INTERNATIONAL STANDARD

ISO 16653-2

Second edition
2021-10

Mobile elevating work platforms — Design, calculations, safety requirements and test methods relative to special features —

Part 2: MEWPs with non-conductive (insulating) components

Plates-formes élévatrices mobiles de personnel — Conception, calculs, exigences de sécurité et méthodes d'essai concernant les caractéristiques spéciales —

Partie 2: PEMP avec composants non conducteurs (isolants)

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 214, *Elevating work platforms*.

This second edition cancels and replaces the first edition (ISO 16653-2:2009), which has been technically revised.

The main changes compared to the previous edition are as follows:

— the limitation of applicability to 46 kV and below has been clarified in the Scope;

— the normative references have been updated;

— the hazard list has been moved to Annex A;

— in Clause 4, the bursting safety factors have been aligned with ISO 16368;

— in Clause 4, the requirements for vacuum flashover have been removed and the work platform requirements have been clarified and re-organized;

— in Clause 5, general requirements for examination and test have been added;

— Table 1 and Table 2 have been updated.

A list of all parts in the ISO 16653 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The object of this document is to define rules for safeguarding persons and objects against the risk of accident associated with the operation of special-application mobile elevating work platforms (MEWPs).

This document does not repeat all the general technical rules applicable to every electrical, mechanical or structural component.

The safety requirements of this document have been drawn up on the basis that MEWPs are periodically maintained according to the manufacturer's instructions, working conditions, frequency of use and applicable regulations.

It is assumed that MEWPs will be checked for proper function daily before start of work and that the MEWP will not be put into operation unless all required controls and safety devices are available and in working order. If a MEWP is seldom used, the checks may be made before start of work.

Where, for clarity, an example of a safety measure is given in the text, the example is intended as a possible solution. Any other safety measure solution leading to an equivalent level of safety is permissible.

Mobile elevating work platforms — Design, calculations, safety requirements and test methods relative to special features —

Part 2: MEWPs with non-conductive (insulating) components

1 Scope

This document specifies the design, calculations, safety requirements and test methods for mobile elevating work platforms (MEWPs) with non-conductive (insulating) components. It is intended to be used in conjunction with ISO 16368.

It is applicable to all types and sizes of MEWPs with non-conductive (insulating) components, including dielectric components designed and tested to meet the specific electrical properties consistent with the manufacturer's identification plate. This equipment is intended to move persons, tools and equipment to working positions where they can carry out work from a work platform located above a non-conductive (insulating) boom section.

This document covers structural design calculations and the application of stability criteria, construction, safety examinations and tests done before MEWPs with non-conductive (insulating) components are first put into service. Annex A identifies the hazards arising from the use of MEWPs with non-conductive (insulating) components and describes methods for the elimination or reduction of these hazards.

MEWPs covered in this document are not intended to have any of their components make contact with live parts of electrical installations. The electrical properties of a MEWP's non-conducting (insulating) components can provide electrical protection in case of inadvertent contact above the non-conductive boom component at the platform end. If a MEWP is equipped with a chassis insulating system, it can provide electrical protection for ground personnel in case of inadvertent contact above that system.

This document is not applicable to MEWPs designed for or capable of operating in live working conditions (see IEC 61057). The electrical insulation level is limited to voltages experienced in electrical distribution systems 46 kV and below.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 12100, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

ISO 16368:2010, *Mobile elevating work platforms — Design, calculations, safety requirements and test methods*

ISO 18893:2014, *Mobile elevating work platforms — Safety principles, inspection, maintenance and operation*

IEC 61057, *Live working — Insulating aerial devices for mounting on a chassis*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16368:2010 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
chassis insulating system
system of non-conductive (insulating) components installed between the chassis and the structure supporting the upper non-conductive (insulating) boom

Note 1 to entry: Such a system, when properly maintained, can provide insulation of the chassis, should the portion of the MEWP between the upper non-conductive (insulating) boom and this system inadvertently contact an energized conductor or other apparatus.

3.2
electrical insulation level
level of phase-to-earth (ground) electrical insulation offered by the non-conductive (insulating) components of the upper boom and expressed by the maximum nominal voltage of an electrical installation (line or equipment) in case of inadvertent contact with this installation above the non-conductive (insulating) components at the platform end of the MEWP

Note 1 to entry: The electrical insulation level is established by the MEWP's responsible entity.

Note 2 to entry: The electrical insulation level is limited to voltages experienced in electrical distribution systems (46 kV and below).

3.3
insulating liner
insert made of non-conductive (insulating) material and designed to fit inside the work platform

3.4
non-destructive examination
examination by various means of devices or their components without alteration of the original components, so that they can function as before the testing

Note 1 to entry: These include acoustic emissions (AE), magnetic particle (MT), liquid penetrant (PT), ultrasonic (UT), radiography (RT), dielectric (DT), and visual (VT).

4 Safety requirements and/or protective/risk reduction measures

4.1 General

4.1.1 The machine shall be designed according to the principles of ISO 12100 for relevant but not significant hazards that are not dealt with by this document.

