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COMMISSION DELEGATED REGULATION (EU) No 1322/2014

of 19 September 2014

supplementing and amending Regulation (EU) No 167/2013 of the European Parliament and of the Council with regard to vehicle construction and general requirements for the approval of agricultural and forestry vehicles

(Text with EEA relevance)

(OJ L 364, 18.12.2014, p. 1)

Amended by:

		Official Journal		
		No	page	date
►**M1**	Commission Delegated Regulation (EU) 2016/1788 of 14 July 2016	L 277	1	13.10.2016

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COMMISSION DELEGATED REGULATION (EU) No 1322/2014

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CHAPTER I

SUBJECT MATTER AND DEFINITIONS

Article 1

Subject matter

This Regulation establishes the detailed technical requirements and test procedures regarding vehicle design, construction and assembly for the approval of agricultural and forestry vehicles and their systems, components and separate technical units, the detailed arrangements and requirements with regard to type-approval procedures, virtual testing and conformity of production, the technical specifications with regard to access to repair and maintenance information and the performance standards and criteria for the assessment of technical services in accordance with Regulation (EU) No 167/2013.

Article 2

Definitions

The following definitions shall apply:

(1) ‘seat reference point (S)’ means the point of intersection in the median longitudinal plane of the seat between the tangential plane at the base of the padded backrest and a horizontal plane. This horizontal plane intersects the lower surface of the seat 150 mm in front of the seat reference point (S) as determined in Appendix 8 to Annex XIV.

(2) ‘control device’ means any device whose direct actuation enables the state or operation of the tractor or of any equipment linked to it to be altered.

(3) ‘shield’ means a protective device located immediately in front of a dangerous part and which, either on its own or with other parts of the machine, protects on all sides against contact with the dangerous part.

(4) ‘guard’ means a protective device which, by means of a rail, grille or similar device, provides the necessary safety distance preventing contact with the dangerous part.

(5) ‘hood’ means a protective device located in front of the dangerous part and which protects against contact with it on the covered side.

(6) ‘firmly attached’ means that removal of such devices should be possible only with the aid of tools.

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(7) ‘hot surface’ means any metal surface of the tractor that reaches, during the normal use envisaged by the Manufacturer, a temperature higher than 85 °C or any plastic surface that reaches a temperature higher than 100 °C.

CHAPTER II

VEHICLE CONSTRUCTION AND GENERAL TYPE-APPROVAL REQUIREMENTS

Article 3

Manufacturer’s general obligations regarding vehicle construction

1. Manufacturers shall equip agricultural and forestry vehicles with systems, components and separate technical units affecting occupational safety that are designed, constructed and assembled so as to enable the vehicle in normal use and maintained according to the prescriptions of the manufacturer to comply with the detailed technical requirements and testing procedures set out in Articles 4 to 32.

2. Manufacturers shall demonstrate by means of physical demonstration testing to the approval authority that the agricultural and forestry vehicles made available on the market, registered or entering into service in the Union comply with the detailed technical requirements and test procedures laid down in Articles 4 to 32.

3. Manufacturers shall ensure that spare parts and equipment that are made available on the market or are entering into service in the Union comply with the detailed technical requirements and test procedures referred to in this Regulation. An approved agricultural and forestry vehicle equipped with such a spare part or equipment shall meet the same test requirements and performance limit values as a vehicle equipped with an original part.

4. Manufacturers shall ensure that type-approval procedures for verifying conformity of production are followed as regards the detailed vehicle construction requirements laid down in this Regulation.

Article 4

Application of UNECE regulations

The UNECE regulations and amendments thereto set out in Annex I to this Regulation shall apply to type-approval of agricultural and forestry vehicles subject to the conditions laid down in this Regulation.

Article 5

Recognition of test reports issued on the basis of OECD Codes for the purposes of EU type-approval

In accordance with Article 50 of Regulation (EU) No 167/2013, the test reports issued on the basis of OECD Codes set out in Annex II to this Regulation shall be recognised for the purpose of EU type approval as an alternative to the test report issued on the basis of this Regulation.

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Article 6

Arrangements with regard to type-approval procedures, including the requirements relating to virtual testing

The arrangements with regard to type-approval procedures referred to in Article 20 (8) of Regulation (EU) No 167/2013 and the requirements relating to virtual testing referred to in Article 27(6) of that Regulation shall be laid down in Annex III to this Regulation.

Article 7

Arrangements with regard to conformity of production

The arrangements with regard to conformity of production referred to in Article 28(6) of Regulation (EU) No 167/2013 shall be laid down in Annex IV to this Regulation.

Article 8

Requirements with regard to access to repair and maintenance information

The requirements with regard to access to repair and maintenance information referred to in Article 53(12) of Regulation (EU) No 167/2013 shall be laid down in Annex V to this Regulation.

Article 9

Requirements applying to roll-over protection structures (dynamic testing)

The test procedures and requirements applying to roll-over protection structures as regards dynamic testing for vehicles of categories T1, T4.2 and T4.3 referred to in Article 18(2)(a) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex VI to this Regulation.

Article 10

Requirements applying to roll-over protection structures (track-laying tractors)

The test procedures and requirements applying to roll-over protection structures as regards track-laying tractors for vehicles of categories C1, C2, C4.2 and C4.3 referred to in Article 18(2)(a) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex VII to this Regulation.

Article 11

Requirements applying to roll- over protection structures (static testing)

As an alternative to the requirements laid down in Article 9 and Article 10, manufacturers may choose to comply with the requirements of this Article, where the type of vehicle falls within the field of application set out in Annex VIII to this Regulation. The test procedures and requirements applying to roll-over protection structures as regards static

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testing for vehicles of categories T1/C1, T4.2/C4.2 and T4.3/C4.3 referred to in Article 18(2)(a) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex VIII to this Regulation.

Article 12

Requirements applying to roll-over protection structures (front mounted roll-over protective structures on narrow-track tractors)

The test procedures and requirements applying to front mounted roll-over protective structures as regards narrow- track tractors for vehicles of categories T2, T3 and T4.3 referred to in Article 18(2)(a) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex IX to this Regulation.

Article 13

Requirements applying to roll-over protection structures (rear mounted roll-over protective structures on narrow-track tractors)

The test procedures and requirements applying to rear mounted roll-over protective structures as regards narrow-track tractors for vehicles of categories T2/C2, T3/C3 and T4.3/C4.3 referred to in Article 18(2)(a) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex X to this Regulation.

Article 14

Requirements applying to falling objects protection structures

The test procedures and requirements applying to falling objects protection structures for vehicles of categories T and C referred to in Article 18(2)(b) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex XI to this Regulation.

Article 15

Requirements applying to passenger seats

The test procedures and requirements applying to passenger seats for vehicles of categories T and C referred to in Article 18(2)(c) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex XII to this Regulation.

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Article 16

Requirements applying to the driver's exposure to noise level

The test procedures and requirements applying to the driver's exposure to noise level for vehicles of categories T and C referred to in Article 18(2)(d) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex XIII to this Regulation.

Article 17

Requirements applying to the driving seat

The test procedures and requirements applying to the driving seat for vehicles of categories T and C referred to in Article 18(2)(e) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex XIV to this Regulation.

Article 18

Requirements applying to operating space and to access to the driving position

The test procedures and requirements applying to operating space and to access to the driving position for vehicles of categories T and C referred to in Article 18(2)(f) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex XV to this Regulation.

Article 19

Requirements applying to power take-offs

The test procedures and requirements applying to power take-offs for vehicles of categories T and C referred to in Article 18(2)(g) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex XVI to this Regulation.

Article 20

Requirements applying to the protection of drive components

The test procedures and requirements applying to protection of drive components for vehicles of categories T and C referred to in Article 18(2)(h) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex XVII to this Regulation.

Article 21

Requirements applying to seat-belt anchorages

The test procedures and requirements applying to seat-belt anchorages for vehicles of categories T and C referred to in Article 18(2)(i) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex XVIII to this Regulation.

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Article 22

Requirements applying to safety belts

The test procedures and requirements applying to safety belts for vehicles of categories T and C referred to in Article 18(2)(j) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex XIX to this Regulation.

Article 23

Requirements applying to the protection against penetrating objects

The test procedures and requirements applying to the protection against penetrating objects for vehicles of categories T and C referred to in Article 18(2)(k) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex XX to this Regulation.

Article 24

Requirements applying to exhaust systems

The test procedures and requirements applying to exhaust systems for vehicles of categories T and C referred to in Article 18(2)(l) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex XXI to this Regulation.

Article 25

Requirements applying to the operator's manual

The requirements applying to the operator's manual, including aspects relating to the protection against hazardous substances and operation and maintenance of the vehicle, for vehicles of categories T, C, R and S referred to in points (l), (n) and (q) of Article 18(2) of Regulation (EU) No 167/2013 shall be laid down in Annex XXII to this Regulation.

Article 26

Requirements applying to control devices, including safety and reliability of control systems and emergency and automatic stop devices

The test procedures and requirements applying to control devices, including safety and reliability of control systems and emergency and automatic stop devices for vehicles of categories T and C referred to in Article 18(2)(o) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex XXIII to this Regulation.

Article 27

Requirements applying to the protection against other mechanical hazards

The test procedures and requirements applying to the protection against mechanical hazards, including aspects relating to the protection against rough surfaces, sharp edges and angles, rupture of pipes carrying fluids

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and uncontrolled movement of the vehicle, other than those mentioned in Articles 9 to 14, 19 and 23 for vehicles of categories T, C, R and S referred to in Article 18(2)(p) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex XXIV to this Regulation.

Article 28

Requirements applying to guards and protective devices

The test procedures and requirements applying to guards and protective devices for vehicles of categories T, C, R and S referred to in Article 18(2)(r) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex XXV to this Regulation.

Article 29

Requirements applying to information, warnings and markings

The test procedures and requirements applying to information, warnings and markings, including aspects relating to the warning signals with regard to braking and the operation and maintenance of the vehicle, for vehicles of categories T, C, R and S referred to in Article 18(2)(s) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex XXVI to this Regulation.

Article 30

Requirements applying to materials and products

The test procedures and requirements applying to materials and products for vehicles of categories T and C referred to in Article 18(2)(t) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex XXVII to this Regulation.

Article 31

Requirements applying to batteries

The test procedures and requirements applying to batteries for vehicles of categories T and C referred to in Article 18(2)(u) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex XXVIII to this Regulation.

Article 32

Requirements applying to protection against hazardous substances

The test procedures and requirements applying to protection against hazardous substances for vehicles of categories T and C referred to in Article 18(2)(l) of Regulation (EU) No 167/2013 shall be conducted and verified in accordance with Annex XXIX to this Regulation.

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CHAPTER III

REQUIREMENTS RELATING TO TECHNICAL SERVICES

Article 33

Performance standards and assessment of technical services

Technical services have to comply with the performance standards and the procedure for their assessment referred to in Article 61 of Regulation (EU) No 167/2013, which shall be verified in accordance with Annex XXX to this Regulation.

Article 34

Permissibility of self-testing

Self-testing by in-house technical services referred to in Article 60(1) of Regulation (EU) No 167/2013 may only be conducted where permitted in Annex III to this Regulation.

CHAPTER IV

NATIONAL TYPE-APPROVAL OF VEHICLES, SYSTEMS, COMPONENTS OR SEPARATE TECHNICAL UNITS

Article 35

National type-approval of vehicles, systems, components or separate technical units

National authorities shall not refuse to grant national type-approval to a type of vehicle, system, component or separate technical unit on grounds relating to the construction requirements where the vehicle, system, component or separate technical unit complies with the requirements set out in this Regulation.

CHAPTER V

FINAL PROVISIONS

Article 36

Amendments to Annex I to Regulation (EU) No 167/2013

Annex I to Regulation (EU) No 167/2013 is amended as follows:

(1) in row No 39, the entries corresponding to vehicle categories Ca and Cb are replaced by ‘X’;

(2) in row No 41, the entries corresponding to vehicle categories T2a and T2b are replaced by ‘X’;

(3) in row No 43, the entries corresponding to vehicle categories Ca and Cb are replaced by ‘X’;

(4) in row No 44, the entries corresponding to vehicle categories Ca and Cb are replaced by ‘X’.

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Article 37

Entry into force and application

This Regulation shall enter into force on the twentieth day following that of its publication in the *Official Journal of the European Union*.

It shall apply from 1 January 2016.

This Regulation shall be binding in its entirety and directly applicable in all Member States.

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SUMMARY

Annex Number	Annex title
Vehicle construction and general type-approval requirements	
I	Application of UNECE regulations
II	Recognition of test reports issued on the basis of OECD Codes for the purposes of EU type-approval
III	Arrangements with regard to type-approval procedures, including the requirements relating to virtual testing
IV	Arrangements with regard to conformity of production
V	Requirements with regard to access to repair and maintenance information
VI	Requirements applying to roll-over protection structures (dynamic testing)
VII	Requirements applying to roll-over protection structures (track-laying tractors)
VIII	Requirements applying to roll-over protection structures (static testing)
IX	Requirements applying to roll-over protection structures (front mounted roll-over protective structures on narrow-track tractors)
X	Requirements applying to roll-over protection structures (rear mounted roll-over protective structures on narrow-track tractors)
XI	Requirements applying to falling objects protection structures
XII	Requirements applying to passenger seats
XIII	Requirements applying to the driver's exposure to noise level
XIV	Requirements applying to the driving seat
XV	Requirements applying to operating space and to access to the driving position
XVI	Requirements applying to power take-offs
XVII	Requirements applying to the protection of drive components
XVIII	Requirements applying to seat-belt anchorages
XIX	Requirements applying to safety belts
XX	Requirements applying to the protection against penetrating objects
XXI	Requirements applying to exhaust systems

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Annex Number	Annex title
XXII	Requirements applying to the operator's manual
XXIII	Requirements applying to control devices, including safety and reliability of control systems and emergency and automatic stop devices
XXIV	Requirements applying to the protection against other mechanical hazards
XXV	Requirements applying to guards and protective devices
XXVI	Requirements applying to information, warnings and markings
XXVII	Requirements applying to materials and products
XXVIII	Requirements applying to batteries
XXIX	Requirements applying to protection against hazardous substances
Requirements relating to technical services	
XXX	Performance standards and assessment of technical services

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ANNEX I

Application of UNECE regulations

UNECE regulation No	Subject	Series of amendments	OJ Reference	Applicability
14	Safety-belt anchorages, ISOFIX anchorages systems and ISOFIX top tether anchorages	Supplement 1 to the 07 series of amendments	OJ L 109, 28.4.2011, p. 1	T and C
16	Safety belts, restraint systems and child restraint systems	Supplement 1 to the 06 series of amendments	OJ L 233, 9.9.2011, p. 1	T and C
43	Safety glazing	Supplement 12 to the 00 series of amendments	OJ L 230, 31.8.2010, p. 119	T and C
60	Driver operated controls — identification of controls, tell-tales and indicators (moped/ motorcycles)		OJ L 95, 31.3.2004, p. 10	T and C
79	Steering equipment	Supplement 3 to the 01 series of amendments and Corrigendum 20 January 2006	OJ L 137, 27.5.2008, p. 25	T and C

Explanatory note:

The fact that a component is included in this list does not make its installation mandatory. For certain components, however, mandatory installation requirements are laid down in other Annexes to this Regulation.

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ANNEX II

Recognition of test reports issued on the basis of OECD Codes for the purposes of EU type-approval

Test report on the basis of OECD Code No	Subject	Edition	Applicability	Alternative to the EU test report on the basis of
3	Official testing of protective structures on agricultural and forestry tractors (dynamic test)	Edition 2015-July 2014-	T1, T4.2 and T4.3	Annex VI and Annex XVIII (if the seat-belt anchorages have been tested)
4	Official testing of protective structures on agricultural and forestry tractors (static test)	Edition 2015-July 2014-	T1/C1, T4.2/C4.2 and T4.3/C4.3	Annex VIII and Annex XVIII (if the seat-belt anchorages have been tested)
5	Official measurement of noise at the driving position(s) on agricultural and forestry tractors	Edition 2015-July 2014-	T and C	Annex XIII
6	Official testing of front mounted roll-over protective structures on narrow-track wheeled agricultural and forestry tractors	Edition 2015-July 2014-	T2, T3 and T4.3	Annex IX and Annex XVIII (if the seat-belt anchorages have been tested)
7	Official testing of rear mounted roll-over protective structure on narrow-track wheeled agricultural and forestry tractors	Edition 2015-July 2014-	T2/C2, T3/C3 and T4.3/C4.3	Annex X and Annex XVIII (if the seat-belt anchorages have been tested)
8	Official testing of protective structures on agricultural and forestry track-laying tractors	Edition 2015-July 2014-	C1, C2, C4.2 and C4.3	Annex VII and Annex XVIII (if the seat-belt anchorages have been tested)
10	Official testing of falling object protective structures on agricultural and forestry tractors	Edition 2015-July 2014-	T and C	Annex XI Part C

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ANNEX III

Arrangements with regard to type-approval procedures, including the requirements relating to virtual testing

1. **Type-approval process**

When receiving an application for vehicle type-approval, the approval authority shall:

1.1. verify that all EU type-approval certificates issued and test reports granted pursuant to Regulation (EU) No 167/2013 and the delegated and implementing acts adopted pursuant to that Regulation which are applicable for vehicle type-approval cover the vehicle type and correspond to the prescribed requirements;

1.2. by reference to the documentation make sure that the vehicle specifications and data contained in the vehicle information document are included in the data in the information packages and in the EU type-approval certificates issued in accordance with Regulation (EU) No 167/2013 and the delegated and implementing acts adopted pursuant to that Regulation;

1.3. on a selected sample of vehicles from the type to be approved carry out or arrange to be carried out inspections of vehicle parts and systems to verify that the vehicle(s) is/are built in accordance with the relevant data contained in the authenticated information package in respect of Regulation (EU) No 167/2013 and the delegated and implementing acts adopted pursuant to that Regulation;

1.4. carry out or arrange to be carried out relevant installation checks in respect of separate technical units where applicable;

1.5. carry out or arrange to be carried out necessary checks in respect of the presence of the subjects provided for in Annex I of Regulation (EU) No 167/2013;

2. **Combination of technical specifications**

The number of vehicles to be submitted shall be sufficient to permit the proper check of the various combinations to be type-approved according to the following criteria:

2.1. propulsion unit;

2.2. transmission;

2.3. powered axles (number, position and interconnection);

2.4. steered axles (number and position);

2.5. braking system and braked axles (number);

2.6. roll-over protection structure;

2.7. protection against hazardous substances.

3. **Specific provisions**

Where no approval certificates or test reports in respect of the subjects covered by Regulation (EU) No 167/2013 or the delegated and implementing acts adopted pursuant to that Regulation are available, the approval authority shall:

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3.1. arrange for the necessary tests and checks as required by Regulation (EU) No 167/2013 and the delegated and implementing acts adopted pursuant to that Regulation;

3.2. verify that the vehicle conforms to the particulars in the vehicle information folder and that it meets the technical requirements of Regulation (EU) No 167/2013 and the delegated and implementing acts adopted pursuant to that Regulation;

3.3. carry out or arrange to be carried out relevant installation checks in respect of components and separate technical units where applicable.

4. **Procedures to be followed during multi-stage EU type-approval**

4.1. General

4.1.1. The satisfactory operation of the process of multi-stage EU type-approval requires joint action by all the manufacturers concerned. To this end type-approval authorities shall ensure, before granting first and subsequent stage approval, that suitable arrangements exist between the relevant manufacturers for the supply and interchange of documents and information such that the completed vehicle type meets the technical requirements of Regulation (EU) No 167/2013 and the delegated and implementing acts adopted pursuant to that Regulation. Such information shall include details of relevant system, component and separate technical unit approvals and of vehicle parts which form part of the incomplete vehicle but are not yet approved.

4.1.2. EU Type-approvals in accordance with point 4 are granted on the basis of the current state of completion of the vehicle type and shall incorporate all approvals granted at earlier stages.

4.1.3. Each manufacturer in a multi-stage EU type-approval process is responsible for the approval and conformity of production of all systems, components or separate technical units manufactured by him or added by him to the previously built stage. He is not responsible for subjects which have been approved in an earlier stage except in those cases where he modifies relevant parts to an extent that the previously granted approval becomes invalid.

4.2. Procedures

The approval authority shall:

4.2.1. verify that all EU type-approval certificates issued and test reports granted pursuant to Regulation (EU) No 167/2013 and the delegated and implementing acts adopted pursuant to that Regulation which are applicable for vehicle type-approval cover the vehicle type at its state of completion and correspond to the prescribed requirements;

4.2.2. ensure that all the relevant data, taking account of the state of completion of the vehicle, is included in the information folder;

4.2.3. by reference to the documentation make sure that the vehicle specification(s) and data contained in the vehicle information folder are included in the data in the information packages and in the EU type-approval certificates, in accordance with Regulation (EU) No 167/2013 or the delegated and implementing acts adopted pursuant to that Regulation; and in the case of a completed vehicle, where an item number in the information folder is not included in any of the information packages, confirm that the relevant part of characteristic conforms to the particulars in the information folder;

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4.2.4. on a selected sample of vehicles from the type to be approved carry out or arrange to be carried out inspections of vehicle parts and systems to verify that the vehicle(s) is/are built in accordance with the relevant data contained in the authenticated information package in respect of Regulation (EU) No 167/2013 and the delegated and implementing acts adopted pursuant to that Regulation;

4.2.5. Carry out or arrange to be carried out relevant installation checks in respect of separate technical units where applicable.

4.3. The number of vehicles to be inspected for the purposes of point 4.2.4 shall be sufficient to permit the proper control of the various combinations to be EU type-approved according to the state of completion of the vehicle and the criteria set-out in point 2.

5. **Conditions under which virtual testing has to be performed and requirements which can be subject to virtual testing**

5.1. Objectives and scope

Point 5 lays down appropriate provisions concerning virtual testing in accordance with Article 27(6) of Regulation (EU) No 167/2013. It shall not apply to the second subparagraph of Article 27(3) of that Regulation.

5.2. List of requirements which may be subject to virtual testing

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Table 1

List of requirements which may be subject to virtual testing

Delegated act reference	Annex No	Requirements	Restrictions/comments
Regulation (EU) No 1322/2014	IX	continuous or interrupted roll over behaviour in case of a laterally overturning narrow track tractor with a protective frame mounted in front of the driver's seat	Section B4
Regulation (EU) No 1322/2014	XV	Requirements applying to operating space and to access to the driving position	Only requirements related to dimensions and positioning
Regulation (EU) 2015/208	VII	Requirements on the field of vision and windscreen wipers	Only requirements related to dimensions, positioning and visibility
Regulation (EU) 2015/208	IX	Requirements on rear view mirrors	Only requirements related to dimensions, positioning and visibility
Regulation (EU) 2015/208	XII	Requirements on lighting installation	Only requirements related to dimensions, positioning and visibility in point 5 and 6 (with the exception of colorimetric or photometric requirements)
Regulation (EU) 2015/208	XIII	Requirements on vehicle occupant protection, including interior fittings, head restraints, seat belts, vehicle doors	Part 2 Only requirements related to dimensions, including detailed shape, and positioning

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Delegated act reference	Annex No	Requirements	Restrictions/comments
Regulation (EU) 2015/208	XIV	Requirements on vehicle exterior and accessories	Only requirements related to dimensions, including detailed shape, and positioning

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6. **Conditions under which virtual testing has to be performed**

6.1. Virtual test pattern

The following scheme shall be used as a basic structure for describing and conducting virtual testing:

6.1.1. purpose;

6.1.2. structure model;

6.1.3. boundary conditions;

6.1.4. load assumptions;

6.1.5. calculation;

6.1.6. assessment;

6.1.7. Documentation.

6.2. Fundamentals of computer simulation and calculation

6.2.1. Mathematical model

The mathematical model shall be supplied by the manufacturer. It shall reflect the complexity of the structure of the vehicle, system and components to be tested in relation to the requirements. The same provisions shall apply *mutatis mutandis* for testing components or technical units independently from the vehicle.

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6.2.2. Validation process of the mathematical model

The mathematical model shall be validated in comparison with the actual test conditions. A physical test shall be conducted for the purposes of comparing the results obtained when using the mathematical model with the results of a physical test. Comparability of the test results shall be proven. For that purpose, manufacturers shall provide the technical service with a correlation report containing the information on the mathematical model and the correlation between the results obtained with such model and those obtained in the physical tests in accordance with the scheme set out in point 6.1. A validation report, confirming the compliance of the mathematical model, shall be drafted by the manufacturer or by the technical service and submitted to the approval authority. Any change made to the mathematical model or to the software likely to invalidate the validation report shall be brought to the attention of the approval authority, which may require that a new validation process is conducted. The flow chart of the validation process is shown in Figure 1 of point 7.

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6.2.3. Documentation

The data and auxiliary tools used for the simulation and calculation shall be made available by the manufacturer and be documented in a suitable way.

6.2.4. Tools and support

At the request of the technical service, the manufacturer shall supply or provide access to the necessary tools, including appropriate software.

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6.2.5. In addition, the manufacturer shall provide appropriate support to the technical service.

6.2.6. Providing access and support to a technical service does not detract from any obligation of the technical service regarding the skills of its personnel, the payment of licence rights and respect of confidentiality.

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6.2.7. Approval process when using virtual testing

The compliance with the requirements set out in Table 1 of point 5.2. may be demonstrated by virtual testing procedures only if these are carried out in accordance with a mathematical model validated in accordance with the requirements set out in point 6.2.2. The applicability and restrictions of the model shall be agreed with the technical services and shall be subject to the approval of the approval authority.

