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Tractors for agriculture and forestry — Roll-over protective structures (ROPS) — Static test method and acceptance conditions

Tracteurs agricoles et forestiers — Structures de protection contre le retournement (ROPS) — Méthode d'essai statique et conditions d'acceptation

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 5700 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 2, *Common tests*.

This fourth edition cancels and replaces the third edition (ISO 5700:1989), which has been technically revised. It also incorporates the Amendment ISO 5700:1989/Amd.1:1998.

Introduction

Testing of roll-over protective structures (ROPS) for wheeled tractors for agriculture and forestry aims at minimizing the likelihood of driver injury resulting from accidental overturning during normal operation (e.g. field work) of the tractor. The strength of the ROPS is tested by applying static loads and a static crushing test to simulate actual loads which can be imposed on the cab or frame when the tractor overturns either to the rear or to the side without free fall. The tests allow observations to be made on the strength of the structure and the attachment brackets to the tractor and also of the tractor parts that could be affected by the load imposed on the structure.

Provision is made to cover both tractors with the conventional forward facing driver's position only, as well as those with a reversible driver's position, which is in agreement with the relevant OECD test code practice. For tractors with a reversible driver's position, a clearance zone is defined to be the combined clearance zones for the two driving positions. The point of application of the side loading is determined as the mid-point between the seat index points measured in the two positions.

It is recognized that there may be designs of tractors — for example, lawn-mowers, narrow vineyard tractors, low profile tractors used in low buildings with limited overhead clearance, orchards, etc., stilt tractors and certain forestry machines such as forwarders — for which this International Standard is not appropriate.

NOTE For narrow-track wheeled tractors, see ISO 12003-1[5] and ISO 12003-2[6].

Tractors for agriculture and forestry — Roll-over protective structures (ROPS) — Static test method and acceptance conditions

1 Scope

This International Standard specifies a static test method and the acceptance conditions for roll-over protective structures (cab or frame) of wheeled tractors for agriculture and forestry.

It is applicable to tractors having at least two axles for wheels mounted with pneumatic tyres, or having tracks instead of wheels, with an unballasted tractor mass of not less than 800 kg and a minimum track width of the rear wheels greater than 1 150 mm.

2 Normative references

The following referenced documents are indispensable for the application 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 630, *Structural steels — Plates, wide flats, bars, sections and profiles*

ISO 5353:1995, *Earth-moving machinery, and tractors and machinery for agriculture and forestry — Seat index point*

ASTM A370, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
roll-over protective structure
ROPS
framework protecting drivers of agricultural and forestry tractors that minimizes the likelihood of driver injury resulting from accidental overturning during normal operation

NOTE The ROPS is characterized by the provision of space for a clearance zone, either inside the envelope of the structure or within a space bounded by a series of straight lines from the outer edges of the structure to any part of the tractor that might come into contact with flat ground and that is capable of supporting the tractor in that position if the tractor overturns.

3.2
tractor mass
mass of the unladen tractor in working order with tanks and radiators full, roll-over protective structure with cladding, and any track equipment or additional front-wheel drive components required for normal use

NOTE Not included are the operator, optional ballast weights, additional wheel equipment, special equipment and loads.

3.3
reference mass
m_t
mass, not less than the tractor mass, selected by the manufacturer for calculation of the energy inputs to be used in the tests

3.4
horizontal loading test
application of a horizontal load to the rear, front and side of the roll-over protective structure

3.5
crushing test
application of a vertical load through a beam placed laterally across the uppermost members of the roll-over protective structure

3.6
longitudinal median plane
longitudinal plane of symmetry
zero Y plane
vertical plane Y passing through the mid-points of AB, perpendicular to AB, A and B being such that

— for each wheel, the vertical plane passing through its axis cuts the mid-plane of the wheel following a straight line Δ which meets the supporting surface of the vehicle at one point, and

— A and B are two points thus defined which correspond to two wheels, both of which are either steering or powered wheels, situated respectively at the two ends of the same real or imaginary axle

See Figure 1.

NOTE 1 The mid-plane of the dual wheels being equidistant from the inner edge of one wheel and the outer edge of the other, the straight line Δ is, in this particular case, the intersection of the mid-plane of the dual wheels and the vertical plane passing through the axis of the axle pin.

NOTE 2 Adapted from ISO 612:1978[1], Clause 5.

3.7
reference plane
vertical plane generally longitudinal to the tractor and passing through the seat index point and the steering-wheel centre.

NOTE Normally, this plane coincides with the longitudinal median plane of the tractor.

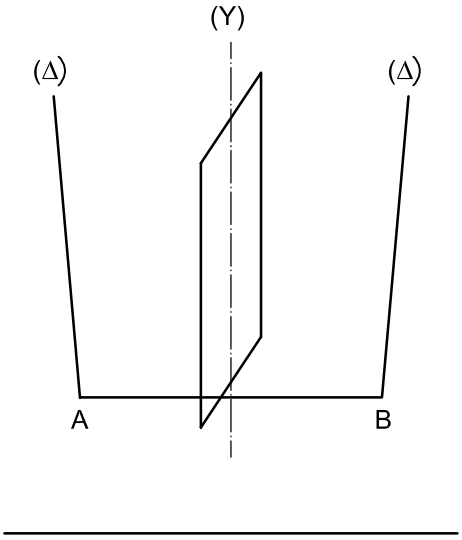


Figure 1 — Longitudinal median plane

4 Symbols and abbreviated terms

For the purposes of this document, the symbols given in Table 1 are used.