4.1.2 Except where otherwise specified in this document, the machine shall be in accordance with ISO 16368:2010.

NOTE National or local requirements can apply, which could be more stringent.

4.2 Structural requirements

Structural requirements shall be in accordance with ISO 16368:2010.

4.3 Hydraulic liquid

Hydraulic liquid (usually oil or similar fluid) shall meet the requirements of the responsible entity and the insulating requirements of the MEWP.

4.4 Non-conductive hydraulic and pneumatic hoses

Non-conductive hydraulic hoses and pneumatic hoses shall meet the requirements of IEC 61057.

4.5 Work platforms

4.5.1 Work platform materials

The work platform shall be constructed of non-conductive materials that does not sustain a flame after an ignition source has been removed.

NOTE UL 94 – H-B or IEC 60695-11-10 can be used for guidance.

4.5.2 Work platforms designed for use without an insulating liner

A work platform designed for use without an insulating liner shall meet the requirements of ISO 16368:2010, 4.6.16.

4.5.3 Work platforms designed for use with an insulating liner

A work platform designed for use with an insulating liner shall be identified as non-insulating. The insulating liner shall be constructed from non-conductive materials and tested in accordance with IEC 61057. The insulating liner shall be supported by the inside bottom surface of the work platform. A work platform designed for use with an insulating liner shall not have drain holes or access openings.

4.5.4 Non-conductive (insulating) work platforms

A non-conductive (insulating) platform shall have no drain holes or access openings and shall be tested in accordance with the dielectric tests for insulating liners as defined in IEC 61057.

4.6 Electrical requirements

4.6.1 Non-conductive (insulating) components

All components crossing non-conductive (insulating) portions of the applicable MEWP shall have appropriate electrical insulating properties so that it conforms to the test requirements of this document. All non-conductive (insulating) systems shall maintain the electrical insulating values in all working boom positions, as defined by the responsible entity.

4.6.2 Hydraulic and pneumatic hose

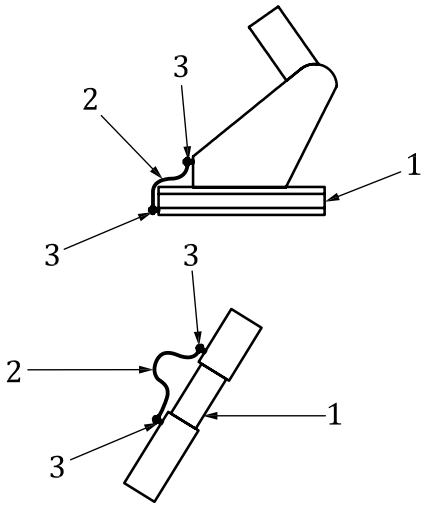
All hydraulic and pneumatic hoses crossing the non-conductive (insulating) portion of the upper boom shall be tested in accordance with IEC 61057.

4.6.3 Lower test electrode system for MEWPs with non-conductive (insulating) components

MEWPs with non-conductive (insulating) components equipped with a lower test electrode system shall meet the lower test electrode system requirements of IEC 61057.

4.6.4 Chassis insulating system

MEWPs with a chassis insulating system shall have a means provided to bypass the chassis insulating system during dielectric tests. See Figure 1.



Key

1 insulating system
2 temporary shunt (to be removed after test)
3 stainless steel stud with 25 mm thread exposed

Figure 1 — Example of shunting arrangement for chassis insulating systems

5 Verification of the safety requirements and/or protective/risk reduction measures

5.1 Examinations and tests

5.1.1 The MEWP shall conform to the safety requirements and/or protective measures of ISO 16368 and this document.

5.1.2 Examinations and tests shall consist of

a) design checks (see 5.2),

b) manufacturing checks (see 5.3), and

c) tests (see 5.4).

5.1.3 The results of examinations and tests shall be recorded.

5.2 Design check

The design check shall verify that the MEWP is designed in accordance with this document. It shall include verification of the following:

a) drawings containing the main dimensions of the MEWP;

b) description of the MEWP, with necessary information about its capabilities;

c) information about the materials used;

d) diagrams of the electrical, hydraulic and pneumatic circuits;

e) the operator's manual;

f) calculations.

5.3 Manufacturing check

The manufacturing check shall verify that

a) the MEWP is manufactured in accordance with the design check documents,

b) the components are in accordance with the drawings,

c) test certificates are available for each type of rope, chain and hydraulic or pneumatic hose, and that these certificates indicate the minimum breaking force or bursting pressure, as appropriate,

d) the quality of welds is ensured by use of the appropriate standard(s), and

e) the construction and installation of parts, components and systems are in accordance with this document.

5.4 Tests

5.4.1 Dielectric tests

5.4.1.1 Test criteria for MEWPs with a non-conductive (insulating) boom

5.4.1.1.1 Each MEWP with non-conductive (insulating) upper boom shall undergo one of the tests described in Table 1 to verify the insulating performance of the components of the non-conductive (insulating) boom assembly. This test can be conducted before or after installation on a chassis.

5.4.1.1.2 When a MEWP is modified or altered after the dielectric test prior to mounting, the test shall be performed again following the modification or alteration.

