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Lifting Industry Standards

CICA Guidance Note
Crane Major Inspection

Author: The Crane Industry Council of Australia
Date: 24/07/2017

CICA-GN-0025-2

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1. Amendment Records

Revision	Revision Details	Date
0	First Draft	16/02/2017
1	Draft for CICA Member Review	16/05/2017
2	Updated draft with CICA Member's comments	24/07/2017

2. Introduction

Confusion was created in the industry when Major Inspections were assigned a 10-year time threshold in the now superseded 2002 Australian Standards [1]. In the previous 1993 Australian Standard [2], Major Inspections were synonymous with what is now termed "Periodic Third-Party Inspections" [3]. The 2002 Australian Standard, in relation to Major Inspections, has now been superseded by Standards published in 2011 and 2016. In 2006, the Queensland Codes of Practice defined a Major Inspection as "10-year Major Inspection" [4]. What has been forgotten in practice are the manufacturer's recommendations and a crane's design life. In this Guidance Note, CICA provides guidance and clarity of the manufacturer's positions and their requirements, with the support of both the European Materials Handling Association (FEM) and the American Association of Equipment Manufacturers (AEM).

A safer alternative to the industry practice of completing a Major Inspection at the end of 10-years of service should be considered. An on-going Condition Monitoring Approach using thorough record keeping and CICA's national 3rd Party Inspection Program, Crane**Safe**, together with manufacturer's recommendation is the recommended approach to determine the interval and contents of a crane Major Inspection. This method is endorsed by international crane industry associations and is safer than the current practice, it also aligns with the recent AS2550.5-2016 and AS2550.11-2016 and ISO 9927-1:2013 publication and emphasizes the detection and resolution of component faults when they arise rather than waiting for the 10-year inspection date.

3. Definitions

For the purposes of this Guidance Note the following definitions apply:

- Competent Person – A person who has acquired through training, qualification or experience or a combination of these, the knowledge and skill to carry out the task.
    - Crane**Safe** Endorsed Assessor - means a 3rd party crane expert who has been endorsed by Crane**Safe** to carry out Crane**Safe** Assessments of specified crane types.
    - Professional Engineer – engineer who is registered under a professional accreditation, i.e. CPeng, RPEQ.
- Crane**Safe** - A division of The Crane Industry Council of Australia (CICA) which administers the Crane**Safe** Assessment program and endorses Crane**Safe** Endorsed Assessors to conduct Crane**Safe** Assessments.
- Crane**Safe** Assessment - A voluntary inspection of a specific crane at a specified interval completed using forms and policies provided by Crane**Safe**.
- Design Life [5] – Estimation of the allowable service life of the crane based on its original design specifications and taking into consideration the stress cycles and stress collectives (design constraints) before a Major Inspection is required.
- Residual Life – Estimation of remaining design life of the crane based on the original design specifications and actual usage.
- Service Life – Duration of time when the crane is in use beginning when the original owner starts using the crane (puts the crane in service) and ending when use

ceases. Service Life does not begin at the time of manufacturer and does not restart when the crane changes ownership.

- Condition Monitoring – The detection and collection of information and data that indicates the state of a crane.
- Data Logging – Recording crane usage in terms of crane working hours and crane load spectrum.

