



Professional Engineers
Ontario

PRACTICE STANDARD

**Review of Tower Cranes as
Required by the *Occupational
Health and Safety Act***

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1. Purpose and Scope of Standard

The standard prescribes responsibilities for professional engineers carrying out review of tower cranes as required by Ontario Regulation 213/91 (O. Reg. 213/91) under the *Occupational Health and Safety Act*. The primary purpose of these reviews is to ensure that a tower crane can be put into service. Section 159 of the regulation requires professional engineers to document that all work specified in sections 158 and 159 has been completed to his or her satisfaction and that, in his or her opinion, the crane is ready to operate. The practices provided in this standard are those judged to be the minimum basis for making this assessment.

2. Practice Standard for Professional Engineers Reviewing Tower Cranes

1. (1) In this section,

“constructor” has the same meaning as given in the *Occupational Health and Safety Act*.

“demarcation point” means the point at which the electricity provider’s distribution system ends at the customer’s transformer or disconnect switch;

“load test” means a process specified by the manufacturer or a professional engineer of putting weight on the load block or hook to verify a crane’s ability to operate at its designated maximum operating capacity.

“non-destructive testing” means testing carried out on any component of a crane to establish the presence, location and extent of any defects that can affect the integrity of the component without cutting, piercing, or otherwise damaging or altering the article being tested;

“qualified electrician” means a person holding a valid certificate of qualification for “Electrician – construction and maintenance” issued under the *Ontario College of Trades and Apprenticeships Act, 2009*.

“qualified NDT technician” means a person holding a valid CGSB 48.9712 certification.

“qualified technician” means a person competent by training and experience to perform maintenance on mechanical and hydraulic components of a tower crane and who carries out such work on an ongoing basis for a tower crane owner or manufacturer.

“review engineer” means a holder of a licence or a temporary licence to practise professional engineering who is carrying out the work described in s. 2;

“structural repair” means any modification, alteration or addition required to restore a damaged structural component to its original or rated capacity.

2. The following are prescribed as the practice standard with respect to a review by a professional engineer of a tower crane as provided for in ss. 158 and 159, O. Reg. 213/91 under the *Occupational Health and Safety Act*:

Review of Tower Cranes prior to Erection

- (1) Before conducting an on-site review of a tower crane, the review engineer shall:
 - (a) obtain and review installation drawings and manuals, all available technical information, manuals, crane logs, previous pre-erection and post-erection reports, records of previous non-destructive testing, maintenance records, parts replacement records and details of any structural repairs, and any non-routine maintenance, and all records of modifications for the tower crane to be reviewed that provide information for each major component or sub assembly, including, but not limited to, the following:
 - (i) crane manufacturer, model and serial numbers,
 - (ii) unique marks for each component,
 - (iii) basic dimensional information to aid identification of components,
 - (iv) height under hook,
 - (v) reeving specifications,
 - (vi) tower height (type and number of sections),

- (vii) boom length (type and number of sections),
 - (viii) anchor bolt specifications,
 - (ix) counterweight specifications, including arrangement and weight of each counterweight,
 - (x) central base ballast weight specifications, including arrangement and weight of each ballast component, if applicable,
 - (xi) travelling base and track bed, if applicable,
 - (xii) foundation drawings,
 - (xiii) building tie-ins,
 - (xiv) electrical wiring diagram, including control circuits, electronic schematics, transformer specifications, and electric motor specifications,
 - (xv) power supply or generator specifications,
 - (xvi) hydraulic schematics and manuals,
 - (xvii) manufacturer's or engineer's welding procedure specifications,
 - (xviii) software verification documentation, if available,
 - (xix) documentation of all modifications,
 - (xx) load test criteria, and
 - (xxi) record of the manufacturer, mark of manufacturer and technical specifications of the crane anchorages, anchor bolts and nuts;
- (b) ensure that the information provided under (a) is sufficiently detailed to enable the review engineer to confirm that the specified components have been assembled correctly;
 - (c) verify that the components made available for inspection are those identified in the information provided in (a);
 - (d) verify that, according to the crane log, the crane operator has, at a minimum, carried out equipment maintenance according to a pre-existing schedule;
 - (e) obtain and review wire rope documentation and verify that the ropes conform to the crane manufacturer's specifications or specifications prepared by a professional engineer;
 - (f) obtain and examine all available recall notices and technical bulletins from the manufacturer of the tower crane being reviewed and verify from the

crane log book that all recalls and warranty matters for the crane have been dealt with; and

- (g) where it is not possible to verify that matters identified in (f) have been dealt with, the review engineer shall take whatever steps are necessary to resolve the matter.
- (2) Where a previous review report has identified defects requiring rectification, the review engineer shall obtain evidence that the necessary remedial action has been taken before a new pre-erection review is completed.
 - (3) If there is no evidence or record that defects have been repaired, the engineer must either:
 - (a) carry out all inspection or tests needed to verify defects have been corrected; or
 - (b) provide updated instructions for the repair.