NOTE Modifications or alterations can include the addition of other devices (for example, another platform, a jib, a winch auxiliary devices).

5.4.1.2 Modifications and alterations

The installer shall acquire written approval from the responsible entity for modifications or alterations to verify that design testing requirements have been met.

Table 1 — Dielectric test values for MEWPs with non-conductive (insulating) boom

Test for MEWPs with lower test electrode system	
Required 50 Hz to 60 Hz test voltage (rms kV) for 1 min	**Maximum allowable current**
Line-to-earth (ground) voltage of nominal line voltage[a] [b] X 2	1 µA per kilovolt of test voltage
Test for MEWPs without lower test electrode system	
Required 50 Hz to 60 Hz test voltage (rms kV) for 3 min	**Maximum allowable current**
Line-to-earth (ground) voltage of nominal line voltage[a] [b] X 2	10 µA per kilovolt of test voltage

[a] Earth (ground) to line voltage is equal to the rated voltage divided by $\sqrt{3}$.

[b] Nominal line voltage (rms kV) reflects the responsible entity's rated electrical insulation level and shall be not more than 46 kV.

5.4.2 Test criteria for MEWPs with a chassis insulating system

5.4.2.1 Each MEWP equipped with a chassis insulating system shall undergo a dielectric test to verify the non-conductivity or insulating quality of the non-conductive (insulating) components of the chassis insulating system. The test shall be carried out in accordance with 5.5.5.

5.4.2.2 The test voltage shall be applied to the metal above the chassis insulating system. The test voltage shall be 50 kV (rms) at a frequency of 50 Hz to 60 Hz and shall be applied for 3 min.

5.4.2.3 The current shall not exceed 3 mA.

5.5 Electrical tests

5.5.1 General

The electrical tests in this clause are designed to ensure consistency in testing practices.

5.5.2 Test criteria for MEWPs with non-conductive (insulating) boom including lower test electrode system

MEWPs having non-conductive (insulating) components including lower test electrode system shall have the following:

a) all metal at the platform end of the non-conductive (insulating) boom electrically bonded during the test;

b) the lower test electrode system inspected for completeness and for continuity to confirm that it is intact and any problem found corrected before continuing testing.;

c) all hoses crossing the non-conductive (insulating) boom section completely filled with hydraulic liquid during the test;

d) elbows shunted as shown in Figure 2;

e) chassis insulating systems, if provided, shunted as shown in Figure 1;

f) the vehicle chassis or test stand earthed;

g) the current meter receptacle connected through a shielded cable to a current meter and then to earth;

h) booms positioned in accordance with Figure 2 or Figure 3, and these positions recorded for test reliability;

NOTE Other positions are acceptable, for example, when indoor testing.

i) the test criteria of Table 1 applied;

j) the current value and voltage documented.

5.5.3 Test criteria for MEWPs having non-conductive (insulating) components without lower test electrode system

MEWPs having non-conductive (insulating) components without lower test electrode system shall have the following:

a) all metal at the platform end of the non-conductive (insulating) boom electrically bonded during the test;

b) all hoses crossing the non-conductive (insulating) boom section completely filled with hydraulic liquid during the test;

c) all elbows shunted to ensure good continuity and if good continuity across the elbow cannot be ensured, shunted as required (see Figure 4);

d) chassis insulating systems, if provided, shunted as shown in Figure 1;

e) the MEWP tested as shown in Figure 4;

NOTE 1 Other positions are acceptable, for example, when indoor testing.

f) positions used for alternative current (rms) tests documented;

g) for purposes of repeatability, if boom positions are altered, those positions documented;

h) for test reliability, other test documents;

NOTE 2 Owing to capacitive currents, these boom angles are more critical than those for MEWPs equipped with lower test electrode systems.

i) the MEWP or test stand connected through a shielded cable to a current meter and then connected to earth;

