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February 13, 2009

**TO: PARTIES INTERESTED IN EVALUATION REPORTS ON
STRUCTURAL CAPACITY OF COMPONENTS OF WORK CAGES
FOR WIND TURBINE TOWERS**

**SUBJECT: Revisions to the Acceptance Criteria for Structural Capacity of
Components of Work Cages for Wind Turbine Towers, Subject AC394-
0209-R1 (MO/NH)**

Dear Madam or Sir:

Enclosed is a copy of the subject revised acceptance criteria approved by the ICC-ES Evaluation Committee on February 4, 2009, effective March 1, 2009.

The criteria was previously approved by the committee in May 2008 as Subject AC394-0508-R1. The work cage, using steel cables and an electric motor, transports workers to and from elevated maintenance locations and is defined in Section 1.4.1 of the criteria. The criteria only covers the structural requirements for cables (wire rope), safety wire, shackles and work cage platform, as noted in Section 1.2 (Scope) of the criteria. The applicable code section for evaluation of this product is Section 3005.4 (Personnel and material hoists) of the 2006 *International Building Code*[®].

The revisions approved by the criteria address questions raised by the proponent and their test laboratory concerning test procedures and conditions of acceptance. The following are the approved revisions:

1. Section 3.3, on floor strength includes a minimum number of test samples of 3, a factor of safety of 3, and conditions of acceptance. The factor of safety was reduced from 8 to 3. Staff is of the opinion that only the cable components and cable assembly need a factor of safety of 8.
2. Section 3.4, on cable capacity, includes a minimum number of test samples of 5, and conditions of acceptance.
3. Sections 3.2 and 3.8 include a factor of safety of 3 for the complete work cage assembly, for documenting the maximum lifting capacity that is to be posted on the work cage.
4. Sections 3.3 and 3.4 were revised to change the terminology from "minimum strength" to "minimum allowable load," to clarify that capacity is based on tested values.

5. Section 5.1.5 was revised to refer to “maximum lifting capacity” instead of “maximum load,” to be consistent with Section 3.2 of the criteria.

Evaluation reports issued on or after the effective date noted above, and falling within the scope of this criteria, will be required to comply with the enclosed edition of the criteria. Evaluation reports issued prior to the effective date may be in compliance either with the enclosed acceptance criteria or with the previous edition. Evaluation reports based on a superseded version of an acceptance criteria must be brought into compliance with the most recent edition at the time the reports are reissued. Therefore, applicants should submit data verifying compliance at the time they apply for re-examination.

ICC-ES evaluation reports issued on or after the effective date noted above, both new reports and conversions of legacy reports, must comply with this criteria if they fall within its scope.

If you have any questions, please contact Michael O’Reardon, P.E., at (800) 423-6587, extension 5685. You may also reach us by e-mail at es@icc-es.org.

Yours very truly,



Kurt Stochlia, P.E.
Vice President

KS/ raf

Enclosure

cc: Evaluation Committee

ACCEPTANCE CRITERIA FOR STRUCTURAL CAPACITY OF COMPONENTS OF WORK CAGES FOR WIND TURBINE TOWERS

AC394

Approved February 2009

Effective March 1, 2009

Previously approved May 2008

PREFACE

Evaluation reports issued by ICC Evaluation Service, Inc. (ICC-ES), are based upon performance features of the International family of codes and other widely adopted code families, including the Uniform Codes, the BOCA National Codes, and the SBCCI Standard Codes. Section 104.11 of the International Building Code® reads as follows:

The provisions of this code are not intended to prevent the installation of any materials or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.

Similar provisions are contained in the Uniform Codes, the National Codes, and the Standard Codes.

This acceptance criteria has been issued to provide all interested parties with guidelines for demonstrating compliance with performance features of the applicable code(s) referenced in the acceptance criteria. The criteria was developed and adopted following public hearings conducted by the ICC-ES Evaluation Committee, and is effective on the date shown above. All reports issued or reissued on or after the effective date must comply with this criteria, while reports issued prior to this date may be in compliance with this criteria or with the previous edition. If the criteria is an updated version from the previous edition, a solid vertical line (|) in the margin within the criteria indicates a technical change, addition, or deletion from the previous edition. A deletion indicator (→) is provided in the margin where a paragraph has been deleted if the deletion involved a technical change. This criteria may be further revised as the need dictates.

ICC-ES may consider alternate criteria, provided the report applicant submits valid data demonstrating that the alternate criteria are at least equivalent to the criteria set forth in this document, and otherwise demonstrate compliance with the performance features of the codes. Notwithstanding that a product, material, or type or method of construction meets the requirements of the criteria set forth in this document, or that it can be demonstrated that valid alternate criteria are equivalent to the criteria in this document and otherwise demonstrate compliance with the performance features of the codes, ICC-ES retains the right to refuse to issue or renew an evaluation report, if the product, material, or type or method of construction is such that either unusual care with its installation or use must be exercised for satisfactory performance, or if malfunctioning is apt to cause unreasonable property damage or personal injury or sickness relative to the benefits to be achieved by the use of the product, material, or type or method of construction.