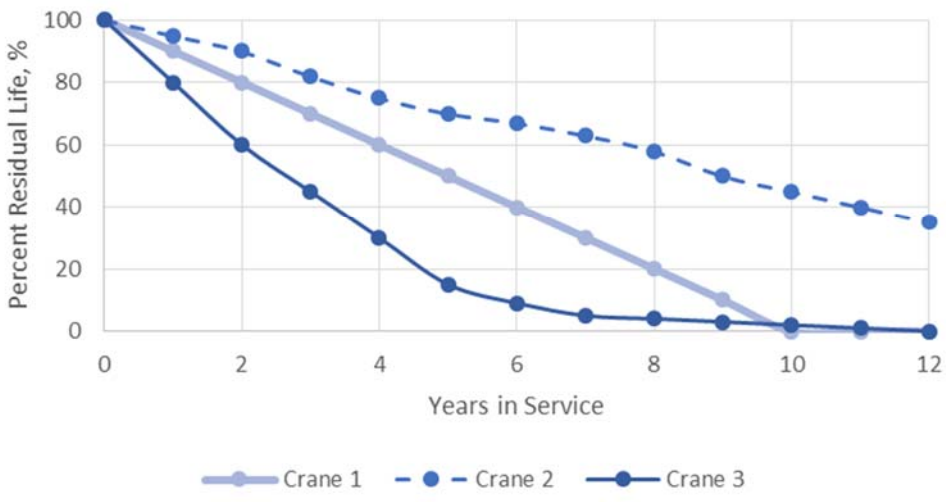
4. Background

Each Major Inspection is different and only a Competent Person can determine the extent of the inspections required to ensure that the crane is safe for continued use. This guidance note developed by CICA aims at providing guidance for crane owners on crane major inspection requirements. The recently released version of Australian Standard AS2550.5-2016 and AS2550.11-2016 updated the Major Inspection section to provide more information on Major Inspection intervals and Major Inspection content. With input from the Australian Standards, crane manufacturers, repairers, hirers, crane engineers and international crane associations, this guidance note represents industry recommendations for best practice for crane Major Inspection.

Historically, Australian Crane Industry operators have completed what has been termed a 10 Year Major Inspection after the initial 10 years of the crane being in service. However, crane usage is a more important indicator of potential wear to crane components than the age of the crane alone.

Following a Major Inspection after 10 years, a subsequent Major Inspection is typically at 5 or 10 years, when the overall crane service life is 15 years or 20 years of service, respectively. The flow-on effect has been that crane residual value at 10 years is significantly diminished, which disincentives the modern best practice of Condition Monitoring and on-going preventative maintenance. Figure 1 shows a hypothetical example of three cranes with varying utilization.

Figure 1 - Crane Utilisation



The ‘Crane 1’ example is the ideal crane for using a 10 year service life model. Each year the crane’s usage reduces the residual life of the crane by 10%. This linear reduction year-over-year means that after 10 years the crane will have exactly zero residual life.

‘Crane 2’ is used at regular intervals, but with either fewer lifts or at lower capacities. This reduction in utilization might be due to an extended period on a site that requires the crane to be de-rated below the rated capacity specified by the manufacturer. Or a crane that is designed for a higher capacity, but is regularly constrained by stability limits, not structural limits. Heavy lift, 300+ tonne capacity cranes are common examples of cranes that do very few lifts during a given period of time due to the volume of work and the preparation time needed to assemble the crane and rig the lifted load. Using the 10 year Major Inspection model, this crane is inspected prematurely with 45% residual life remaining in the crane at 10 years. It has the equivalent residual life at 10 years that ‘Crane 1’ had at 5 years.

‘Crane 3’ has highly variable usage. For the first five years, the crane was used more frequently than ‘Crane 1’ and forecast on the residual life would indicate its expiry at the 6th year. However, usage changed and from Year 6 to Year 10 the crane was underutilized. An example scenario of this would be five years of production on a site at which time the project finished and the crane was pulled from service. Due to a slowing economy, the work for this particular crane was distributed across several similar cranes available in an over-supply condition.

Figure 1 represents a simplified scenario of three different cranes. Most cranes in use in Australia would operate somewhere between ‘Crane 2’ and ‘Crane 3’ making a generic 10-year Major Inspection interval over simplified.

The service requirements for the three cranes would be expected to be different due to the varying severity of their use.

The usage of years to define when a crane has reached its design life is not granular enough to relate to the time of operation. Ten years from the in-service date assumes how many weeks of use each year? How many days of use each week? How many hours of use each day? Are hours accumulated if the engine is on or traveling down the road or hours when a load is attached to the hook?

In line with ISO 9927-1:2013, AS2550.5-2016, AS2550.11-2016, AS2550.1- 2011 and AS2550.10-2006, CICA recommends considering an alternative condition monitoring approach to the existing default practice of conducting a Major Inspection at 10 years.