6.2.8. Virtual testing test report

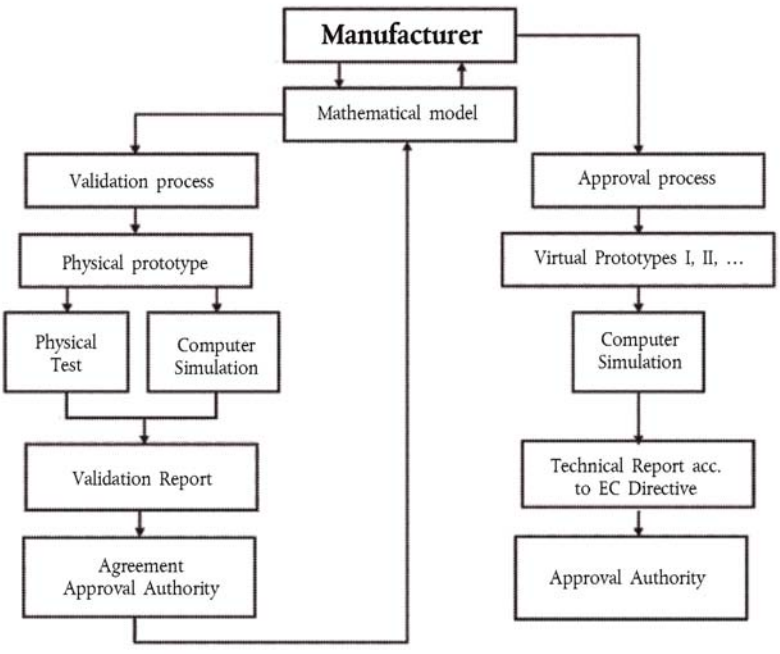
A test report of the virtual testing results shall be provided by the technical service. The test report should be coherent with the correlation report and the validation report and shall include at least the following elements: the building of a virtual prototype, the simulation inputs and the simulation results related to the technical requirements.

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7. **Validation process virtual testing**

Figure 1

Virtual testing validation process flow chart



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ANNEX IV

Arrangements with regard to conformity of production

1. **Definitions**

For the purposes of this Annex the following definitions shall apply:

1.1. ‘quality management system’ means a set of interrelated or interacting elements that organisations use to direct and control how quality policies are implemented and quality objectives are achieved;

1.2. ‘audit’ means an evidence-gathering process used to evaluate how well audit criteria are being applied; it should be objective, impartial and independent, and the audit process should be both systematic and documented;

1.3. ‘corrective actions’ means a problem-solving process with subsequent steps taken to remove the causes of a nonconformity or undesirable situation and designed to prevent their recurrence;

2. **Purpose**

2.1. The conformity of production procedure aims to ensure that each vehicle, system, component, separate technical unit, part or equipment produced is in conformity with the specification, performance and marking requirements of the approved type.

2.2. Procedures include inseparably the assessment of quality management systems, referred as ‘initial assessment’ and set out in section 3. and verification and production-related controls, referred to as ‘product conformity arrangements’ and set out in section 4.

3. **Initial assessment**

3.1. Before granting type-approval, the approval authority shall verify the existence of satisfactory arrangements and procedures established by the manufacturer for ensuring effective control so that vehicles, systems, components or separate technical units when in production conform to the approved type.

3.2. Guidelines for quality and/or environmental management systems auditing set out in the EN ISO 19011:2011 standard shall apply to the initial assessment.

3.3. The requirements referred to in point 3.1 shall be verified to the satisfaction of the approval authority granting type-approval. The approval authority shall be satisfied with the initial assessment and the product conformity arrangements in section 4. taking account as necessary of one of the arrangements described in points 3.3.1 to 3.3.3 or a combination of those arrangements in full or in part as appropriate.

3.3.1. The initial assessment and/or verification of product conformity arrangements shall be carried out by the approval authority granting the approval or an appointed body acting on behalf of the approval authority.

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3.3.1.1. When considering the extent of the initial assessment to be carried out, the approval authority may take account of available information relating to:

3.3.1.1.1. the manufacturer's certification described in point 3.3.3, which has not been qualified or recognised under that point;

3.3.1.1.2. in the case of components or separate technical units type-approvals, quality system assessments performed in the component or separate technical unit manufacturer's premises by vehicle manufacturer(s), according to one or more of the industry sector specifications satisfying the requirements in harmonised standard EN ISO 9001:2008.

3.3.2. The initial assessment and/or verification of product conformity arrangements may also be carried out by the approval authority of another Member State, or the appointed body designated for this purpose by the approval authority.

3.3.2.1. In such a case, the approval authority of the other Member State shall prepare a statement of compliance outlining the areas and production facilities it has covered as relevant to the vehicles, systems, components or separate technical units to be type-approved.

3.3.2.2. On receiving an application for a compliance statement from the approval authority of a Member State granting type-approval, the approval authority of another Member State shall send forthwith the statement of compliance or advise that it is not in a position to provide such a statement.

3.3.2.3. The statement of compliance shall include at least the following:

3.3.2.3.1. group or company (e.g. XYZ automotive);

3.3.2.3.2. particular organisation (e.g. European division);

3.3.2.3.3. plants/sites (e.g. Engine plant 1 (United Kingdom) — vehicle plant 2 (Germany));

3.3.2.3.4. vehicle/component range (e.g. All category T1 models);

3.3.2.3.5. areas assessed (e.g. Engine assembly, body pressing and assembly, vehicle assembly);

3.3.2.3.6. documents examined (e.g. Company and site quality manual and procedures);

3.3.2.3.7. date of the assessment (e.g. Audit conducted from 18 to 30.5.2013);

3.3.2.3.8. planned monitoring visit (e.g. October 2014).

3.3.3. The approval authority shall also accept the manufacturer's suitable certification to harmonised standard EN ISO 9001:2008 or an equivalent harmonised standard as satisfying the initial assessment requirements of point 3.3. The manufacturer shall provide details of the certification and undertake to inform the approval authority of any revisions to its validity or scope.

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3.4. For the purpose of vehicle type-approval, the initial assessments carried out for granting approvals for systems, components and separate technical units of the vehicle need not be repeated but shall be complemented by an assessment covering the locations and activities relating to the assembly of the whole vehicle not covered by the former assessments.

4. **Product conformity arrangements**

4.1. Every vehicle, system, component or separate technical unit approved pursuant to Regulation (EU) No 167/2013 and the delegated and implementing acts adopted pursuant to that Regulation, pursuant to a UNECE regulation annexed to the Revised 1958 Agreement, or pursuant to a complete test report issued on the basis of OECD Codes listed in Annex II to this Regulation, shall be so manufactured as to conform to the approved type by meeting the requirements of this Annex, Regulation (EU) No 167/2013 and the delegated and implementing acts adopted pursuant to that Regulation, as well as the relevant UNECE regulation(s) and OECD Code(s).

4.2. Before granting a type-approval pursuant to Regulation (EU) No 167/2013 and the delegated and implementing acts adopted pursuant to that Regulation, a UNECE regulation annexed to the Revised 1958 Agreement or an OECD Code, the approval authority of a Member State shall verify the existence of adequate arrangements and documented control plans, to be agreed with the manufacturer for each approval, to carry out at specified intervals those tests or associated checks necessary to verify continued conformity with the approved type, including, where applicable, tests specified in Regulation (EU) No 167/2013, the UNECE regulation and the OECD Code.

4.3. The holder of the type-approval shall, in particular:

4.3.1. ensure the existence and application of procedures for effective control of the conformity of products (vehicles, systems, components or separate technical units) to the approved type;

4.3.2. have access to the testing or other appropriate equipment necessary for checking conformity to each approved type;

4.3.3. ensure that test or check result data are recorded and that annexed documents remain available for a period of up to 10 years to be determined in agreement with the approval authority;

4.3.4. analyse the results of each type of test or check, in order to verify and ensure the stability of the product characteristics, making allowance for variation in industrial production;

4.3.5. ensure that for each type of product, at least the checks and the tests prescribed in Regulation (EU) No 167/2013 and the delegated and implementing acts adopted pursuant to that Regulation as well as those set out in the relevant UNECE Regulation or OECD Code are carried out;

4.3.6. ensure that any set of samples or test pieces giving evidence of non-conformity in the type of test in question gives rise to a further sampling and test or check. All the necessary steps shall be taken to restore the production process to ensure conformity with the approved type;

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4.3.7. in the case of vehicle type-approval, the checks referred to in point 4.3.5 shall at least consist in verifying the correct built specifications in relation to the approval and the information required for certificates of conformity.

4.4. In the case of step-by-step, mixed or multi-stage type-approvals, the approval authority granting whole vehicle type-approval may request specific details regarding compliance with the conformity of production requirements set out in this Annex from any approval authority that granted type-approval of any relevant system, component or separate technical unit.

4.5. If the approval authority granting whole vehicle type-approval is not satisfied with the reported information referred to in point 4.4 and has communicated this in writing to the manufacturer in question and the approval authority granting type-approval for the system, component or separate technical unit, the approval authority granting whole vehicle type-approval shall demand additional conformity of production audits or checks to be performed at the site of the manufacturer(s) of those systems, components or separate technical units and the results shall immediately be made available to the approval authority concerned.

4.6. If points 4.4 and 4.5 apply and the further audit or check results are deemed not to be satisfactory in the opinion of the approval authority granting whole vehicle type-approval, the manufacturer shall ensure that conformity of production is restored as soon as possible by corrective actions to the satisfaction of the approval authority granting whole vehicle type-approval and to the satisfaction of the approval authority granting type-approval of the system, component or separate technical unit.

5. **Continued verification arrangements**

5.1. The authority which has granted type-approval may at any time verify the conformity of production control methods applied in each production facility by means of periodic audits. The manufacturer shall for that purpose allow access to the manufacture, inspection, testing, storage and distribution sites and shall provide all necessary information with regard to the quality management system documentation and records.

5.1.1. The normal approach for such periodic audits shall be to monitor the continued effectiveness of the procedures laid down in sections 3 and 4 (initial assessment and product conformity arrangements) of this Annex.

5.1.1.1. Surveillance activities carried out by the technical services (qualified or recognised as required in point 3.3.3) shall be accepted as satisfying the requirements of point 5.1.1 with regard to the procedures established at initial assessment.

5.1.1.2. The normal frequency of these verifications by the approval authority (other than those referred to in point 5.1.1.1) shall be such as to ensure that the relevant conformity of production controls applied in accordance with sections 3 and 4 are reviewed over a period consistent with the climate of trust established by the approval authority.

5.2. At every review, the records of tests, checks and production records, and in particular the records of those tests or checks documented as required in point 4.2, shall be available to the inspector.

5.3. The inspector may select random samples to be tested in the manufacturer's laboratory or in the facilities of the technical service, in which case only physical tests shall be carried out. The minimum number of samples may be determined according to the results of the manufacturer's own verification.

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5.4. Where the level of control appears unsatisfactory, or when it seems necessary to verify the validity of the tests carried out in application of point 5.2, the inspector shall select samples to be sent to the technical service to perform physical tests in accordance with the requirements set out in section 4 and in Regulation (EU) No 167/2013, the delegated and implementing acts adopted pursuant to that Regulation, the relevant UNECE Regulation or OECD Code.

5.5. Where unsatisfactory results are found during an inspection or a monitoring review, the approval authority shall ensure that all necessary steps are taken to restore conformity of production as rapidly as possible.

5.6. Where Regulation (EU) No 167/2013 requires compliance with UNECE regulations or allows to use complete test reports issued on the basis of OECD standard Codes as an alternative to the requirements set out in the delegated acts adopted pursuant to that Regulation, the manufacturer may choose to apply the provisions of this Annex as an alternative to the conformity of production requirements in the respective UNECE regulations or OECD Codes. However, if point 4.5 or 4.6 apply, all separate conformity of production requirements in UNECE Regulations or OECD Codes have to be complied with to the satisfaction of the approval authority until it decides that conformity of production has been restored.

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ANNEX V

Requirements with regard to access to repair and maintenance information

LIST OF APPENDICES

Appendix Number	Appendix title
1	Access to vehicle OBD and vehicle repair and maintenance information
2	Information to enable the development of generic diagnostic tools

1. **Definition**

For the purposes of this Annex the following definition shall apply: 'access to Vehicle OBD and Vehicle Repair and Maintenance Information' means the availability of all OBD and repair and maintenance information required for the inspection, diagnosis, servicing or repair of the vehicle.

2. **Compliance with access to vehicle OBD and vehicle repair and maintenance information requirements in the type-approval procedure**

2.1. The manufacturer shall ensure compliance with the technical requirements in this Annex regarding access to vehicle OBD and vehicle repair and maintenance information.

2.2. Approval authorities shall grant type-approval only after receiving from the manufacturer a Certificate on Access to Vehicle OBD and Vehicle Repair and Maintenance Information.

2.3. The Certificate on Access to Vehicle OBD and Vehicle Repair and Maintenance Information shall serve as the proof of compliance with Chapter XV of Regulation (EU) No 167/2013.

2.4. The Certificate on Access to Vehicle OBD and Vehicle Repair and Maintenance Information shall be drawn up in accordance with the model referred to in Article 53(8)(3) to Regulation (EU) No 167/2013.

3. **Fees for access**

In addition to time-based access under Article 55 of Regulation (EU) No 167/2013, manufacturers may offer transaction-based access for which fees are charged per transaction and not based on the time for which access is granted. Where manufacturers offer both time-based and transaction-based access systems, independent repairers shall choose a preferred access system, either time-based or transaction based.

4. **Service parts, diagnostic tools and test equipment**

4.1. In the context of Article 53 (6) of Regulation (EU) No 167/2013, the manufacturer shall make the following information available to interested parties on the basis of individual arrangements to which the principle of Article 55 of Regulation (EU) No 167/2013 apply and to provide contact details on its website:

4.1.1. relevant information to enable the development of replacement components which are critical to the correct functioning of the OBD system;

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4.1.2. information to enable the development of generic diagnostic tools as listed in Appendix 2.

4.2. For the purposes of point 4.1.1, the development of replacement components shall not be restricted by any of the following:

4.2.1. the unavailability of pertinent information;

4.2.2. the technical requirements relating to malfunction indication strategies if the OBD thresholds are exceeded or if the OBD system is unable to fulfil the basic OBD monitoring requirements of this Regulation;

4.2.3. specific modifications to the handling of OBD information to deal independently with vehicle operation on liquid or gaseous fuels;

4.2.4. the type-approval of gaseous-fuelled vehicles that contain a limited number of minor deficiencies.

4.3. For the purposes of point 4.1.2, where manufacturers use diagnostic and test tools in accordance with ISO 22900-2:2009 regarding Modular Vehicle Communication Interface (MVCI) and ISO 22901-2:2011 on Open Diagnostic Data Exchange (ODX) in their franchised networks, the ODX files shall be accessible to independent operators via the manufacturer's website.

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4.4. Point 4.1.2 shall apply from 1.7.2021.

However, manufacturers of vehicles of R- and S-category that do not employ diagnostic tools or a physical or wireless communication with the on-board electronic control unit(s) for the purposes of diagnostics or reprogramming of their vehicles are exempted from the obligations set out in point 4.1.2.

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5. **Multi-stage type-approval**

5.1. In the case of multi-stage type-approval, as defined in Article 20 of Regulation (EU) No 167/2013, the final manufacturer shall be responsible for providing access to vehicle OBD and vehicle repair and maintenance information regarding its own manufacturing stage(s) and the link to the previous stage(s).

5.2. In addition, the final manufacturer shall on its website provide independent operators with the following information:

5.2.1. website address of the manufacturer(s) responsible for the previous stage(s);

5.2.2. name and address of all the manufacturers responsible for the previous stage(s);

5.2.3. type-approval number(s) of the previous stage(s);

5.2.4. the engine number.

5.3. Manufacturers responsible for a particular stage or stages of type-approval shall be responsible for providing through their website access to vehicle OBD and vehicle repair and maintenance information regarding the stage(s) of type-approval for which they are responsible and the link to the previous stage(s).

5.4. The manufacturer responsible for a particular stage or stages of type-approval shall provide the following information to the manufacturer responsible for the next stage:

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5.4.1. the Certificate of Conformity relating to the stage(s) for which it is responsible;

5.4.2. the Certificate on Access to Vehicle OBD and Vehicle Repair and Maintenance Information, including its appendices;

5.4.3. the type-approval number corresponding to the stage(s) for which it is responsible;

5.4.4. the documents referred to in points 5.4.1, 5.4.2 and 5.4.3 as provided by the manufacturer(s) involved in the previous stage(s).

5.5. Each manufacturer shall authorise the manufacturer responsible for the next stage to pass the documents to the manufacturers responsible for subsequent and final stages.

5.6. In addition, on a contractual basis, the manufacturer responsible for a particular stage or stages of type-approval shall:

5.6.1. provide the manufacturer responsible for the next stage with access to OBD and repair and maintenance information and interface information corresponding to the particular stage(s) for which it is responsible;

5.6.2. provide, at the request of a manufacturer responsible for a subsequent stage of type-approval, with access to vehicle OBD and vehicle repair and maintenance information and interface information corresponding to the particular stage(s) for which he is responsible.

5.7. A manufacturer, including a final manufacturer, may charge fees in accordance with Article 55 of Regulation (EU) No 167/2013 only in respect of the particular stage(s) for which he is responsible.

5.8. A manufacturer, including a final manufacturer, shall not charge fees for providing information relating to the website address or contact details of any other manufacturer.

6. **Small volume manufacturers**

6.1. Manufacturers shall provide access to repair and maintenance information in a readily accessible and prompt manner, and in a manner which is non-discriminatory as compared with the provisions given or access granted to authorised dealers and repairers in accordance with Article 53(13) of Regulation (EU) No 167/2013, if their annual worldwide production of a type of vehicle covered by that regulation is less than:

(a) for T-category: 200 vehicles;

(b) for C-category: 80 vehicles;

(c) for R-category: 400 vehicles;

(d) for S-category: 200 vehicles.

For a type of system, component or separate technical unit covered by that Regulation, the relevant figure in the meaning of this provision is 250 units.

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6.2. Vehicles, systems, components and separate technical units covered by point 6.1 shall be listed on the manufacturer's repair and maintenance information website.

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6.3. The approval authority shall inform the Commission of all type-approvals granted to small-volume manufacturers.

7. **Compliance with the obligations regarding access to vehicle OBD and vehicle repair and maintenance information**

7.1. An approval authority may, at any time, on their own initiative, or on the basis of a complaint or of an assessment by a technical service, check a manufacturer's compliance with its obligations under Regulation (EU) No 167/2013, this Regulation and the terms of the Certificate on Access to Vehicle OBD and Vehicle Repair and Maintenance Information.

7.2. Where an approval authority finds that a manufacturer has failed to comply with its obligations regarding access to vehicle OBD and vehicle repair and maintenance information, the approval authority which granted the relevant type-approval shall take appropriate measures to remedy the situation.

7.3. Such measures may include withdrawal or suspension of type-approval, fines or other measures adopted in accordance with Regulation (EU) No 167/2013.

7.4. If an independent operator or a trade association representing independent operators files a complaint to the approval authority, the authority shall carry out an audit to verify the manufacturer's compliance with obligations concerning access to vehicle OBD and vehicle repair and maintenance information.

7.5. When carrying out the audit, the approval authority may ask a technical service or any other independent expert to carry out an assessment to verify whether these obligations are met.

7.6. If the vehicle OBD and vehicle repair and maintenance information is not available when the application for type-approval is made, the manufacturer shall provide that information within six months of the date of type-approval.

7.7. Where the vehicle is placed on the market more than six months after type-approval, the information shall be provided on the date on which the vehicle is placed on the market.

7.8. The approval authority may presume on the basis of a completed Certificate on Access to Vehicle OBD and Vehicle Repair and Maintenance Information that the manufacturer has put in place satisfactory arrangements and procedures with regard to access to vehicle OBD and vehicle repair and maintenance information, provided that no complaint was made and that the manufacturer provides the certificate within the periods referred to in paragraph 7.7.

7.9. If the certificate of compliance is not provided within that period, the approval authority shall take appropriate measures to ensure compliance.

8. **Information requirements for granting access to independent operators to non-secure areas**

8.1. For access to any OBD and repair and maintenance information other than that relating to secure areas of the vehicle, registration requirements for use of the manufacturer's website by an independent operator shall require only such information as is necessary to confirm how payment for the information is to be made.

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9. **Information requirements for granting access to independent operators to secure areas**

9.1. For access to any OBD and repair and maintenance information concerning access to secure areas of the vehicle, the independent operator shall be approved and authorised for this purpose on the basis of documents demonstrating that it pursues a legitimate business activity and has not been convicted of relevant criminal activity.

9.2. Independent operators shall be given access to vehicle security features used by authorised dealers and repair shops under protection of security technology concerning the exchange of data to ensure confidentiality, integrity and protection against replay.

9.3. The Forum on Access to Vehicle Information provided for by Article 56 of Regulation (EU) No 167/2013 will specify state-of-the-art parameters for fulfilling these requirements.

9.4. For information concerning access to secure areas of the vehicle, the independent operator shall present a certificate in accordance with ISO 20828:2006 to identify itself and the organisation to which it belongs. The manufacturer shall respond with its own certificate in accordance with ISO 20828:2006 to confirm to the independent operator that it is accessing a legitimate site of the manufacturer in question. Both parties shall keep a log of any such transactions indicating the vehicles and changes made to them under this provision.

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Appendix 1

Access to vehicle OBD and vehicle repair and maintenance information

1. **Introduction**

1.1. This Appendix lays down technical requirements for the accessibility of vehicle OBD and vehicle repair and maintenance information.

2. **Requirements**

2.1. The manufacturer shall provide vehicle repair and maintenance information using only open text and graphic formats or formats which can be viewed and printed using only standard software plug-ins that are freely available, easy to install, and which run with computer operating systems commonly in use.

2.1.1. Vehicle OBD and vehicle repair and maintenance information available through websites shall follow the common standard referred to in Article 53(2) of Regulation (EU) No 167/2013.

2.1.2. Where possible, keywords in the metadata shall conform to ISO 15031-2:2010. Such information shall be always available, except as required for website maintenance purposes.

2.1.3. Those requiring the right to duplicate or re-publish the information should negotiate directly with the manufacturer concerned.

2.1.4. Information for training material shall also be available, but may be presented through media other than websites.

2.2. Information on all parts of the vehicle, with which the vehicle, as identified by the model and serial number, or by VIN number of the vehicle and any additional criteria such as wheelbase, engine output, trim level or options, is equipped by the vehicle manufacturer and which can be replaced by spare parts offered by the vehicle manufacturer to its authorised repairers or dealers or third parties by means of reference to original equipment (OE) parts numbers, shall be made available in a database easily accessible to independent operators.

2.3. This database or alternative accessible format shall comprise the VIN, OE parts numbers, OE naming of the parts, validity attributes (valid-from and valid-to dates), fitting attributes and, where applicable, structuring characteristics.

2.4. The information on the database or available in another accessible format shall be regularly updated. In particular, the updates shall include all modifications to individual vehicles after their production if this information is available to authorised dealers.

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2.5. Reprogramming and diagnostics of control units for the purposes of recalibration after a repair or loading software to a replacement ECU or recoding or reinitialising replacement parts or components, must allow the use of non-proprietary hardware.

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2.5.1. Reprogramming and diagnostics (PC-VCI communication interface) shall be conducted in accordance with either ISO 22900-2, SAE J2534 or TMC RP1210 from 1.7.2021;

However, the first paragraph shall apply from 1.7.2023 to the following manufacturers:

(a) manufacturers of vehicles of R- and S-category;

(b) manufacturers of vehicles of T- and C-category whose production is below the limits set out in point 6.1 of this Annex;

(c) manufacturers of systems, components or separate technical units whose production is below the limits set out in point 6.1 of this Annex.

2.5.2. Ethernet, serial cable or Local Area Network (LAN) interface and alternative media like Compact Disc (CD), Digital Versatile Disc (DVD) or solid state memory device may also be used, but on the condition that no proprietary communication software (e.g. drivers or plug-ins) and hardware is required. For the validation of the compatibility of the manufacturer-specific application and the vehicle communication interfaces (VCI) complying to ISO 22900-2, SAE J2534 or TMC RP1210, the manufacturer shall offer either a validation of independently developed VCIs or the information, and loan of any special hardware, required for a VCI manufacturer to conduct such validation himself. The conditions set out in Article 55 of Regulation (EU) No 167/2013 shall apply to fees for such validation or information and hardware.

2.5.3. Co-existence of vehicle manufacturers' software shall be ensured from 1.7.2021;

However, the first paragraph shall apply from 1.7.2023 to the following manufacturers:

(a) manufacturers of vehicles of R- and S-category;

(b) manufacturers of vehicles of T- and C-category whose production is below the limits set out in point 6.1 of this Annex;

(c) manufacturers of systems, components or separate technical units whose production is below the limits set out in point 6.1 of this Annex.

2.5.4. To ensure communication between the vehicle and diagnostic tools, the following standards shall apply for the physical diagnostic connectors between VCI and vehicle: SAE J1939-13, ISO 11783-2, ISO 15031-3 and ISO 13400-4.

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2.5.5. When a manufacturer recommends a combination of a type of tractor with a type of R or S category vehicle or vice versa, he shall provide the vehicle OBD and vehicle repair and maintenance information related to the interconnectivity of both vehicles to independent operators. This information may also be provided through a website set up jointly by several manufacturers or a consortium of manufacturers if this website is compliant with the provisions of this Regulation, as indicated by recital 23 to Regulation (EU) No 167/2013.

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2.6. Manufacturers' repair information websites shall indicate type-approval numbers by model.

2.7. Manufacturers shall establish reasonable and proportionate fees for hourly, daily, monthly, annual and if applicable per-transaction access to their repair and maintenance information websites.

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Appendix 2

Information to enable the development of generic diagnostic tools

1. **Information required for the manufacture of diagnostic tools**

In order to facilitate the provision of generic diagnostic tools for multi-make repairers, vehicle manufacturers shall make available the information referred to in points 1.1, 1.2 and 1.3 through their repair information websites. That information shall include all diagnostic tool functions and all the links to repair information and troubleshooting instructions. The access to the information may be subject to the payment of a reasonable fee.

1.1. Communication protocol information

The following information shall be required indexed against vehicle make, model and variant, or other workable definition such as VIN or vehicle and systems identification:

(a) Any additional protocol information system necessary to enable complete diagnostics in addition to the standards prescribed in point 4.7.3 of Annex 9B to UNECE Regulation No 49, including any additional hardware or software protocol information, parameter identification, transfer functions, 'keep alive' requirements, or error conditions;

(b) Details of how to obtain and interpret all fault codes which are not in accordance with the standards prescribed in point 4.7.3 of Annex 9B to UNECE Regulation No 49;

(c) A list of all available live data parameters, including scaling and access information;

(d) A list of all available functional tests, including device activation or control and the means to implement them;

(e) Details of how to obtain all component and status information, time stamps, pending DTC and freeze frames,

(f) Resetting adaptive learning parameters, variant coding and replacement component setup, and customer preferences,

(g) ECU identification and variant coding,

(h) Details of how to reset service lights;

(i) Location of diagnostic connector and connector details;

(j) Engine code identification.