Pre-Erection Inspections

- (4) The review engineer shall determine the type of non-destructive testing to be done and shall provide this information to the qualified NDT technician or firm carrying out these tests.
- (5) The review engineer shall perform, if certified to CGSB 48.9712, or direct a qualified NDT technician to perform, a non-destructive test of each of the following components, if the review engineer judges such testing is necessary:
 - (a) tower fasteners;
 - (b) apex fasteners;
 - (c) boom fasteners;
 - (d) bridle fasteners;
 - (e) pendant fasteners;
 - (f) turntable-to-tower fasteners;
 - (g) counterweight jib;
 - (h) reusable foundation anchor bolts; and
 - (i) counterweight suspension points.
- (6) The review engineer shall perform a visual inspection, or if determined to be necessary perform, if certified to CGSB 48.9712, or direct a qualified NDT technician to perform, a non-destructive test of each structural component, including, but not limited to, the following:

- (a) access platforms;
 - (b) stairways;
 - (c) ladders;
 - (d) signs and sign connections;
 - (e) crane cabin connection;
 - (f) boom;
 - (g) counterjib;
 - (h) tower sections;
 - (i) apex;
 - (j) pendant;
 - (k) travelling base;
 - (l) trolley;
 - (m) hook block; and
 - (n) turntable.
- (7) The review engineer shall request non-destructive testing or dismantling and inspection of any other tower crane component if justified on the basis of:
- (a) the content of the previous reviews; or
 - (b) the result of the current visual examination.
- (8) The review engineer shall require the technician who carries out the tests described in (5), (6) and (7) to provide evidence of certification to CGSB 48.9712.
- (9) The review engineer shall obtain and review the reports of non-destructive testing detailed in (5) and (6) and shall verify that the report includes:
- (a) date and location where the tests were conducted;
 - (b) name, qualifications and position of the person conducting the tests;
 - (c) description, serial number or identifying mark of the components examined;
 - (d) details of the test method employed and reference to appropriate standards;
 - (e) calibration details of any test equipment used; and
 - (f) results of the examination.
- (10) The review engineer shall verify that all pins and bolts are of proper size and in accordance with or equivalent to manufacturer specification.
- (11) The review engineer shall measure pin holes for roundness and excessive wear.
- (12) The review engineer shall verify that all pin retainers are in good condition and properly installed.
- (13) The review engineer shall visually inspect panels, operator controls, and power wiring for compliance with the manufacturer's specifications, local standards and the Electrical Specification Tower Cranes, ESA Spec 00X-13, and verify that all electrical components are approved by a recognized authority; alternatively, the review engineer can use a report from a qualified electrician.
- (14) In assessing the slew ring, the review engineer shall:
- (a) obtain the serial number or unique identifying mark of the slew ring;
 - (b) observe the condition of the gear teeth on bearing and pinion;
 - (c) observe the condition of the slew ring greasing systems including the condition of the grease, grease lines, nipples and lip seals;
 - (d) verify tightening of bolts is done according to the manufacturer's specifications; and
 - (e) verify that bolts needing replacement as a result of the pre-erection review comply with the manufacturer's specifications or engineer's direction;
- (15) The review engineer or a qualified technician shall check the preload torque on the turntable bolts.
- (16) The review engineer shall inspect the hydraulic system, including pumps and motors and report any improper or inadequate connections, corroded elements, leaks, hose wear and other deficiencies.
- (17) The review engineer shall prepare a written pre-erection report that includes:
- (a) date and location where the examination was completed;
 - (b) weather conditions at the time of the review;
 - (c) record of observations made in (10), (11), (12), (13), (14), (15) and (16); and

- (d) the non-destructive testing report, including the name, qualifications and employing organization of the person completing the inspection and tests.
- (18) The review engineer shall immediately notify the crane owner in writing of any defects found during the inspection of the crane.
- (19) The review engineer shall verify that all defects are corrected before the crane is erected.

Review of Tower Cranes after Erection

- (20) The review engineer shall include the following information in every tower crane post-erection review report required by ss. 159 of Ontario Regulation 213/91:
- (a) name and location of the project;
 - (b) make and model of the tower crane reviewed;
 - (c) owner of the tower crane;
 - (d) the time period in which the review took place;
 - (e) the date on which the report was completed;
 - (f) the parties to whom the report is addressed;
 - (g) contact information for the review engineer who prepared the report;
 - (h) the purpose of the report;
 - (i) specific identification of drawings, blueprints, photographs, documents, manuals and other reference material used;
 - (j) references to legislation, codes, standards, or guidelines that have relevance to the work;
 - (k) where judgments or opinions are made, details of the reasoning that led to the report's conclusion or findings;
 - (l) list of defects discovered during review;
 - (m) all reports obtained from third-parties, including, but not limited to, those identified in (25), (26), and (37);
 - (n) all directions for repairing damage or incorrect installation that were provided to the crane owner;
 - (o) identification and contact information for everyone contributing to the report; and
 - (p) a statement that the crane is ready to be put into service, or ready to put into service with specific limitations, or not ready to be put into service due to specific deficiencies.