Acceptance criteria are developed for use solely for purposes of issuing ICC-ES evaluation reports.

ACCEPTANCE CRITERIA FOR STRUCTURAL CAPACITY OF COMPONENTS OF WORK CAGES FOR WIND TURBINE TOWERS (AC 394)

1.0 INTRODUCTION

1.1 Purpose: The purpose of this acceptance criteria is to establish requirements for the structural capacity of components of work cage lifts to be recognized in an ICC Evaluation Service, Inc. (ICC-ES), evaluation report under the 2006 *International Building Code*[®] (IBC). The basis of recognition is IBC Section 104.11. The applicable code section is 3005.4 (Personnel and material hoists).

The reason for the development of this criteria is to establish guidelines for the evaluation of the structural capacity of components of work cage lifts, since IBC Section 3005.4 and associated referenced standards do not specify requirements for the structural capacity of components of work cage lifts.

1.2 Scope: This criteria applies to the structural capacity of components of work cage assemblies intended to serve as man and material lifts in single steel tubular wind tower structures. The labeled safety devices, which are mandatory for field installation, are beyond the scope of this criteria. The work cage uses an electric motor connected to steel cabling to move vertically. This criteria covers the structural requirements for cables (wire rope), safety wire, shackles and the work cage platform. Recognition under this criteria is for all Seismic Design Categories. The work-cage product is only for worker access inside wind tower structures.

1.3 Codes and Referenced Standards:

1.3.1 2006 *International Building Code*[®] (IBC), International Code Council, Inc.

1.3.2 ASTM A239-95 (2004), Standard Practice for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles, ASTM International.

1.3.3 UL Standard 1322-1999, Fabricated Scaffold, Planks and Stages, Underwriters Laboratories, Inc.

1.3.4 ISO 4309:2004(E), Cranes — Wire ropes — Care, maintenance, installation, examination and discard, International Standards Organization

1.4 Definitions:

1.4.1 Work Cage: The work cage assemblies serve as permanent access platforms that hoist workers and materials to various levels inside a wind tower, to perform maintenance and provide access throughout the tower. The work cage is not designed for use in silos, on drilling sites, as a permanently installed facade lift, as a crane lift, or in environments with explosion hazards. The work cage is fully enclosed. The work cage is not considered an elevator.

1.4.2 Cable: A flexible tension member consisting of a wire strand or a multiplicity of wire strands forming a wire rope.

1.4.3 Cable Assembly: An assembly fabricated from wire rope with shackles fitted on each end.

1.4.4 External Tensile Force: Tensile service force in a cable assembly, imposed by external force.

1.4.5 Corrosion-resistant Materials: Materials that have corrosion resistance against seawater

exposure and proven durability to resist such exposure for a minimum of ten years.

1.4.6 Rope: A plurality of strands twisted about an axis or about a core which may be a strand or another wire rope.

1.4.7 Work Cage Motor: The primary motor device utilized to provide tensioning in the cable for lifting the work cage (traction hoist).

1.4.8 Wind Tower Structure: The main structure that supports a wind power generation system supported at any height.

1.4.9 Strand: A plurality of wires either parallel or helically twisted about an axis, usually about a central wire.

1.4.10 Work Cage Capacity: The maximum number of workers and weight permitted inside one work cage, referenced by a maximum lifting capacity. All work cages under this criteria shall have a minimum lifting capacity of 500 pounds (220 kg).

2.0 BASIC INFORMATION

2.1 General: The following information shall be submitted:

2.1.1 Product Description:

2.1.1.1 Work Cage: Complete information pertaining to the work cage and assembly, including component descriptions, material specifications and drawn-to-scale production drawings showing all dimensions and tolerances, and the manufacturing process as well as the factor of safety for the cable assembly.

2.1.1.2 Lifting Capacity Description: Lifting capacity shall be completely described, including the maximum lifting capacity, and the nominal diameter and maximum length of steel cables.

2.1.1.3 Material Properties: Physical properties, including strength properties and a description of compatibility with steel cable materials, shall be submitted. Protective coatings and compliance of materials for a service life of ten years shall be documented.

2.1.2 Installation Instructions: Complete dated manufacturer's installation instructions shall be submitted. Such instructions shall include details of structural connections to the tower.

2.1.3 Packaging and Identification: A description of the method of packaging and field identification of the work cage. Identification provisions shall include the evaluation report number and, if applicable, the name or logo of the inspection agency.

2.1.4 Field Preparation: Complete instructions for field adjustments shall be provided.

2.2 Testing Laboratories: Testing laboratories shall comply with Section 2.0 of the ICC-ES Acceptance Criteria for Test Reports (AC85) and Section 4.2 of the ICC-ES Rules of Procedure for Evaluation Reports. The testing laboratory shall prepare cable and end fitting assemblies, or shall verify that preparation of cable and

ACCEPTANCE CRITERIA FOR STRUCTURAL CAPACITY OF COMPONENTS OF WORK CAGES FOR WIND TURBINE TOWERS (AC394)

end fitting assemblies is in accordance with the cable assembly manufacturer's quality control documentation.