1.2. Test and diagnosis of OBD monitored components

The following information shall be required:

(a) A description of tests to confirm its functionality, at the component or in the harness;

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(b) Test procedure including test parameters and component information;

(c) Connection details including minimum and maximum input and output and driving and loading values;

(d) Values expected under certain driving conditions including idling;

(e) Electrical values for the component in its static and dynamic states;

(f) Failure mode values for each of the above scenarios;

(g) Failure mode diagnostic sequences including fault trees and guided diagnostics elimination;

1.3. Data required to perform the repair

The following information shall be required:

(a) ECU and component initialisation (in the event of replacements being fitted);

(b) Initialisation of new or replacement ECU's where relevant using pass-through (re-) programming techniques.

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ANNEX VI

Requirements applying to roll-over protection structures (dynamic testing)

A. GENERAL PROVISION

1. The Union requirements applying to roll-over protection structures (dynamic testing) are set out in point B.

B. REQUIREMENTS APPLYING TO ROLL-OVER PROTECTION STRUCTURES (DYNAMIC TESTING) ([1])

1. **Definitions**

1.1. [Not applicable]

1.2. *Rolling Over Protective Structure (ROPS)*

Roll-over protective structure (protective cab or frame), hereinafter called 'protective structure', means the structure on a tractor the essential purpose of which is to avoid or limit risks to the driver resulting from roll-over of the tractor during normal use.

The roll-over protective structure is characterized by the provision of space for a clearance zone large enough to protect the driver when seated 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.

1.3. *Track*

1.3.1. Preliminary definition: median plane of the wheel

The median plane of the wheel is equidistant from the two planes containing the periphery of the rims at their outer edges.

1.3.2. Definition of track

The vertical plane through the wheel axis intersects its median plane along a straight line which meets the supporting surface at one point. If A and B are the two points thus defined for the wheels on the same axle of the tractor, then the track width is the distance between points A and B. The track may be thus defined for both front and rear wheels. Where there are twin wheels, the track is the distance between two planes each being the median plane of the pairs of wheels.

For track-laying tractors, the track is the distance between the median planes of the tracks.

1.3.3. Additional definition: median plane of the tractor

Take the extreme positions of points **A** and **B** for the tractor rear axle, which gives the maximum possible value for the track. The vertical plane at right angles to the line **AB** at its centre point is the median plane of the tractor.

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1.4. *Wheelbase*

The distance between the vertical planes passing through the two lines **AB** as defined above, one for the front wheels and one for the rear-wheels.

1.5. *Determination of seat index point; Seat location and adjustment for test*

1.5.1. Seat Index Point (SIP) (2)

The seat index point shall be determined in accordance with ISO 5353:1995.

1.5.2. Seat location and adjustment for test

1.5.2.1. Where the inclination of the backrest and seat pan is adjustable, these must be adjusted so that the Seat Index Point is in its rear uppermost position;

1.5.2.2. Where the seat is equipped with suspension, the latter must be blocked at mid-travel, unless this is contrary to the instructions clearly laid down by the seat manufacturer;

1.5.2.3. Where the position of the seat is adjustable only lengthwise and vertically, the longitudinal axis passing through the Seat Index Point shall be parallel with the vertical longitudinal plane of the tractor passing through the centre of the steering wheel and not more than 100 mm from that plane.

1.6. *Clearance zone*

1.6.1. Reference plane

The clearance zone is illustrated in Figures 3.8 to 3.10 and Table 3.3. The zone is defined in relation to the reference plane and the Seat Index Point. The reference plane is a vertical plane, generally longitudinal to the tractor and passing through the Seat Index Point 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 roll-over protective structure. The clearance zone shall be defined on the basis of sub clauses 1.6.2 and 1.6.3.

1.6.2. Determination of clearance zone for tractors with a non-reversible seat

The clearance zone for tractors with a non-reversible seat is defined in 1.6.2.1 to 1.6.2.10 below and is bounded by the following planes, the tractor being on a horizontal surface, the seat, where adjustable, adjusted to its rear uppermost position (2), and the steering wheel, where adjustable, adjusted to the mid position for seated driving:

1.6.2.1. a horizontal plane A1 B1 B2 A2, (810 + av) mm above the seat index point (SIP) with line B1B2 located (ah – 10) mm behind the SIP;

1.6.2.2. an inclined plane G1 G2 I2 I1, perpendicular to the reference plane, including both a point 150 mm behind line B1B2 and the rearmost point of the seat backrest;

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1.6.2.3. a cylindrical surface A1 A2 I2 I1 perpendicular to the reference plane, having a radius of 120 mm, tangential to the planes defined in 1.6.2.1 and 1.6.2.2 above;

1.6.2.4. a cylindrical surface B1 C1 C2 B2, perpendicular to the reference plane, having a radius of 900 mm extending forward for 400 mm and tangential to the plane defined in 1.6.2.1 above along line B1B2;

1.6.2.5. an inclined plane C1 D1 D2 C2, perpendicular to the reference plane, joining the surface defined in 1.6.2.4 above 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 B1B2 tangentially to the surface defined in 1.6.2.4 above;

1.6.2.6. a vertical plane D1 E1 E2 D2 perpendicular to the reference plane 40 mm forward of the external edge of the steering wheel;

1.6.2.7. a horizontal plane E1 F1 F2 E2 passing through a point (90 – av) mm below the seat index point (SIP);

1.6.2.8. a surface G1 F1 F2 G2, if necessary curved from the bottom limit of the plane defined in 1.6.2.2 above to the horizontal plane defined in 1.6.2.7 above, perpendicular to the reference plane, and in contact with the seat backrest throughout its length;

1.6.2.9. vertical planes J1 E1 F1 G1 H1 and J2 E2 F2 G2 H2. These vertical planes shall extend upwards from plane E1 F1 F2 E2 for 300 mm; the distances E1 E0 and E2 E0 shall be 250 mm;

1.6.2.10. parallel planes A1 B1 C1 D1 J1 H1 I1 and A2 B2 C2 D2 J2 H2 I2 inclined so that the upper edge of the plane on the side on which the force is applied is at least 100 mm from the vertical reference plane.

1.6.3. Determination of clearance zone for tractors with a reversible driver's position

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

1.6.4. Optional seats

1.6.4.1. In case of tractors that could be fitted with optional seats, the envelope comprising the seat index points of all options offered shall be used during the tests. The protective structure shall not enter the larger clearance zone which takes account of these different seat index points.

1.6.4.2. In the case where a new seat option is offered after the test has been performed, a determination shall be made to see whether the clearance zone around the new SIP falls within the envelope previously established. If it does not, a new test must be performed.

1.6.4.3. Optional seat does not include a seat for a person in addition to the driver and from where the tractor cannot be controlled. The SIP shall not be determined because the definition of the clearance zone is in relation to the driver seat.

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1.7. *Unballasted mass*

The mass of the tractor without ballasting devices and, in the case of tractors with pneumatic tyres, without liquid ballast in the tyres. The tractor shall be in running order with tanks, circuits and radiator full, protective structure with cladding and any track equipment or additional front wheel drive components required for normal use. The operator is not included.

1.8. *Permissible measurement tolerances*

Distance	± 0,5 mm
Force	± 0,1 % (of the sensor full scale)
Mass	± 0,2 % (of the sensor full scale)
Tyre pressure	± 5,0 %
Angle	± 0,1°

1.9. *Symbols*

a_h	(mm)	Half of the horizontal seat adjustment
a_v	(mm)	Half of the vertical seat adjustment
E	(J)	Energy input during test
F	(N)	Static load force
H	(mm)	Height of lift of the centre of gravity of the pendulum block
I	($kg.m^2$)	Moment of inertia about rear axle, excluding wheels used for calculating rear impact energy
L	(mm)	Wheelbase used for calculating rear impact energy
M	(kg)	Mass used for calculating energy and crushing forces

2. **Field of application**

2.1. This Annex is applicable to tractors having at least two axles for pneumatic tyred wheels with or without track attachments and with an unballasted tractor mass greater than 600 kg but generally less than 6 000 kg.

2.2. The minimum track width of the rear-wheels should generally be greater than 1 150 mm. It is recognised that there may be designs of tractors, for example, lawn mowers, narrow vineyard tractors, low profile tractors used in buildings with limited overhead clearance or in orchards, high-clearance tractors and special forestry machines, such as forwarders and skidders, for which this Annex is not applicable.

3. **Rules and directions**

3.1. *General regulations*

3.1.1. The protective structure may be manufactured either by the tractor manufacturer or by an independent firm. In either case a test is only valid for the model of tractor on which it is carried out. The protective structure must be retested for each model of tractor to which it is to be fitted. However, testing stations may certify that

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the strength tests are also valid for tractor models derived from the original model by modifications to the engine, transmission and steering and front suspension *(see below 3.6: Extension to other tractor models)*. On the other hand, more than one protective structure may be tested for any one model of tractor.

3.1.2. The protective structure submitted for dynamic test must be supplied attached in the normal manner to the tractor model in connection with which it is being tested. The tractor submitted shall be complete and in running order.

3.1.3. Where a 'tandem' tractor is concerned, the mass of the standard version of that part to which the protective structure is fitted is to be used.

3.1.4. A protective structure may be designed solely to protect the driver in the event of the tractor overturning. Onto this structure it may be possible to fit weather protection for the driver, of a more or less temporary nature. The driver will usually remove this in warm weather. There are protective structures however, in which the cladding is permanent and warm weather ventilation provided by windows or flaps. As the cladding may add to the strength of the structure and if removable may well be absent when an accident occurs, all parts that can be so taken away by the driver will be removed for the purpose of the test. Doors, roof hatch and windows that can be opened shall be either removed or fixed in the open position for the test, so that they do not add to the strength of the protective structure. It shall be noted whether, in this position, they would create a hazard for the driver in the event of overturning.

Throughout the remainder of these rules, reference will only be made to testing the protective structure. It must be understood that this includes cladding not of a temporary nature.

A description of any temporary cladding supplied is to be included in the specifications. All glass or similar brittle material shall be removed prior to the test. Tractor and protective structure components which might sustain needless damage during the test and which do not affect the strength of the protective structure or its dimensions may be removed prior to the test if the manufacturer wishes. No repairs or adjustment may be carried out during the test.

3.1.5. Any component of the tractor contributing to the strength of the protective structure such as mud-guards, which has been reinforced by the manufacturer, should be described and its measurements given in the test report.

3.2. *Apparatus and test conditions*

3.2.1. The structure shall be struck by a block acting as a pendulum and submit to a front and a rear crushing test.

3.2.2. The mass of the pendulum bloc (Figure 3.1) shall be 2 000 kg. Its impact face shall have dimensions 680 × 680 mm ± 20. It shall be made in such a way that the position of its centre of gravity is constant (for example with iron bars bound in concrete). It shall be suspended from a pivot point about 6 m above the floor in such a way that the height of the pendulum may be conveniently and safely adjusted.

3.2.3. For tractors with less than 50 % of their mass on the front wheels, the first blow shall be at the rear of the structure. This shall be followed by a crushing test also at the rear of the structure. The second blow shall be at the front and the third at the side. Finally, there shall be a second crushing test at the front.

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For tractors with 50 % or more of their mass on the front wheels, the first blow shall be at the front and the second blow at the side. This shall be followed by the two crushing tests, firstly at the rear and secondly at the front.

3.2.4. For tractors with a reversible driver's position (reversible seat and steering wheel), the first blow shall be longitudinal at the heavier end (with more than 50 % of the mass of the tractor). This shall be followed by a crushing test on the same end. The second blow shall be at the other end, and the third at the side. Finally, there shall be a second crushing test at the lighter end.

3.2.5. A track width setting for the rear-wheels shall be chosen such that the structure is in no way supported by the tyres during the test. This provision may be disregarded if such support is given when the wheels are in their widest alternative track setting.

3.2.6. The side of the tractor from which the side blow is struck shall be that which, in the opinion of the testing station, is likely to give the greatest distortion. The rear blow shall be on the corner opposite the side blow and the front blow on the corner nearer the side blow. The rear blow shall be administered at two-thirds the distance from the median plane of the tractor to the vertical plane touching the outside extremity of the structure. However, if a curve in the back of the structure starts at less than two-thirds of the distance from the centre, the blow shall be struck at the beginning of the curve, i.e. at the point where this curve is tangential to a line at right angles to the median plane of the tractor.

3.2.7. If, during the test, any lashings, props or blocks move or break, the test must be repeated.

3.3. *Impact tests*

3.3.1. Impact at the rear (Figures 3.2.a and 3.2.b)

3.3.1.1. The rear impact is not required on tractors having 50 % or more of their mass (as defined above) on the front wheels.

3.3.1.2. The tractor shall be placed in relation to the pendulum so that this will strike the structure when the striking face and the supporting chains are at an angle of 20° to the vertical unless the structure at the point of contact has, during deflection, a greater angle with the vertical. In this case the striking face shall be adjusted parallel to the side of the structure at the point of contact at the moment of maximum deflection by an additional support, the supporting chains remaining at an angle of 20° to the vertical. The point of impact shall be that part of the structure likely to hit the ground first in a rearward overturning accident, normally the upper edge. The height of the pendulum will be so adjusted that it has no tendency to turn about the point of contact.

3.3.1.3. The tractor will be lashed down. The points of attachment of the lashings shall be approximately 2 m behind the rear axle and 1,5 m in front of the front axle. There shall be two lashings on each axle, one on each side of the median plane of the tractor. The lashings shall be steel cable of 12,5 to 15 mm diameter, tensile strength

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1 100-1 260 MPa. The tyres of the tractor shall be inflated, and the lashings tightened to give tyre pressures and deflections, as shown in the Table 3.1, below.

After the lashings have been tightened a wood beam 150 × 150 mm shall be clamped in front of the rear-wheels, driven tight against them.

3.3.1.4. The pendulum shall be pulled back so that the height H of its centre of gravity above that at the point of impact is given by one of the following formulae at the option of the manufacturer:

$$H = 2,165 \times 10^{-8} ML^2 \text{ or } H = 5,73 \times 10^{-2} I$$

3.3.1.5. The pendulum shall be released and allowed to crash against the structure. The quick release mechanism must be so positioned that it does not tilt the weight in relation to the chains supporting it at the moment of release.

Table 3.1

Tyre Pressures

	Tyre pressures kPa (*)	Deflection mm
Four-wheel drive tractors with front and rear wheels of the same size:		
Front	100	25
Rear	100	25
Four-wheel drive tractors with front wheels smaller than rear wheels:		
Front	150	20
Rear	100	25
Two-wheel drive tractors:		
Front	200	15
Rear	100	25

(*) No water ballast is to be used.

3.3.2. Impact at the front (Figures 3.3.a and 3.3.b)

3.3.2.1. This shall be carried out in the same way as the impact at the rear. The lashings shall be the same but the wooden beam shall be behind the rear-wheels. The height of fall of the centre of gravity of the pendulum shall be given by the following formula:

$$H = 125 + 0,02\ M$$

3.3.2.2. The point of impact shall be that part of the structure that would hit the ground first when turning over sideways while travelling forward, normally the top of the front corner.

3.3.3. Impact at the side (Figure 3.4)

3.3.3.1. The tractor shall be placed in relation to the pendulum so that this will strike the structure when the striking face and the supporting chains are vertical unless the structure at the point of contact is, during deflection, other than vertical. In this case the striking face shall be adjusted so that it is approximately parallel to the structure

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at the point of contact at the moment of maximum deflection. This adjustment shall be made by an additional support, the supporting chains remaining vertical at the moment of impact. The point of impact shall be that part of the structure likely to hit the ground first in a sideways overturning accident, normally the upper edge.

3.3.3.2. Unless it is certain that any other part of this edge would hit the ground first, the point of impact shall be in the plane at right angles to the median plane of the tractor and passing 60 mm in front of the seat index point, the seat being at its mid-point of longitudinal adjustment. The height of the pendulum will be so adjusted that it has no tendency to turn about the point of contact.

3.3.3.3. For tractors with a reversible driver's position, the point of impact shall be in the plane at right angles to the median plane of the tractor and at the mid-point between the two seat index points.

3.3.3.4. The rear-wheel of the tractor on the side to be struck shall be lashed down. The tension in the lashings shall be determined as for the impact at the rear. After lashing, a beam 150 × 150 mm shall be clamped against the side of the rear-wheel opposite the blow, and driven hard against the tyre. A beam shall be placed as a prop against this wheel and secured on the floor so that it is held tight against the wheel during impact. The length of this beam shall be chosen so that when in position against the wheel it makes an angle of 25 to 40° with the horizontal. Furthermore its length shall be 20 to 25 times its thickness and its width 2 to 3 times its thickness.

3.3.3.5. The pendulum shall be pulled back as in the previous tests so that the height H of its centre of gravity above that at the moment of impact is determined by the following formula:

$$H = 125 + 0{,}15\ M$$

3.3.3.6. During the side impact test the difference between the maximum momentary deflection and the permanent deflection at a height of $(810 + a_v)$ mm above the seat index point shall be recorded. This may be done with a device on which a moving friction collar shall be fitted on a horizontal rod. One end of the rod shall be attached to the top member of the structure and the other will pass through a hole in a vertical bar attached to tractor chassis. The collar will be positioned against the vertical bar attached to tractor chassis before the blow and its distance from it after the blow will give the difference between the maximum momentary deflection and the permanent deflection.

3.4. *Crushing tests*

It may be necessary to hold down the front of the tractor when carrying out the test at the rear. Blocks will be placed under the axles so that the tyres do not bear crushing force. The cross beam used shall have a width of approximately 250 mm and shall be connected to the load applying mechanism by universal joints (Figure 3.5).

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3.4.1. Crushing at the rear (Figures 3.6.a and 3.6.b)

3.4.1.1. The crushing beam shall be positioned across the rear uppermost structural members so that the resultant of the crushing forces is located in the vertical reference plane of the tractor. The crushing force (F) shall be applied where:

$$F = 20\ M$$

This force shall be maintained for 5 seconds after cessation of any visually detectable movement of the protective structure.

3.4.1.2. Where the rear part of the protective structure roof will not sustain the full crushing force (Figures 3.7.a and 3.7.b), the force shall be applied until the roof is deflected to coincide with the plane joining the upper part of the protective structure with that part of the rear of the tractor capable of supporting the tractor when overturned.

The force shall then be removed and the crushing beam repositioned over that part of the protective structure that would support the tractor when completely overturned. The crushing force **F** shall be applied.

3.4.2. Crushing at the front (Figures 3.6.a and 3.6.b)

3.4.2.1. The crushing beam shall be positioned across the front uppermost structural members so that the resultant of the crushing forces is located in the vertical reference plane of the tractor. The crushing force (F) shall be applied where:

$$F = 20\ M$$

This force shall be maintained for 5 seconds after cessation of any visually detectable movement of the protective structure.

3.4.2.2. When the front part of the roof of the protective structure will not sustain the full crushing force (Figures 3.7.a and 3.7.b), the force shall be applied until the roof is deflected to coincide with the plane joining the upper part of the protective structure with that part of the front of the tractor capable of supporting the tractor when overturned.

The force shall then be removed and the crushing beam repositioned over that part of the protective structure that would support the tractor when completely overturned. The crushing force **F** shall then be applied.

3.5. *Conditions for acceptance*

3.5.1. The structure and tractor shall be visually examined for cracks and tears after each part of the test. For the structure to pass the test the following conditions shall be complied with:

3.5.1.1. there shall be no cracks in structural members, mounting components or tractor parts contributing to the strength of the protective structure (except as covered by 3.5.1.3 below);

3.5.1.2. there shall be no cracks in welds contributing to the strength of the protective structure or its mounting components. Spot or tack welding used for the attachment of cladding panels shall normally be excluded from this condition;

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3.5.1.3. energy-absorbing tears in sheet metal structures are acceptable, providing that they are judged by the testing station to have not significantly reduced the resistance to deflection of the protective structure. Tears in sheet metal components caused by edges of the pendulum weight shall be ignored;

3.5.1.4. the required force must be sustained in both crushing tests;

3.5.1.5. the difference between the maximum momentary deflection and the permanent deflection in the side impact test must not exceed 250 mm (Figure 3.11);

3.5.1.6. no part shall enter the clearance zone during any part of the tests. No part may strike the seat during the tests. Furthermore, the clearance zone shall not be outside the protection of the protective structure. For this purpose, it shall be considered to be outside the protection of the structure if any part of it would come in contact with flat ground if the tractor overturned towards the direction from which the test load is applied. For estimating this, the tyres and track width setting shall be the smallest standard fitting specified by the manufacturer.

3.5.1.7. for the articulated tractors, the median planes of the two parts shall be assumed to be in line.

3.5.2. After the final crushing test, the permanent deformation of the protective structure shall be recorded. For this purpose, before the start of the test, the position of the main members in relation to the seat index point must be recorded. Then any movement of the members struck in the tests and any change of the height of the front and back members of the roof shall be recorded.

3.6. *Extension to other tractor models*

3.6.1. [Not applicable]

3.6.2. Technical extension

When technical modifications occur on the tractor, the protective structure or the method of attachment of the protective structure to the tractor, the testing station that has carried out the original test can issue a ‘technical extension report’ in the following cases:

3.6.2.1. Extension of the structural test results to other models of tractors

The impact and crushing tests need not be carried out on each model of tractor, provided that the protective structure and tractor comply with the conditions referred to hereunder 3.6.2.1.1 to 3.6.2.1.5.

3.6.2.1.1. The structure shall be identical to the one tested;

3.6.2.1.2. The required energy shall not exceed the energy calculated for the original test by more than 5 %. The 5 % limit shall also apply to extensions in the case of substituting tracks for wheels on the same tractor;

3.6.2.1.3. The method of attachment and the tractor components to which the attachment is made shall be identical;

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3.6.2.1.4. Any components such as mud-guards and bonnet that may provide support for the protective structure shall be identical;

3.6.2.1.5. The position and critical dimensions of the seat in the protective structure and the relative position of the protective structure on the tractor shall be such that the clearance zone would have remained within the protection of the deflected structure throughout all tests (this shall be checked by using the same reference of clearance zone as in the original test report, respectively Seat Reference Point [SRP] or Seat Index Point [SIP]).

3.6.2.2. Extension of the structural test results to modified models of the protective structure

This procedure has to be followed when the provisions of paragraph 3.6.2.1 are not fulfilled, it may not be used when the method of attachment of the protective structure to the tractor does not remain of the same principle (e.g. rubber supports replaced by a suspension device):

3.6.2.2.1. Modifications having no impact on the results of the initial test (e.g. weld attachment of the mounting plate of an accessory in a non-critical location on the structure), addition of seats with different SIP location in the protective structure (subject to checking that the new clearance zone(s) remain(s) within the protection of the deflected structure throughout all tests);

3.6.2.2.2. Modifications having a possible impact on the results of the original test without calling into question the acceptability of the protective structure (e.g. modification of a structural component, modification of the method of attachment of the protective structure to the tractor). A validation test can be carried out and the test results will be drafted in the extension report.

The following limits for this type extension are fixed:

3.6.2.2.2.1. No more than 5 extensions may be accepted without a validation test;

3.6.2.2.2.2. The results of the validation test will be accepted for extension if all the acceptance conditions of this Annex are fulfilled and if the deflection measured after each impact test does not deviate from the deflection measured after each impact test in the original test report by more than ± 7 %;

3.6.2.2.2.3. More than one protective structure modifications may be included in a single extension report if they represent different options of the same protective structure, but only one validation test can be accepted in a single extension report. The options not tested shall be described in a specific section of the extension report.

3.6.2.2.3. Increase of the reference mass declared by the manufacturer for a protective structure already tested. If the manufacturer wants to keep the same approval number it is possible to issue an extension report after having carried out a validation test (the limits of ± 7 % specified in 3.6.2.2.2.2 are not applicable in such a case).

3.7. [Not applicable]

3.8. *Cold weather performance of protective structures*

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3.8.1. If the protective structure is claimed to have properties resistant to cold weather embrittlement, the manufacturer shall give details that shall be included in the report.

3.8.2. The following requirements and procedures are intended to provide strength and resistance to brittle fracture at reduced temperatures. It is suggested that the following minimum material requirements shall be met in judging the protective structure's suitability at reduced operating temperatures in those countries requiring this additional operating protection.

Table 3.2

Minimum Charpy V-notch impact energies

Specimen size	Energy at	Energy at
	– 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 × 3,5	6	15
10 × 3	6	15
10 × 2,5 [a]	5,5	14

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

[b] The energy requirement at – 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 steel.

3.8.2.1. Bolts and nuts used to attach the protective structure to the tractor and used to connect structural parts of the protective structure shall exhibit suitable controlled reduced temperature toughness properties.

3.8.2.2. All welding electrodes used in the fabrication of structural members and mounts shall be compatible with the protective structure material as given in 3.8.2.3 below.

3.8.2.3. Steel materials for structural members of the protective structure shall be of controlled toughness material exhibiting minimum Charpy V-Notch impact energy requirements as shown in Table 3.2. Steel grade and quality shall be specified in accordance with ISO 630:1995; Amd1:2003.

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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 protective structure made from materials other than steel shall have equivalent low temperature impact resistance.

3.8.2.4. When testing the Charpy V-Notch impact energy requirements, the specimen size shall be no less than the largest of the sizes stated in Table 3.2 that the material will permit.

3.8.2.5. The Charpy V-Notch tests shall be made in accordance with the procedure in ASTM A 370-1979, except for specimen sizes that shall be in accordance with the dimensions given in Table 3.2.

3.8.2.6. Alternatives to this procedure are the use of killed or semi-killed steel for which an adequate specification shall be provided. Steel grade and quality shall be specified in accordance with ISO 630:1995; Amd1:2003.