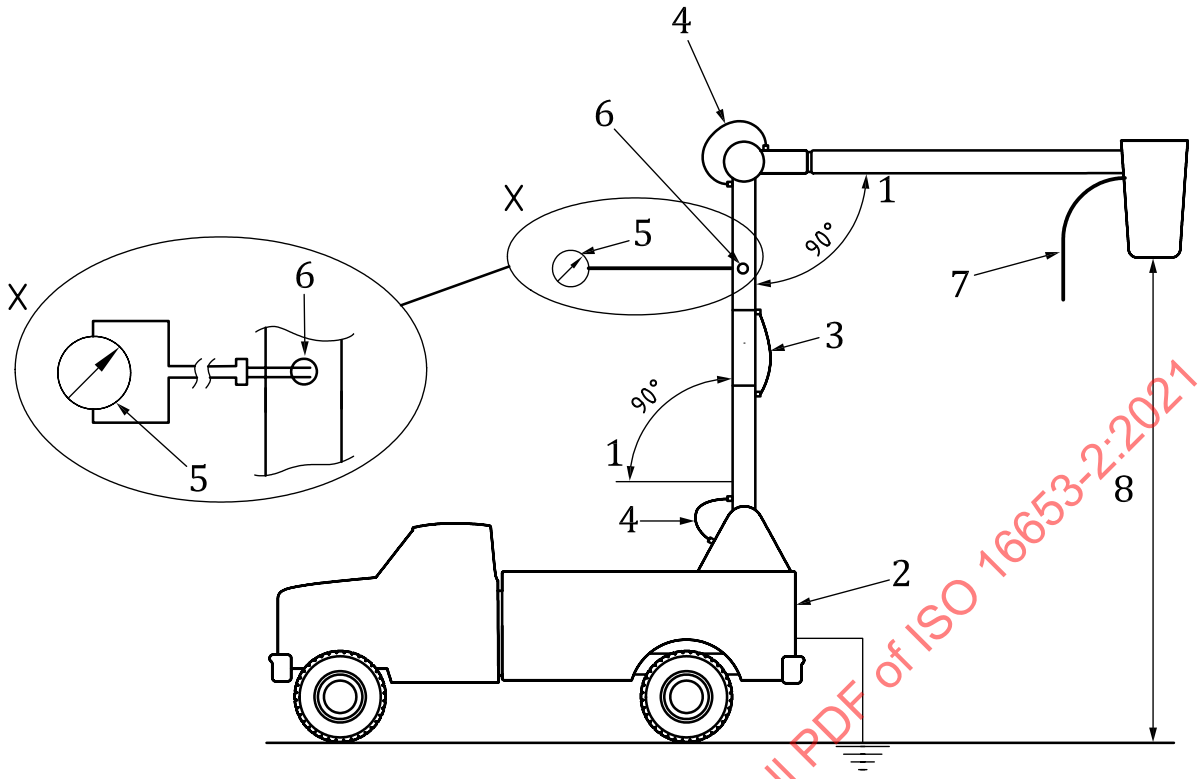
j) booms positioned as shown in Figure 2 or Figure 3 and for repeatability, boom positions documented;

NOTE 3 The boom angle can be altered. However, in the case of 50 Hz to 60 Hz (rms), tests conducted on MEWPs without lower test electrode systems, capacitance considerations are more critical than on MEWPs having lower test electrode systems

k) the test criteria of Table 1 applied;

l) the current value and voltage documented;

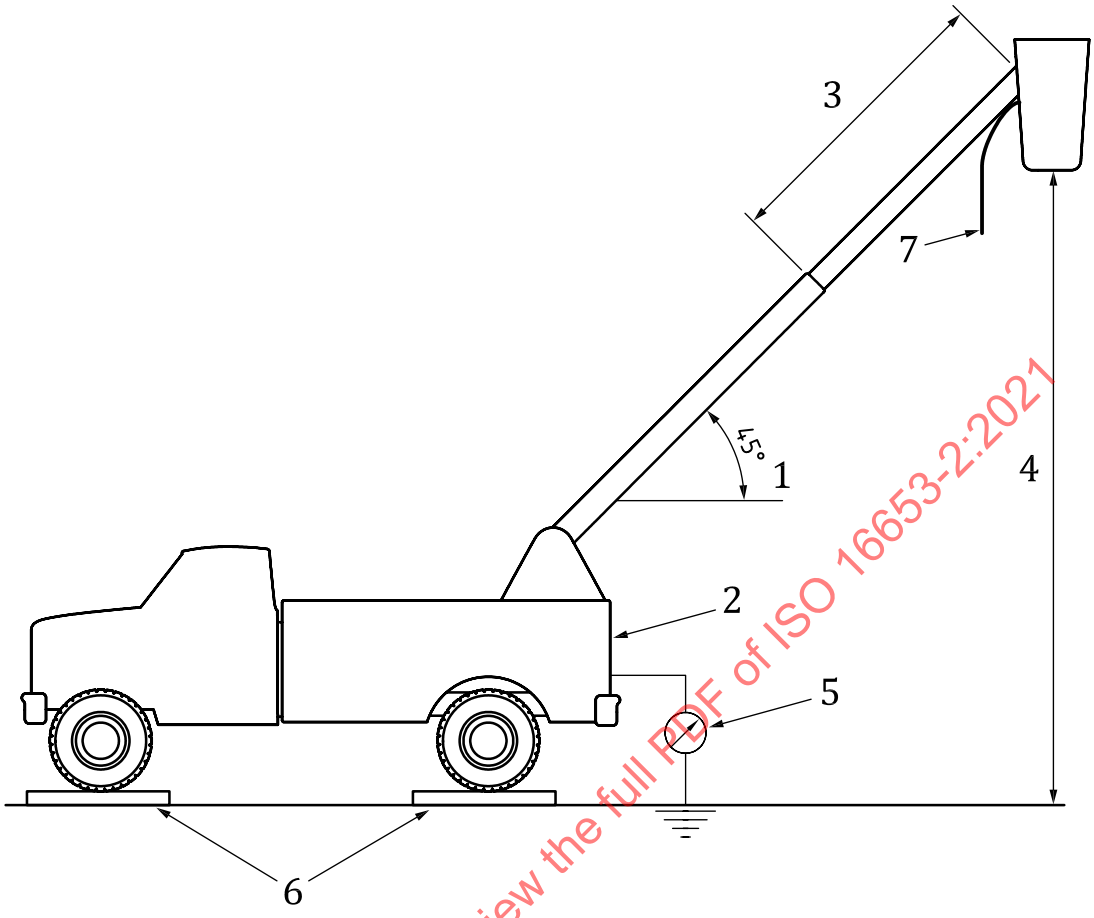
m) insulating pads installed under the wheels.



