

# Age-old questions

Does age affect a tower crane's operational safety?

Based on Haag Engineering's *Tower Crane Life Expectancy* report, the answer is no.



Should age be a determinant of when a tower crane, or any crane for that matter, should be taken out of service? Over the past decade, this question has been a global topic of discussion. At this point, there is no prevailing thought process on whether a maximum service life should be set for tower cranes based solely on their age.

In 2014, Houston-based Haag Engineering published a crane study titled *Crane Accidents: A Study of Causes and Trends to Create a Safer Work Environment, 1983-2013*. Led by Haag Chairman/Principal Engineer Jim Wiethorn, the study chronicles details on some 500 crane accidents over a 30-year period.

Based on the information revealed in the report, the Specialized Carriers & Rigging Association (SC&RA) asked Haag Engineering to answer additional questions to determine if any correlation exists between tower crane accidents and the age of the crane.

"SC&RA became aware that some cities were exploring possible legislation to set age limits on cranes," said AmQuip's

Dennis Bates, who is chairman of the SC&RA Tower Crane Committee. "We felt there was a need for these city officials to have accurate facts and information available from an independent source. With Haag Engineering's large database of crane accidents, they were the logical firm to approach to answer our questions."

Millions of people fly every day on older airplanes that have been properly maintained with no age limitations, Bates said. The same should apply to construction cranes. Having a third-party offer expertise on this issue was important to SC&RA.

"As the leading advocate for our industry, it was imperative that SC&RA address this issue," said Beth O'Quinn, vice president, SC&RA. "Members and committees thought it would be beneficial to consult a third party in addition to the expertise of key industry companies. The research conducted by Haag Engineering, as well as their response to SC&RA's specific questions regarding crane age, should prove to be beneficial to cities who consider limiting the age of cranes now and in the future."

In early 2015, Haag Engineering produced its report to the SC&RA. Titled *Tower Crane Life Expectancy*, the document is an examination of recent trends to establish age limits on tower cranes. Following is a summary of the report and answers to the questions SC&RA submitted to Haag.

## Age limit policy history

The first policy to stipulate calendar ages of cranes as a limit to their service lives was enacted in Singapore in 2006. The statute states that any tower crane not manufactured in Singapore and over five years old shall be subjected to an inspection by a third-party inspection agency and that, for the most part, tower cranes more than 20 years old are banned.

In 2007, Cal/OSHA received a petition recommending that Section 4884 of the General Industry Safety Orders be amended to require that all hammerhead and luffing tower cranes older than 20 years old not be climbed and/or tied to any structure. All the requests in the petition were denied.

In 2012, the Crane Industry Council of Australia recommended stringent independent inspection procedures and verification of past maintenance history for cranes less than 10 years of age and in excess of 20 years old.

Crane age also has been an issue addressed by the Ontario Ministry of Labour as well as the New York City Department of Buildings, both of which looked at banning tower cranes 20 to 25 years old.



Tower crane age has been an issue addressed by authorities around the world. Pictured are several tower cranes working at the Dell Children's Hospital in Austin.





Many contractors require a complete annual inspection before a crane is brought onto the site. They may also require an independent inspection company perform the inspection. Pictured is a team of tower cranes working on the Brickell City Centre in Miami.

The restriction of service life due to age of a crane appears to have originated in the Asia-Pacific region where there had been no prior restrictions on used cranes brought in from various countries. This region was determined to be a “dumping ground” for old and worn out cranes that had exceeded their economic life and for counterfeit cranes.

“Proper maintenance, documentation and ongoing inspection and testing of cranes remains the foundation for crane longevity as noted by leadership in Singapore, Australia, Cal-OSHA and the City of New York” Haag Engineering’s report states. “The alternative to allowing insufficient maintenance and inspection/testing is limiting the age of a crane; however, abuse and improper operation of any mechanical equipment has no age limit and can cause severe damage over a short period of time. Certainly structural, mechanical, hydraulic, pneumatic and electrical degradation is inevitable as a crane ages.

Crane maintenance is more intense with an aged crane since components naturally wear with use, because metal fatigue develops with repeated severe cycles and because systems become inoperable, break due to impact or misuse and deteriorate from environmental conditions.”

**BASED ON HAAG’S STUDY, HOW MANY ACCIDENTS/INCIDENTS WERE DUE TO A CRANE’S AGE?**

None. Cases with which we have been involved that were associated with condition of the crane were associated

directly with lack of maintenance or abuse during operations. No crane that was operated and had been maintained in accordance with consensus national standards has been involved in any accident which we have investigated.

**HOW DOES A TOWER CRANE MANUFACTURER DEFINE THEIR CRANES’ ‘LIFE EXPECTANCY’ AND DOES IT VARY FROM MANUFACTURER TO MANUFACTURER?**

Manufacturers do not define a “life expectancy” for their cranes. Crane designers may apply design criteria for load cycles predicated on the crane lifting at least 85 to 100 percent of its capacity during every lift with the understanding that such will not happen. This is particularly true of tower cranes which rarely make consistent lifts approaching allowable capacities.

Proper maintenance and use will assure service exceeding any projected “life expectancy.” Conversely, the lack of maintenance and operational abuse will reduce greatly the estimated “life expectancy.” Both maintenance and operational issues cannot be controlled by the manufacturer; therefore, no life expectancy ever is addressed by the designer. Ultimately, some “end of life” criteria must be defined. We have discussed this specific issue with multiple crane manufacturers and designers, and currently no end-of-life definition has been devised. Although sophisticated life-extension technologies exist for older equipment, implementation often includes extensive inspection, refurbishment and

component replacements. Life extension programs are cost effective for capital-intensive equipment, such as aircraft and power plants, but probably not for cranes. During a bare lease, owners do not have control of the equipment; control of the inspection and maintenance; and, operational control during the lease period, and must rely on the contractor renting the crane to perform the required tasks and operate within chart allowables.