Table 1 — Symbols

Symbol	Description	Unit
a_h	Half of the horizontal seat adjustment	mm
a_v	Half of the vertical seat adjustment	mm
D	Deflection of the ROPS for the calculated basic energy required at the point of, and in line with, the load application	mm
E_{il1}	Energy input to be absorbed during first longitudinal loading	J
E_{il2}	Energy input to be absorbed during second longitudinal loading	J
E_{is}	Energy input to be absorbed during side loading	J
F	Static load force for the basic energy required	N
F_{max}	Maximum static load force occurring during loading (excluding overload)	N
F_f	Applied force at front in the crushing test	N
F_r	Applied force at rear in the crushing test	N
m_t	Reference mass	kg
W	Width of the ROPS	mm

5 Apparatus

5.1 Horizontal loading tests

5.1.1 Material, equipment and attachment means to ensure that the tractor chassis is firmly fixed to the ground (and supported) independently of the tyres.

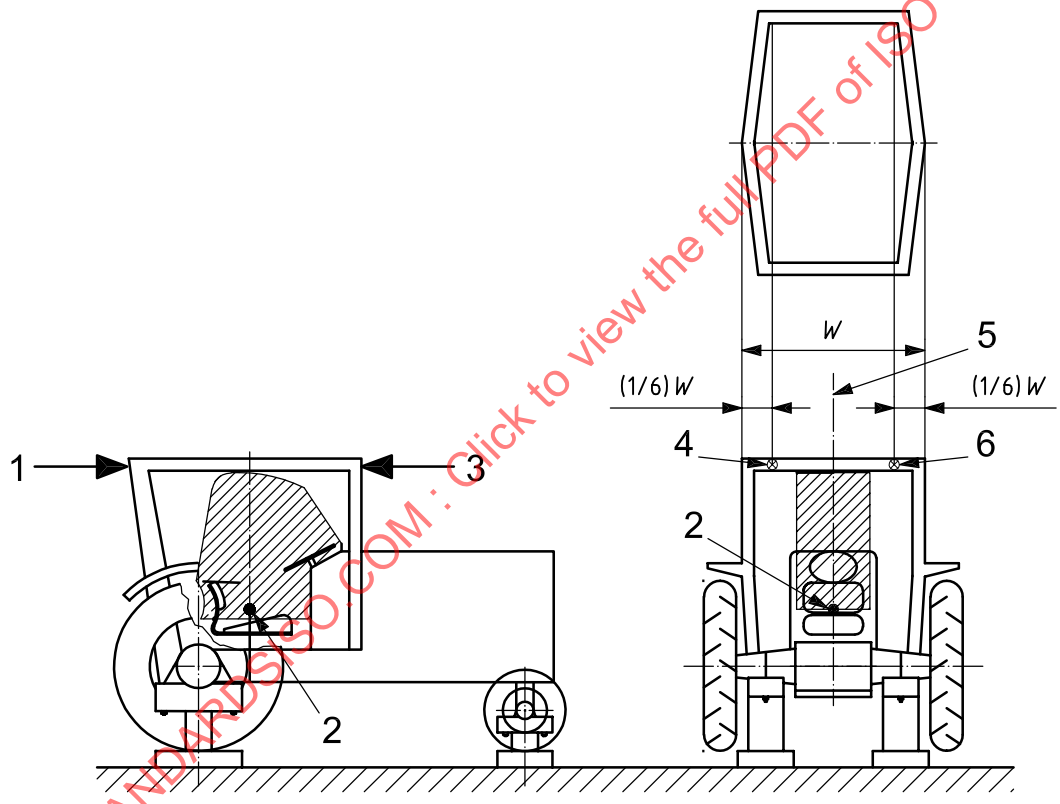
5.1.2 Means to apply a horizontal force to the roll-over protective structure, such as are shown in Figures 2 and 3, complying with the requirements of 5.1.2.1 to 5.1.2.4.

5.1.2.1 It shall be ensured that the load can be uniformly distributed normal to the direction of loading and along a beam of length between 250 mm and 700 mm, in an exact multiple of 50 mm.

5.1.2.2 The edges of the beam in contact with the roll-over protective structure shall be curved with a maximum radius of 50 mm.

5.1.2.3 Universal joints, or the equivalent, shall be incorporated to ensure that the loading device does not constrain the structure in rotation or translation in any direction other than the loading direction.

5.1.2.4 Where the roll-over protective structure's length, covered by the appropriate load-applying beam, does not constitute a straight line normal to the load application direction, the space shall be packed so as to distribute the load over this length.

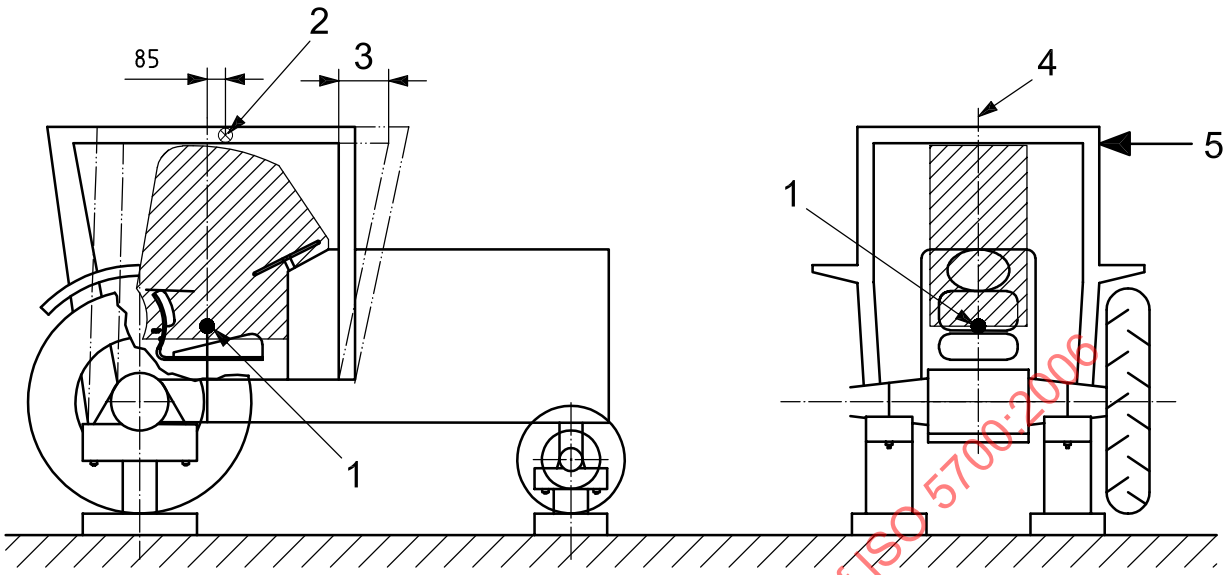


Key

1 rear load
2 seat index point (SIP)
3 front load
4 point of second longitudinal load application, front or rear
5 SIP, longitudinal centre-plane
6 point of longitudinal load application, rear or front