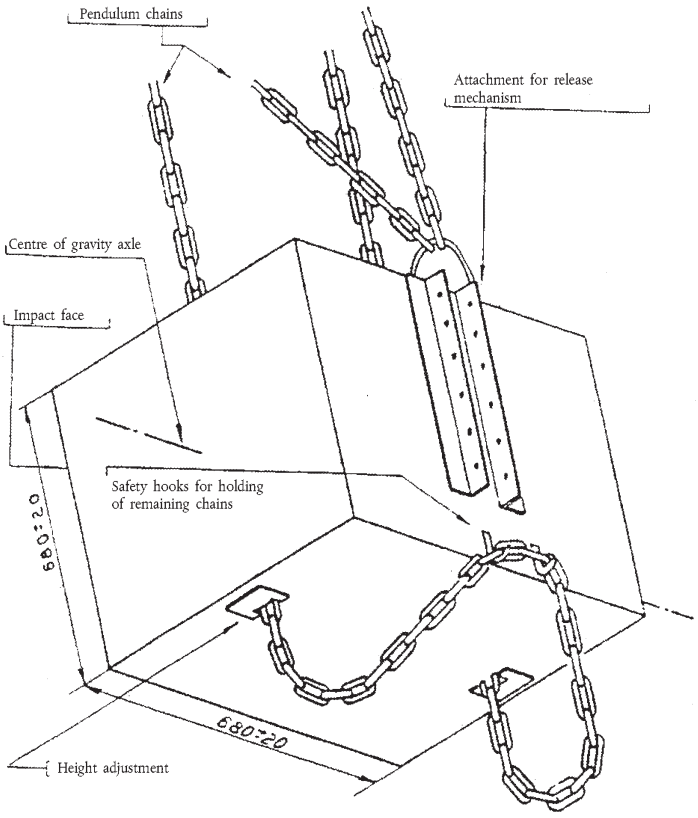
3.8.2.7. Specimens are to be longitudinal and taken from flat stock, tubular or structural sections before forming or welding for use in the protective structure. Specimens from tubular or structural sections are to be taken from the middle of the side of greatest dimension and shall not include welds.

3.9. [Not applicable]

Figure 3.1

Pendulum block and its suspending chains or wire ropes

(Dimensions in mm)



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Figure 3.2

Method of impact from rear

Figure 3.2.a

Protective cab

Dimensions in mm

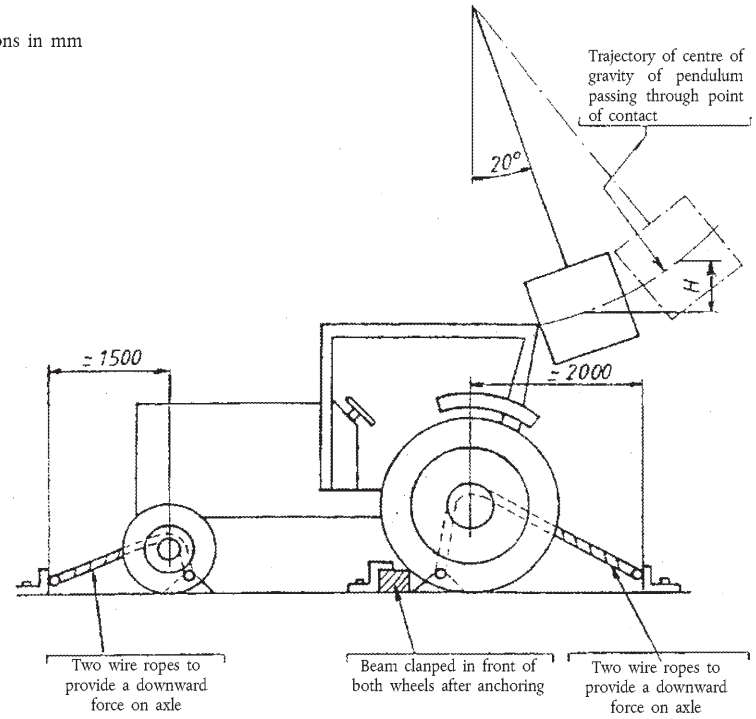
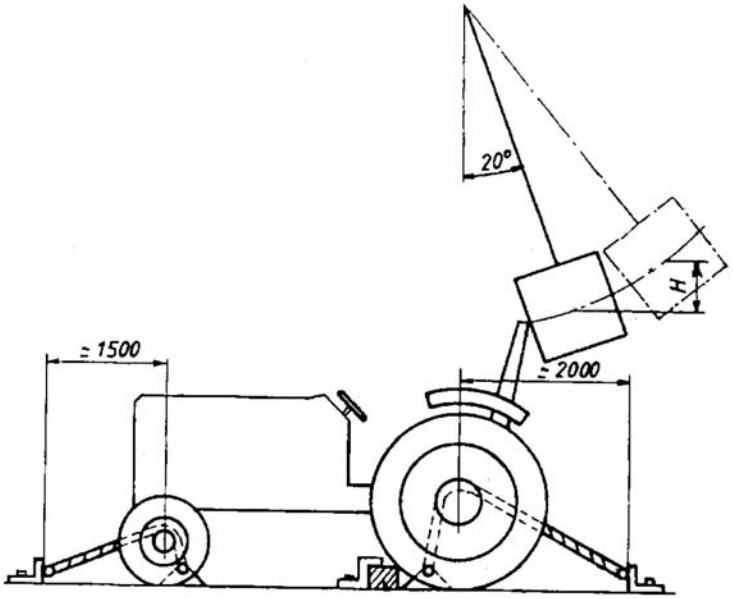


Figure 3.2.b

Rear roll bar frame



▼B

Figure 3.3

Method of impact from front

Figure 3.3.a

Protective cab

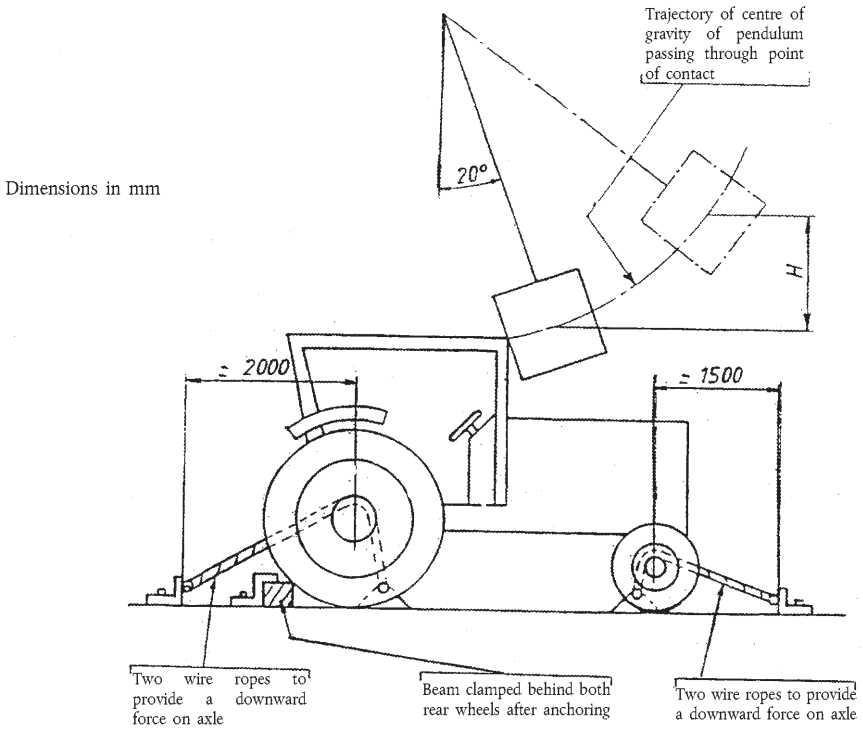
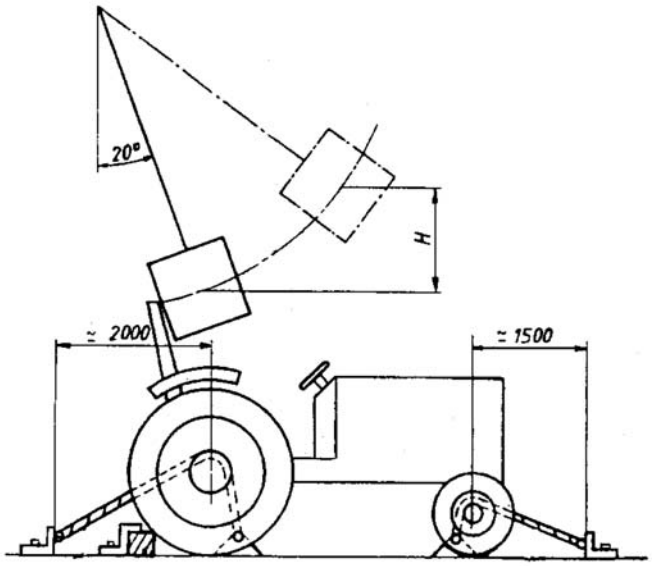


Figure 3.3.b

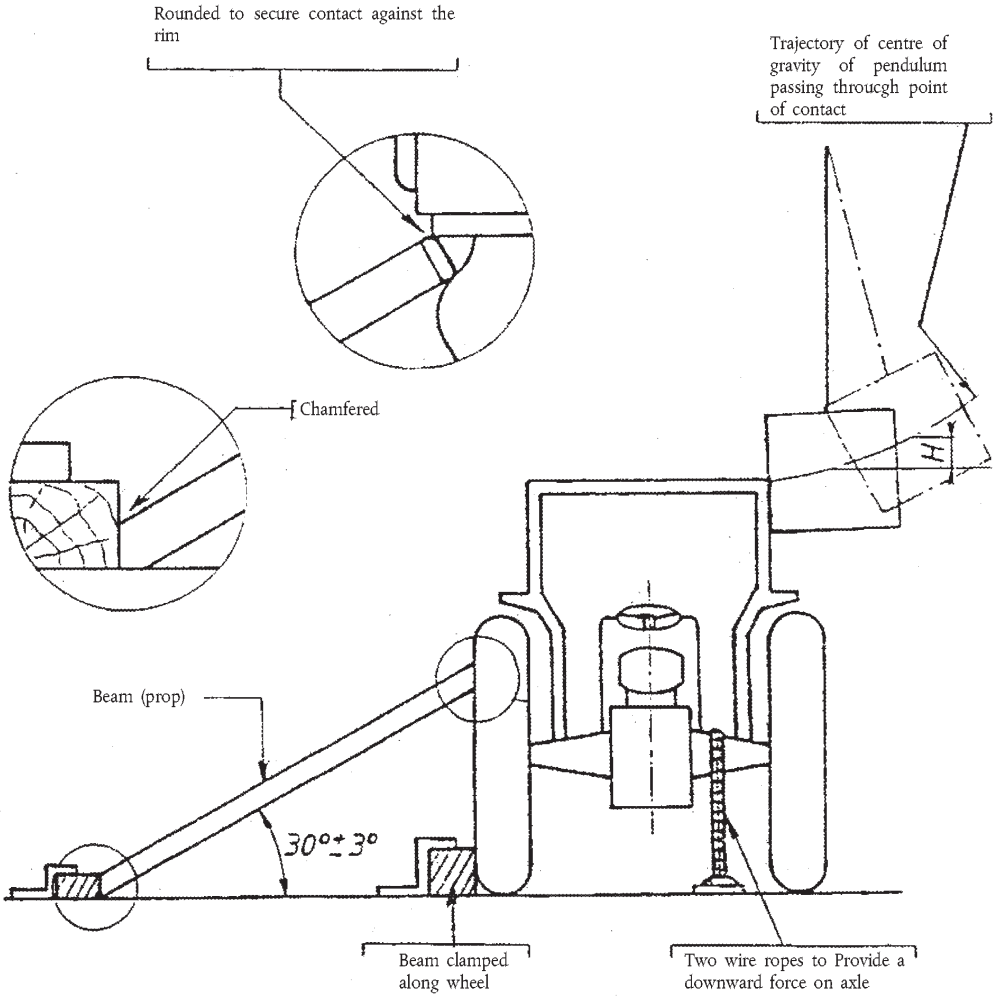
Rear roll bar frame



▼B

Figure 3.4

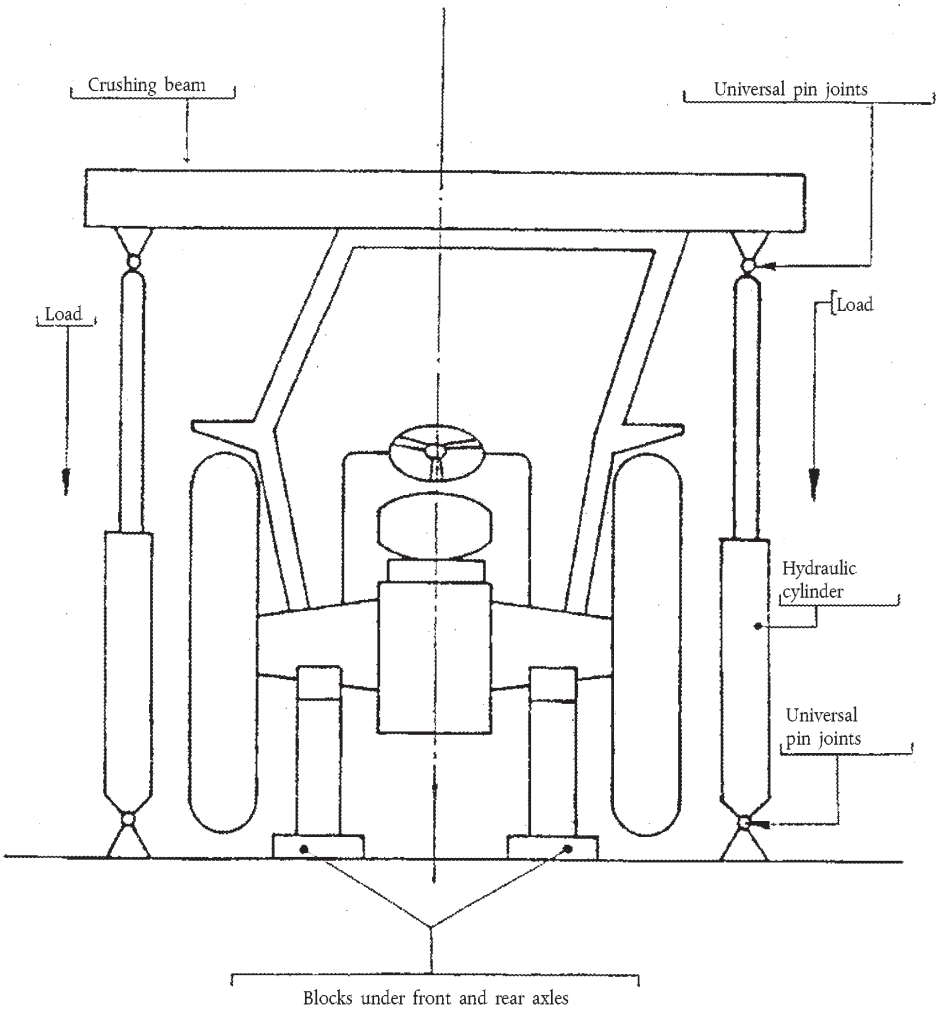
Method of impact from side



▼B

Figure 3.5

Example of an arrangement for crushing tests



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Figure 3.6

Position of beam for front and rear crushing tests

Figure 3.6.a

Protective cab

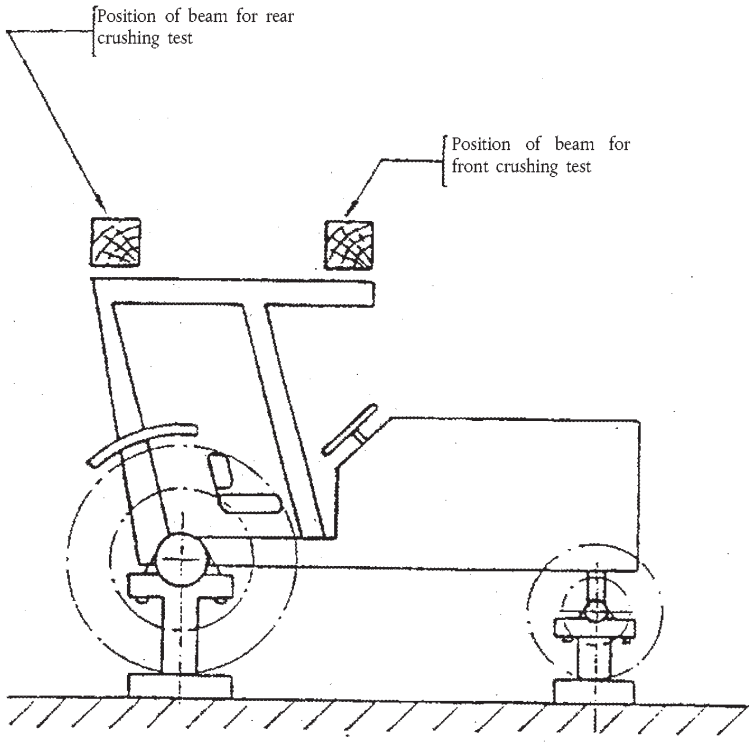
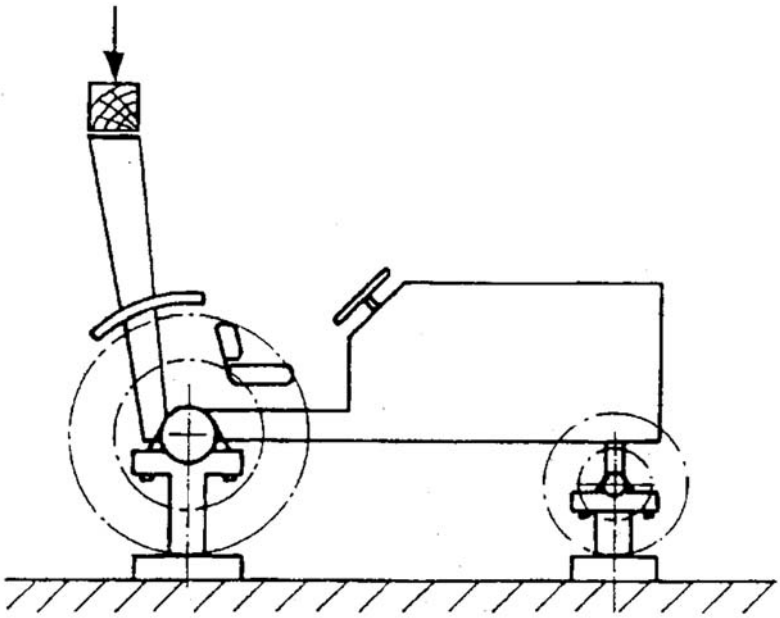


Figure 3.6.b

Rear roll bar frame



▼B

Figure 3.7

Position of beam for front crushing test when full crushing force not sustained in front

Figure 3.7.a

Protective cab

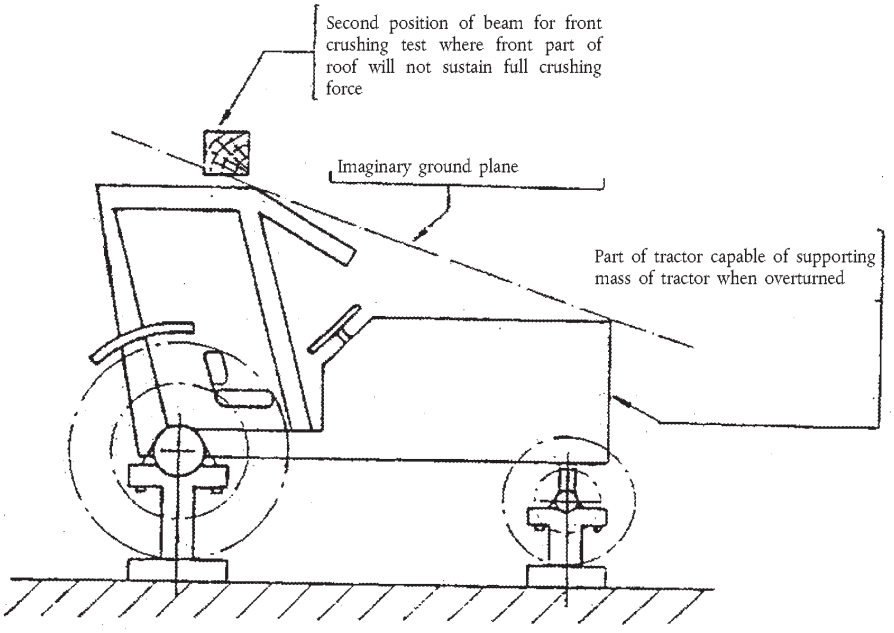
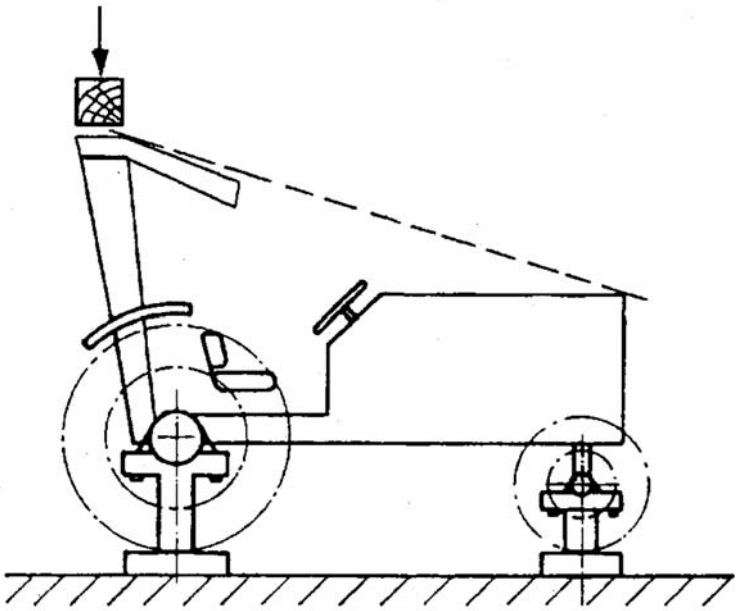


Figure 3.7.b

Rear roll bar frame



▼B

Table 3.3

Dimensions of the clearance zone

Dimensions	mm	Remarks
A_1 A_0	100	minimum
B_1 B_0	100	minimum
F_1 F_0	250	minimum
F_2 F_0	250	minimum
G_1 G_0	250	minimum
G_2 G_0	250	minimum
H_1 H_0	250	minimum
H_2 H_0	250	minimum
J_1 J_0	250	minimum
J_2 J_0	250	minimum
E_1 E_0	250	minimum
E_2 E_0	250	minimum
D_0 E_0	300	minimum
J_0 E_0	300	minimum
A_1 A_2	500	minimum
B_1 B_2	500	minimum
C_1 C_2	500	minimum
D_1 D_2	500	minimum
I_1 I_2	500	minimum
F_0 G_0	—	depending on the tractor
I_0 G_0	—	
C_0 D_0	—	
E_0 F_0	—	

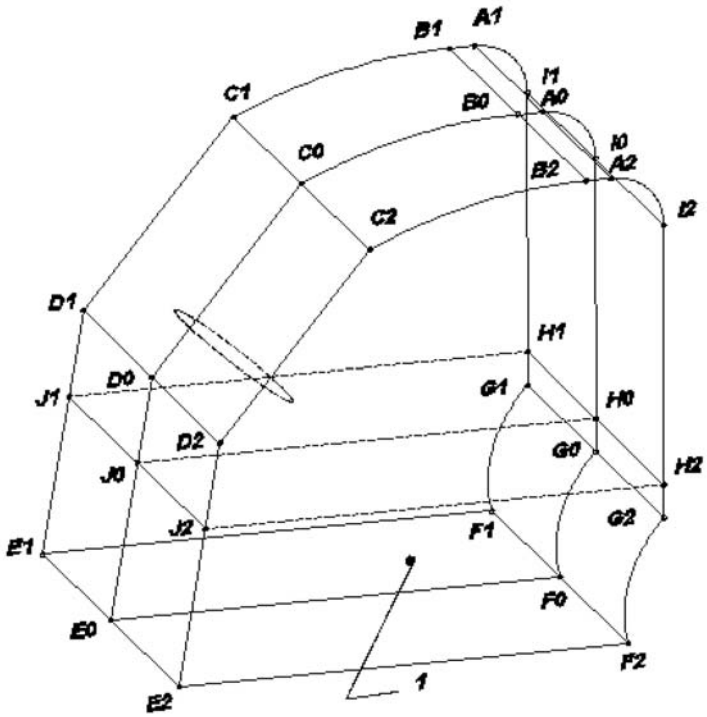
▼B

Figure 3.8

Clearance zone

Note:

for dimensions, see Table 3.3 above;



1 – Seat index point

Figure 3.9

Clearance zone

Figure 3.9.a
Side view section in reference plane

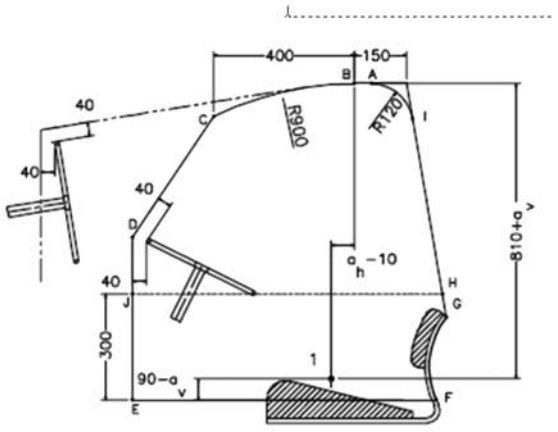
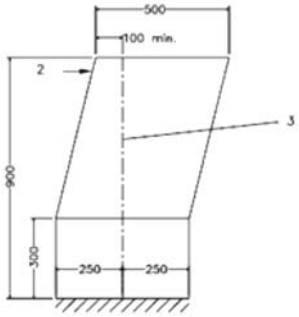