**SOME CITIES AND STATES HAVE INDICATED A DESIRE TO HAVE TOWER CRANE OWNERS COUNT CRANE ‘CYCLES.’ HOW CAN A TOWER CRANE OWNER COUNT A CRANE’S CYCLES?**

Suggestions how to count cycles in cranes include counting the number of “picks,” recording load line forces, recording boom strains and recording strains on the tower.

Although instrumentation can be devised to measure forces, strains, accelerations and deflections, there is no consistent algorithm to convert reliably any of these factors by which to estimate cumulative damage or residual life. In fact, installing such instrumentation into an older crane will result in erroneous data and potentially instill false confidence. With no historical data to input, the instrumentation will consider the old crane to be new with a full complement of service life left to be consumed. Reliance on such instrumentation potentially would supplant the use of vigorous and competent inspections of crane components and lead to missed opportunities to discover cracks and other mechanical damage.

**DOES THE MANNER IN WHICH THE TOWER CRANE HAS BEEN MAINTAINED AND SERVICED HAVE A DIRECT CORRELATION TO THE LONGEVITY AND CONTINUED SAFE USE OF A TOWER CRANE?**

Yes, in both positive and negative manners. OSHA regards replacement of a worn part with a “replacement in-kind” to be a safe maintenance practice. Replacement parts considered replacement in-kind must provide the same functionality and performance, but need not be geometrically identical or made from the same materials. So long as the replacement part is fit for its intended purpose, no engineering analyses are required, and the worn part merely is swapped for the replacement. Considering the number of component parts and the number of crane manufacturers no longer in business, the OSHA criterion is the best alternative to assuring safety and





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## SPECIAL REPORT TOWER CRANES

continued economic use. Retrofitting non-replacement in-kind parts is permitted, along with re-rating the maximum load, provided an engineering analysis justifies adaptation of different or alternatively designed parts.

### CAN PROPER INSPECTIONS OF THE TOWER CRANE PROLONG ITS LIFE EXPECTANCY?

Yes. Proper inspections and indicated maintenance are key elements to prolonging the life of a tower crane. Regular inspections documented accurately provide a road map of historical information regarding condition of the crane.

Competent inspections at appropriate intervals also should detect cracking and other structural problems prior to development of a critical condition. It is imperative that bare leased equipment is properly inspected, repaired and operated during the lease and then documented in order that the owner of the equipment is aware of issues that could affect the longevity of the crane.

### WHAT KEY INDICATORS AFFECT THE LIFE EXPECTANCY OF A TOWER CRANE?

Proper maintenance and timely inspections in conjunction with operations within allowable constraints are key factors to longevity and minimal wear. The most vulnerable period for a tower crane is during a bare lease when the lessee has complete control of the equipment and of its maintenance/inspections.

Proper maintenance and timely competent inspections coupled with proper erection and disassembly by crews with appropriate experience and expertise are crucial to assure a long, trouble-free service life. Post-disassembly inspections, repairs and maintenance should verify the crane has no dangerous deterioration issues. It is imperative that bare leased cranes are properly maintained and documented during operation as the unit will not be re-assembled in the yard when returned from the work site.

### BASED ON HAAG'S RESEARCH, IS THERE A DIRECT CORRELATION BETWEEN A TOWER CRANE'S AGE AND ACCIDENTS/INCIDENTS?

No. Study results have demonstrated no correlation between calendar age and accidents. Operation, maintenance, site preparation, erection, foundation suitability and adequate tie-in bracing are the factors which affect tower crane accidents.

### DOES THE AGE OF A TOWER CRANE DIRECTLY RELATE TO ITS LIFE EXPECTANCY?

We have determined there is an "economic life" of tower cranes, as there is with all other construction equipment. Recent changes to ASME B30.3 includes a section, "Major Inspections," which in addition to normal maintenance, requires specific elements of tower cranes be examined and even dismantled at 60-month (5-year) intervals. (Owners may decide to conduct inspections based on a specified hours of operation of such components.) The costs of regular ongoing maintenance plus replacement of worn or damaged parts and subsequent major inspections increase with age. These maintenance and repair costs ultimately reach or exceed the potential revenue that the equipment can generate. It then is no longer economically feasible to maintain and operate the crane.

### BASED ON HAAG'S RESEARCH, IS THERE ANY ENGINEERING EVIDENCE TO SET AN ARBITRARY TIME LIMIT ON THE USAGE OF A TOWER CRANE?

No. For properly maintained and inspected tower cranes, no definable time limit for equipment retirement age is supported or derived from any engineering principles. In fact, historical data show conclusively that exclusive of cost considerations, properly maintained and inspected tower cranes can remain in service indefinitely.

### SINGAPORE RECENTLY INVOKED AN AGE LIMITATION OF 25 YEARS ON TOWER CRANES. BASED ON HAAG'S RESEARCH, HAVE YOU FOUND ANY DOCUMENTATION TO SUPPORT THIS LIMITATION?

No. It is interesting to note that Singapore has adopted a very systematic approach to tower crane safety that mirrors that of ASME B30.3, including responsibilities, maintenance, assembly/disassembly, site layout, inspections and certifications. Their limitation is applicable strictly to older tower cranes being brought into the country, cranes whose historical use and maintenance records are inadequate and cannot prove the cranes have been inspected properly on a periodic basis. Such tower cranes could not be permitted for erection in the United States under similar circumstances. No basis or reasoning was provided relative to the final 25-year age limitation which, as presented, has no scientific basis or engineering foundation.