Figure 2 — Front and rear load application

Dimensions in millimetres



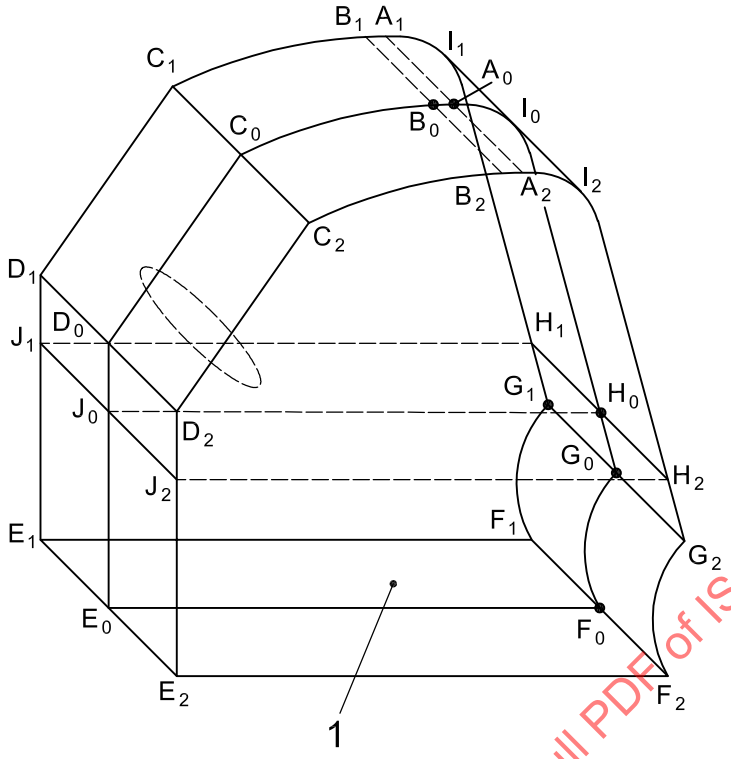
Key

1 seat index point (SIP)
2 point of side load application (see 7.2.3)
3 deflection due to rear longitudinal loading
4 SIP, longitudinal centre-plane
5 load

Figure 3 — Side load application

5.1.3 Equipment for measuring force and deflection along the direction of application of the force and relative to the tractor chassis. To ensure accuracy, measurements shall be taken as continuous recordings. The measuring devices shall be located so as to record the force and deflection at the point of, and along the line of, loading.

5.1.4 Means to prove that the clearance zone has not been entered during the test. A measuring rig based on the clearance zone as shown in Figure 4 may be used.



Key

1 seat index point (SIP)

Dimensions	mm	Remarks
A_1A_0, B_1B_0	100	Minimum
A_1A_2, B_1B_2, C_1C_2	500	
D_1D_2, E_1E_2	500	Minimum or equal to the steering-wheel radius plus 40 mm, whichever is greater
F_1F_2, G_1G_2, H_1H_2, I_1I_2, J_1J_2	500	
E_1E_0, E_2E_0	250	Minimum or equal to the steering-wheel radius plus 40 mm, whichever is greater
J_0E_0	300	
F_0G_0, I_0G_0, C_0D_0, E_0F_0	---	Depending on the tractor

NOTE For other dimensions, see Figure 6 a) and b).

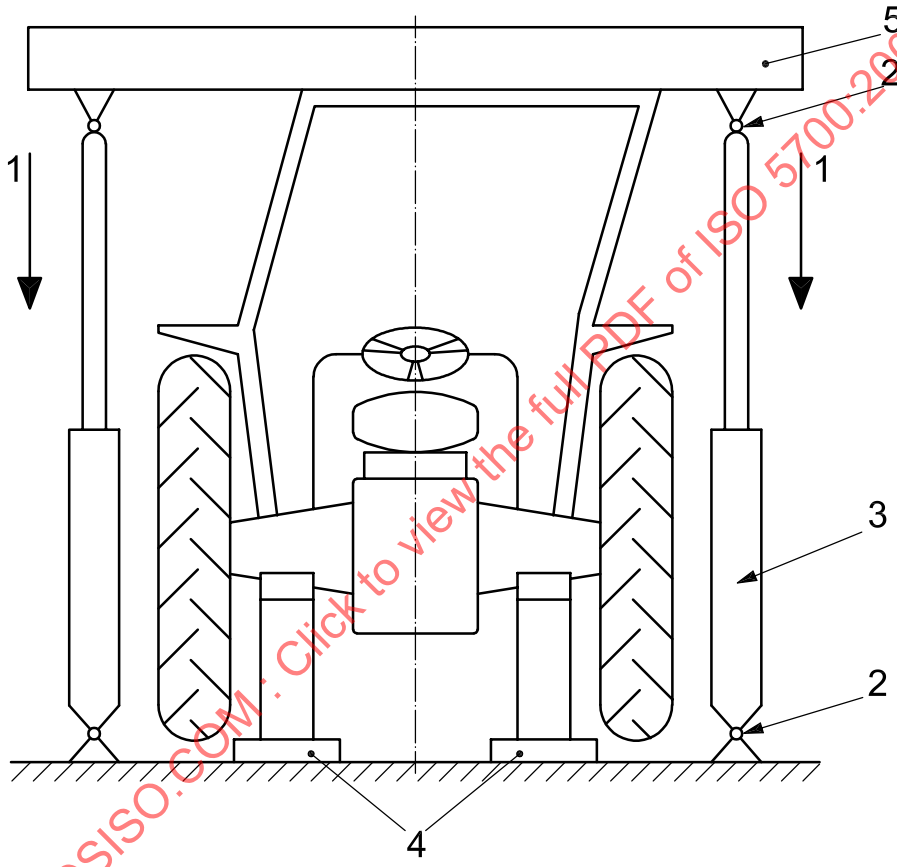
Figure 4 — Clearance zone measuring rig

5.2 Crushing tests

5.2.1 Material, equipment and attachment means to ensure that the tractor chassis is firmly fixed to the ground (and supported) independently of the tyres.