Figure 3.9.b
Rear or front view



1 – Seat index point

2 – Force

3 – Vertical reference plane

▼B

Figure 3.10

Clearance zone for tractor with reversible seat and steering wheel

Figure 3.10.a

Protective cab

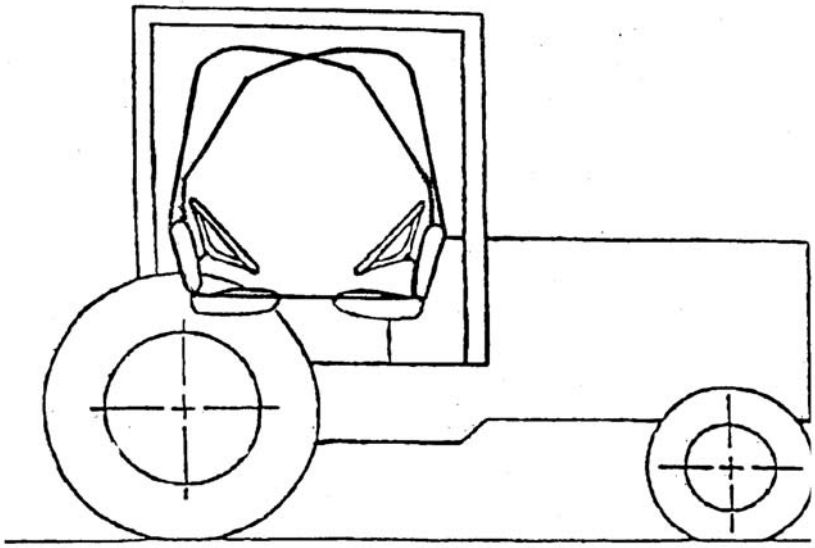
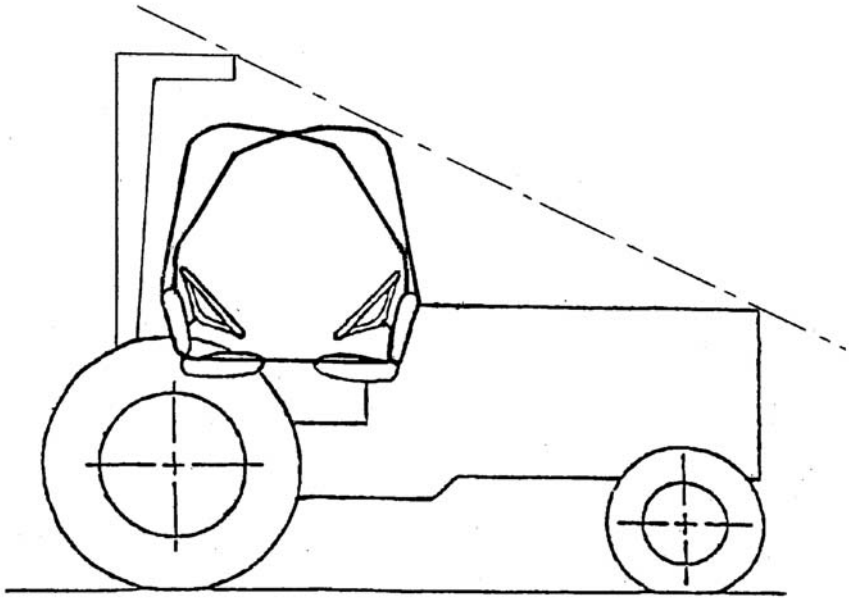


Figure 3.10.b

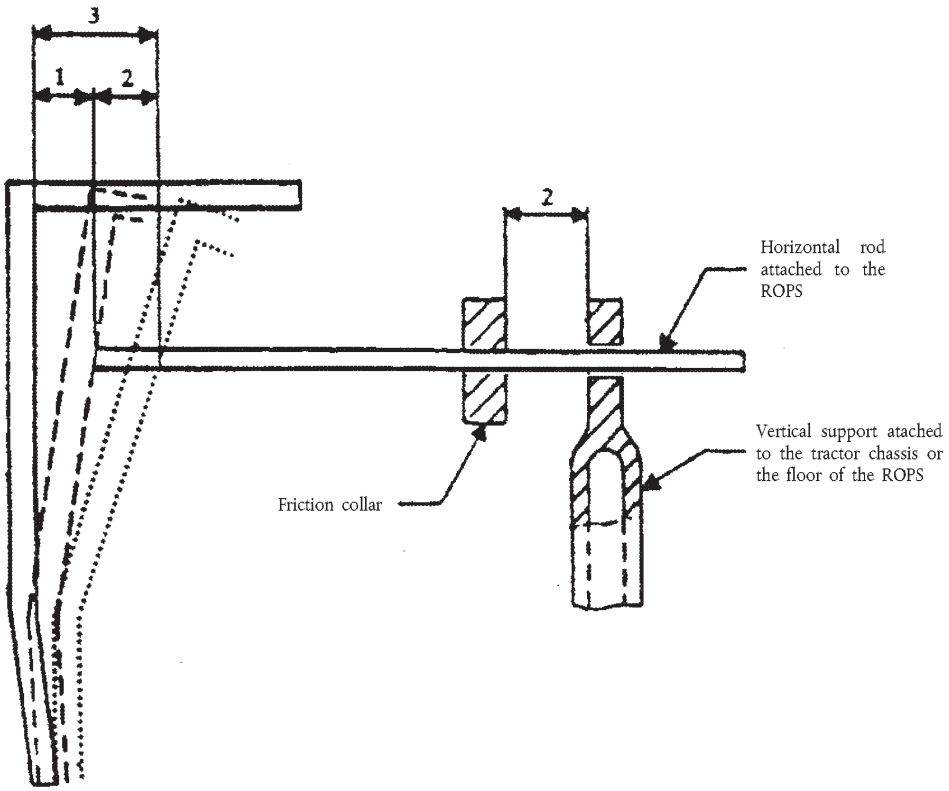
Rear roll bar frame



▼B

Figure 3.11

Example of apparatus for measuring elastic deflection



1 – Permanent deflection

2 – Elastic deflection

3 – Total deflection (permanent plus elastic)

Explanatory notes to Annex VI

([1]) Unless otherwise stated, the text of the requirements and the numbering set out in point B are identical with the text and numbering of the OECD standard code for the official testing of protective structures on agricultural and forestry tractors (dynamic test), OECD Code 3, Edition 2015 of July 2014.

([2]) Users are reminded that the seat index point is determined according to ISO 5353 and is a fixed point with respect to the tractor that does not move as the seat is adjusted away from the mid-position. For purposes of determining the clearance zone, the seat shall be placed in the rear and uppermost position.

▼B

ANNEX VII

Requirements applying to roll-over protection structures (track-laying tractors)

A. GENERAL PROVISION

1. The Union requirements applying to roll-over protection structures (track-laying tractors) are set out in point B.

B. REQUIREMENTS APPLYING TO ROLL-OVER PROTECTION STRUCTURES (TRACK-LAYING TRACTORS)[1]

1. **Definitions**

1.1. [Not applicable]

1.2. *Rolling Over Protective Structure (ROPS)*

Roll-over protective structure (protective cab or frame), hereinafter called 'protective structure', means the structure on a tractor the essential purpose of which is to avoid or limit risks to the driver resulting from roll-over of the tractor during normal use.

The roll-over protective structure is characterised by the provision of space for a clearance zone large enough to protect the driver when seated 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.

1.3. *Track*

1.3.1. Preliminary definition: median plane of the track

The median plane of the track is equidistant from the two planes containing its periphery at their outer edges.

1.3.2. Definition of track width

Track width is the distance between the median planes of the tracks

1.3.3. Additional definition: median plane of the tractor

The vertical plane at right angles to the axle at its centre point is the median plane of the tractor.

1.4. *Protective structure*

System of structural members arranged on a tractor in such a way as to accomplish its primary purpose of reducing the likelihood of an operator being crushed should his tractor roll-over. Structural members include any sub-frame, bracket, mounting, socket, bolt, pin, suspension or flexible shock absorber used to secure the system to the tractor frame but exclude mounting provisions which are integral with the tractor frame.

1.5. *Tractor frame*

The main chassis or main load-bearing member(s) of the tractor which extend(s) over a major part of the tractor and upon which the protective structure is directly mounted.

▼B

1.6. *Protective structure-tractor frame assembly*

System consisting of the protective structure attached to the tractor frame.

1.7. *Bedplate*

A substantially rigid part of the test structure to which the tractor frame is attached for the purpose of the test.

1.8. *Seat index point (SIP)*

1.8.1. The seat index point (**SIP**) is located in the central longitudinal plane of the apparatus for determination when installed in the operator seat. The **SIP** is fixed with respect to the tractor and does not move with the seat through its range of adjustment and/or oscillation.

1.8.2. When determining the **SIP**, the seat shall be adjusted with all fore, aft, vertical and angular seat adjustments placed in their centre position. The suspension systems shall be set so that the seat is at the mid-point of its oscillation range with the weighted apparatus for determination of **SIP** in place.

1.8.3. The **SIP** must be established by means of the apparatus illustrated in Figure 8.1. The apparatus is placed on the seat. A 20 kg mass is added 40 mm in front of the **SIP** mark on the horizontal section of the apparatus. A horizontal force of about 100 N shall then be applied to the apparatus at the **SIP** (see $\mathbf{F_o}$ in Figure 8.1). Finally, a further 39 kg mass shall be placed 40 mm in front of the **SIP** mark on the horizontal section of the apparatus.

1.9. *Deflection-limiting volume (DLV)*

That volume, related to the operator, which serves to set limits and deflections permissible when performing laboratory evaluations of the protective structure (Figure 8.2). It is an orthogonal approximation of the dimensions of a large, seated operator.

1.10. *Vertical reference plane*

A vertical plane, generally longitudinal to the tractor and passing through the seat index point and the centre of the steering wheel or of the control hand levers. Normally, the vertical reference plane coincides with the median plane of the tractor.

1.11. *Lateral simulated ground plane*

Surface on which a tractor, after rolling over, is assumed to come to a standstill with the tractor lying on its side. The simulated ground plane is determined as follows (see 3.5.1.2):

(a) upper member to which the force is applied;

(b) outermost point in end view of member as defined in **(a)** above;

(c) vertical line through point defined in **(b)** above;

(d) vertical plane parallel to vehicle's longitudinal centreline through the line defined in **(c)** above;

▼B

(e) rotate plane described in **(d)** above, 15° away from the **DLV** about an axis which is perpendicular to the vertical line given in **(c)** above and also passes through the point described in **(b)** above; this establishes the simulated ground plane;

The simulated ground plane shall be established on an unloaded protective structure and shall move with the member to which the load is applied.

1.12. *Vertical simulated ground plane*

For a machine coming to rest in an upside-down position, the plane is defined by the top cross-member of the protective structure and that front (rear) part of the tractor likely to come in contact with flat ground at the same time as the protective structure and capable of supporting the upside-down tractor. The vertical simulated ground plane moves with the deformed protective structure.

Note: The vertical simulated ground plane applies only to two-post protective structures.

1.13. *Unballasted mass*

The mass of the tractor without ballasting devices. The tractor shall be in running order with tanks, circuits and radiator full, protective structure with cladding and any track equipment or additional front wheel drive components required for normal use. The operator is not included.

1.14. *Permissible measurement tolerances*

Time: ± 0,1 s

Distance: ± 0,5 mm

Force: ± 0,1 % (of the sensor full scale)

Angle ± 0,1°

Mass: ± 0,2 % (of the sensor full scale)

1.15. *Symbols*

D	(mm)	Deflection of the structure;
F	(N)	Force;
M	(kg)	Maximum tractor mass recommended by the tractor manufacturer. It shall be equal or superior to the unballasted mass as defined in paragraph 1.13;
U	(J)	Energy absorbed by the structure related to the tractor mass.

2. **Field of application**

This Annex is applicable to tractors, propelled and steered by endless tracks, having at least two axles with track attachments, and with following features:

2.1. an unballasted tractor mass not less than 600 kg;

2.2. the ground clearance not more than 600 mm beneath the lowest point of the front and rear axles.

▼B

3. **Rules and directions**

3.1. *General regulations*

3.1.1. The protective structure may be manufactured either by the tractor manufacturer or by an independent firm. In either case a test is only valid for the model of tractor on which it is carried out. The protective structure must be retested for each model of tractor to which it is to be fitted. However, testing stations may certify that the strength tests are also valid for tractor models derived from the original model by modifications to the engine, transmission and steering and front suspension *(see below 3.6: Extension to other tractor models)*. On the other hand, more than one protective structure may be tested for any one model of tractor.

3.1.2. The protective structure submitted for test must be supplied attached in the normal manner to the tractor or tractor chassis on which it is used. The tractor chassis shall be complete including attaching brackets and other parts of the tractor that may be affected by loads imposed on the protective structure.

3.1.3. A protective structure may be designed solely to protect the driver in the event of the tractor overturning. Onto this structure it may be possible to fit weather protective for the driver, of a more or less temporary nature. This will usually be removed by the driver in warm weather. There are protective structures however, in which the cladding is permanent and warm weather ventilation provided by windows or flaps. As the cladding may add to the strength of the structure and if removable may well be absent when an accident occurs, all parts that can be so taken away by the driver will be removed for the purpose of the test. Doors, roof hatch and windows which can be opened shall be either removed or fixed in the open position for the test, so that they do not add to the strength of the protective structure. It shall be noted whether, in this position, they would create a hazard for the driver in the event of overturning.

Throughout the remainder of these rules, reference will only be made to testing the protective structure. It must be understood that this includes cladding not of a temporary nature.

A description of any temporary cladding supplied is to be included in the specifications. All glass or similar brittle material shall be removed prior to the test. Tractor and protective structure components which might sustain needless damage during the test and which do not affect the strength of the protective structure or its dimensions may be removed prior to the test if the manufacturer wishes. No repairs or adjustment may be carried out during the test.

3.1.4. Any component of the tractor contributing to the strength of the protective structure such as mud-guards, which has been reinforced by the manufacturer, should be described and its measurements given in the test report.

3.2. *Apparatus*

3.2.1. Deflection-limiting volume

The **DLV** and its location shall be in accordance with ISO 3164:1995 (see Figure 8.3). The **DLV** shall be fixed firmly to the same part of the machine to which the operator's seat is secured, and shall remain there during the entire formal test period.

▼B

For track-laying tractors with an unballasted mass of less than 5 000 kg, fitted with a two-post front mounted protective structure, the **DLV** corresponds to Figures 8.4 and 8.5.

3.2.2. Zone of clearance and safeguard plane

The zone of clearance, as defined in Annex VIII (Definitions Chapter, Section 1.6), must remain covered by the safeguard plane, **S**, as shown in Figures 8.2 and 8.4. The safeguard plane is defined as an oblique plane, perpendicular to the vertical longitudinal plane of the tractor, forming a tangent at the front with the protective structure and at the back with whichever of the following hard fixtures of the tractor prevents the aforementioned plane **S** from entering the zone of clearance, via:

— a housing or rigid part of the rear of the tractor,

— the tracks,

— an additional hard structure firmly mounted on the rear of the tractor.

3.2.3. Rear hard fixture test

If the tractor is fitted with a rigid section, a housing or other hard fixture placed behind the driver's seat, this fixture shall be regarded as a protective point, in the event of sideways or rear overturning. This hard fixture placed behind the driver's seat shall be capable of withstanding, without breaking or entering the zone of clearance, a downward force $\mathbf{F_i}$ where:

$$F_i = 15\ M$$

applied perpendicularly to the top of the frame in the central plane of the tractor. The initial angle of application of force shall be 40° calculated from a parallel to the ground as shown in Figure 8.4. The minimum width of this rigid section shall be 500 mm (see Figure 8.5).

In addition, it shall be sufficiently rigid and firmly attached to the rear of the tractor.

3.2.4. Lashings

Facilities for securing the protective structure-tractor frame assembly to the bedplate, as described above, and for applying the horizontal and vertical loads shall be provided (see Figures 8.6 to 8.9).

3.2.5. Measuring instruments

The test apparatus shall be equipped with instruments for measuring the force applied to the protective structure and the deflection (deformation) of the structure.

The percentages below are nominal ratings of the accuracy of the instrumentation and shall not be taken to indicate that compensating tests are required.

▼B

Measure	Accuracy
Deflection of the protective structure	± 5 % of maximum deflection measured
Force applied to the protective structure	± 5 % of maximum force measured

3.2.6. Arrangements for load application

Loading arrangements for load application are shown in Figures 8.7, 8.10 to 8.13 (side loading), in Figures 8.8 and 8.9 (vertical loading) and Figure 8.14 (longitudinal loading).

3.3. *Test conditions*

3.3.1. The protective structure shall comply with production specifications and shall be fitted to the appropriate tractor model chassis in accordance with the manufacturer's declared method of attachment.

3.3.2. The protective structure - tractor frame assembly shall be secured to the bedplate so that the members connecting the assembly and the bedplate experience minimal deflection when the protective structure is side loaded. During side loading, the protective structure - tractor frame assembly shall not receive any support from the bedplate, other than that due to the initial attachment.

3.3.3. The protective structure shall be instrumented with the necessary equipment to obtain the required force-deflection data.

3.3.4. All tests shall be performed on the same protective structure. No repair or straightening of any protective structure - tractor member shall be carried out during or between the side and vertical loadings.

3.3.5. For side and longitudinal loading, connection to the bedplate shall be through the main housing or track frames (see Figures 8.6 to 8.8).

3.3.6. For vertical loading, there is no limitation on securing or supporting the protective structure-tractor frame assembly.

3.3.7. On completion of all the tests, permanent deflections of the protective structure shall be measured and recorded.

3.4. *Test procedure*

3.4.1. General

The test procedures shall consist of the operations described in 3.4.2, 3.4.3 and 3.4.4 in the order listed.

3.4.2. Side loading

3.4.2.1. The force-deflection characteristics shall be determined by side loading the top major longitudinal members of the protective structure.

For a protective structure having more than two posts, the side loading shall be applied through a load-distribution device having a length not greater than 80 per cent of the top member straight length **L** between the front and rear posts of the protective structure

▼B

(see Figures 8.13 to 8.16). The initial loading shall be within the zone that is established by the vertical projection of two planes parallel to the front and rear planes of the **DLV** and located 80 mm outside of them.

3.4.2.2. For a protective structure with an overhead shield, having a two-post system, the initial loading shall be dictated by the total longitudinal distance between major, upper protective structure members **L** and the vertical projection of the front and rear planes of the **DLV**. The force (load) point shall not be within **L/3** distance from the posts.

Should the **L/3** point be between the vertical projection of the **DLV** and the posts, the force (load) point shall be moved away from the post until it enters the vertical projection of the **DLV** (see Figures 8.13 to 8.16). Any load distribution plate used shall not impede or restrict the rotation of the protective structure around a vertical axis during the loading and shall not distribute the load over a distance greater than 80 per cent of **L**.

The force shall be applied to the major, upper and longitudinal members except when a post structure is used without the cantilevered overhead shield. For this type of structure, the force shall be applied in line with the upper cross-member.

3.4.2.3. The initial direction of the force shall be horizontal and perpendicular to a vertical plane through the tractor's longitudinal centre-line

3.4.2.4. As loading continues, the deformations of the protective structure - tractor frame assembly may cause the direction of the force to change; this is permissible.

3.4.2.5. Should the operator's seat be off the tractor's longitudinal centre-line, the loading shall be against the outermost side nearest the seat.

3.4.2.6. For on-centre-line seats, if mounting of the protective structure is such that different force-deflection relations are obtained from loading from left or right sides, the side loaded shall be that which will place the most severe requirements on the protective structure - tractor frame assembly.

3.4.2.7. The rate of deflection (application of load) shall be such that it can be considered static, i.e. less than or equal to 5 mm/s.

3.4.2.8. At deflection increments no greater than 25 mm at the point of application of the resultant load, the force and deflection shall be recorded and plotted (Figure 8.17).

3.4.2.9. The loading shall be continued until the protective structure has achieved both the force and energy requirements. The area under the resulting force-deflection curve (Figure 8.17) equals the energy.

3.4.2.10. The deflection used in calculating energy shall be that of the protective structure along the line of action of the force. The deflection should be measured at the mid-point of the loading.

3.4.2.11. Any deflection of members used to support load-application devices shall not be included in deflection measurements used for calculation of energy absorption.

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3.4.3. Vertical loading

3.4.3.1. After removal of the side load, a vertical load shall be applied to the top of the protective structure.

3.4.3.2. The load shall be applied using a stiff beam with a width of 250 mm.

3.4.3.3. For structures having more than two posts, the vertical load shall be applied at both the front and the rear

3.4.3.3.1. Vertical loading at the rear (Figures 8.10, 8.11.a and 8.11.b)

3.4.3.3.1.1. The crushing beam shall be positioned across the rear uppermost structural members so that the resultant of the crushing forces is located in the vertical reference plane. The crushing force shall be applied and maintained for 5 seconds after cessation of any visually detectable movement of the protective structure.

3.4.3.3.1.2. Where the rear part of the protective structure 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 protective structure with that part of the rear of the tractor capable of supporting the tractor when overturned. The force shall then be removed and the crushing beam repositioned over that part of the protective structure that would support the tractor when completely overturned. The crushing force shall then be applied.

3.4.3.3.2. Vertical loading at the front (Figures 8.10 to 8.12)

3.4.3.3.2.1. The crushing beam shall be positioned across the front uppermost structural members so that the resultant of the crushing forces is located in the vertical reference plane. The crushing force F shall be applied and maintained for 5 seconds after cessation of any visually detectable movement of the protective structure.

3.4.3.3.2.2. Where the front part of the roof of the protective structure will not sustain the full crushing force (Figures 8.12.a and 8.12.b), the force shall be applied until the roof is deflected to coincide with the plane joining the upper part of the protective structure with that part of the front of the tractor capable of supporting the tractor when overturned. The force shall then be removed and the crushing beam repositioned over that part of the protective structure that would support the tractor when completely overturned. The crushing force shall then be applied.

3.4.3.4. For a protective structure having a two-post system, the vertical loading shall be dictated by the total longitudinal distance between major upper protective structure members L and the vertical projection of the front and rear planes of the DLV. The force (load) point shall be at a distance not less than L/3 distance from the posts (see Figure 8.9).

Should the L/3 point be between the vertical projection of the DLV and the posts, the force (load) point shall be moved away from the post until it enters the vertical projection of the DLV.

For front-mounted protective structures having a two-post system without an overhead shield, the vertical loading shall be applied in line with the transverse member connecting the upper members.

▼B

3.4.4. Longitudinal loading

3.4.4.1. After removal of the vertical load, a longitudinal load shall be applied to the protection structure.

3.4.4.2. The longitudinal load shall be applied at the deformed location of the originally established point, since the lateral (and vertical) loading of the protection structure is likely to result in permanent deformation of the structure. The originally established point is determined by the location of the load distributor and socket prior to any test being performed on the structure.

The load distribution device may span the width in cases where no rear (front) cross-member exists. In all other cases, the device may not distribute the load over a length greater than 80 % of the width, W, of the protection structure (see Figure 8.18).

3.4.4.3. The longitudinal load shall be applied to the upper structural members of the protection structure along the longitudinal centreline of the protection structure.

3.4.4.4. The direction of loading shall be selected to place the most severe requirements on the protection structure/tractor frame assembly. The initial direction of loading shall be horizontal and parallel to the original longitudinal centreline of the tractor. Some additional factors to consider in deciding on the direction to apply the longitudinal load are:

(a) location of protection structure relative to DLV and the effect that longitudinal deflection of the protection structure would have on providing crush protection for the operator;

(b) tractor characteristics, e.g. other structural members of the tractor which may resist longitudinal deflection of the protection structure, that can limit direction of the longitudinal component of loading on the protection structure;

(c) experience which may indicate the possibility of longitudinal tipping or the tendency of a particular classification tractor to skew as it rotates about a longitudinal axis during an actual roll-over.

3.4.4.5. The rate of deflection shall be such that the loading may be considered static (see 3.4.2.7). This loading is to continue until the protection structure has achieved the force requirement(s)

3.5. *Conditions for acceptance*

3.5.1. General

3.5.1.1. During each test, no part of the protective structure shall enter the deflection-limiting volume. Also, the deformation of the protective structure shall not allow the simulated ground plane (defined in paragraphs 1.11 and 1.12) to enter the DLV.

3.5.1.2. The protective structure deflection during each test shall not cause the load side planes of the **DLV** to extend beyond or intersect the simulated ground plane (see Figures 8.19 and 8.20).

The protective structure shall not break away from the tractor frame due to failure of the tractor frame.

▼B

3.5.2. Requirements for the side loading force-energy, the vertical loading force and the longitudinal loading force

3.5.2.1. These requirements shall be met within the deflection(s) permitted in 3.5.1.1.

3.5.2.2. The side-load force and the minimum energy absorbed shall attain at least those given in Table 8.1, where:

— F is the minimum force attained during side loading,

— M (kg) is the tractor manufacturer's maximum recommended mass,

— U is the minimum energy absorbed during side loading.

If the required force is attained before the energy requirement is met, the force may decrease but shall again attain the required level when the minimum energy is obtained or exceeded.

3.5.2.3. After removal of the side load, the protective structure-tractor frame assembly shall support a vertical force:

$$F = 20\ M$$

for a period of 5 min or until any deformation has ceased, whichever is shorter.

3.5.2.4. The longitudinal-load force shall attain at least that given in Table 8.1, where F and M are defined at point 3.5.2.2.

3.6. *Extension to other tractor models*

3.6.1. [Not applicable]

3.6.2. Technical extension

When technical modifications occur on the tractor, the protective structure or the method of attachment of the protective structure to the tractor, the testing station that has carried out the original test can issue a ‘technical extension report’ in the following cases:

3.6.2.1. Extension of the structural test results to other models of tractors

The impact and crushing tests need not be carried out on each model of tractor, provided that the protective structure and tractor comply with the conditions referred to hereunder 3.6.2.1.1 to 3.6.2.1.5.

3.6.2.1.1. The structure shall be identical to the one tested;

3.6.2.1.2. The required energy shall not exceed the energy calculated for the original test by more than 5 per cent;

3.6.2.1.3. The method of attachment and the tractor components to which the attachment is made shall be identical;

3.6.2.1.4. Any components such as mud-guards and bonnet that may provide support for the protective structure shall be identical;

▼B

3.6.2.1.5. The position and critical dimensions of the seat in the protective structure and the relative position of the protective structure on the tractor shall be such that the DLV would have remained within the protection of the deflected structure throughout all tests.

3.6.2.2. Extension of the structural test results to modified models of the protective structure

This procedure has to be followed when the provisions of paragraph 3.6.2.1 are not fulfilled, it may not be used when the method of attachment of the protective structure to the tractor does not remain of the same principle (e.g. rubber supports replaced by a suspension device):

3.6.2.2.1. Modifications having no impact on the results of the initial test (e.g. weld attachment of the mounting plate of an accessory in a non-critical location on the structure), addition of seats with different SIP location in the protective structure (subject to checking that the new DLV(s) remain(s) within the protection of the deflected structure throughout all tests);

3.6.2.2.2. Modifications having a possible impact on the results of the original test without calling into question the acceptability of the protective structure (e.g. modification of a structural component, modification of the method of attachment of the protective structure to the tractor). A validation test can be carried out and the test results will be drafted in the extension report.

The following limits for this type extension are fixed:

3.6.2.2.2.1. no more than 5 extensions may be accepted without a validation test;

3.6.2.2.2.2. the results of the validation test will be accepted for extension if all the acceptance conditions of this Annex are fulfilled and if the force measured when the required energy level has been reached in the various horizontal load tests does not deviate from the force measured when the required energy has been reached in the original test by more than ± 7 % and the deflection measured[(2)] when the required energy level has been reached in the various horizontal load tests does not deviate from the deflection measured when the required energy has been reached in the original test report by more than ± 7 %.