Key

1 reference boom positions for outdoor testing
2 test stand or vehicle is earthed
3 chassis insulating system shunt
4 shunting jumper
5 current meter
6 meter receptacle
7 voltage source (AC or DC)
8 platform height recorded for consistency or duplication of test results

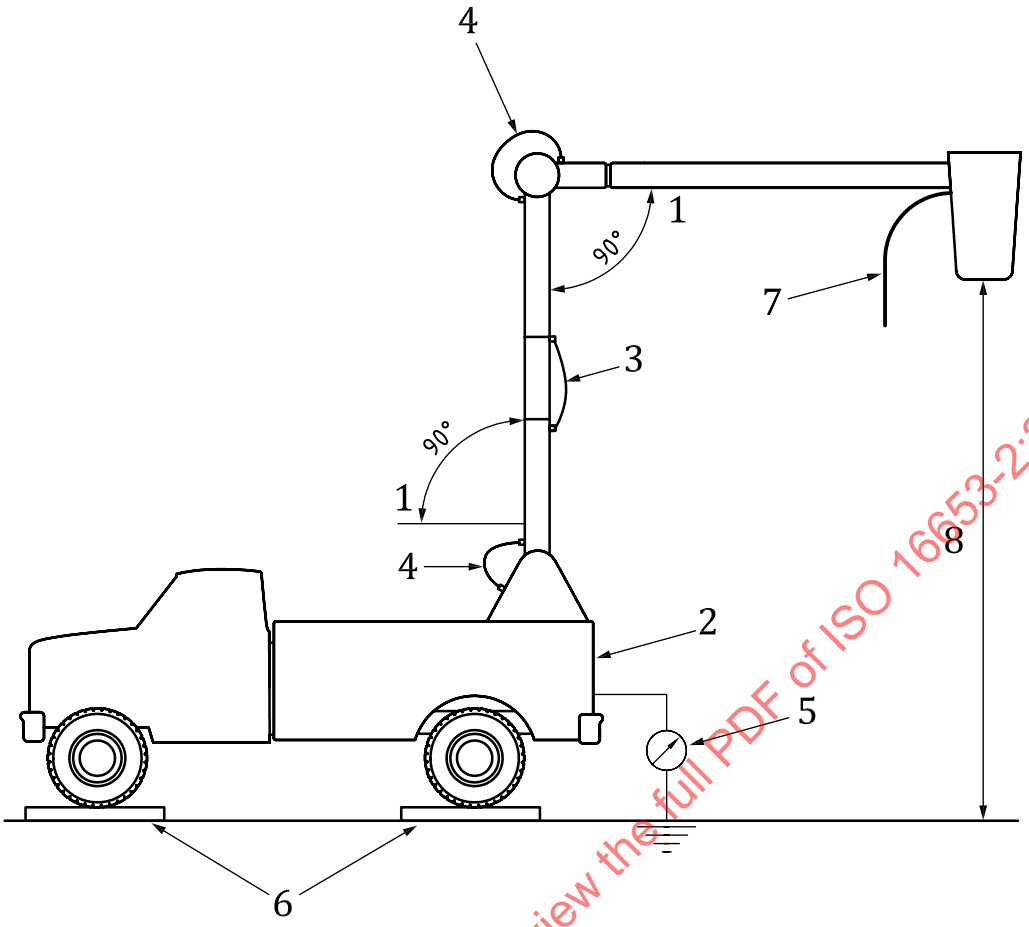
Figure 2 — Test configuration for MEWPs with non-conductive (insulating) boom including lower test electrode system



Key

1 reference boom position
2 test stand or vehicle
3 insulating section extended to minimum extension required by the manufacturer
4 platform height recorded for consistency or duplication of test results
5 current meter
6 insulating platform under wheels and outriggers
7 voltage source (AC or DC)

Figure 3 — Boom configuration for dielectric test of extensible MEWPs with non-conductive (insulating) boom



Key

1 reference boom positions for outdoor testing
2 test stand or vehicle
3 chassis insulating system shunt
4 shunting jumper
5 current meter
6 insulating platform under wheels and outriggers
7 voltage source (AC or DC)
8 platform height recorded for consistency or duplication of test results

Figure 4 — Test configuration for MEWPs with non-conductive (insulating) boom without lower test electrode system

5.5.4 Test criteria for aerial ladder and vertical tower MEWPs with non-conductive (insulating) components (sections)

Aerial ladder and vertical tower MEWPs with non-conductive (insulating) components (sections) shall have the following:

a) the test for aerial ladder-type MEWPs with non-conductive (insulating) components (sections) performed with the upper section extended only so far as to permit the ladder platform to drop into its operating position or for a predetermined extended length, as indicated on the ladder section;

b) the test for aerial ladder-type or vertical tower-type MEWPs with non-conductive (insulating) components (sections) stated by the responsible entity as having insulating value performed in accordance with Table 1 and 7.2.4.1;

c) the test for vertical tower-type MEWPs with non-conductive (insulating) components (sections) performed with the tower platform rails in a raised position within the confines of the platform and with the unit in a normally stored position or as recommended by the responsible entity.