2.3 Test Reports: Test reports shall comply with AC85.

2.4 Product Sampling: Sampling of the work cage for tests under this criteria shall comply with Section 3.1 of AC85.

3.0 TEST METHODS AND PERFORMANCE REQUIREMENTS

3.1 Physical Dimensions: A recognized work cage shall be documented as having a minimum height of 6 feet (1.80 m), a minimum width of 3 feet (914 mm), and a minimum depth of 2 feet (610 mm). The minimum lifting capacity shall be 500 pounds (220 kg). The minimum lifting capacity shall be increased as the size of the cage is increased.

3.2 Work Cage Capacity: The maximum lifting capacity shall be determined by tests utilizing the safety factors noted in Sections 3.3 and 3.4. The maximum lifting capacity shall be posted on the work cage as noted in Section 5.1.5 of this criteria.

3.3 Floor Allowable Load: The floor of the work cage shall be tested and documented to provide a minimum allowable load of 300 psf (1464 kg/m²) at the floor level while suspended, with a minimum factor of safety of 3. A minimum of three samples shall be tested.

Conditions of Acceptance: All samples shall demonstrate a minimum allowable load of 300 psf (1464 kg/m²).

3.4 Cable: Cables (wire rope), safety wire, shackles and connections to the work cage platform must be tested utilizing a minimum factor of safety of 8. A minimum of five samples shall be tested.

Conditions of Acceptance: The allowable capacity shall be the average of the failure loads divided by the factor of safety.

3.5 Motor Strength: The motor shall be tested and documented to move the work cage while loaded in accordance with Section 3.1. The motor shall be labeled by an accredited inspection agency for the intended use.

3.6 Manual Operation: The work cage shall have a manual method for raising or lowering which can be actuated from within the cage.

3.7 Corrosion Resistance: All components of the work cage and lift system shall be documented in accordance with ASTM A239 as having an ten-year corrosion resistance.

3.8 Minimum Structural Factor of Safety: The minimum factor of safety for the work cage assembly shall be 3. Documentation shall also be submitted demonstrating that the structural components have been evaluated for dynamic forces.

3.9 Functional Requirements: Documentation shall be provided to indicate that work cage safety includes evaluation of the following functional requirements:

3.9.1 Work cage door opening mechanism shall be linked to an automatic stoppage of the work cage during operation.

3.9.2 Work cage shall have an end-of-travel limit switch to automatically stop motion upward and downward.

3.9.3 Work cage shall have an over-weight-limit switch.

3.9.4 Work cage shall have block stops in the final installation.

4.0 QUALITY CONTROL

4.1 The products shall be manufactured under an approved quality control program with inspections by an inspection agency accredited by the International Accreditation Service (IAS) or otherwise acceptable to ICC-ES.

4.2 Quality documentation complying with the ICC-ES Acceptance Criteria for Quality Documentation (AC10) shall be submitted.

4.3 Work cages shall be operated under a quality assurance program and safety plan to be maintained by the manufacturer and implemented through licensing and examination of work cage users.

4.4 Each manufacturer shall submit a quality assurance and quality control (QA/QC) plan for the fabrication and maintenance of the work cage product. Along with the QA/QC plan, the manufacturer shall provide a detailed safety manual and training program for each work cage installation. The safety and training program shall be implemented and maintained through specific local licensing of work cage users, and the manufacturer shall keep records of all user licenses throughout the term of each work cage.

5.0 EVALUATION REPORT RECOGNITION

5.1 The evaluation report shall contain the following conditions of use:

5.1.1 Engineering calculations must be provided for the design of the cable attachment points. The calculations must be sealed by a registered design professional. The design of connections and anchorages, including plates and hold-downs, as well as other components needed to transfer the tension load between portions of the structure, must be determined in accordance with the applicable code for each project. Design loads must be determined by the person responsible for the structural design, and must be specified to accommodate the worst-case scenario for a particular wind tower.

5.1.2 The evaluation report covers the structural capacity of the cables (wire rope), safety wire, shackles and work cage platform.

5.1.3 Documentation on field testing and maintenance of the work cage must be provided to the code official in accordance with Section 3005.4 of the IBC.

5.1.4 Evaluation of the electrical supply is beyond the scope of evaluation.

5.1.5 The work cage must display a permanent label with the maximum lifting capacity.

5.1.6 Use of the work cage assemblies is limited to wind tower structures only.

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5.1.7 Use of the work cages is limited to construction/maintenance workers only, who shall be certified and trained in use of the work cage by the work cage manufacturer.

5.1.8 Use of the work cage assemblies shall specify the wind tower height limitation and minimum tower shell thickness.

5.2 Unless data in accordance with Section 2.1.1.4 of this criteria is submitted, the evaluation report shall state that installation must be limited to dry, interior conditions.

5.3 Special inspection and structural observation shall comply with IBC Sections 1704 and 1709, respectively. ■