B354.9-17

Design, calculations, safety requirements, and test methods for mast climbing work platforms (MCWPs)

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Preface

This is the first edition of CSA B354.9, *Design, calculations, safety requirements, and test methods for mast climbing work platforms (MCWPs)*.

With respect to design and manufacturing criteria, this Standard is closely harmonized with the equivalent ISO 16369, *Elevating work platforms — Mast-climbing work platforms*.

This Standard was prepared by the Technical Committee on Elevating Work Platforms, under the jurisdiction of the Strategic Steering Committee on Occupational Health and Safety, and has been formally approved by the Technical Committee.

Notes:

1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*
2) *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*
3) *This Standard was developed by consensus, which is defined by* CSA Policy governing standardization — Code of good practice for standardization *as "substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity". It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this Standard.*
4) *To submit a request for interpretation of this Standard, please send the following information to inquiries@csagroup.org and include "Request for interpretation" in the subject line:*
   a) *define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;*
   b) *provide an explanation of circumstances surrounding the actual field condition; and*
   c) *where possible, phrase the request in such a way that a specific "yes" or "no" answer will address the issue.*

   Committee interpretations are processed in accordance with the CSA Directives and guidelines governing standardization *and are available on the* Current Standards Activities *page at standardsactivities.csa.ca.*
5) *This Standard is subject to review within five years from the date of publication. Suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to inquiries@csagroup.org and include "Proposal for change" in the subject line:*
   a) *Standard designation (number);*
   b) *relevant clause, table, and/or figure number;*
   c) *wording of the proposed change; and*
   d) *rationale for the change.*

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B354.9-17
Design, calculations, safety requirements, and test methods for mast climbing work platforms (MCWPs)

1 Scope

1.1 General

This Standard applies to mast-climbing work platforms (MCWPs) that are primarily used to provide a working surface for personnel, along with their necessary tools and materials, at elevated work locations.

This Standard is applicable to MCWPs that include the following features (see Figures 1 and 2):

a) one or more work platforms;
b) one or more masts that are
   i) free-standing or laterally supported above their bases;
   ii) of fixed or variable height;
   iii) vertical or inclined between 0 and 30° to the vertical; and
   iv) vertically supported only at their bottom or top;
c) movable or static base (chassis or base frame) capable of transfer at a work site by self-propulsion or towing or any lifting device; and
d) an elevating mechanism that is manually or power operated. Raising and lowering speeds are limited to a maximum of 0.20 m/s (0.8 ft/s).

1.2 Purpose

The purpose of this Standard is to specify minimum design, manufacturing, remanufacturing, rebuilding/ reconditioning, testing, and performance requirements for MCWPs to achieve the following objectives:

a) prevention of personal injuries and accidents;
b) uniformity in ratings; and
c) understanding by manufacturers, dealers, installers, maintenance personnel, operators, owners, and users of their respective responsibilities.

Note: *MCWPs are generally intended for use over level surfaces. Normally, they are not insulated for use near electrically energized circuits, nor are they intended to be used in hazardous locations. For aerial platforms intended for use near electrically energized circuits, see CAN/CSA-C225. The operation of MCWPs is subject to certain hazards and therefore needs to be performed by a competent person trained in the intended use, safe operation, maintenance, and servicing of MCWPs.*

1.3 Application

This Standard applies to MCWPs manufactured after the date of publication of this Standard.

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1.4 Equipment not covered

This Standard does not apply to

a) vehicle-mounted aerial devices covered by CAN/CSA-C225;
b) non-self-propelled elevating rolling work platforms covered by CAN/CSA-B354.1;
c) self-propelled elevating work platforms covered by CAN/CSA-B354.2;
d) self-propelled boom-supported elevating work platforms covered by CAN/CSA-B354.4;
e) construction hoists used to raise and lower materials and personnel covered by CAN/CSA-Z185 and CAN/CSA-Z256;
f) mobile cranes covered by CSA Z150;
g) vehicle-mounted vertical lift devices covered by ANSI/SAIA A92.7;
h) vehicle-mounted bridge inspection and maintenance devices covered by ANSI/SAIA A92.8;
i) permanently installed (non-mobile) elevating lifts used to transport personnel between different elevations; and
j) firefighting equipment.

1.5 Terminology

In this Standard, “shall” is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the Standard; “should” is used to express a recommendation or that which is advised but not required; and “may” is used to express an option or that which is permissible within the limits of the Standard.

Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material.

Notes to tables and figures are considered part of the table or figure and may be written as requirements.

Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

1.6 Measurement

The values given in SI units are the units of record for the purposes of this Standard. The values given in parentheses are for information and comparison only.

2 Reference publications

This Standard refers to the following publications, and where such reference is made, it shall be to the edition listed below, including all amendments published thereto.

CSA Group

CAN/CSA-B354.1-04 (R2016)
Portable elevating work platforms

CAN/CSA-B354.2-01 (R2013)
Self-propelled elevating work platforms

CAN/CSA-B354.4-02 (R2013)
Self-propelled boom-supported elevating work platforms

C22.1-15
Canadian Electrical Code, Part I

CAN/CSA-C22.2 No. 60065:16
Audio, video and similar electronic apparatus — Safety requirements

CAN/CSA-C22.2 No. 60529:16
Degree of protection provided by enclosures (IP Code)

CAN/CSA-C225-10 (R2015)
Vehicle-mounted aerial devices

O86-14
Engineering design in wood

S16-14
Design of steel structures

CAN/CSA-S157-05/S157.1-05 (R2015)
Strength design in aluminum/Commentary on CSA S157-05, Strength design in aluminum

W47.1-09 (R2014)
Certification of companies for fusion welding of steel

W47.2-11 (R2015)
Certification of companies for fusion welding of aluminum

W59-13
Welded steel construction (metal arc welding)

W59.2-M1991 (R2013)
Welded aluminum construction

Z150-16
Safety code on mobile cranes

CAN/CSA-Z185-M87 (R2016)
Safety code for personnel hoists

CAN/CSA-Z256-M87 (R2016)
Safety code for material hoists

CAN/CSA-Z321-96 (withdrawn)
Signs and symbols for the workplace

CAN/CSA-Z432-04 (R2014)
Safeguarding of machinery

AGMA (American Gear Manufacturers Association)

ANSI/AGMA 2001-D04
Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth

EN (European Standard)

982:1996+A1:2008
Safety of machinery — Safety requirements for fluid power systems and their components — Hydraulics

12016:2013
Electromagnetic compatibility — Product family standard for lifts, escalators and moving walks — Immunity

IEC (International Electrotechnical Commission)

60947-5-1:2016
Low-voltage switchgear and controlgear — Part 5-1: Control circuit devices and switching elements — Electromechanical control circuit devices

ISO (International Organization for Standardization)

4301-1:2016
Cranes and lifting appliances — Classification — Part 1: General

4302:2016
Cranes — Wind load assessment

6336-1:2006
Calculation of load capacity of spur and helical gears — Part 1: Basic principles, introduction and general influence factors

6336-2:2016
Calculation of load capacity of spur and helical gears — Part 2: Calculation of surface durability (pitting)

6336-3:2006
Calculation of load capacity of spur and helical gears — Part 3: Calculation of tooth bending strength

6336-5:2003
Calculation of load capacity of spur and helical gears — Part 5: Strength and quality of materials

8686-1:2012
Cranes — Design principles for loads and load combinations — Part 1: General

13849-1:2016
Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design

16369:2007
Elevating work platforms — Mast-climbing work platforms

NEMA (National Electrical Manufacturers Association)

250-2014
Enclosures for Electrical Equipment (1000 Volts Maximum)

ANSI/NEMA Z535.1-2006
Safety colors

ANSI/NEMA Z535.3-2011
Criteria for safety symbols

ANSI/NEMA Z535.4-2011
Product safety signs and labels

NRCC (National Research Council Canada)
National Building Code of Canada, 2015

SAIA (Scaffold and Access Industry Association)
ANSI/SAIA A92.7-2014
Airline Ground Support Vehicle-Mounted Vertical Lift Devices

ANSI/SAIA A92.8-2012 (R2011)
Vehicle-Mounted Bridge Inspection and Maintenance Devices

3 Definitions

The following definitions shall apply in this Standard:

Access position — position(s) to provide access to and from the work platform.

Alternative configuration(s) — arrangements of the platform or its components that differ from each other. Alternative configurations might or might not have the same rated workload.

Anchorage(s) — a designated point of attachment utilized with a fall arrest or travel restraint system.

Attachment — the provision for lateral support consisting of a mast tie and connection points.

Authority having jurisdiction — a federal, provincial, territorial, or municipal ministry, department, board, agency, or commission that has responsibility for regulating by statute the use of products, materials, or services within its jurisdiction.