5.5.5 Test criteria for chassis insulating systems

Chassis insulating systems shall have the following:

a) all hoses crossing the insulating system filled with hydraulic liquid during the test;

b) the MEWP connected to a current meter and then connected to earth through a shielded cable;

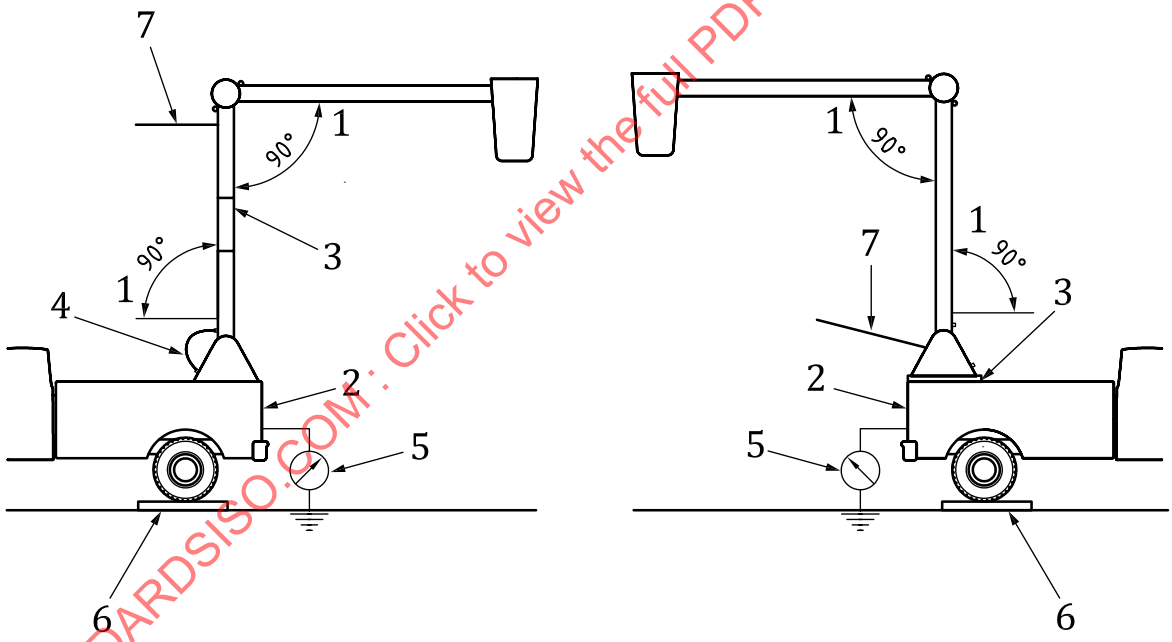
c) booms positioned and testing carried out as shown in Figure 5 a);

NOTE Other positions are acceptable, for example, when indoor testing.

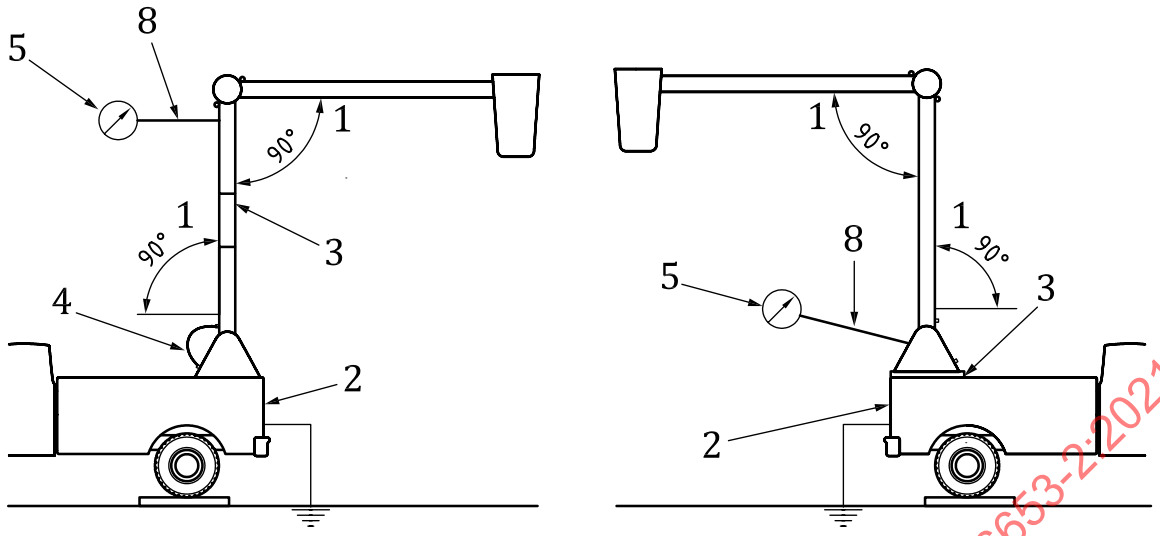
d) document the testing position used for a.c. electrical testing in the testing documentation for the purpose of test repeatability;

e) voltage applied to the metal above the insulating system;

f) a test voltage of 50 kV (rms) at a frequency of 50 Hz to 60 Hz applied for 3 min with the current not exceeding 3 mA.