Responsibilities under workplace legislation can be met in many different ways. There is no "one size fits all" position in relation to safety issues. Workplace safety legislation explicitly allows for this as a way of encouraging safety measure innovation. The following recommendations should be considered:

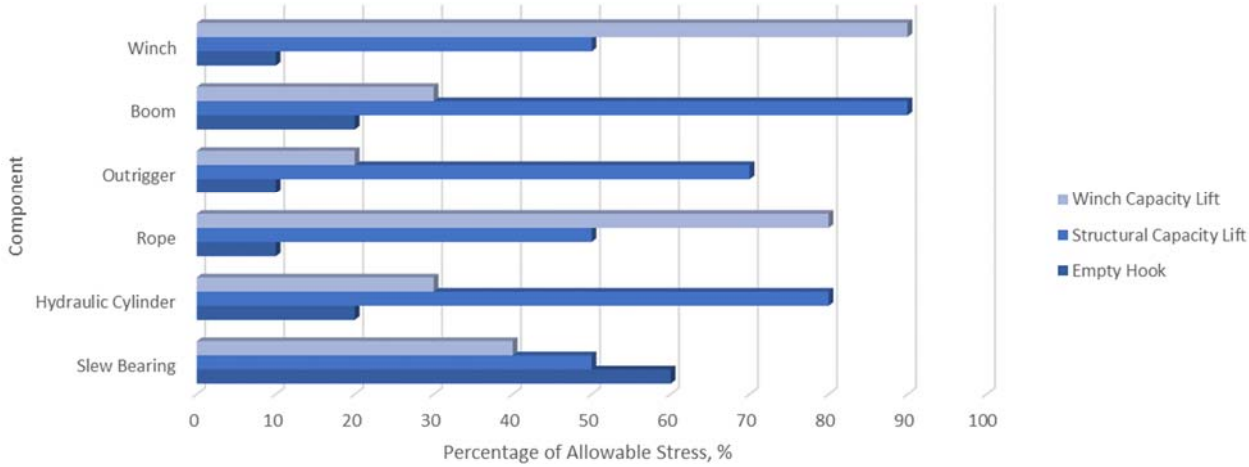
Crane Design Life should be clearly broken into two types according to AS1418.1-2002[8]:

a. Mechanical Components – Design Life of 10 years
b. Structural Components – Design Life of 25 years
   The requirement to perform structural inspections while completing a design life assessment of mechanical components should be at the discretion of the engineer and maintenance provider. However, some mechanical components require disassembly of the structure to inspect.

The variability in the usage of cranes, the hours used and the percentage of rated capacity at the time of use, makes linking Design Life to Service Life in determining Residual Life very difficult. Even when usage is known through data recording methods, manufacturing and material variability makes accurately pin pointing Residual Life of a specific crane impossible.

Furthermore, each component is not stressed equally during each lift. Graphically, a theoretical example is shown in Figure 2. The operating configuration of a crane is infinitely variable. The boom length, boom angle, boom section configuration, slew orientation, counterweight configuration, extension of outriggers, falls of winch rope, and winch (main or auxiliary) used are examples of variables in each lift.

Figure 2 - Component Stress Level in Different Lift Scenarios



5. Recommended Practice

5.1 Condition Monitoring Approach

A combination of Condition Monitoring and Manufacturer's Recommendations are the best approach to maintain a crane. It is critical for crane owners to follow the maintenance regime outlined by the manufacturer and maintain records of crane operation, service, and maintenance. Service and maintenance records throughout the life of the crane should be retained, e.g. photos, maintenance logbooks, service checklists, invoices, etc. These records can assist in detecting the Residual Life of the crane and crane components. Manufacturers may then recommend the need for a Major Inspection.

Recent advancements in the Crane**Safe** assessment forms allow for additional record keeping during the Crane**Safe** inspection by endorsed Crane**Safe** assessors*****. This will assist with retaining maintenance and service records required for the Condition Monitoring Approach.

Data logging by the crane owner or operator can assist in condition monitoring. Crane load spectrum can be calculated based on crane operation hours and the percentage of crane rated capacity used (Figure 3). Once the load spectrum is determined, with access to the

historical operation hours of the crane available from the Crane**Safe** program, CICA members can assess winch life by a calculation tool developed by CICA (Figure 4).

The calculation result can give crane owners an overview of the winch life and forecast the remaining design life of the winch. Environmental factors haven't been taken into consideration in this calculation, these factors could reduce winch life. For example, the crane might be exposed to extreme heat, high-UV condition or exposed to an abrasive environment.