Authorized person — person approved or assigned to perform a duty or duties at a location specific to the platform.

Base — that part of the platform that provides support for the mast and elevating assembly.

Broker — an independent business entity or person that arranges a lease or transfer of ownership of the platform, but does not own the platform.
Note: *If the entity or person is an employee of the buyer, seller, lessor, or lessee of the platform, that entity or person is not to be considered a broker.*

Buffer — a device designed to stop the vertical movement of the platform beyond its normal limit of travel by storing or by absorbing and dissipating the kinetic energy of the platform.

Chassis — the integral part of the platform that provides support, stability, and mobility for the elevating assembly.

Competent person — the person who is capable of identifying existing and predictable hazards in the surroundings or working conditions that are unsanitary, hazardous, or dangerous to employees and who has the authority to take prompt corrective measures to eliminate such hazards.

Configuration — all positions in which a work platform or any part thereof can be placed within its intended operating limits.

Counter roller — a roller used to counteract the gear meshing separation forces between a rack and pinion.

Critical component(s) — load-supporting elements that support or stabilize the platform.

Dealer — a person or entity who buys, rents, or leases from a manufacturer or distributor and who generally sells, rents, and services the platform.

Directional controls — controls that initiate functions that affect movement of the platform or the platform.

Ductile materials — materials that have a minimum elongation at failure of 10% in a gauge length of 51 mm (2 in) of a standard test specimen.

Elevating assembly — an organization, agency, or individual who, by possession of an appropriate technical degree, certificate, professional standing, or skill, and who, by knowledge, training, and experience, has equivalent ability to deal with the problems relating to the subject matter, as well as the work or the project of the entity referenced.

Engineer — a person licensed to practice professional engineering in the province or territory having jurisdiction.

Exposed side — a side of a platform where the gap to an adjacent building, wall, or structure exceeds the maximum specified distance in this Standard or by the authority having jurisdiction.

Fall arrest system — the fall protection system designed to arrest a fall of a worker.

Guardrail system — a vertical barrier intended to protect personnel and objects from falling to lower levels.

Guides — the parts of a mast that guide a platform.

Instability — a condition in which the sum of the moments that tend to overturn the MCWP platform is equal to or exceeds the sum of the moments tending to resist overturning.

Installer/erector — personnel who have received training in the inspection, application, operation, and erection of a platform, including training in the recognition and avoidance of hazards associated with erection and operation.

Interlock — a control or mechanism that, under specified conditions, automatically allows or prevents the operation of another control or mechanism.

Lessee — a person(s) or entity to whom a work platform is provided by lease, rental, loan, or other arrangement.

Note: *A lessee can also be a dealer, owner, user, or operator.*

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Lessor — a person(s) or entity who leases, rents, loans, or otherwise provides platform to another party for the beneficial use of that party (the user).
Note: *A lessor can also be a dealer, owner, lessee, user, or operator.*

Load diagram — a notice displayed on the platform showing rated load, maximum number of persons, and load distribution profile for the specific configuration.

Lowering — the operation of moving the platform in a downward direction.

Main platform — the part of a platform that is built up using primary structural elements.

Maintenance — the act of upkeep such as inspection, lubrication, refuelling, cleaning, adjustment, and scheduled part(s) replacement.

Manual force — the force produced by person(s) on the platform.

Manufacturer — a person or entity who makes, builds, or produces a platform.

Mast — a structure that supports and guides the platform.

Mast tie — the system used to provide lateral restraint to a mast from a building or other structure.

Modification — change(s) to a platform, including changes to the mast, and all related components that affect the operation, stability, safety factors, rated load, or integrity of the machine in any way.

Most adverse combination/most adverse transfer condition — the permitted configuration of the platform that produces the least stability.

Multi-level platform — two or more work platforms travelling on the same mast or an additional working level attached to and totally supported by a work platform.

Non-destructive testing (NDT) — testing techniques used to determine the structural integrity of a material, component, or system without causing damage.

Non-ductile materials — materials that are not classified as ductile.

Occupant — any person on the platform.

Operator — an authorized person qualified to control the movement of the equipment.

Outriggers — the devices at the base or chassis that provide stability of the platform and are capable of lifting and leveling the platform.

Overspeed — any speed above rated speed.

Overspeed detector — a device that, when the platform attains a predetermined speed above rated speed, causes the overspeed safety device to be applied.