a) Configuration for AC test (see 5.5.4 and 7.2.4.4)



b) Configuration for DC test (Maintenance testing only) (see 7.2.4.4)

Key

1 reference boom positions for outdoor testing
2 vehicle or test stand
3 chassis insulating system
4 optional bonding jumper
5 current meter
6 insulating platform under wheels and outriggers
7 voltage source (AC or DC)
8 voltage source (DC only)

Figure 5 — Dielectric test configuration for chassis insulating systems

5.5.6 Test criteria for insulating platform liners

Insulating platform liners shall be tested in accordance with IEC 61057.

5.5.7 Verification of tests in 5.5

The tests in 5.5 shall be verified by the responsible entity or one or more qualified persons.

5.6 Initial inspection and test

Prior to initial use, all new or modified MEWPs shall be inspected and tested in accordance with the provisions of this document by the responsible entity or one or more qualified persons.

6 Information for use

6.1 General

In addition to the requirements of ISO 16368 and ISO 18893, the following shall apply to MEWPs with non-conductive (insulating) components.

6.2 Operator's manual

The operator's manual shall contain

a) descriptions, specifications and dielectric properties of non-conductive components of the MEWP,

b) replacement part information,

c) instructional markings according to 6.3, and

d) inspection and maintenance instructions.

6.3 Markings

6.3.1 General

Markings which reduce the non-conductive (insulating) properties of the MEWP shall, in no event, be applied.

6.3.2 Responsible entity's plate

In addition to the requirements in ISO 16368:2010, 6.3.1, it shall be clearly stated in the operator's manual and on the MEWP the following information:

a) an indication that this MEWP has insulating components, but should not be used near energized electrical lines or apparatus;

b) cautions and restrictions of operation, including the applicable ambient temperature range in which the MEWP can be used;

c) designation of the work platform as being designed for use with or without insulating liner;

d) information on dielectric properties of the non-conductive (insulating) components.

6.3.3 Work platform

The following information shall be permanently and clearly marked at each work platform in an easily visible place. Markings shall be determined by the responsible entity or jointly by the responsible entity and the custodian to indicate hazards inherent in the operation of a MEWP. Instructional or informational markings shall be provided for the following:

a) electrical hazards involved in the operation of the machine, warning that a MEWP does not provide protection to the operator when he/she is in contact with, or in close proximity to, electrically charged equipment, conductors or other components when the operator is in contact with, or in close proximity to, another electrical component;

b) electrical hazards involved in the operation of the machine, warning that a MEWP, when working in proximity to energized conductors, shall be considered energized, and that contact with the MEWP or chassis (including attached trailers) under those conditions can cause serious injuries;

c) minimum approach distance requirements for energized electrical lines or apparatus, as defined in ISO 18893.

NOTE Work platforms having non-conductive components are not necessarily insulating.

7 Safety principles, inspection, maintenance, and operation

7.1 General

In addition to the requirements of ISO 18893, the following inspections, maintenance and tests shall be performed on MEWPs with non-conductive (insulating) components.

7.2 Maintenance

7.2.1 Pre-start inspection

7.2.1.1 Items determined by the custodian in accordance with the responsible entity's recommendations for each specific MEWP shall be inspected. The following inspections and tests shall be performed once daily by the operator of a MEWP with non-conductive (insulating) components prior to first use:

— hydraulic or pneumatic systems for observable deterioration or leakage, which can affect insulating properties;

— insulating components and other components made of non-conductive materials for visible damage or contamination;

— electrical systems of, or related to, the MEWP for malfunction, signs of excessive deterioration, dirt and moisture accumulation.

7.2.1.2 Any suspected items shall be carefully examined or tested and a determination made by a qualified person as to whether they constitute a safety hazard. All unsafe items shall be replaced or repaired before use.

7.2.2 Annual mechanical inspection/testing

7.2.2.1 In addition to the requirements specified in ISO 18893:2014, 5.3, any vacuum prevention systems and the function of such systems shall be inspected in accordance with the responsible entity's instructions.

7.2.2.2 Annual inspection/testing shall also include the following:

a) Non-conductive (insulating) components of MEWPs shall be thoroughly inspected for lack of cleanliness and other conditions that compromise insulation and, after cleaning and correction of any of the compromising conditions, shall be tested in accordance with 7.2.3.

b) Any non-conductive (insulating) replacement boom shall be tested in accordance with 5.4.2 and Table 1.

c) After any event during which structural members of a MEWP are suspected of being subjected to loading or stresses in excess of design stress, for example after an accident involving overturning of the MEWP or application of unintended external mechanical or electrical forces to the MEWP, the MEWP shall be removed from service and subjected to the applicable annual inspection requirements.