* FEM European Materials Handling Association and AEM Association of Equipment Manufacturers endorsed the Crane**Safe** program as a system of condition monitoring of the crane condition to determine when maintenance, service, or repair are required. See Appendix A and Appendix B.

Figure 3 Crane Load Spectrum

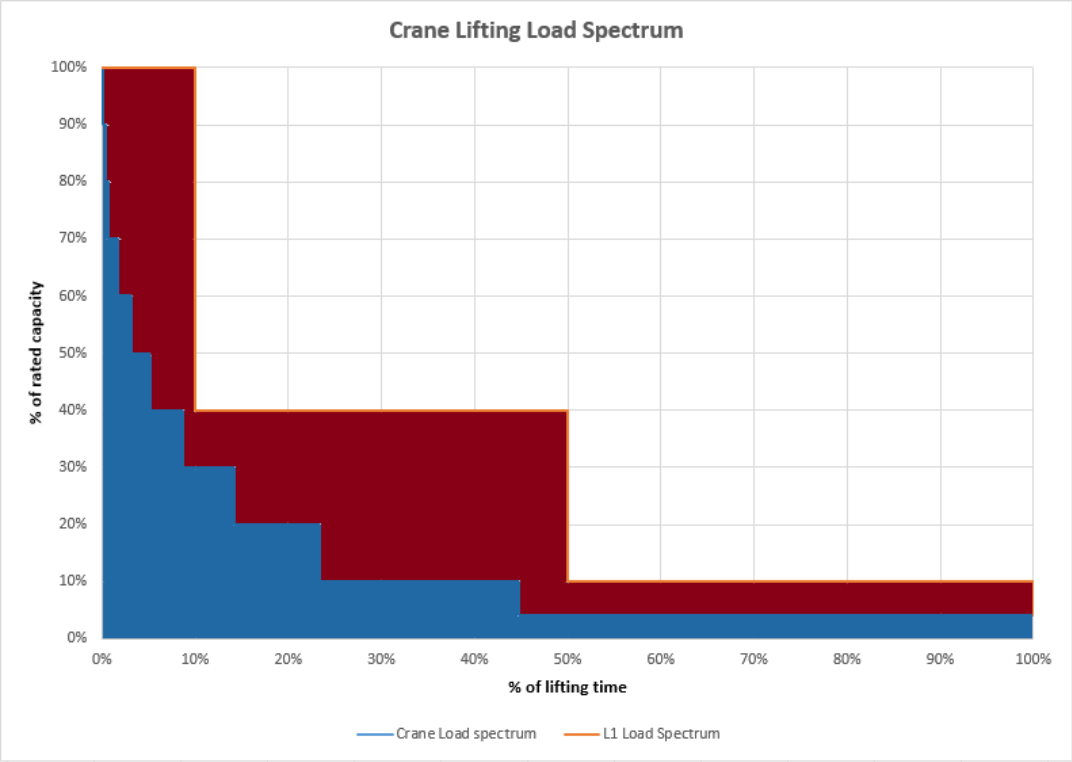


Figure 4 CICA Winch Life Calculation

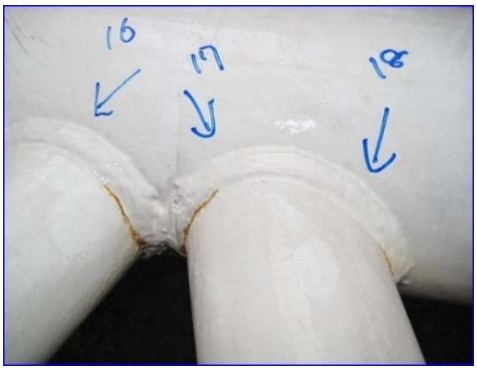
5.2 Time-Based Approach

Otherwise, the default period without on-going maintenance and inspection records is referenced in Table 1 in Appendix C. This is based on crane operation cabin engine hours. The 10 year mark used previously by the industry is just an arbitrary number.