3.6.2.2.2.3. more than one protective structure modifications may be included in a single extension report if they represent different options of the same protective structure, but only one validation test can be accepted in a single extension report. The options not tested shall be described in a specific section of the extension report

3.6.2.2.3. Increase of the reference mass declared by the manufacturer for a protective structure already tested. If the manufacturer wants to keep the same approval number it is possible to issue an extension report after having carried out a validation test (the limits of ± 7 % specified in 3.6.2.2.2.2 are not applicable in such a case).

3.7. [Not applicable]

3.8. *Cold weather performance of protective structures*

3.8.1. If the protective structure is claimed to have properties resistant to cold weather embrittlement, the manufacturer shall give details which shall be included in the report.

▼B

3.8.2. The following requirements and procedures are intended to provide strength and resistance to brittle fracture at reduced temperatures. It is suggested that the following minimum material requirements shall be met in judging the protective structure's suitability at reduced operating temperatures in those countries requiring this additional operating protective.

3.8.2.1. Bolts and nuts used to attach the protective structure to the tractor and used to connect structural parts of the protective structure shall exhibit suitable controlled reduced temperature toughness properties.

3.8.2.2. All welding electrodes used in the fabrication of structural members and mounts shall be compatible with the protective structure material as given in 3.8.2.3 below

3.8.2.3. Steel materials for structural members of the protective structure shall be of controlled toughness material exhibiting minimum Charpy V-Notch impact energy requirements as shown in Table 8.2. Steel grade and quality shall be specified in accordance with ISO 630:1995; Amd1:2003.

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

Structural members of the protective structure made from materials other than steel shall have equivalent low temperature impact resistance.

3.8.2.4. When testing the Charpy V-Notch impact energy requirements, the specimen size shall be no less than the largest of the sizes stated in Table 8.2 that the material will permit

3.8.2.5. The Charpy V-Notch tests shall be made in accordance with the procedure in ASTM A 370-1979, except for specimen sizes which shall be in accordance with the dimensions given in table 8.2.

3.8.2.6. Alternatives to this procedure are the use of killed or semi-killed steel for which an adequate specification shall be provided. Steel grade and quality shall be specified in accordance with ISO 630:1995; Amd1:2003

3.8.2.7. Specimens are to be longitudinal and taken from flat stock, tubular or structural sections before forming or welding for use in the protective structure. Specimens from tubular or structural sections are to be taken from the middle of the side of greatest dimension and shall not include welds

Table 8.1

Force and energy equations

Machine mass, M	Lateral load force, F	Lateral load energy, U	Vertical load force, F	Longitudinal load force, F
kg	N	J	N	N
$800 < M \leq 4\,630$	6 M	$13\,000\ (M/10\,000)^{1,25}$	20 M	4,8 M
$4\,630 < M \leq 59\,500$	$70\,000\ (M/10\,000)^{1,2}$	$13\,000\ (M/10\,000)^{1,25}$	20 M	$56\,000\ (M/10\,000)^{1,2}$
$M > 59\,500$	10 M	2,03 M	20 M	8 M

▼B

Table 8.2

Minimum Charpy V-notch impact energies

Specimen size	Energy at	Energy at
	– 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 × 3,5	6	15
10 × 3	6	15
10 × 2,5 [a]	5,5	14

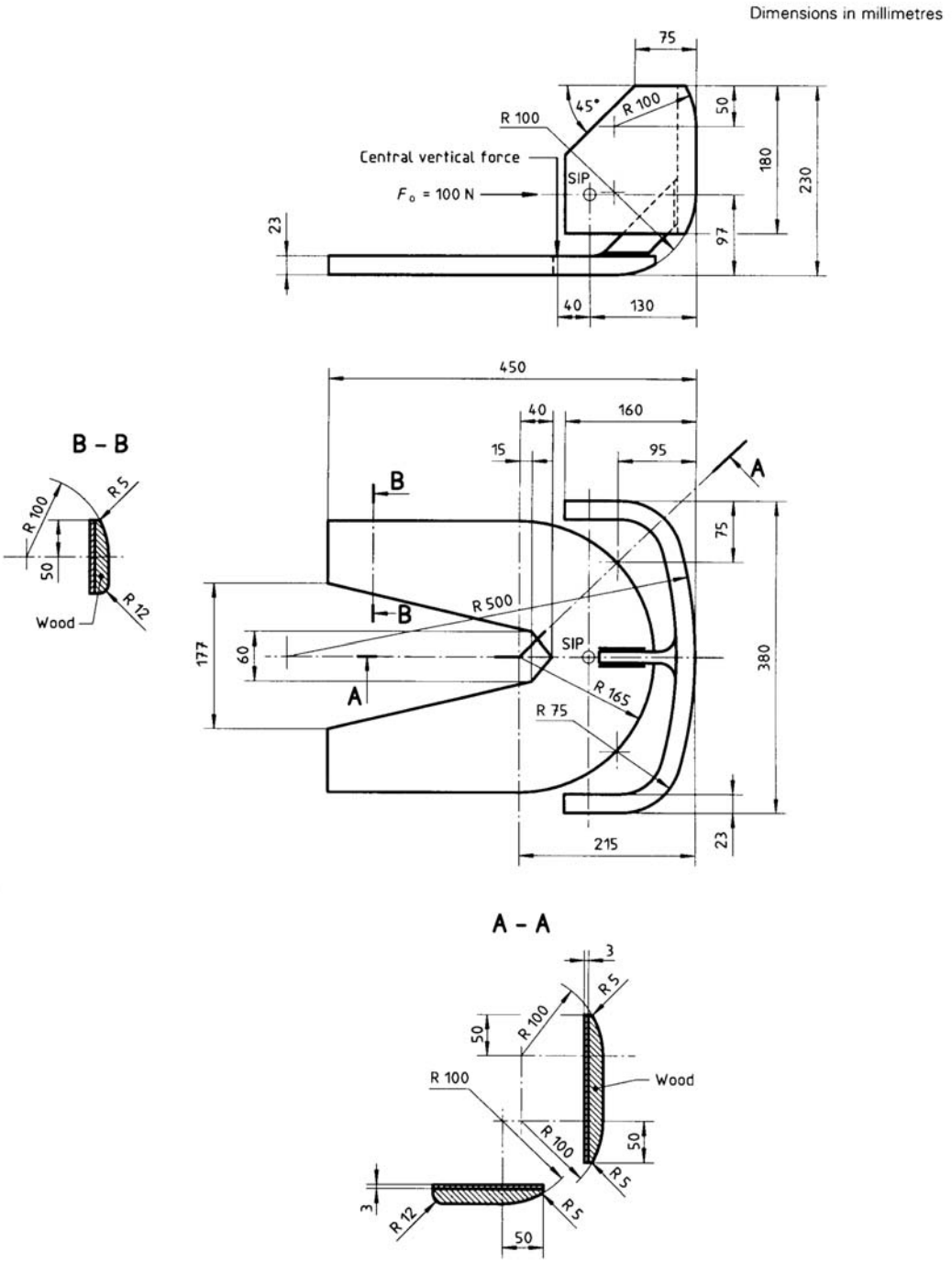
[a] Indicates preferred size. Specimen size shall be no less than largest preferred size that the material permits.

[b] The energy requirement at – 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 steel.

▼B

Figure 8.1

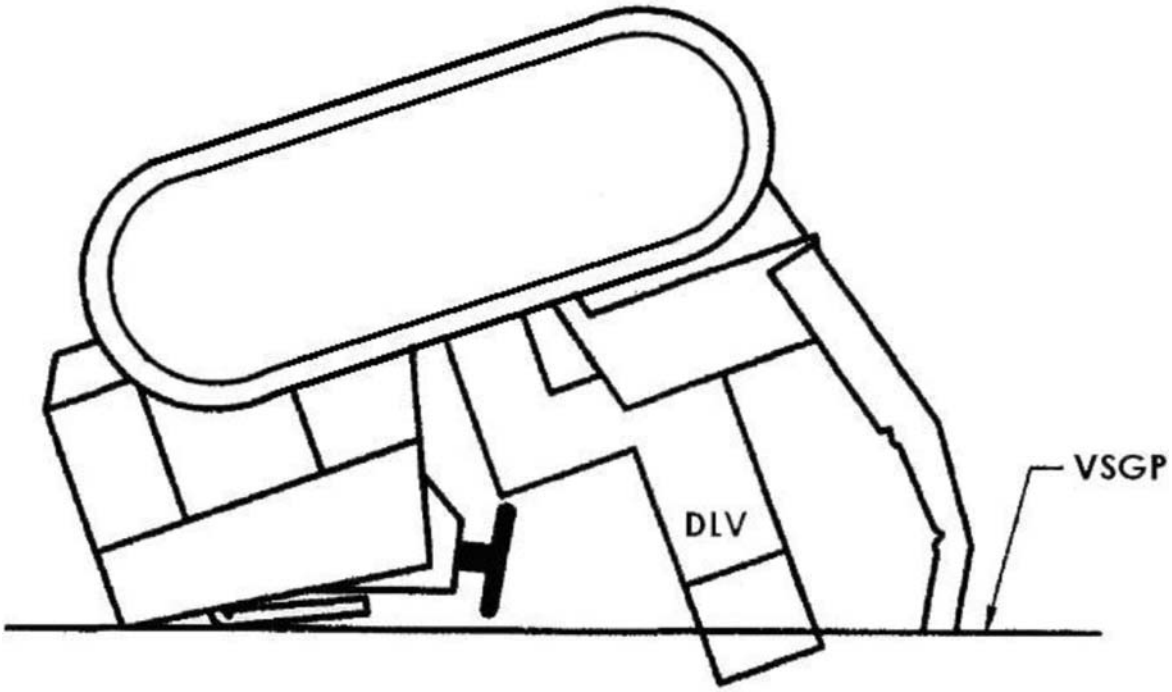
Apparatus for determination of seat index point (SIP)



▼B

Figure 8.2

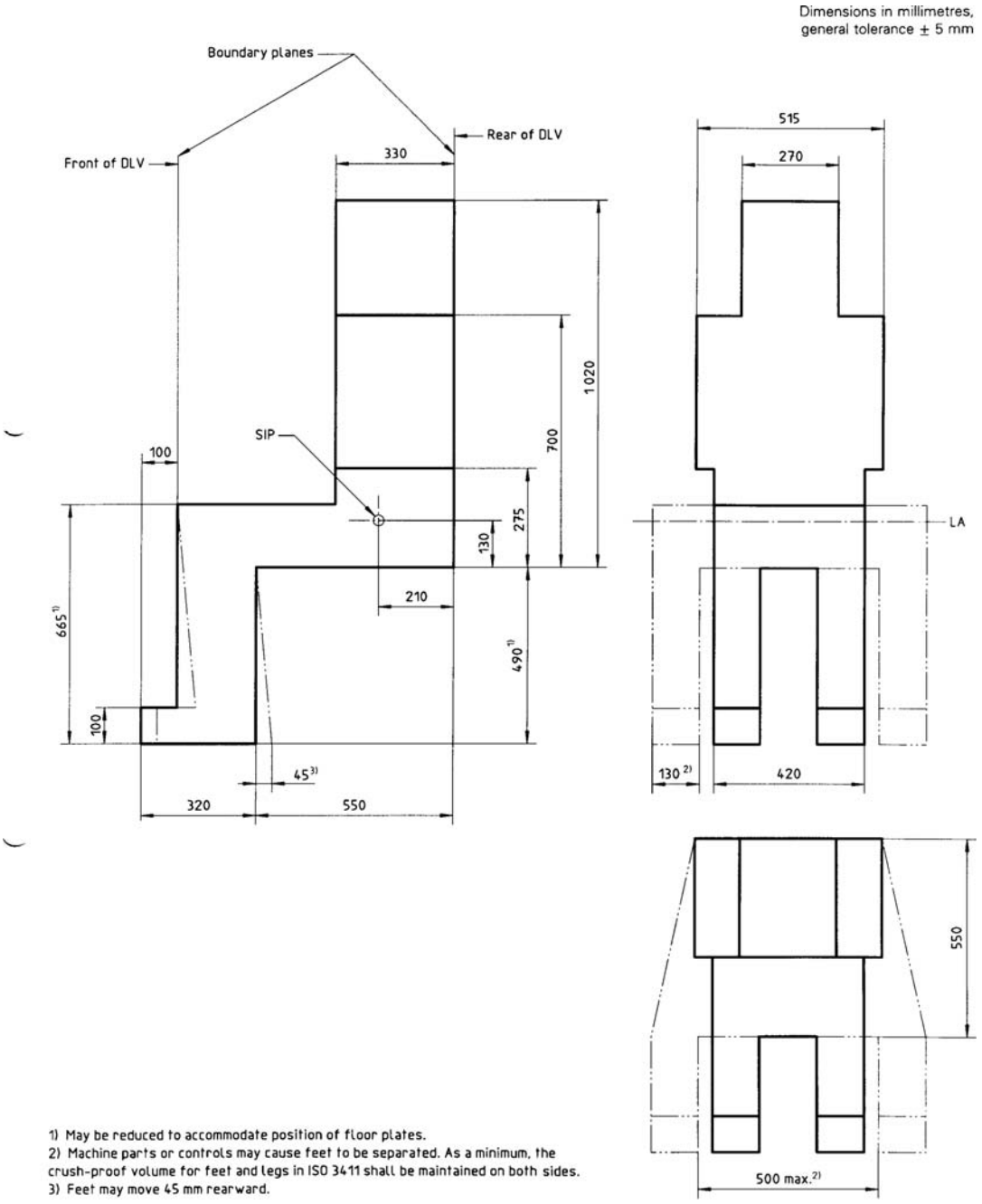
Intrusion of vertical simulated ground plane into DLV



▼B

Figure 8.3

Deflection-limiting volume (DLV)



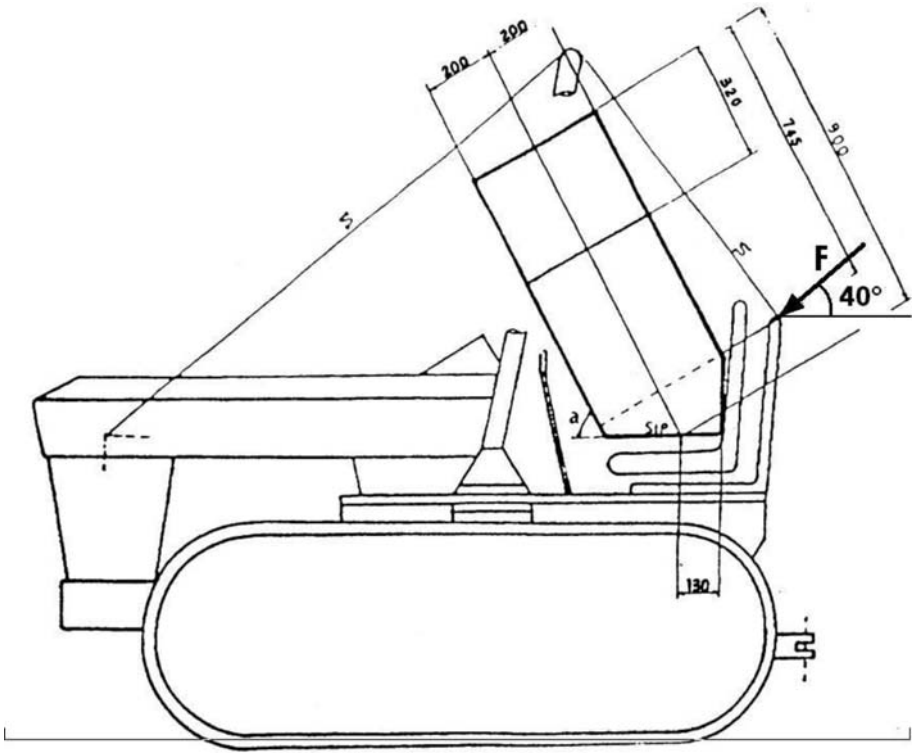
1) May be reduced to accommodate position of floor plates.
2) Machine parts or controls may cause feet to be separated. As a minimum, the crush-proof volume for feet and legs in ISO 3411 shall be maintained on both sides.
3) Feet may move 45 mm rearward.

▼B

Figure 8.4

Two-post front-mounted protective structure, side view

Deflection-limiting volume (DLV)

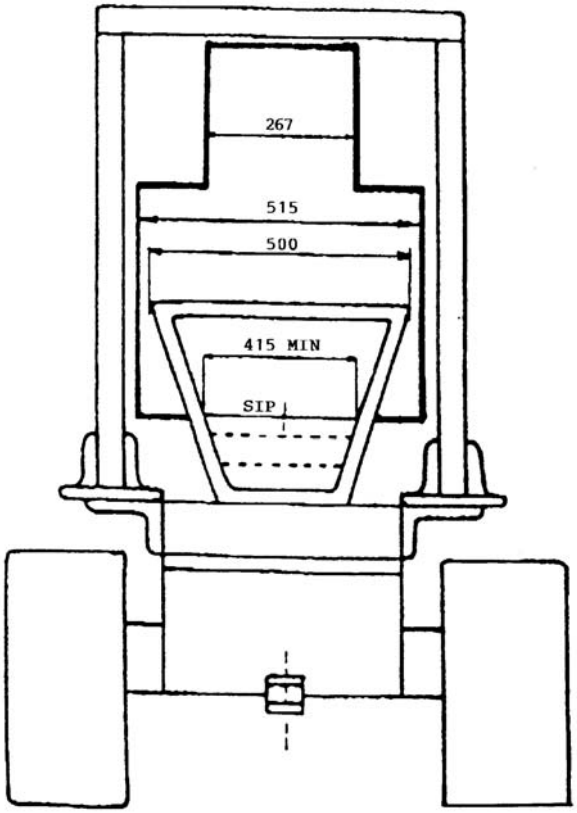


▼B

Figure 8.5

Two-post front-mounted protective structure, rear view

Deflection-limiting volume (DLV)



▼B

Figure 8.6

Typical arrangement for fastening the protective structure to the tractor frame

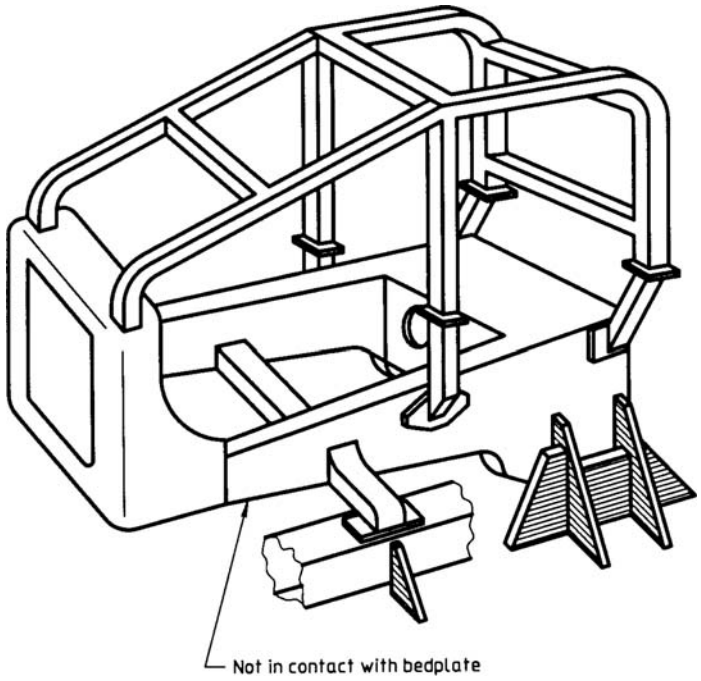
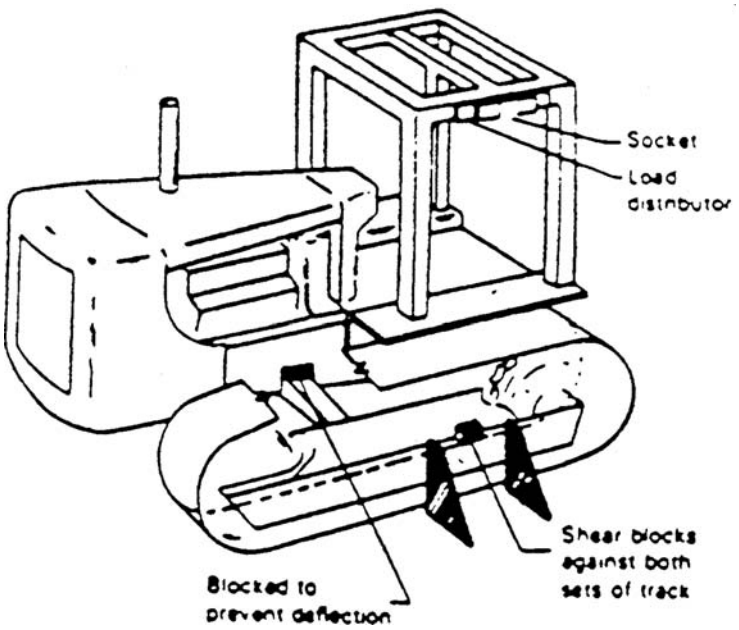


Figure 8.7

Typical arrangement for protective structure side loading



▼B

Figure 8.8

Typical arrangement for fixing the tractor frame and applying vertical load

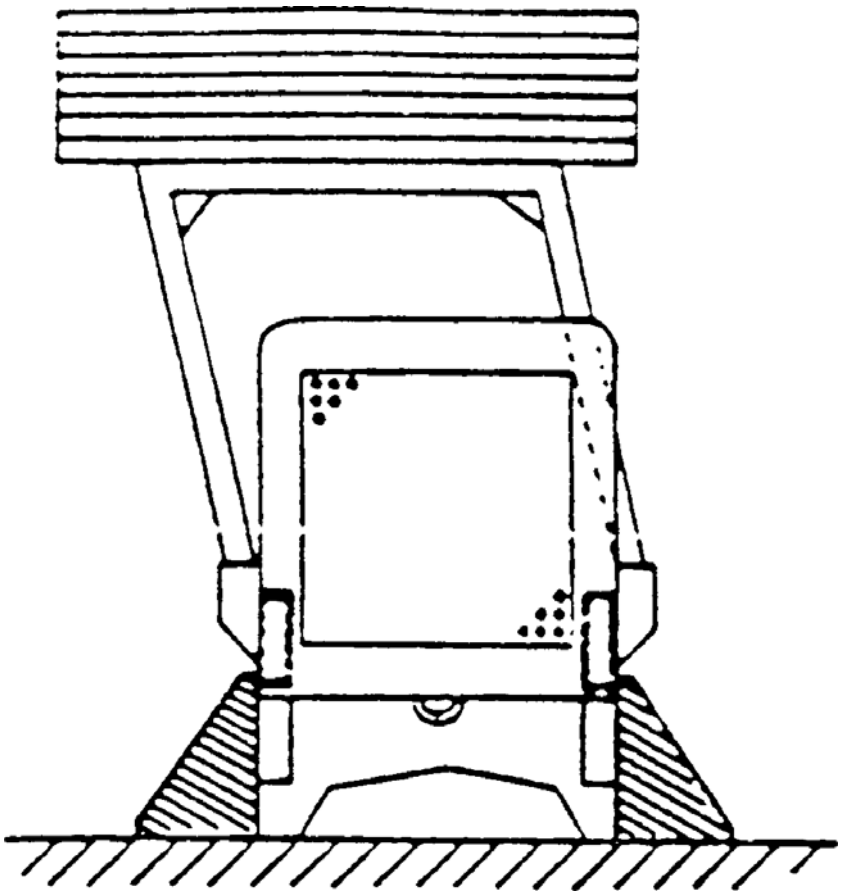
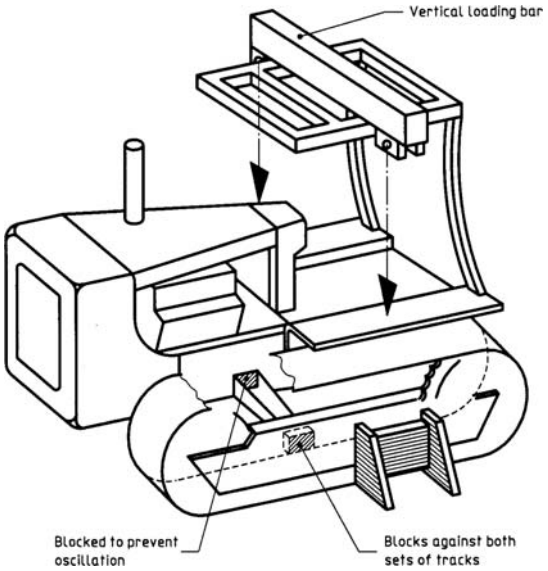


Figure 8.9

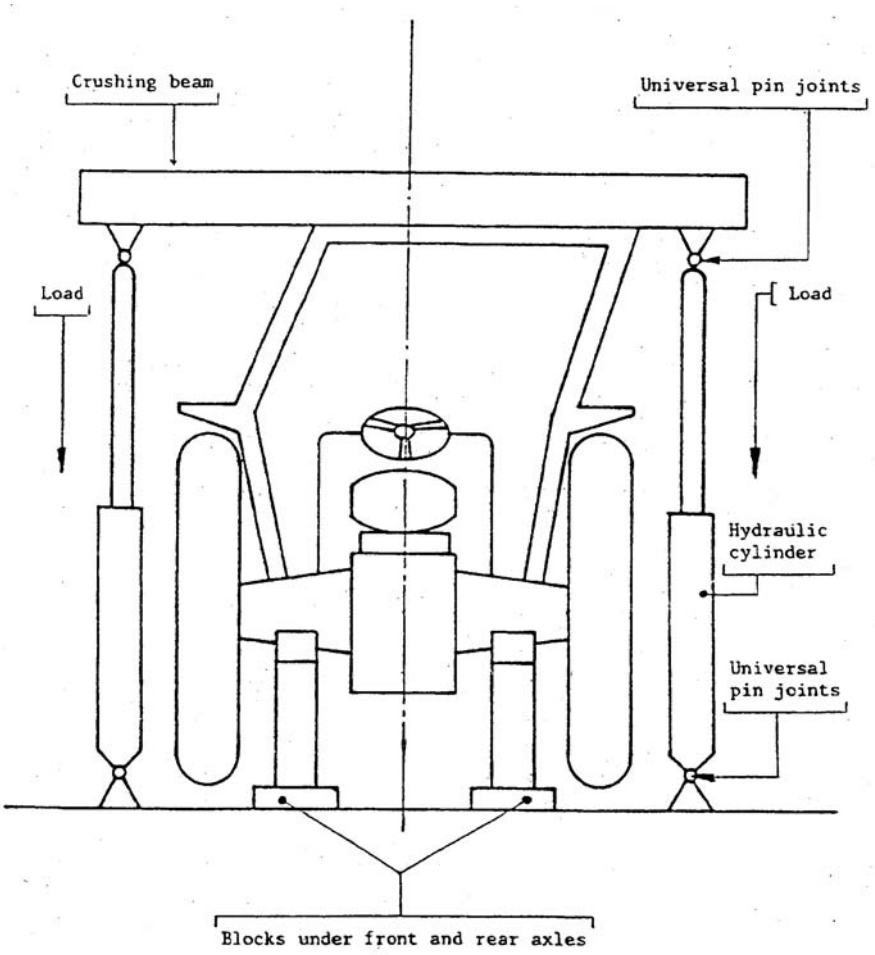
Typical arrangement for applying vertical load to the protective structure