5.2.2 Means of applying a downward force on the roll-over protective structure, such as that shown in Figure 5, including a stiff beam with a width of 250 mm.

5.2.3 Means for proving that the clearance zone has not been entered during the test. A measuring rig based on the clearance zone as shown in Figure 4 may be used.



Key

1 force
2 universal pin joints
3 hydraulic cylinder
4 supports under front and rear axles
5 crushing beam

Figure 5 — Example of arrangement for crushing test

6 Preparation of tractor and ROPS for testing

6.1 The roll-over protective structure shall be manufactured to production specifications and shall be fitted to the appropriate tractor model chassis in accordance with the manufacturer's declared attachment method.

6.2 The assembly shall be secured to the bedplate so that the members connecting the assembly and the bedplate do not deflect significantly in relation to the ROPS under loading. The assembly shall not receive any support under loading other than that due to the initial attachment.

6.3 A track width setting for the rear wheels, if present, shall be chosen such that there is no interference with the ROPS during testing.

The assembly shall be supported and secured or modified so that all the test energy is absorbed by the ROPS and its attachment to the tractor's rigid components.

6.4 All detachable windows, panels and removable non-structural fittings shall be removed so that they do not contribute to the strength of the ROPS.

In cases where it is possible to fix doors and windows open or remove them during work, they shall be either removed or fixed open for the test, so that they do not add to the strength of the ROPS. It shall be noted whether, in this position, they would create a hazard for the driver in the event of overturning.

6.5 The ROPS shall be instrumented with the necessary equipment to obtain the required force-deflection data.

7 Test procedures

CAUTION — Some of the tests specified in this International Standard involve the use of processes which could lead to a hazardous situation.

7.1 Sequence of tests

7.1.1 The test shall be carried out in accordance with the procedures given in a) to e) in the sequence as given.

a) First longitudinal loading

For a tractor with at least 50 % of its tractor mass on the rear wheels, the longitudinal loading shall be applied from the rear. For other tractors the longitudinal loading shall be applied from the front.

b) First crushing test

The first crushing test shall be applied at the same end of the ROPS as the longitudinal loading.

c) Loading from the side

In the case of an offset seat and/or non-symmetrical strength of the ROPS, the side loading shall be on the side most likely to lead to entering the clearance zone.

d) Second crushing test

The second crushing test shall be applied at the opposite end of the ROPS to the longitudinal loading.

In the case of two-post designs, it may be at the same point as in b).

e) Second longitudinal loading

A second longitudinal loading shall be applied to tractors fitted with a ROPS designed to be tilted when the longitudinal loading in a) was not applied in the direction in which the ROPS is designed to tilt.

7.1.2 All tests shall be performed on the same ROPS. No repairs or straightening of any member shall be carried out between tests.

7.1.3 On completion of all tests, permanent deflections of the ROPS shall be measured and recorded.

After each part test given in 7.1.1, the ROPS shall be inspected visually with the load removed. If cracks or tears have occurred during loading other than during the second crushing test, the overload test specified in 11.4 shall be carried out before proceeding to the next loading in the sequence given in 7.1.1.

As loading continues, the cab/frame deformation may cause the direction of loading to change. This is permissible.

7.2 Horizontal loading from rear, front and side

7.2.1 General requirements for horizontal loading tests

7.2.1.1 The loads applied to the ROPS shall be distributed by means of a stiff beam, complying with the requirements of 5.1.2, located normal to the direction of load application; the stiff beam may have a means of preventing its being displaced sideways. The rate of load application shall be such that that the rate of deflection does not exceed 5 mm/s. As the load is applied, F and D shall be recorded simultaneously as continuous recordings, to ensure accuracy. Once the initial application has commenced, the load shall not be reduced until the test has been completed; but it is permissible to cease increasing the load if desired, for example, to record measurements.

7.2.1.2 The application of the load shall comply with the requirements of 7.2.1.1 and 5.1.2. In particular, if the structural member to which the load is to be applied is curved, the requirements of 5.1.2.4 shall be met.

7.2.1.3 If no structural cross-member exists at the application point, a substitute test beam which does not add strength to the structure may be used to complete the test procedure.

7.2.2 First longitudinal loading

The load shall be applied horizontally and parallel to the longitudinal median plane of the tractor from the rear or the front as required by 7.1.1 a). If from the rear, it shall be applied to the opposite side to that to which the side load is applied. If from the front, it shall be to the same side as the side load.

The load shall be applied to the uppermost transverse structural member of the ROPS (i.e. that part which would be likely to strike the ground first in an overturning accident).

The load application point shall be at one-sixth of the width of the roll-over protective structure's top, inwards from the outside corner. The width of the ROPS shall be taken as the distance between two lines parallel to the longitudinal median plane of the tractor and touching the outside extremities of ROPS in the horizontal plane touching the top of the uppermost transverse structural members.

The beam length shall be not less than one-third of the roll-over protective structure's width (as described above) and not more than 49 mm over this minimum.