NOTE In such cases, in addition to annual inspection, supplemental non-destructive examination procedures or other tests to assist in detecting possible structural damage to the MEWP can be required.

d) All damaged items shall be replaced or repaired before the unit is returned to service.

e) A dielectric test shall be made in accordance with 7.2.3 when repairing or replacing insulating components such as hoses or insulating levelling rods.

f) Any suspected items shall be carefully examined or tested and a determination made by a qualified person as to whether they constitute a safety hazard. All unsafe items shall be replaced or repaired before use.

7.2.3 Annual confirmation electrical test

7.2.3.1 Each MEWP with non-conductive (insulating) boom shall be electrically tested once a year (at one- to twelve-month intervals) in accordance with Table 2 to detect changes in dielectric integrity and detect conductivity changes in its non-conductive (insulating) sections.

7.2.3.2 The chassis insulating system, where present, shall be tested annually in accordance with 7.2.4.4.

7.2.3.3 The insulating liner, where present, shall be tested annually in accordance to 7.2.4.5.

Table 2 — Annual dielectric test values for MEWPs equipped with non-conductive (insulating) boom

Test for MEWPs when tested using a supplied lower test electrode system (either of the two tests and values below may be used)	
Required 50 Hz to 60 Hz voltage test (rms kV) for 1 min	**Maximum allowable current**
Line-to-ground voltage of nominal line voltage voltage[a] [b] X 1,5	1 µA per kilovolt of test voltage
or	
Direct current voltage test for 3 min	Maximum allowable current
Line-to-ground voltage of nominal line voltage[a] [b] X $\sqrt{2}$ [c] X 1,5	0,5 µA per kilovolt of test voltage
Test for MEWPs when tested without a lower test electrode system (either of the two tests and values below may be used)	
Required 50 Hz to 60 Hz voltage test (rms kV) for 3 min	**Maximum allowable current**
Line-to-ground voltage of nominal line voltage[a] [b] X 1,5	10 µA per kilovolt of test voltage
or	
Direct current voltage test for 3 min	Maximum allowable current
Line-to-ground voltage of nominal line voltage[a] [b] X $\sqrt{2}$ [c] X 1,5	1 µA per kilovolt of test voltage

[a] Earth (ground) to line voltage is equal to the rated voltage divided by $\sqrt{3}$.

[b] Nominal line voltage (rms kV) reflects the responsible entity's rated electrical insulation level and shall be not more than 46 kV.

[c] AC to DC conversion.

7.2.4 Electrical tests

7.2.4.1 Test criteria for MEWPs having non-conductive (insulating) components including lower test electrode system

NOTE 1 MEWPs rated or valued by a responsible entity as being capable of live working are not covered by this document (see IEC 61057).

MEWPs having non-conductive (insulating) components including lower test electrode system shall have the following:

a) all conductive material at the upper end of the non-conductive (insulating) boom electrically bonded during the test;

b) the lower test electrode system inspected for completeness and tested for continuity to confirm that it is intact, and any problem found corrected before testing continues;

c) all hoses crossing the non-conductive (insulating) boom section completely filled with hydraulic liquid during the test.

d) elbows shunted as shown in Figure 2.

e) chassis insulating systems, if provided, shunted as shown in Figure 1;

f) the vehicle chassis earthed;

g) the current meter receptacle connected through a shielded cable to a current meter (when used) and then to earth;

h) booms positioned in accordance with Figure 2.

i) either of the following tests performed on them:

   1) a rms test voltage in accordance with Table 2;

   2) a direct current test voltage in accordance with Table 2.

NOTE 2 Other in-field tests covered in IEC 61057 can serve as a substitute for these annual tests where appropriate arrangements with electricity suppliers can be made.

7.2.4.2 Test criteria for MEWPs having non-conductive (insulating) components without lower test electrode system

MEWPs having non-conductive (insulating) components without lower test electrode system shall have the following:

a) all metal at the platform end of the non-conductive (insulating) boom electrically bonded during the test;

b) all hoses crossing the non-conductive (insulating) boom section completely filled with hydraulic liquid during the test;

c) all elbows shunted to ensure good continuity and if good continuity across the elbow is in doubt, shunt as required (see Figure 2);

d) chassis insulating systems, if provided, shunted as shown in Figure 1;

e) either of the following tests performed on them:

   1) with the MEWP insulated from all paths to earth, and booms positioned as shown in Figure 4, and connected through a coaxial cable to a current meter and then to earth, measure the current to ensure the values given in Table 2 are not exceeded.

   2) with the MEWP earthed and direct current tests conducted by the alternate method shown in Figure 6, and with a current meter connected between the voltage source and the unit, measure the current to ensure the values given in Table 2 are not exceeded.

NOTE Other in-field tests covered in IEC 61057 can serve as a substitute for these annual tests where appropriate arrangements with electricity suppliers can be made.