Overspeed safety device — the mechanical device for stopping and maintaining the platform in a stationary position on the mast in the event the overspeed detector has been engaged.

Overturning — the principle where the platform is in an unstable condition in any axis.

Owner — a person or entity who has possession of a platform by virtue of proof of purchase or legal possession of a platform.

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Planking — a work surface used on platform extensions.

Platform extensions — those additional parts of the work platform that are built up using secondary structural elements, whose support and location is dependent upon the main platform.

Platform height — the vertical distance measured from the base level to the floor of the platform.

Qualified person — a person who, by possession of a recognized degree, certificate, or professional standing, or by extensive knowledge, training, and experience, has successfully demonstrated his/her ability to solve or resolve problems related to the subject matter, the work, or the project.

Rack-and-pinion drive system — a drive system using a gearing arrangement consisting of a cylindrical gear (pinion) that engages a linear gear (rack) attached to the mast.

Rail-mounted chassis — a chassis designed to transmit horizontal as well as vertical forces to the ground via rails.

Raising — the operation of moving the platform in an upward direction.

Ratchet drive system — a drive system that operates by attaching a ratcheting device to the rungs or other elements of the mast in an alternating manner and elevates or lowers the platform a predefined distance. The platform may be supported by a pawl or similar device when the drive mechanism is not engaged.

Rated load — the designed carrying capacity of the platform as specified by the manufacturer.

Rated speed — the vertical or transfer speed for which the platform has been designed.

Rebuild/recondition — the act of disassembly, repair, or adjustment of a platform or component, utilizing replacement parts and components, in accomplishing work beyond the scope of maintenance (as described and used in this Standard) in order to restore, to the extent possible, the platform or component to the original manufactured specifications.

Remanufacture — the modification of a platform either by the original manufacturer or entity authorized by the manufacturer, so that the platform will comply with the CSA Group Standard in effect on the date the modification is completed.

Repair — the act of restoring to good condition that which has been broken, damaged, or worn due to use, abuse or other reasons.

Screw drive system — a drive system that consists of a mast-mounted rack which meshes with a powered drive screw attached to the platform. Rotation of the powered drive screw elevates or lowers the platform.

Stability — a condition in which the sum of the moments that tend to overturn the machine is less than the sum of the moments tending to resist overturning.

Transfer — any horizontal movement, using different means, of the platform from one position to another on the same working site.

Transfer condition — the configuration of the platform in which the platform is moved from one position to another on the same working site.

Transport — any movement of the equipment outside the boundaries of the working site.

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Transport interlocks — any design features on the platform that prevent unsafe transfer or transportation.

Travel restraint — an assembly of components capable of restricting a worker's movement on a work surface and preventing the worker from reaching a location from which he or she could fall.

User — a person or entity that has care, custody, and control of the equipment.

Note: *This person or entity can also be the employee of the operator, a dealer, owner, lessor, lessee, broker, or operator.*

Work platform — the vertical travelling part of the installation upon which the persons, equipment, and materials are carried and from which work is carried out.

Notes:

1) *This is as opposed to the MCWP, which refers to the whole of the installation, including the work platform, mast, mast ties, base, and chassis.*
2) *The work platform includes the main platform and any platform extension. See Figure 1.*

4 Design and manufacture

4.1 General

Sound engineering principles consistent with all available data on the parameters of intended use and expected environment shall be applied in the design, testing, and manufacture of MCWPs, with awareness that the unit will be carrying personnel. The design of the MCWP should take into consideration the ambient temperature in which it will be used.

Note: *The temperature has direct impact on many selected components (oil, electronics, etc.).*

4.2 Structural and stability calculations

4.2.1 General

4.2.1.1 Consideration of configurations

All of the loads and forces that can occur in any allowed configuration during erection, operation, out-of-service periods, dismantling, and transfer shall be considered. The loads due to inclined or hanging masts shall also be considered.

4.2.1.2 Manufacturer's responsibility

The manufacturer shall be responsible for

a) stability calculations, and shall identify the various configurations of the MCWP and the combinations of loads and deflections that together create conditions of instability, and structural calculations; and
b) evaluating the individual forces and making allowance for deflections. All combinations of forces shall be considered, including those that produce the most unfavourable stresses in the components.

4.2.2 Loads and forces

4.2.2.1 General

The loads and forces described in Clauses 4.2.2.2 to 4.2.2.13 shall be taken into account.