The test shall be stopped when

a) the strain energy absorbed by the ROPS is equal to or greater than the required input energy, E_{il1}, in joules, where

$$E_{il1} = 1{,}4 \cdot m_t$$

or,

b) the ROPS enters the clearance zone (see Clause 9) or leaves it unprotected.

7.2.3 Loading from side

The load shall be applied from the side horizontally normal to the longitudinal median plane. It shall be applied to the roll-over protective structure's upper extremity at a point generally 85 mm (see Figure 3) forward of the SIP (see Figure 3 and Clause 8), or, for a tractor with reversible driver's position, midway between the SIPs measured in the two driving directions.

If it is certain that any particular part of the cab side will touch the ground first when the tractor overturns sideways, the loading shall be applied at that point, provided that this permits uniform load distribution as specified in 7.2.1. In the case of a two-post structure, side loading shall be applied at the structural member uppermost on the side, regardless of the SIP.

The beam length shall be as long as practicable, subject to a maximum of 700 mm.

The test shall be stopped when

a) the strain energy absorbed by the ROPS is greater than or equal to the required input energy, E_{is}, in joules, where

$$E_{is} = 1{,}75 \cdot m_t$$

or

b) the ROPS enters the clearance zone (see Clause 9) or leaves it unprotected.

7.3 Crushing tests

7.3.1 Crushing at rear

The beam shall be positioned across the rear uppermost structural members and the resultant crushing forces shall be located in the vertical reference plane. The force, F_r, shall be applied, where $F_r = 20\, m_t$, in newtons. This force shall be maintained for at least 5 s after the cessation of any visually detectable movement of the ROPS.

Where the rear part of the roll-over protective structure's roof will not sustain the full crushing force, the force shall be applied until the roof is deflected to coincide with the plane joining the upper part of the ROPS to that part of the tractor rear capable of supporting the vehicle mass when overturned. The force shall then be removed and the tractor or loading force repositioned so that the beam is over that point of the ROPS which would then support the tractor front when completely overturned and the full force applied.

7.3.2 Crushing at front

The beam shall be positioned across the front uppermost structural members and the resultant crushing forces shall be located in the vertical reference plane. The force, F_f, shall be applied, where $F_f = 20\,m_t$, in newtons. This force shall be maintained for at least 5 s after the cessation of any visually detectable movement of the ROPS.

Where the front part of the roll-over protective structure's roof will not sustain the full crushing force, the force shall be applied until the roof is deflected to coincide with the plane joining the upper part of the ROPS to that part of the tractor front capable of supporting the vehicle mass when overturned. The force shall then be removed and the tractor or loading force repositioned so that the beam is over that part of the ROPS which would then support the tractor rear when completely overturned and the full force applied.

7.4 Second longitudinal loading

The second longitudinal loading shall be applied in the opposite direction to, and at the corner furthest from, the longitudinal loading according to 7.2.2, but otherwise in accordance with 7.2.1.

The test shall be stopped when

a) the strain energy absorbed by the protective structure is equal to or greater than the required input energy, E_{il2}, in joules, where

$$E_{il2} = 0{,}35 \cdot m_t$$

or

b) the ROPS enters the clearance zone (see Clause 9) or leaves it unprotected.

8 Seat index point

The seat index point (SIP) shall be determined in accordance with ISO 5353.

For a suspended seat, the manufacturer's directions for setting the suspension shall be followed if provided. Otherwise, the seat suspension shall be set to the suspension mid-travel point. After the installation of the seat on the tractor, the SIP becomes a fixed point with respect to the tractor and does not move with the seat through its horizontal and vertical adjustment range.

9 Clearance zone

9.1 The clearance zone is illustrated in Figures 4, and 6 a) and 6 b). The zone is defined in relation to the reference plane and the SIP. The reference plane is a vertical plane, generally longitudinal to the tractor and passing through the SIP and the centre of the steering wheel. Normally, the reference plane coincides with the longitudinal median plane of the tractor. This reference plane shall be assumed to move horizontally with the seat and steering wheel during loading but to remain perpendicular to the tractor or the floor of the ROPS. The clearance zone shall be defined on the bases of 9.2 and 9.3.

9.2 The clearance zone for tractors with a non-reversible seat is defined and is bounded by the planes listed in a) to j) below; the tractor being on a horizontal surface, the seat, where adjustable, adjusted to its rear uppermost position, and the steering wheel, where adjustable, adjusted to the mid-position for seated driving.

a) A horizontal plane, $A_1B_1B_2A_2$, $(810 + a_v)$ mm above the SIP with line B_1B_2 located $(a_h - 10)$ mm behind the SIP.

b) An inclined plane, $G_1G_2I_2I_1$, perpendicular to the reference plane, including both a point 150 mm behind line B_1B_2 and the rearmost point of the seat backrest.

c) A cylindrical surface, $A_1A_2I_2I_1$, perpendicular to the reference plane, having a radius of 120 mm, tangential to the planes defined in a) and b).

d) A cylindrical surface, $B_1C_1C_2B_2$, perpendicular to the reference plane, having a radius of 900 mm extending forward for 400 mm and tangential to the plane defined in a) along line B_1B_2.

e) An inclined plane, $C_1D_1D_2C_2$, perpendicular to the reference plane, joining the surface defined in d) and passing 40 mm from the forward external edge of the steering wheel. In the case of a high steering wheel position, this plane extends forward from line B_1B_2 tangentially to the surface defined in d).

f) A vertical plane, $D_1E_1E_2D_2$, perpendicular to the reference plane 40 mm forward of the external edge of the steering wheel.