▼B

Figure 8.10

Example of an arrangement for crushing test



▼B

Figures 8.11

Position of beam for front and rear crushing tests, protective cab and rear roll bar frame

Figure 8.11.a

Protective cab

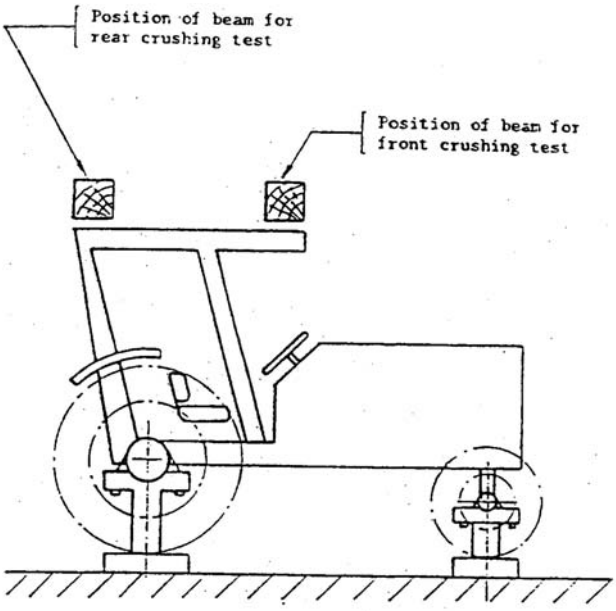
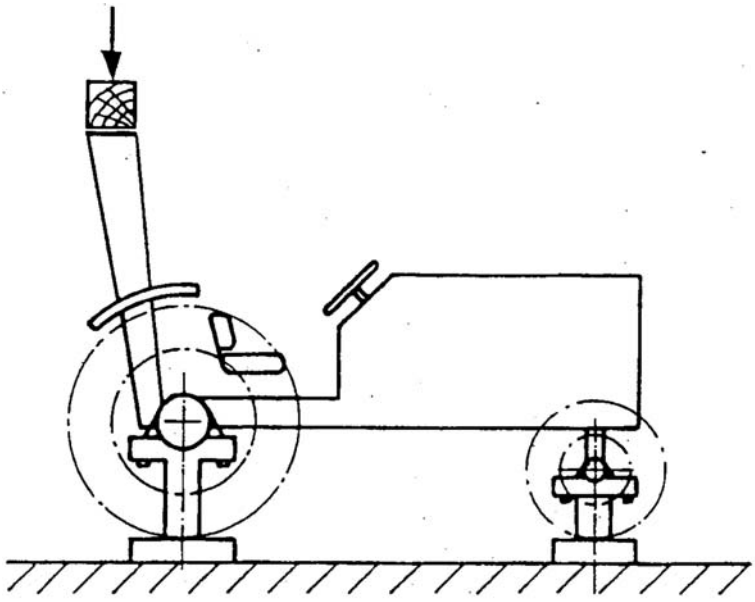


Figure 8.11.b

Rear roll bar frame



▼B

Figures 8.12

Position of beam for front crushing test when full crushing force not sustained in front

Figure 8.12.a

Protective cab

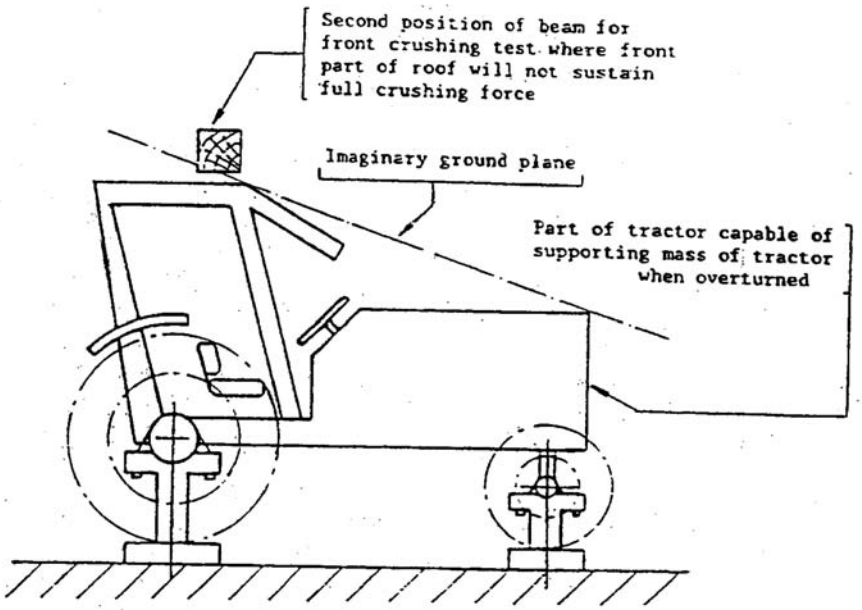
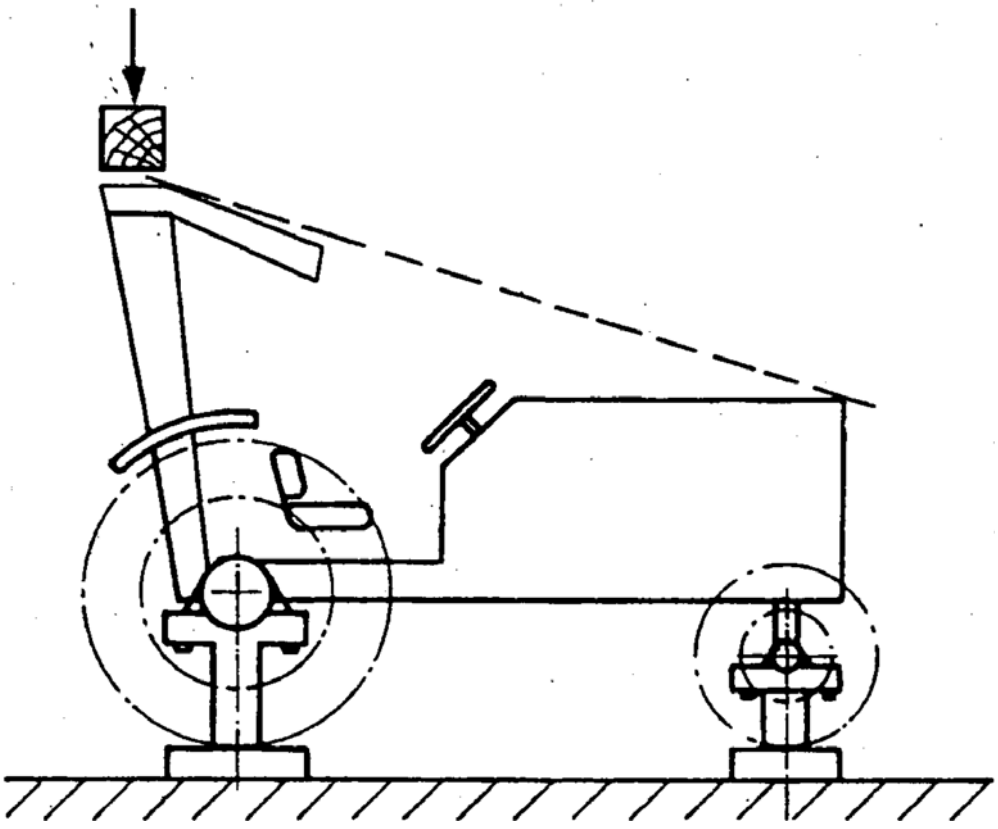


Figure 8.12.b

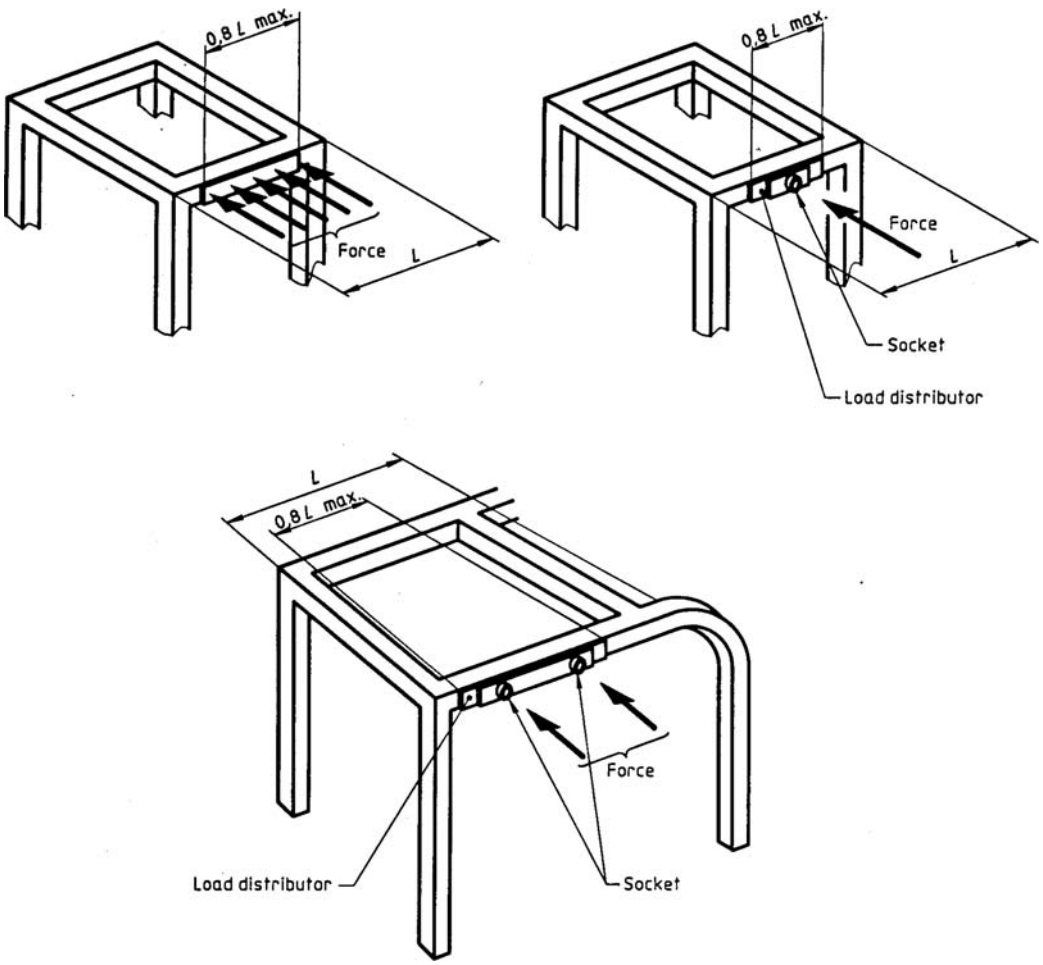
Rear roll bar frame



▼B

Figures 8.13 and 8.14

Structure with four-post system Load-distribution devices, side loading



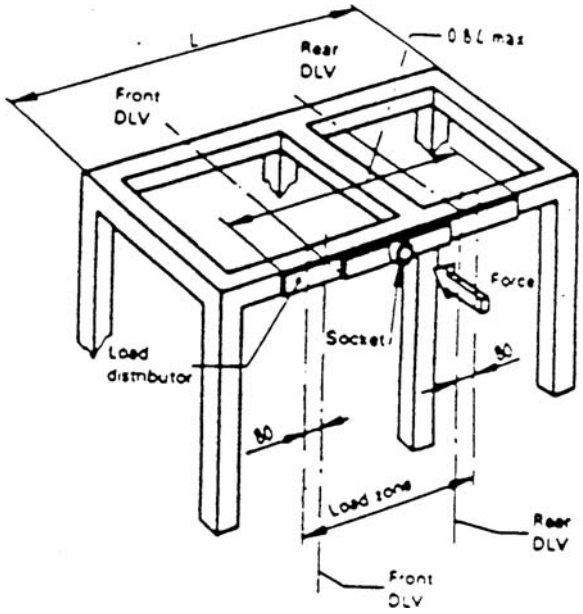
Load distributor and sockets are to prevent local penetration and to hold end load-generating device

▼B

Figure 8.15

Structure with more than a four-post system

Load-distribution device, side loading

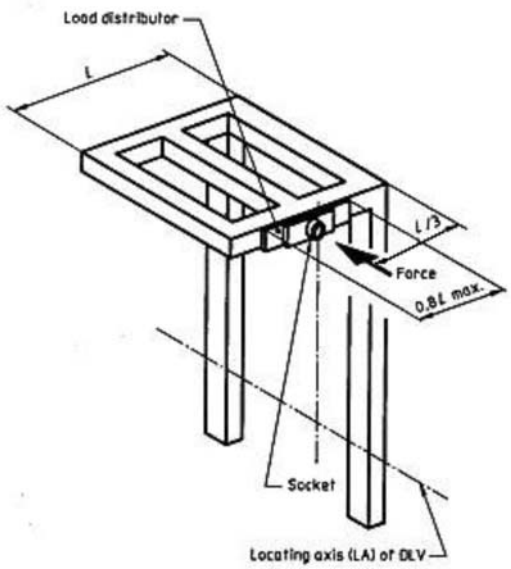


Load distributor and socket are to prevent penetration and to hold end load generating device

Figure 8.16

Structure with two-post system

Load-distribution device, side loading

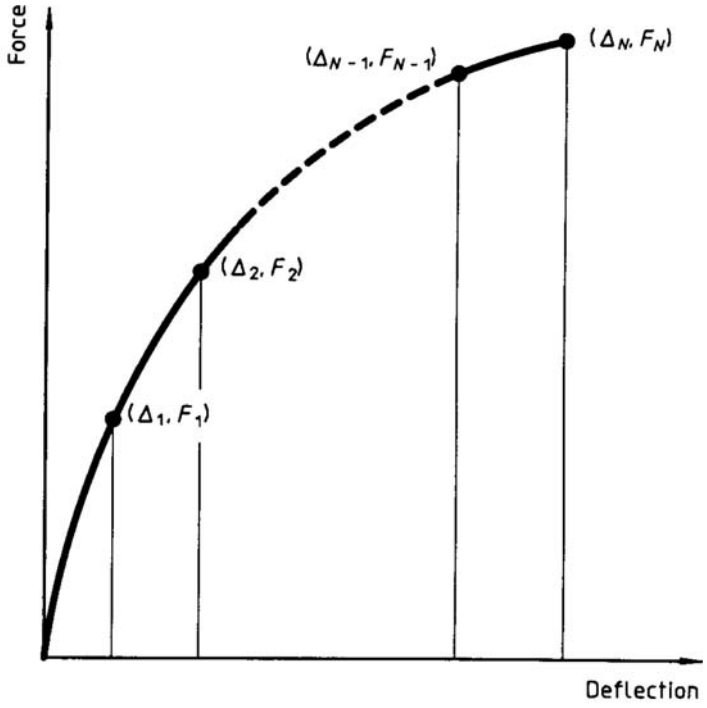


Load distributor and socket are to prevent penetration and to hold end load generating device

▼B

Figure 8.17

Force-deflection curve for loading tests



Energy

$$U = \frac{\Delta_1 F_1}{2} + (\Delta_2 - \Delta_1)\frac{F_1 + F_2}{2} + \ldots$$

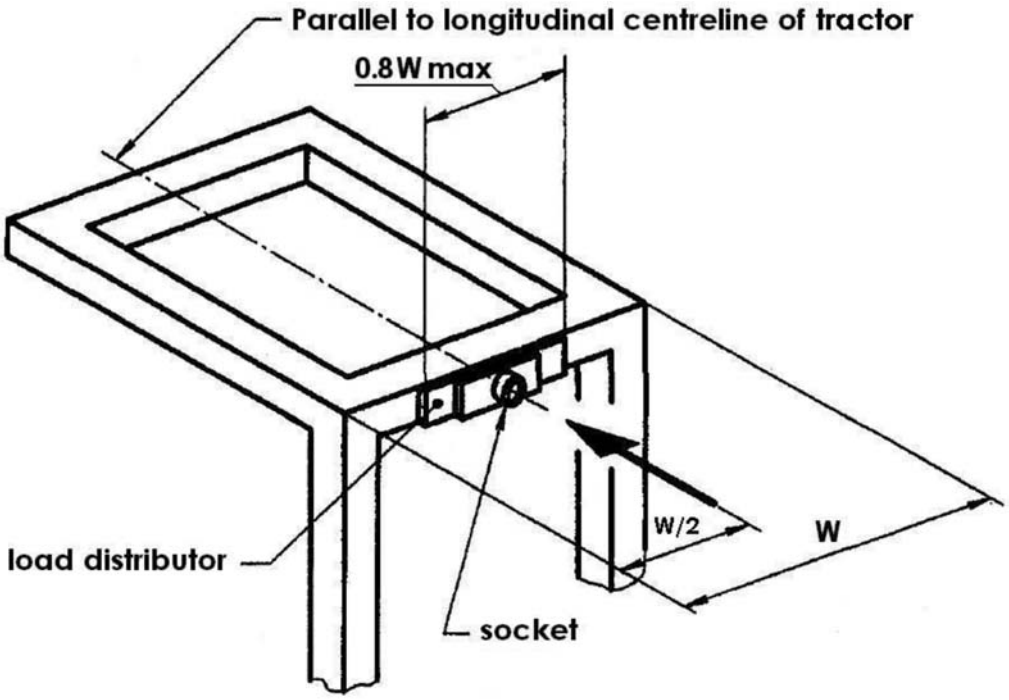
$$+ (\Delta_N - \Delta_{N-1})\frac{F_{N-1} + F_N}{2}$$

To obtain the energy in joules, divide the area beneath the force-deflection curve by 1 000.

▼B

Figure 8.18

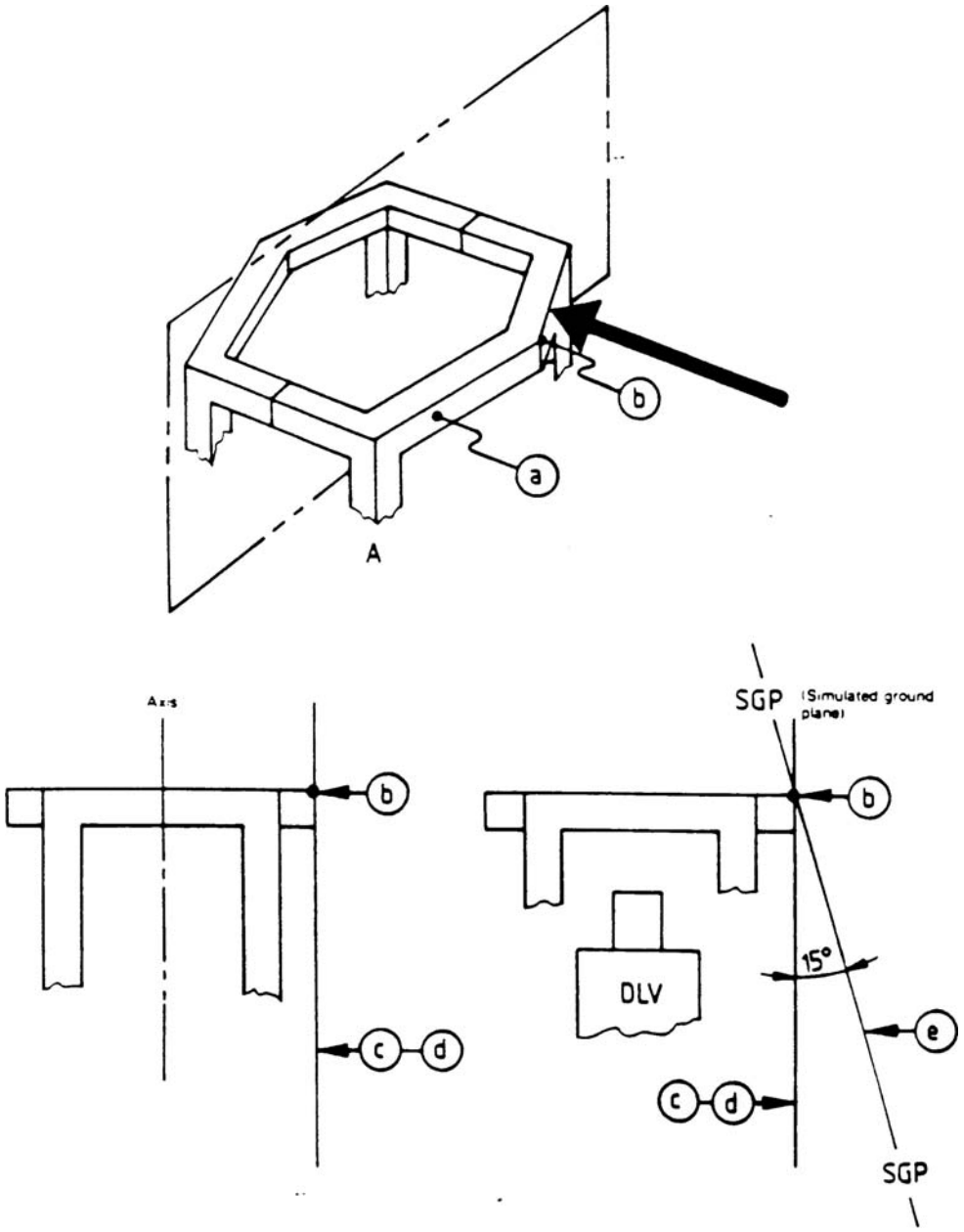
Longitudinal load application point



▼B

Figure 8.19

Deflection-limiting volume (DLV) application - determination of the lateral simulated ground plane (SGP)

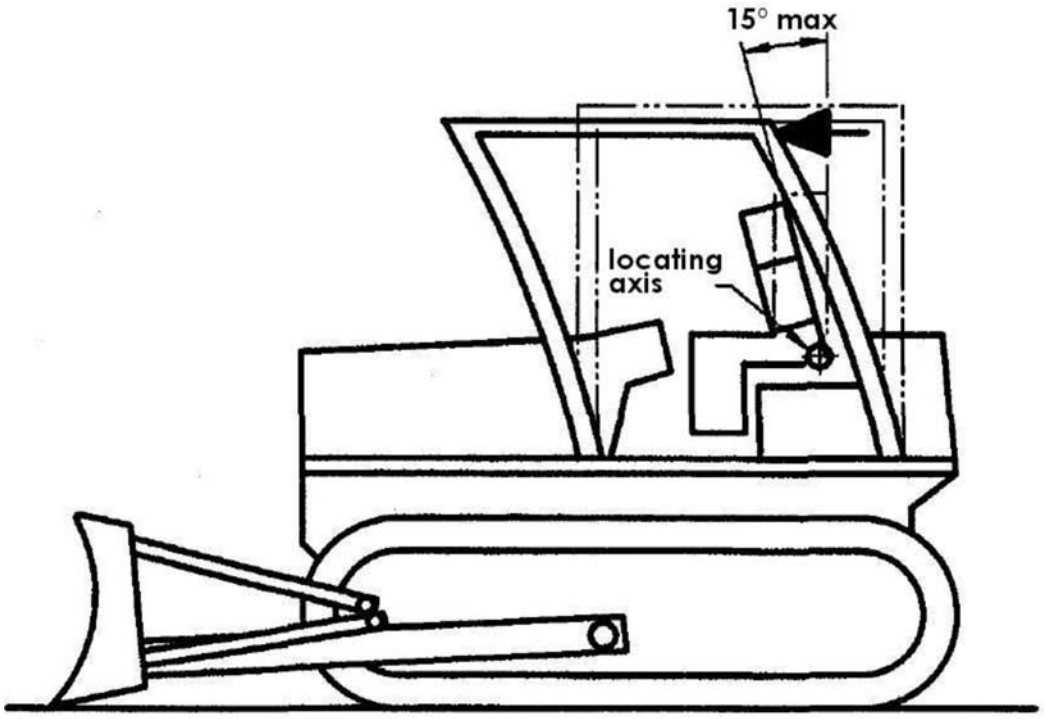


Note: See paragraph 1.11 for the meaning of **a** to **e**.

▼B

Figure 8.20

Allowable rotation of upper DLV about locating axis (LA)



Explanatory notes to Annex VII

(1) Unless otherwise stated, the text of the requirements and the numbering set out in point B are identical with the text and numbering of the OECD standard code for the official testing of protective structures on agricultural and forestry track-laying tractors, OECD Code 8, Edition 2015 of July 2014.

(2) Permanent + elastic deflection measured at the point when the required energy level is obtained.

▼B

ANNEX VIII

Requirements applying to roll-over protection structures (static testing)

A. GENERAL PROVISION

1. The Union requirements applying to roll-over protection structures (static testing) are set out in point B.

B. REQUIREMENTS APPLYING TO ROLL-OVER PROTECTION STRUCTURES (STATIC TESTING)[1]

1. **Definitions**

1.1. [Not applicable]

1.2. *Roll-Over Protective Structure (ROPS)*

Roll-over protective structure (protective cab or frame), hereinafter called 'protective structure', means the structure on a tractor the essential purpose of which is to avoid or limit risks to the driver resulting from roll-over of the tractor during normal use.

The roll-over protective structure is characterised by the provision of space for a clearance zone large enough to protect the driver when seated 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.

1.3. *Track*

1.3.1. Preliminary definition: median plane of the wheel or track

The median plane of the wheel or track is equidistant from the two planes containing the periphery of the rims or tracks at their outer edges.