When a Major Inspection is completed it should be overseen and signed-off by a competent person. A competent person should be a Chartered (CPeng) or Registered Professional Engineer (RPEQ) (Refer to Model Work Health and Safety Regulations Division 4, Subdivision 1, 235 [6] and AS2550.5[7]). At the completion of a Major Inspection, the Professional Engineer should provide a suggested inspection interval and future Major Inspection date (Refer to AS2550.5, Section 7.3.6[7]).

NDT Testing – Follow manufacturers recommendation on specific parts. In general, manufacturers do not require NDT methods beyond thorough visual inspection (examples of problems detected by thorough visual inspection are shown in Figure 5). Other subsequent NDT methods can be used if thorough visual inspection indicates that further investigation is required. Examples of subsequent methods include Magnetic Particle Inspection, Eddy Current Inspection, and Ultrasonic Testing. The requirements for each method should be followed as outlined in Australian Standards, AiNDT, and NATA.

Figure 5 Through Visual Inspection



Cranes compliant with the guidelines of the Condition Monitoring Approach or the Time-Based Approach are eligible to receive the CICA Major Inspection Verification Gold Plate.

http://cica.com.au/docs/default-source/technical-information/cica-major-inspection-verification-plate-requirements.pdf?sfvrsn=2

6. Components for Inspection

When inspecting individual components, Manufacturer's recommendation and instruction should be followed for the scope of work. The manufacturer may recommend a certain period of time for the maintenance and service interval for some specific components. A competent person shall provide information on the scope of work if Manufacturer's recommendations are unavailable.

Where allowed, in situ inspections are preferred if functional tests can determine the condition of the component. Unless otherwise specified by the manufacturer, the major inspection shall include removal and dismantling items specified in relevant Australian Standards. For example, when completing a major inspection for mobile cranes, AS2550.5 requires removal and dismantling of the following items:

- Crane assembly from the carrier
- Slew ring
- Boom sections
- Stabilizers
- Structural pins
- Winch gear boxes
- Crane hydraulic system including pumps and motors

Acceptable tolerances and discard criteria for components shall be based on the crane manufacturer's specifications, where available. Where documentation verifying the replacement, inspection or repair of a component or part within the last 5 years exists, the competent person overseeing the major inspection may reduce the inspection criteria.

The Major Inspection shall include a comparison of the crane design to the current edition of AS 1418. A risk assessment shall be carried out to determine where it is practical to upgrade the crane design to the current edition of AS 1418 to control additional risks. Safety-related modifications specified by the manufacturer shall be made.

7. Reference

[1] AS2550.1-2002 Cranes, hoists and winches – Safe use Part 1: General, Section 7.3.5
[2] AS2550.1-1993 Cranes, hoists and winches – Safe use Part 1: General, Section 8.2.1
[3] AS2550.1-2011 Cranes, hoists and winches – Safe use Part 1: General, Section 7.3.4
[4] Queensland Mobile Crane Code of Practice 2006, Section 18.6
Queensland Tower Crane Code of Practice 2006, Section 14.8
[5] ISO 9927-1:2013 Cranes – Inspections – Part 1: General
[6] Model Work Health and Safety Regulation 2011, Revised January 2014.
[7] AS2550.5 - 2016 Cranes, hoists and winches—Safe use Part 5: Mobile cranes
[8] AS1418.1 - 2002 Cranes, hoists and winches - Part 1: General requirements, Section 2.2

8. Further Information

This Guidance Note contains summary information only. Further information and resources, including a listing of CICA Endorsed Engineers, is available by contacting The Crane Industry Council of Australia:

Contact details	
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Appendix A – Letter from FEM European Materials Handling Association

European Materials Handling Federation
Product Group Cranes and Lifting Equipment

To whom it may concern

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Secretary

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Frankfurt, 17.10.2016

Major Inspection Requirements in Australia

FEM is the European materials handling association and has represented the European lifting and materials handling equipment manufacturers since it was founded in 1953. Within the product group Cranes and Lifting Equipment (FEM PG CLE) topics which are related to mobile cranes are covered by the subgroup Mobile Cranes, including European manufactured mobile cranes exported to Australia. Further information about FEM, the member companies and on-going activities can be found on our website under http://www.fem-eur.com/product-groups/cranes-lifting/mobile-cranes-mc/.