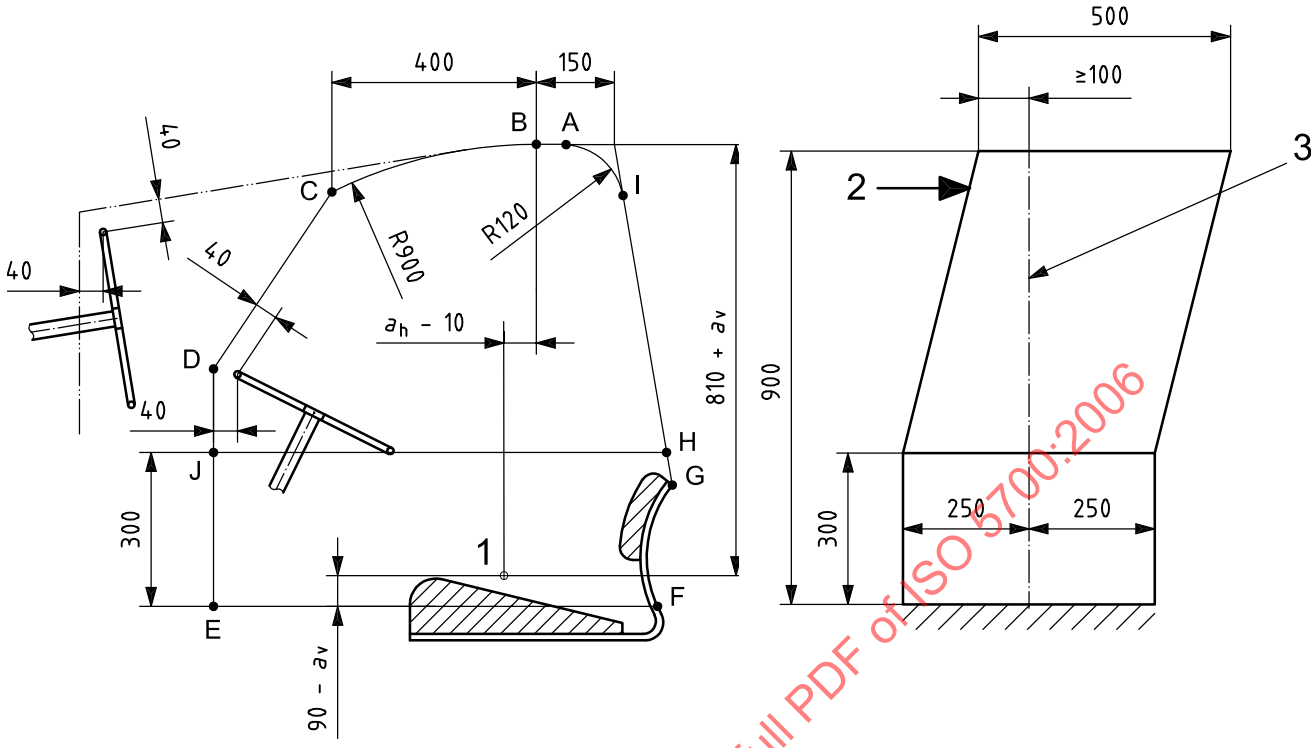
g) A horizontal plane, $E_1F_1F_2E_2$, passing through a point $(90 - a_v)$ mm below the SIP.

h) A surface, $G_1F_1F_2G_2$, if necessary curved from the bottom limit of the plane defined in b) to the horizontal plane defined in g), perpendicular to the reference plane, and in contact with the seat backrest throughout its length.

i) Vertical planes, $J_1E_1F_1G_1H_1$ and $J_2E_2F_2G_2H_2$. These vertical planes shall extend upwards from plane $E_1F_1F_2E_2$ for 300 mm; the distances E_1E_0 and E_2E_0 shall be 250 mm.

j) Parallel planes, $A_1B_1C_1D_1J_1H_1I_1$ and $A_2B_2C_2D_2J_2H_2I_2$, inclined so that the plane upper edge of the plane on the side on which the force is applied is at least 100 mm from the vertical reference plane.

9.3 For tractors with a reversible driver's position (reversible seat and steering wheel), the zone of clearance is the envelope of the two clearance zones defined by the two different positions of the steering wheel and the seat.



a) Section in reference plane **b) Front or rear view**

Key

1 SIP
2 force
3 vertical reference plane

Figure 6 — Clearance zone

10 Tolerances

Measurements during the tests shall be made to the following tolerances:

a) time ± 0,2 s

b) distance ± 0,5 %

c) force ± 1,0 %

d) mass ± 0,5 %

11 Acceptance conditions

11.1 General

For the ROPS to be accepted, it shall fulfil the conditions in 11.2 to 11.5 during and after the tests. On articulated tractors, the clearance zone shall remain protected at any angle of articulation of the tractor when overturned.

11.2 Clearance zone

No part shall enter the clearance zone as defined in Clause 9. No part may strike the seat during the tests. Furthermore, the clearance zone shall not be outside the protection given by the ROPS (see Note to 3.1). For this purpose, it shall be considered to be outside if any part of it would have come into contact with flat ground if the tractor had overturned towards the direction from which the blow was struck. To estimate this, the tyres and track width setting shall be the smallest standard fitting specified by the manufacturer.

NOTE It is the responsibility of the tractor manufacturer to ensure that other components not present during the ROPS test do not present a hazard to the operator in the event of an overturn by entering into the clearance zone.

11.3 Required force

At the point where the required energy is met in each of the specified horizontal loading tests, the force shall exceed $0{,}8F_{max.}$

11.4 Overload test

11.4.1 An overload test shall be required if the force drops by more than 3 % over the last 5 % of the deflection attained while absorbing the required energy [see Figures 7 a) and b)].

11.4.2 The overload test shall consist of continuing the horizontal loading in increments of 5 % of the original required energy up to a total of 20 % additional energy [see Figure 7 c)].

11.4.2.1 The overload test shall be successfully completed if,

— after the absorption of 5 %, 10 % or 15 % additional energy, the force drops by less than 3 % for each 5 % increment and is greater than $0{,}8F_{max}$, and if,

— after the absorption of 20 % additional energy, the force is greater than $0{,}8F_{max}$.

