greek Philosopher**
- **Lifelong learning becomes increasingly critical for ongoing success in the global workforce.**
- **IES Academy. The Institute of Engineers, Singapore**
  - **Close collaboration with local universities and polytechnics**
  - **Organizes courses, seminars and talks for engineers and IES members to advance the continuous development of engineers**
  - **Maintains close links with professional organizations of engineers regionally and throughout the world.**

# Appointed Person Course

## 5-Day Course for Appointed Person – Lifting Operations – 5<sup>th</sup> Run

### Introduction

As the Singapore Government pushes for higher productivity in various sectors, more and more cranes will be deployed at various work places. Use of cranes at site involves many people from various organisations, such as the crane manufacturer, site occupier, crane contractor, and various sub-contractors that use the cranes. According to the latest Singapore Standard on Safe Use of Tower Cranes SS 559:2010, it is crucial that one person be appointed to have overall control of the cranes. This appointed person shall be notified formally in writing of their appointment. This course is aimed at anyone who is required to plan safe systems of work, using lifting equipment and intends to take up this position as an appointed person. It is recommended that prior to attending this course, individuals should have some experience of working with lifting equipment, especially mobile cranes and tower cranes.

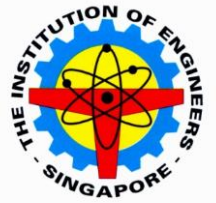
### PROGRAMME DETAILS

Date	: 14, 17, 22, 24, 25, 26 Sep 2018 04 Oct 2018 (Written Test)
Duration	: 5 Days
Time	: Please refer to schedule
Venue	: IES Academy@Jurong East & BCA Academy@Braddell
CPD Programme	: 30 SDUs 33 PDUs (To confirm)
Fees	: \$2,782.00 (IES Members/SISO Members) \$2,996.00 (Non-Members)
Organizer	: IES Academy

- Fees inclusive of 7% GST & course materials.
- Certificate of Completion will be issued to participants with passed on both Practical and Written tests.

- **Summary**
  - **Crane Lift for Tower Cranes**
  - **RFID and Data Logger**
  - **BIM**
  - **Variable Outriggers for Mobile Cranes**
  - **Remote Control Cranes**
  - **Autonomous / Driverless Cranes**
  - **Synthetic / Fibre Ropes**
  - **Life Long Learning**





**Thank You**  
**HAPPY NEW YEAR**  
**恭喜发财**