The key role of the Mobile Crane Sub-Group is to draft and communicate industry positions. It represents the technical, economic and political interests of the industry. It strives for technical progress and improved safety at work (e.g. via CEN and ISO through the publication of guidelines and FEM documents) involving all industry stakeholders and is a bridgehead between industry and authorities, formulating and communicating the industry's positions on European and worldwide legislation.

FEM also closely monitors crane safety developments throughout Europe and the world and welcomes the adoption of CEN TC 147 WG11 design standard "EN13000 – Mobile Cranes" by Standards Australia in the year 2013.

FEM supports CICA's CraneSafe program in Australia. As far as FEM is aware CICA has the most comprehensive crane safety inspection program in the world. FEM continues to support CICA's safety initiatives.

In Australia, we understand major inspections are to be carried out by a competent person to assess the suitability of a crane for continued safe operation:

1) at the end of design life recommended by the manufacturer,
2) or, if not available, the recommendations of a competent person,
3) or, if not reasonably practicable, after 10 years in-service[1].

[1]"In-service" means the continuous period of time from which the crane began its working life, not the date manufactured, e.g. The crane may be manufactured in 2015, but is not sold and put to use until 2016. The in-service date is 2016 and ten years in-service expires in 2026 regardless of usage.

FEM has the following opinion regarding the above mentioned Australian requirements:

To 1): The so called design life is a theoretical life time based on a lot of assumptions (e.g. number of load cycles, load spectrum, environmental conditions) which may not reflect the real life operation. Determining the end of design life for a mobile crane structure is not feasible due to the variability in lifting operations and the resulting stresses subjected on the crane structure and mechanisms.

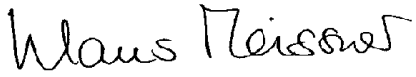
To 2): O.K.

To 3): FEM does not support major inspections based on a crane age of 10 years in-service only.

FEM continues to recommend a system of regular monitoring of the crane condition to determine when maintenance, service, or repair are required. FEM supports the use of CICA's CraneSafe program of inspection for the regular monitoring of crane condition.

FEM will continue the strong relationship forged with CICA to assist the CraneSafe program and with Standards Australia to collectively improve the safety of the Crane Industry in Australia and Internationally.

Yours sincerely,



Klaus Meissner
President FEM PG CLE Mobile Cranes

Paul Zepf
Secretary FEM PG CLE

Appendix B – Letter from AEM Association of Equipment Manufacturers

ASSOCIATION OF
EQUIPMENT MANUFACTURERS

AGRICULTURE
CONSTRUCTION
FORESTRY
MINING
UTILITY

April 12, 2017

Brandon Hitch
Chief Executive Officer
CICA
Unit 10, 18-22 Lexia Place
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Good Day Mr. Hitch:

Please accept this in response to our conversations regarding crane interests that have developed within our industry.

AEM, the Association of Equipment Manufacturers, is a North American based trade association representing over 900 member companies that either manufacture or directly support the manufacture of mobile cranes. Our main office is in Milwaukee Wisconsin and we have remote offices in Washington DC, Beijing China and Ottawa Canada. We support many technical committees and represent a group called Crane Technical Committee and the International Crane Stakeholders Association who deal with crane manufacturing.

Our crane committees closely monitor crane safety throughout the USA and around the world and enjoy working with CICA and your members striving to improve crane safety globally.

In Australia and as we know in many parts of the world, we understand that many global bodies have placed additional scrutiny on crane operations in their regions. At this time, I would like to define our position on a few key issues affecting our crane industry.

Crane Age Limit

Retirement criteria for a crane is not something that can be based solely on the amount of years that have elapsed since the crane's manufacture date. There are cranes that are not sold or put into operation for two or three years after their manufacture date. Also, crane users may have completely different use patterns, so a crane could be much older but have been used less. A crane's useful life must be determined by its amount of use and maintenance as determined by a complete inspection of the crane.

Load Cycle Counters

Many cranes are now being equipped with electronic cycle counters. As mobile cranes can be configured differently for every job, and can change configuration during each lift, a cycle counter on a crane would not collect/give useful information or have any valuable purpose. Tower cranes also change configuration regularly during each job and the interchangeability of the mast and jib components would make it impossible to apply the data from a cycle counter to assess the condition of a component. A cycle counter on a crane

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would not take into account the configuration of the crane. If a crane were to be loaded to only 10% of its capacity for a period of 5 years, with 3000 cycles being recorded by the cycle counter, this would not determine any useful information about the life of the crane itself or which components were affected by that operation.