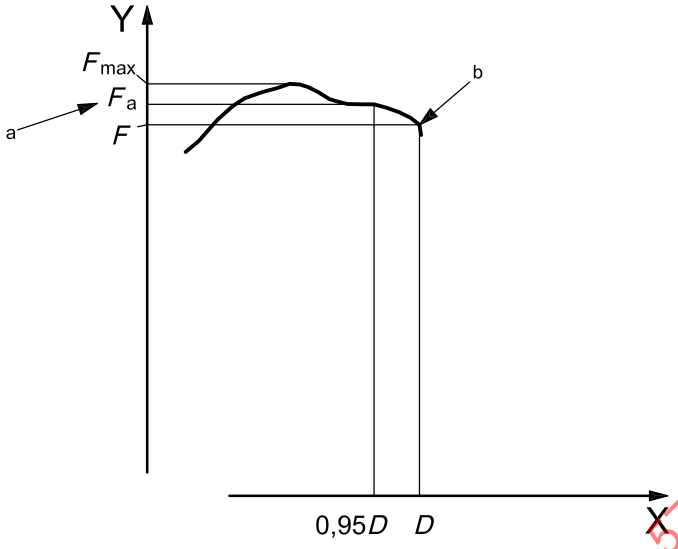
11.4.2.2 Entry into the clearance zone or lack of protection of the clearance zone is permitted during this overload test. After removing the load, the structure shall not be in the clearance zone and shall protect the clearance zone.

11.5 Cold weather embrittlement

If the ROPS is claimed to have properties resistant to cold weather embrittlement, the manufacturer shall give details which shall be included in the report (see Clause 14).

Cold weather embrittlement properties may be verified by either performing the tests in accordance with Clause 7 at −18°C or colder, or in accordance with Annex A.

NOTE In some countries, ROPS are required to meet the cold weather embrittlement requirements of Annex A. A partial list of those countries is given in Annex A.



Key

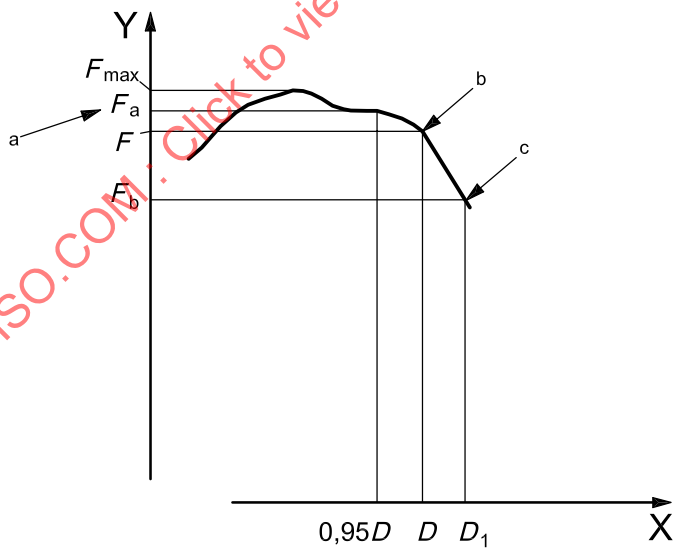
X deflection

Y static load force

a Locate F_a in relation to 0,95D.

b Overload test not necessary as $F_a \leqslant 1{,}03F$.

a) Overload test not necessary



Key

X deflection

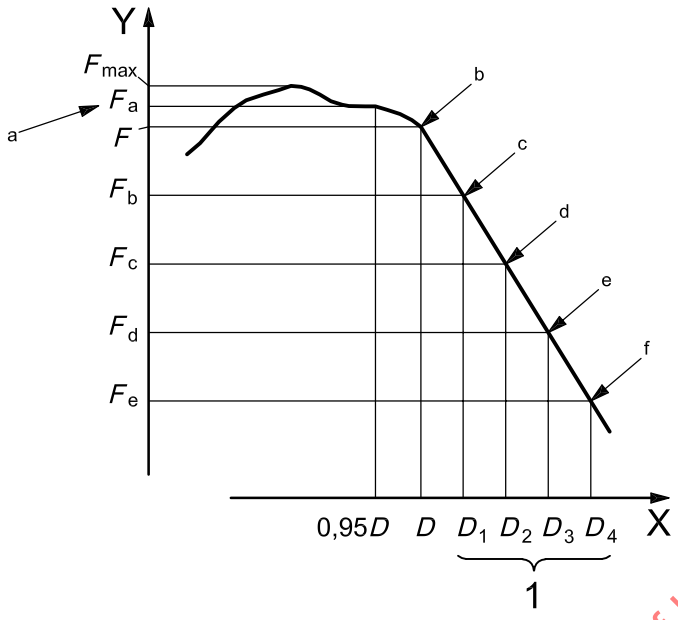
Y static load force

a Locate F_a in relation to 0,95D.

b Overload test necessary as $F_a > 1{,}03F$.

c Overload test performance satisfactory, as $F_b > 0{,}97F$ and $F_b > 0{,}8F_{max}$.

b) Overload test necessary



Key

X deflection

Y static load force

1 overload

a Locate F_a in relation to 0,95D.

b Overload test necessary as $F_a > 1{,}03F$.

c $F_b < 0{,}97F$, further overload therefore necessary.

d $F_c < 0{,}97F_b$, further overload therefore necessary.

e $F_d < 0{,}97F_c$, further overload therefore necessary.

f Overload test performance satisfactory if $F_e > 0{,}8F_{max}$. Failure at any stage when load drops below $0{,}8F_{max}$.

c) Continuing overload test

Figure 7 — Static load force load relative to deflection

12 Extension to other tractor models

In the case of a ROPS which has fulfilled the conditions required for acceptance and which is designed to be used on other tractor models, the test as specified in Clause 7 need not be carried out on each tractor model, provided that the ROPS and the tractor comply with the following conditions.

a) The tractor mass of the new tractor shall not exceed the reference mass used in the test by more than 5 %.

b) The attachment method and the tractor components to which the attachment is made shall be identical or of equivalent strength.

c) Any components, such as mudguards and bonnet, which may provide support for the ROPS, shall be identical or judged to give at least the same support.

d) The position and critical dimensions of the seat in the ROPS and the roll-over protective structure's relative position shall be such that the clearance zone would have remained within the protection of the deflected structure throughout all the tests.