- (21) The review engineer carrying out tests on a tower crane shall provide, or have access to, and be competent in the use of, all testing and measuring equipment needed to perform the tests or shall delegate the testing to a "qualified person" as defined in CSA Z248-04.
- (22) Following delivery of the crane components to the site and before the tower crane is erected, the review engineer shall inspect any items identified by the owner, erector or contractor as having been damaged, and provide instructions for dealing with this damage.
- (23) The engineer shall verify that the components are the same ones inspected during the pre-erection inspection.
- (24) The review engineer shall obtain and review the pre-erection report prepared by the pre-erection engineer and verify the information remains valid and that any instructions have been followed.
- (25) The review engineer shall obtain and review the erection report prepared by the erector and verify that the installed configuration and counterweights conform to the design drawings prepared by a professional engineer.
- (26) The review engineer shall obtain from the erector a report confirming that, if tower sections are bolted together, tower bolts have been preloaded to the specified amount. The review engineer shall confirm that the tower bolt preload report includes the following information:
- (a) date the work was completed;
 - (b) the name of the person preparing the report;
 - (c) details of the equipment used, including the serial numbers or identifying marks;
 - (d) calibration details for the equipment used; and
 - (e) settings used on the torque or stretching device.
- (27) The review engineer shall verify the mast verticality after erection and take necessary measures to correct any installation problem at his or her discretion.
- (28) The review engineer shall inspect wire ropes and end connections as per CSA Standard Z248-04, Code for Tower Cranes, section 4.11.2 Wire rope fittings and terminations.

- (29) The review engineer shall ensure that swivel on any rope is installed in accordance with crane manufacturer's specifications.
- (30) The results of the examination of wire ropes described in (27) and (28) shall be included in the post-erection review report.
- (31) Accessible structural components of the tower examined by non-destructive testing during the pre-erection review shall be visually inspected by the review engineer following erection, to confirm the parts have not been damaged.
- (32) The review engineer shall verify that the following components are properly installed:
- all accessible parts of the crane structure;
 - ladders, landings, guardrails and access walkways;
 - pins and pin retainers;
 - bolt head and nut locking means, if specified by the manufacturer;
 - counterweights; and
 - tower crane supports shown on the installation drawing (including, but not limited to, shoring, bracing and tie-ins).
- (33) The review engineer shall climb the tower and access all areas with access platforms and guard rails provided to carry out the inspections identified in (31) and (32).
- (34) The review engineer shall verify that the foundation, rail bed, and tower crane supports shown on the installation drawing (including, but not limited to, shoring, bracing and tie-ins) have been inspected by a professional engineer.
- (35) The review engineer shall provide the crane owner instructions for dealing with any damage or incorrect installation noted in (31), (32) or (34).
- (36) The post-erection report shall identify any deficiencies in the structural components of the crane and the review engineer shall verify these components are repaired to their manufacturer's specifications or professional engineer's instructions prior to submitting the final report.
- (37) The review engineer shall arrange for a qualified electrician to carry out a grounding continuity test for both the tower and power supply grounding systems in accordance with the Electrical Safety Code and to prepare a report containing:
- the name, qualifications and employing organization of the person completing the test;
 - results of the test;
 - comparison of the test results with standard requirements;
 - identification and calibration details of the test equipment used; and
 - the date the test was completed.
- (38) The review engineer shall obtain and review, prior to the crane being put into service, a report of any electrical repairs or tests done to the crane since the last time the crane was in operation. The report shall contain:
- the name, qualifications and employing organization of the person completing the inspection and tests;
 - results of the inspection and tests;
 - comparison of the test results with manufacturer's specifications; and
 - the date the inspection and tests were completed.
- (39) The review engineer shall:
- verify the demarcation point with the local power authority or general contractor;
 - visually inspect the entire electrical system from the demarcation point or generator to the electrical equipment on the crane, looking for damage or violations of the Electrical Safety Code and compliance with manufacturer's specifications;
 - power up the electrical system and check all operating electrical components for vibration and excessive heat, and verify that the components are functioning as intended;
 - verify that the electrical equipment is appropriate for the environment in which it will be operating;
 - verify that each in-use limit switch, overload limit device and any other limiting device specified by the manufacturer is properly located, set and operating as intended;
 - verify that emergency stops function as intended;
 - verify that the tower is grounded separately from