Data Loggers

Some cranes manufactured in the recent past (approximately 10 years) are equipped with "event recorders" that are commonly misrepresented as "data loggers". These devices record some of the operational data when an "event" triggers such a recording.

Below is a list of operational characteristics of event recorders:

- Event recorders are not separate devices from the crane's RCL/LMI/LML system and as such are not able to receive the operator's name and license number as an input for recording purposes.
- Event recorders cannot be retrofit onto older cranes that were not originally equipped with them.
- When an event triggers a recording, the data is recorded as part of the proprietary program code to the OEM of the RCL/LMI/LML system installed on the crane. Typically, only the OEM of the system can download and interpret this proprietary code.
- Depending on the system, amount of data, etc., the download and interpretation process can take months, if not longer. The data is not instantaneously recognizable/readable.
- The data record is not infinite; there is only a finite amount of data that can remain recorded before the system must reuse the memory by over writing the oldest recorded data.

If all environmental and jobsite conditions are not known for the data that has been retrieved, interpreted and is in review, there may be no logical way to understand what the data shows.

As such, using an arbitrary measure such as age alone to determine when certain activities including major inspections are to be performed would not be recommended. AEM continues to recommend a process of regularly monitoring the crane's condition and usage to determine when maintenance, service or repair are required. AEM supports the use of CICA's CraneSafe inspection programs for the regular monitoring of a cranes condition.

AEM appreciates the strong relationship formed with CICA and your CraneSafe program that continues to improve the safety of the global crane industry.

Sincerely yours,

William Bernhard
Manager, Technical & Safety
Association of Equipment Manufacturers

Appendix C – Recommended Operating Hours before First Major Inspection

Table 1 below lists recommended operating hours before first Major Inspection for different types of cranes. These hours are based on the typical load cycle profile (e.g. L1, L2, L3) in line with the manufactured design life.

Crane Type	Recommended Operating Hours before first Major Inspection
Articulated Crane	15,000 Hours
All Terrain Crane	10,000 Hours*
Hydraulic Truck Crane	10,000 Hours
Crawler Crane	10,000 Hours
Rough Terrain Crane	10,000 Hours
Vehicle Loading Crane	10,000 Hours*
Tower Crane	10,000 Hours

*All Terrain Crane hours are for upper hours

*If Vehicle Loading Crane does not have an hour meter, 10 years of service should be used.

Table 1 - Recommended operating hours before first Major Inspection

Appendix D – CICA Endorsed Engineers

CICA Endorsed Engineers are listed on the CICA website:

http://cica.com.au/resources/endorsed-engineers

Appendix E – List of Relevant Documents

Standard/Regulation	Specific Clause
Model Work Health and Safety Regulations	Part 5.2 Division 4 Subdivision1 Clause 235
AS1418.1 - 2002 Cranes, hoists and winches - Part 1: General requirements	2.2
AS2550.1-2011 Cranes, hoists and winches – Safe use Part 1: General	7.3.4
AS 2550.3 - 2002 Cranes, hoists and winches Bridge, gantry, portal and jib cranes	7.3.4
AS 2550.4 - 2004 Cranes, hoists and winches Tower cranes	6.3.6
AS 2550.5 - 2016 Cranes, hoists and winches Mobile cranes	7.3
AS 2550.10-2006 Cranes, hoists and winches Mobile elevating work platforms	6.4.5
AS 2550.11-2016 Cranes, hoists and winches Vehicle-loading cranes	6.2
ISO 9927-1:2013 Cranes – Inspections – Part 1: General	5.6; 6; 7
General Guidance for Cranes 2016 – Safe Work Australia	Inspection and pre-use safety checks
Guide to Inspecting and Maintaining Cranes 2016 – Safe Work Australia	Major Inspection
Mobile Crane Code of Practice 2006	18.6
Tower Crane Code of Practice 2006	14.8
Western Australia Occupational Safety and Health Regulations 1996	4.54 (4) C