In such cases, the test report shall contain a reference to the original test report.

13 Labelling

If a label is required, it shall be durable and permanently attached to the main structure such that it can be easily read. It shall be protected from damage and shall contain at least the following information:

a) name and address of the manufacturer or constructor of the ROPS;

b) ROPS identification number (design or serial number);

c) tractor make, model(s) or series number(s) the ROPS is designed to fit;

d) reference to this International Standard.

14 Test report

The test report shall contain at least the information given in Annex B.

Annex A
(normative)

Requirements for providing resistance to brittle fracture of ROPS at reduced operation temperature

The following requirements and procedure are intended to provide strength and resistance to brittle fracture at reduced temperature. The following minimum material requirements shall be met in judging the roll-over protective structure's suitability at reduced operating temperature in those countries requiring this additional operating protection.

In certain countries, compliance with the annex is mandatory. See Table A.1.

Table A.1 — Some countries where cold weather embrittlement testing according to this annex is mandatory

Country	Country code
Canada	CA
United States	US

NOTE The requirements and procedure in A.3 and A.4 are given until suitable International Standards are developed.

A.1 Bolts and nuts used to attach the ROPS to the machine frame and to connect structural parts of the ROPS shall be property class 8.8, 9.8 or 10.9 for bolts (see ISO 898-1[2]) and property class 8, 9 or 10 for nuts (see ISO 898-2[3]).

A.2 All welding electrodes used in the fabrication of structural members and mounts shall be compatible with the ROPS material as given in A.3.

A.3 Steel materials for structural members of the roll-over protective structure shall be of controlled toughness material exhibiting minimum Charpy V-notch impact energy requirements according to Table A.2. Structural members that can be demonstrated to be in plane stress or are subjected to sufficiently low strain rates such that the possibility of brittle fracture is precluded in the event of a low temperature field upset need not comply with this requirement.

NOTE Steel with an as-rolled thickness less than *2,5* mm and with a carbon content less than 0,2 % is considered to meet this requirement.

Structural members of the roll-over protective structure made from materials other than steel shall have equivalent low temperature impact resistance. Specimens shall be "longitudinal" and taken from flat stock, tubular or structural sections before forming or welding for use in the roll-over protective structure. Specimens from tubular or structural sections shall be taken from the middle of the biggest side and shall not include welds.

A.4 The Charpy V-notch tests shall be made in accordance with the procedure given in ASTM A370[1)], except that specimen sizes shall be in accordance with the dimensions given in Table A.2.

A.5 One alternative to this procedure is to use killed or semi-killed steel, for which a specification shall be provided.

1) Reference to ASTM A370 is to be replaced as soon as a corresponding International Standard becomes available.

Table A.2 — Minimum Charpy V-notch energy requirements for ROPS material at specimen temperatures of –20 ºC and –30 ºC

Specimen size	Absorbed energy	
	–30 °C	–20 °C
mm	J	J [b]
10 × 10 [a]	11	27,5
10 × 9	10	25
10 × 8	9,5	24
10 × 7,5 [a]	9,5	24
10 × 7	9	22,5
10 × 6,7	8,5	21
10 × 6	8	20
10 × 5 [a]	7,5	19
10 × 4	7	17,5
10 × 3,3	6	15
10 × 3	6	15
10 × 2,5 [a]	5,5	14

[a] Indicates preferred size. Specimen size shall be no less than the largest preferred size that the material will permit.

[b] The energy requirement at the temperature –20° C is 2,5 times the value specified for –30 °C. Other factors affect impact energy strength, i.e. direction of rolling, yield strength, grain orientation and welding. These factors shall be considered when selecting and using a steel.

Annex B
(normative)

Test report for roll-over protective structure

B.1 General

Units shown below, according to ISO 1000 [4], shall be stated, followed by national units in parentheses if necessary.

— ROPS manufacturer's name and address:

— Submitted for test by:

— Make of ROPS:

— Model of ROPS:

— Type of ROPS: cab, frame, rear roll bar, cab with integrated frame, etc.:

— Date and location of test:

B.2 Specification of test tractor

B.2.1 Identification of tractor to which ROPS is fitted

B.2.1.1 General

— Make of tractor: 2)

— Model (trade name):

— Type: 2-wheel drive or 4-wheel drive; rubber or steel tracks (if applicable); articulated 4-wheel drive or articulated 4-wheel drive with twin (dual) wheels (if applicable).

B.2.1.2 Numbers

— 1st serial no. or prototype:

— Serial no.:

B.2.1.3 **Other specifications** (if applicable)

— Model denomination(s) for other countries:

— Transmission type of gears × range:

2) Possibly different from tractor manufacturer's name.

— Speed version: 30, 40 or other: km/h

— Manufacturer identification or technical type number:

B.2.2 Tractor mass

Front	kg
Rear	kg
Total	kg

— Reference mass used for calculating loading energies and crushing forces: kg

B.2.3 Minimum track and tyre sizes

	Minimum track	Tyre size
Front	mm	
Rear	mm	

B.2.4 Tractor seat

— Tractor with reversible driver's position (reversible seat and steering wheel): Yes/No

— Make/type/model of seat:

— Make/type/model of optional seat(s) and position(s) of seat index point (SIP):

(Description of seat 1 and SIP position)

(Description of seat 2 and SIP position)

(Description of seat ... and SIP position)

B.3 Specification of ROPS

B.3.1 Photographs from side and rear showing mounting details, including mudguards.

B.3.2 General arrangement drawing of the side and rear of the structure including position of SIPs and details of mountings.

B.3.3 Brief description of the ROPS, comprising:

— type of construction;

— details of mountings;