- the power system via grounding rods, plates or other means of distributing charge to the earth;
- (h) verify, if power is supplied by a generator, that the generator is separately grounded in accordance with the Electrical Safety Code and manufacturer's instructions; and
 - (i) record in the post-erection report the results of the verification and inspection tasks listed in (a) through (h).
- (40) The review engineer shall:
- (a) confirm that all control levers operate the appropriate function, move smoothly, return to neutral position when released, and are properly identified;
 - (b) verify that calibration of the load moment system (load indicator, angle indicator, height indicator, radius indicator) has been completed;
 - (c) check functioning, integrity and condition of limit switches and operator's controls;
 - (d) visually check control wiring and report damage or improper installation;
 - (e) visually check the condition of electronic components;
 - (f) witness functional tests for all control components at the extreme limits of use, as described by the manufacturer or in the most unfavourable position determined by the review engineer for these components; and
 - (g) record in the post-erection report the results of the verification and inspection tasks listed in (a) through (f).
- (41) Prior to the load test, the review engineer shall visually inspect and report, or obtain a report from a qualified technician, on the condition of the mechanical equipment tested under normal operating conditions, including, but not limited to, motors, gears, brakes, sheaves and bearings and shall specifically report occurrences of any of the following:
- (a) abnormal vibration;
 - (b) unusual noise or temperature of crane components;
 - (c) corrosion;
 - (d) missing, improperly installed or misaligned components;
 - (e) worn or damaged brake linings, brake shoes or brake pads;
 - (f) distorted or damaged brake drums, plates, calipers or other components;
 - (g) insufficient brake solenoid stroke reserve;
 - (h) wire rope improperly spooling on to the drum;
 - (i) incorrect sheave size and excessive wear;
 - (j) incorrect functioning of floating sheave;
 - (k) incorrect functioning of tensioning sheave;
 - (l) leaking lubricants;
 - (m) wear, play or damage of moving equipment;
 - (n) loose or defective bolts or pins;
 - (o) missing cotter pins, retaining or locking devices;
 - (p) missing, improperly installed or damaged guards on exposed moving parts;
 - (q) loose or unsecured materials left on the crane; or
 - (r) any other hazards not herein listed, but deemed important by the review engineer.
- (42) If, as a result of the inspection described in (41), the review engineer finds evidence of any of the occurrences specified in (a) to (r), the engineer shall arrange for further testing, disassembly, inspection or other appropriate action.
- (43) The review engineer shall direct the erector to perform the tests on all brake systems appropriate for the crane under review, verify that the results are compliant with the manufacturer's specifications and record this information in the post-erection test report.
- (44) The review engineer shall witness the load test performed by the erector and shall include the following information in the post-erection report:
- (a) location of the crane;
 - (b) date the test and subsequent examination was completed;
 - (c) weather conditions at time of test;
 - (d) the configuration of the crane at time of test;
 - (e) the serial number or unique identifying mark of the crane;
 - (f) test weights and radii tested;
 - (g) the load test procedure; and
 - (h) details of any defects, unexpected behaviour or abnormal deformation observed during or due to testing.

- (45) Where the newly installed crane is within the working radius of an existing crane, the review engineer shall
- (a) verify that an anti-collision procedure has been prepared by a professional engineer;
 - (b) record this information in the post-erection report; and
 - (c) if there is no anti-collision procedure, notify the constructor, in writing, that the crane cannot be put into operation.

(46) The review engineer shall provide a copy of the report to the client and shall keep a copy for his or her records.

Inspection before Tower Climbing Operations

(47) The review engineer shall perform a visual check of the climbing system prior to the initial climbing operation of the tower crane at the project.

(48) The review engineer shall check that the climbing system used is the one shown in the tower crane drawings and is properly installed with the parts specified by the manufacturer or approved by an engineer.

(49) The review engineer shall perform a visual check of the climbing system attachment points on the tower.

(50) The review engineer shall confirm that the installation drawing for shoring and bracing or tie-ins was approved by a professional engineer and that the drawing indicates all anticipated forces exerted by the tower crane on the building structure.

(51) The review engineer shall obtain and confirm test data indicating that the concrete slabs to which the tower will be affixed after climbing have attained the required strength prior to each climbing operation

(52) The review engineer shall verify after each climbing operation that the shoring and bracing or tie-ins are installed as indicated on the tower crane installation drawings.

(53) The review engineer shall verify that the shoring and bracing system is installed as per standards CSA S269.1 and or CSA S16.1.

Tower Crane Review by a Designated Person

3. The review engineer may designate a competent person to carry out one or more of the functions described in paragraph 2 where it is consistent with prudent engineering practice to do so and the functions are performed under the supervision of the review engineer.



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