1.3.2. Definition of track

The vertical plane through the wheel axis intersects its median plane along a straight line which meets the supporting surface at one point. If **A** and **B** are the two points thus defined for the wheels on the same axle of the tractor, then the track width is the distance between points **A** and **B**. The track may be thus defined for both front and rear wheels. Where there are twin wheels, the track is the distance between two planes each being the median plane of the pairs of wheels.

For track-laying tractors, the track is the distance between the median planes of the tracks.

1.3.3. Additional definition: median plane of the tractor

Take the extreme positions of points **A** and **B** for the tractor rear axle, which gives the maximum possible value for the track. The vertical plane at right angles to the line **AB** at its centre point is the median plane of the tractor.

1.4. *Wheelbase*

The distance between the vertical planes passing through the two lines **AB** as defined above, one for the front wheels and one for the rear-wheels.

▼B

1.5. *Determination of seat index point; Seat location and adjustment for test*

1.5.1. Seat index point (SIP)[2]

The seat index point shall be determined in accordance with ISO 5353:1995

1.5.2. Seat location and adjustment for test

1.5.2.1. where the seat position is adjustable, the seat must be adjusted to its rear uppermost position;

1.5.2.2. where the inclination of the backrest is adjustable, it must be adjusted to the mid position;

1.5.2.3. where the seat is equipped with suspension, the latter must be blocked at mid-travel, unless this is contrary to the instructions clearly laid down by the seat manufacturer;

1.5.2.4. where the position of the seat is adjustable only lengthwise and vertically, the longitudinal axis passing through the Seat Index Point shall be parallel with the vertical longitudinal plane of the tractor passing through the centre of the steering wheel and not more than 100 mm from that plane.

1.6. *Clearance zone*

1.6.1. Reference plane for seat and steering wheel

The clearance zone is illustrated in figures 4.11 to 4.13 and Table 4.2. The zone is defined in relation to the reference plane and the Seat Index Point. The reference plane is defined at the beginning of the series of loadings; it is a vertical plane, generally longitudinal to the tractor and passing through the Seat Index Point 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 roll-over protective structure. The clearance zone shall be defined on the basis of Sections 1.6.2 and 1.6.3 below.

1.6.2. Determination of the clearance zone for tractors with a non-reversible seat

The clearance zone for tractors with a non-reversible seat is defined in 1.6.2.1 to 1.6.2.10 below and is bounded by the following planes, the tractor being on a horizontal surface, the seat adjusted and located as specified in Sections 1.5.2.1 to 1.5.2.4[2], and the steering wheel, where adjustable, adjusted to the mid position for seated driving:

1.6.2.1. a horizontal plane A_1 B_1 B_2 A_2, (810 + a_v) mm above the Seat Index Point with line B_1B_2 located (a_h – 10) mm behind the SIP;

1.6.2.2. an inclined plane G_1 G_2 I_2 I_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;

1.6.2.3. a cylindrical surface A_1 A_2 I_2 I_1 perpendicular to the reference plane, having a radius of 120 mm, tangential to the planes defined in 1.6.2.1 and 1.6.2.2 above;

1.6.2.4. a cylindrical surface B_1 C_1 C_2 B_2, perpendicular to the reference plane, having a radius of 900 mm extending forward for 400 mm and tangential to the plane defined in 1.6.2.1 above along line B_1B_2;

▼B

1.6.2.5. an inclined plane C_1 D_1 D_2 C_2, perpendicular to the reference plane, joining the surface defined in 1.6.2.4 above 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 1.6.2.4 above;

1.6.2.6. a vertical plane D_1 E_1 E_2 D_2 perpendicular to the reference plane 40 mm forward of the external edge of the steering wheel;

1.6.2.7. a horizontal plane E_1 F_1 F_2 E_2 passing through a point $(90 – a_v)$ mm below the Seat Index Point;

1.6.2.8. a surface G_1 F_1 F_2 G_2, if necessary curved from the bottom limit of the plane defined in 1.6.2.2 above to the horizontal plane defined in 1.6.2.7 above, perpendicular to the reference plane, and in contact with the seat backrest throughout its length;

1.6.2.9. vertical planes J_1 E_1 F_1 G_1 H_1 and J_2 E_2 F_2 G_2 H_2. These vertical planes shall extend upwards from plane E_1 F_1 F_2 E_2 for 300 mm; the distances E_1 E_0 and E_2 E_0 shall be 250 mm;

1.6.2.10. parallel planes A_1 B_1 C_1 D_1 J_1 H_1 I_1 and A_2 B_2 C_2 D_2 J_2 H_2 I_2 inclined so that the upper edge of the plane on the side on which the force is applied is at least 100 mm from the vertical reference plane.

1.6.3. Determination of clearance zone for tractors with a reversible driver's position

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

1.6.4. Optional seats

1.6.4.1. In case of tractors that could be fitted with optional seats, the envelope comprising the Seat Index Points of all options offered shall be used during the tests. The protective structure shall not enter the larger clearance zone which takes account of these different Seat Index Points.

1.6.4.2. In the case where a new seat option is offered after the test has been performed, a determination shall be made to see whether the clearance zone around the new SIP falls within the envelope previously established. If it does not, a new test must be performed.

1.6.4.3. Optional seat does not include a seat for a person in addition to the driver and from where the tractor cannot be controlled. The SIP shall not be determined because the definition of the clearance zone is in relation to the driver seat.

1.7. *Mass*

1.7.1. Unballasted Mass

The mass of the tractor without ballasting devices and, in the case of tractors with pneumatic tyres, without liquid ballast in the tyres. The tractor shall be in running order with tanks, circuits and radiator full, protective structure with cladding and any track equipment or additional front wheel drive components required for normal use. The operator is not included.

▼B

1.7.2. Maximum Permissible Mass

The maximum mass of the tractor stated by the manufacturer to be technically permissible and declared on the vehicle's identification plate and/or in the Operator's Handbook;

1.7.3. Reference Mass

The mass selected by the manufacturer for calculation of the energy inputs and crushing forces to be used in the tests. Must not be less than the unballasted mass and must be sufficient to ensure the Mass Ratio does not exceed 1,75 *(see Section 1.7.4).*

1.7.4. Mass Ratio

The ratio of $\left(\frac{\text{Max. Permissible Mass}}{\text{Reference Mass}}\right)$ This must not be greater than 1,75.

1.8. *Permissible measurement tolerances*

Time ± 0,1 s

Distance ± 0,5 mm

Force ± 0,1 % (of the sensor full scale)

Angle ± 0,1°

Mass ± 0,2 % (of the sensor full scale)

1.9. *Symbols*

a_h	(mm)	Half of the horizontal seat adjustment
a_v	(mm)	Half of the vertical seat adjustment
D	(mm)	Deflection of the protective structure at the point of and in line with the load application
D'	(mm)	Deflection of the protective structure for the calculated energy required
E_{IS}	(J)	Energy input to be absorbed during side loading
E_{IL1}	(J)	Energy input to be absorbed during longitudinal loading
E_{IL2}	(J)	Energy input to be absorbed in case of a second longitudinal loading
F	(N)	Static load force
F_{max}	(N)	Maximum static load force occurring during loading, with the exception of the overload
F'	(N)	Force for the calculated energy required
M	(kg)	Reference mass used for calculating energy inputs and crushing forces

2. **Field of application**

2.1. This Annex is applicable to tractors having at least two axles for pneumatic tyred wheels or having tracks instead of wheels and with an unballasted tractor mass not less than 600 kg. The Mass Ratio (Maximum Permissible Mass / Reference Mass) must not be greater than 1,75.

▼B

2.2. The minimum track width of the rear-wheels should generally be greater than 1 150 mm. It is recognised that there may be designs of tractors, for example, lawn mowers, narrow vineyard tractors, low profile tractors used in buildings with limited overhead clearance or in orchards, high-clearance tractors and special forestry machines, such as forwarders and skidders, for which this Annex is not applicable.

3. **Rules and directions**

3.1. *General regulations*

3.1.1. The protective structure may be manufactured either by the tractor manufacturer or by an independent firm. In either case a test is only valid for the model of tractor on which it is carried out. The protective structure must be retested for each model of tractor to which it is to be fitted. However, testing stations may certify that the strength tests are also valid for tractor models derived from the original model by modifications to the engine, transmission and steering and front suspension. On the other hand, more than one protective structure may be tested for any one model of tractor.

3.1.2. The protective structure submitted for static test must be supplied attached in the normal manner to the tractor or tractor chassis on which it is used. The tractor chassis shall be complete including attaching brackets and other parts of the tractor that may be affected by loads imposed on the protective structure.

3.1.3. Where a ‘tandem’ tractor is concerned, the mass of the standard version of that part to which the protective structure is fitted is to be used.

3.1.4. A protective structure may be designed solely to protect the driver in the event of the tractor overturning. Onto this structure it may be possible to fit weather protection for the driver, of a more or less temporary nature. The driver will usually remove this in warm weather. There are protective structures however, in which the cladding is permanent and warm weather ventilation provided by windows or flaps. As the cladding may add to the strength of the structure and if removable may well be absent when an accident occurs, all parts that can be so taken away by the driver will be removed for the purpose of the test. Doors, roof hatch and windows that can be opened shall be either removed or fixed in the open position for the test, so that they do not add to the strength of the protective structure. It shall be noted whether, in this position, they would create a hazard for the driver in the event of overturning.

Throughout the remainder of these rules, reference will only be made to testing the protective structure. It must be understood that this includes cladding not of a temporary nature.

A description of any temporary cladding supplied is to be included in the specifications. All glass or similar brittle material shall be removed prior to the test. Tractor and protective structure components which might sustain needless damage during the test and which do not affect the strength of the protective structure or its dimensions may be removed prior to the test if the manufacturer wishes. No repairs or adjustment may be carried out during the test.

3.1.5. Any component of the tractor contributing to the strength of the protective structure such as mud-guards, which has been reinforced by the manufacturer, should be described and its measurements given in the test report.

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3.2. *Apparatus*

For verifying that the clearance zone has not been entered during the test, means shall be used as described in point 1.6, figures 4.11 to 4.13 and Table 4.2.

3.2.1. Horizontal loading tests (figures 4.1 to 4.5)

The following shall be used in horizontal loading tests:

3.2.1.1. material, equipment and means of attachment to ensure that the tractor chassis is firmly fixed to the ground and supported independently of the tyres;

3.2.1.2. device for applying a horizontal force to the protective structure; provision shall be made so that the load can be uniformly distributed normal to the direction of loading;

3.2.1.2.1. a beam of length not less than 250 mm nor more than 700 mm in exact multiples of 50 mm between these lengths shall be used. The beam shall have a vertical dimension of 150 mm;

3.2.1.2.2. the edges of the beam in contact with the protective structure shall be curved with a maximum radius of 50 mm;

3.2.1.2.3. universal joints or the equivalent shall be incorporated to ensure that the loading device does not constrain the protective structure in rotation or translation in any direction other than the direction of loading;

3.2.1.2.4. where the straight line defined by the appropriate beam on the protective structure is not normal to the direction of application of load the space shall be packed so as to distribute the load over the full length;

3.2.1.3. equipment for measuring force and deflection in the load direction, relative to the tractor chassis. To ensure accuracy, measurements shall be taken as continuous readings. The measuring devices shall be located so as to record the force and deflection at the point of, and along the line of, loading.

3.2.2. Crushing tests (figures 4.6 to 4.8)

The following shall be used in crushing tests:

3.2.2.1. material, equipment and means of attachment to ensure that the tractor chassis is firmly fixed to the ground and supported independently of the tyres;

3.2.2.2. device for applying a downward force to the protective structure, including a stiff beam with a width of 250 mm;

3.2.2.3. equipment for measuring the total vertical force applied.

3.3. *Test conditions*

3.3.1. The protective structure shall be to production specifications and shall be fitted to the appropriate tractor model chassis in accordance with the manufacturer's declared method of attachment.

3.3.2. 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 protective structure under load. The assembly shall not receive any support under load other than that due to the initial attachment.

3.3.3. An adjustable track width setting for the wheels or tracks, if present, shall be chosen such that no interference exists with the protective structure during the tests.

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3.3.4. The protective structure shall be instrumented with the necessary equipment to obtain the required force-deflection data.

3.3.5. All tests shall be performed on the same protective structure. No repairs or straightening of any members shall be carried out between any parts of the test

3.3.6. On completion of all tests, permanent deflections of the protective structure shall be measured and recorded.

3.4. *Sequence of tests*

Tests shall be conducted in the following sequence:

3.4.1. Longitudinal loading

For a wheeled tractor with at least 50 % of its mass on the rear axle and for track-laying tractors, the longitudinal loading shall be applied from the rear. For other tractors the longitudinal loading shall be applied from the front.

3.4.2. First crushing test

The first crushing test shall be applied at the same end of the protective structure as the longitudinal loading

3.4.3. Loading from the side

In the case of an offset seat or non-symmetrical strength of the protective structure, the side loading shall be on the side most likely to lead to infringement of the clearance zone.

3.4.4. Second crushing test

The second crushing test shall be applied at the end of the protective structure opposite from that receiving the first longitudinal loading. In the case of two-post designs, the second crush may be at the same point as the first crush.

3.4.5. Second longitudinal loading

3.4.5.1. A second longitudinal loading shall be applied to tractors fitted with a folding (e.g. two posts) or tiltable (e.g. non-two posts) protective structure, if one or more of the following conditions exists:

Temporary folding for special operating conditions;

Structures designed to tilt for service, unless the tilt mechanism is independent from the structural integrity of the roll-over protective structure.

3.4.5.2. For folding protective structures, if the first longitudinal loading was applied in the folding direction then a second longitudinal loading is not required.

3.5. *Horizontal loading tests from the rear, front and side*

3.5.1. General provisions

3.5.1.1. The load applied to the protective structure shall be distributed uniformly by means of a stiff beam, normal to the direction of load application (see 3.2.1.2). The stiff beam may be equipped with a means of preventing its sideways displacement. The rate of load application shall be such that it can be considered static. As the

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load is applied, force and deflection shall be recorded as a continuous record to ensure accuracy. Once the initial application has commenced, the load shall not be reduced until the test has been completed. The direction of the applied force shall be within the following limits:

— at start of test (no load): ± 2°,

— during test (under load): 10° above and 20° below the horizontal.

The rate of load application shall be considered static if the rate of deflection under loading is not greater than 5 mm/s.

3.5.1.2. If no structural cross member exists at the point of load application, a substitute test beam which does not add strength will be utilised.

3.5.2. Longitudinal loading (figures 4.1 and 4.2)

The load shall be applied horizontally and parallel to the median plane of the tractor. If the load is applied from the rear (Section 3.4.1), the longitudinal load and the lateral load shall be applied on different sides of the median plane of the tractor. If the longitudinal load is applied from the front, it shall be on the same side as the side load.

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

The point of application of the load shall be located at one sixth of the width of the top of the protective structure inwards from the outside corner. The width of the protective structure shall be taken as the distance between two lines parallel to the median plane of the tractor touching the outside extremities of the protective structure in the horizontal plane touching the top of the uppermost transverse structural members.

In the event that the ROPS is formed of curved members and no appropriate corners exist, the following general procedure shall apply for determining W. The test engineer shall identify the curved member most likely to first strike ground in the event of an asymmetrical rear or front overturn (e.g. an overturn to the front or rear where one side of the ROPS is likely to bear the initial loading). The endpoints of W shall be the mid-points of the external radii created between other straight or curved members which form the uppermost ROPS structure. In the event that multiple curved members could be selected, the test engineer shall establish ground lines for each possible member to determine which surface is most likely to strike ground first. See figures 4.3 a) and b) for examples.

Note:

In the event of curved members, only the width at the end of the structure to which the longitudinal load is to be applied need be considered

The length of the load distribution device (see 3.2.1.2) shall be not less than one third of the width of the protective structure and not more than 49 mm greater than this minimum.

The longitudinal loading shall be stopped when:

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3.5.2.1. the energy absorbed by the protective structure is equal to or greater than the required energy input, E_{IL1} where:

$$E_{IL1} = 1{,}4\ M$$

3.5.2.2. the protective structure infringes on the clearance zone or leaves the clearance zone unprotected (Condition of acceptance in 3.8 below).

3.5.3. Side loading (figures 4.4 and 4.5)

The side loading shall be applied horizontally at 90° to the median plane of the tractor. It shall be applied to the upper extremity of the protective structure at a point (160 – a_h) mm forward of the Seat Index Point.

For tractors with a reversible driver's position (reversible seat and steering wheel), it shall be applied to the upper extremity of the protective structure at the mid-point between the two Seat Index Points.

If it is certain that any particular part of the protective structure will touch ground first when the tractor overturns sideways, the loading shall be applied at that point, provided that this permits uniform distribution of the load as specified in 3.5.1.1. In the case of a two-post protective structure, side loading shall be applied at the structural member uppermost on the side, regardless of the seat index position.

Specifications for the load distribution beam are given in Section 3.2.1.2.1.

The side loading shall be stopped when:

3.5.3.1. The energy absorbed by the protective structure is equal to or greater than the required energy, E_{IS}, where:

$$E_{IS} = 1{,}75\ M$$

3.5.3.2. The protective structure infringes on the clearance zone or leaves the clearance zone unprotected (Condition of acceptance in 3.8 below).

3.6. *Crushing tests*

3.6.1. Crushing at the rear (figures 4.6, 4.7.a to 4.7.e)

3.6.1.1. The crushing beam shall be positioned across the rear uppermost structural members so that the resultant of the crushing forces is located in the vertical reference plane of the tractor. The crushing force **F** shall be applied where:

$$F = 20\ M$$

This force shall be maintained for 5 seconds after cessation of any visually detectable movement of the protective structure.

3.6.1.2. Where the rear part of the protective structure 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 protective structure with that part of the rear of the tractor capable of supporting the tractor when overturned. The force shall then be

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removed and the crushing beam repositioned over that part of the protective structure that would support the tractor when completely overturned. The crushing force **F = 20 M** shall then be applied.

3.6.2. Crushing at the front (figures 4.6 to 4.8)

3.6.2.1. The crushing beam shall be positioned across the front uppermost structural members so that the resultant of the crushing forces is located in the vertical reference plane of the tractor. The crushing force **F** shall be applied where:

$$F = 20\ M$$

This force shall be maintained for 5 seconds after cessation of any visually detectable movement of the protective structure.

3.6.2.2. Where the front part of the roof of the protective structure will not sustain the full crushing force (figures 4.8.a and 4.8.b), the force shall be applied until the roof is deflected to coincide with the plane joining the upper part of the protective structure with that part of the front of the tractor capable of supporting the tractor when overturned. The force shall then be removed and the crushing beam repositioned over that part of the protective structure that would support the tractor when completely overturned. The crushing force **F = 20 M** shall then be applied.

3.7. *Second longitudinal loading test*

The load shall be applied in the opposite direction to and at the corner farthest from the point of application of the first longitudinal load (figures 4.1 and 4.2).

The longitudinal loading shall be stopped when:

3.7.1. The energy absorbed by the protective structure is equal to or greater than the required energy, $\mathbf{E_{IL.2}}$, where:

$$E_{IL2} = 0{,}35\ M$$

3.7.2. The protective structure infringes on the clearance zone or leaves the clearance zone unprotected (Condition of acceptance in 3.8 below

3.8. *Conditions for acceptance*

For the protective structure to be accepted it shall fulfil the following conditions during and after completion of the tests:

3.8.1. no part shall enter the clearance zone during any part of the tests. No part may strike the seat during the tests. Furthermore, the clearance zone shall not be outside the protection of the protective structure. For this purpose, it shall be considered to be outside the protection of the structure if any part of it would come in contact with flat ground if the tractor overturned towards the direction from which the test load is applied. For estimating this, the tyres and track width setting shall be the smallest standard fitting specified by the manufacturer;

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3.8.2. for the articulated tractors, the median planes of the two parts shall be assumed to be in line;

3.8.3. after the final crushing test, the permanent deflection of the protective structure shall be recorded. For this purpose, before the start of the test, the position of the main protective structure members in relation to the Seat Index Point must be recorded. Then any displacement of the members resulting from the loading tests and any change of the height of the front and back members of the roof of the protective structure shall be recorded;

3.8.4. at the point where the required energy absorption is met in each of the specified horizontal loading tests the force shall exceed **0,8** F_{max};

3.8.5. an overload test shall be required if the applied force decreases by more than 3 % over the last 5 % of the deflection attained when the energy required is absorbed by the structure (Figures 4.14 to 4.16). Description of the overload test:

3.8.5.1. an overload test shall consist of continuing the horizontal loading in increments of 5 % of the original required energy, up to a maximum of 20 % additional energy;

3.8.5.2. 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 % energy increment whilst remaining greater than **0,8** $\mathbf{F_{max}}$ or if, after the absorption of 20 % additional energy the force is greater than **0,8** $\mathbf{F_{max}}$;

3.8.5.3. additional cracks or tears or entry into or lack of protection of the clearance zone, due to elastic deformation, are permitted during the overload test. After removing the load, however, the protective structure shall not infringe on the clearance zone, which shall be completely protected;

3.8.6. the required force must be sustained in both crushing tests;

3.8.7. there shall be no protruding member or component which would be likely to cause serious injury during an overturning accident or which, through the deformation occurring, might trap the operator, for example by the leg or foot;

3.8.8. there shall be no other components presenting a serious hazard to the operator.

3.9. *Extension to other tractor models*

3.9.1. [Not applicable]

3.9.2. Technical extension

When technical modifications occur on the tractor, the protective structure or the method of attachment of the protective structure to the tractor, the testing station that has carried out the original test can issue a ‘technical extension report’ in the following cases:

3.9.2.1. Extension of the structural test results to other models of tractors

The loading and crushing tests need not be carried out on each model of tractor, provided that the protective structure and tractor comply with the conditions referred to hereunder 3.9.2.1.1 to 3.9.2.1.5

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3.9.2.1.1. The structure shall be identical to the one tested;

3.9.2.1.2. The required energy shall not exceed the energy calculated for the original test by more than 5 %. The 5 % limit shall also apply to extensions in the case of substituting tracks for wheels on the same tractor;

3.9.2.1.3. The method of attachment and the tractor components to which the attachment is made shall be identical;

3.9.2.1.4. Any components such as mud-guards and bonnet that may provide support for the protective structure shall be identical;

3.9.2.1.5. The position and critical dimensions of the seat in the protective structure and the relative position of the protective structure on the tractor shall be such that the clearance zone would have remained within the protection of the deflected structure throughout all tests (this shall be checked by using the same reference of clearance zone as in the original test report, respectively Seat Reference Point [SRP] or Seat Index Point [SIP]).

3.9.2.2. Extension of the structural test results to modified models of the protective structure.

This procedure has to be followed when the provisions of paragraph 3.9.2.1 are not fulfilled, it may not be used when the method of attachment of the protective structure to the tractor does not remain of the same principle (e.g. rubber supports replaced by a suspension device)

3.9.2.2.1. Modifications having no impact on the results of the initial test (e.g. weld attachment of the mounting plate of an accessory in a non-critical location on the structure), addition of seats with different SIP location in the protective structure (subject to checking that the new clearance zone(s) remain(s) within the protection of the deflected structure throughout all tests).

3.9.2.2.2. Modifications having a possible impact on the results of the original test without calling into question the acceptability of the protective structure (e.g. modification of a structural component, modification of the method of attachment of the protective structure to the tractor). A validation test can be carried out and the test results will be drafted in the extension report.

The following limits for this type extension are fixed.

3.9.2.2.2.1. No more than 5 extensions may be accepted without a validation test;

3.9.2.2.2.2. The results of the validation test will be accepted for extension if all the acceptance conditions of this Annex are fulfilled and if the force measured when the required energy level has been reached in the various horizontal load tests does not deviate from the force measured when the required energy has been reached in the original test by more than ± 7 % and the deflection measured[3] when the required energy level has been reached in the various horizontal load tests does not deviate from the deflection measured when the required energy has been reached in the original test report by more than ± 7 %.

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3.9.2.2.2.3. More than one protective structure modifications may be included in a single extension report if they represent different options of the same protective structure, but only one validation test can be accepted in a single extension report. The options not tested shall be described in a specific section of the extension report.

3.9.2.2.3. Increase of the reference mass declared by the manufacturer for a protective structure already tested. If the manufacturer wants to keep the same approval number it is possible to issue an extension report after having carried out a validation test (the limits of ± 7 % specified in 3.9.2.2.2.2 are not applicable in such a case).

3.10. [Not applicable]

3.11. *Cold weather performance of protective structures*

3.11.1. If the protective structure is claimed to have properties resistant to cold weather embrittlement, the manufacturer shall give details that shall be included in the report.

3.11.2. The following requirements and procedures are intended to provide strength and resistance to brittle fracture at reduced temperatures. It is suggested that the following minimum material requirements shall be met in judging the protective structure's suitability at reduced operating temperatures in those countries requiring this additional operating protection.

3.11.2.1. Bolts and nuts used to attach the protective structure to the tractor and used to connect structural parts of the protective structure shall exhibit suitable controlled reduced temperature toughness properties.

3.11.2.2. All welding electrodes used in the fabrication of structural members and mounts shall be compatible with the protective structure material as given in 3.11.2.3 below.

3.11.2.3. Steel materials for structural members of the protective structure shall be of controlled toughness material exhibiting minimum Charpy V-Notch loading energy requirements as shown in Table 4.1. Steel grade and quality shall be specified in accordance with ISO 630:1995; Amd1:2003.

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 protective structure made from materials other than steel shall have equivalent low temperature loading resistance.

3.11.2.4. When testing the Charpy V-Notch loading energy requirements, the specimen size shall be no less than the largest of the sizes stated in Table 4.1 that the material will permit.

3.11.2.5. The Charpy V-Notch tests shall be made in accordance with the procedure in ASTM A 370-1979, except for specimen sizes that shall be in accordance with the dimensions given in Table 4.1.

3.11.2.6. Alternatives to this procedure are the use of killed or semi-killed steel for which an adequate specification shall be provided. Steel grade and quality shall be specified in accordance with ISO 630:1995; Amd1:2003.

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3.11.2.7. Specimens are to be longitudinal and taken from flat stock, tubular or structural sections before forming or welding for use in the protective structure. Specimens from tubular or structural sections are to be taken from the middle of the side of greatest dimension and shall not include welds.

Table 4.1

Minimum Charpy V-notch impact energies

Specimen size	Energy at	Energy at
	– 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 × 3,5	6	15

(a) Indicates preferred size. Specimen size shall be no less than largest preferred size that the material permits.

(b) The energy requirement at – 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 steel.

3.12. [Not applicable]

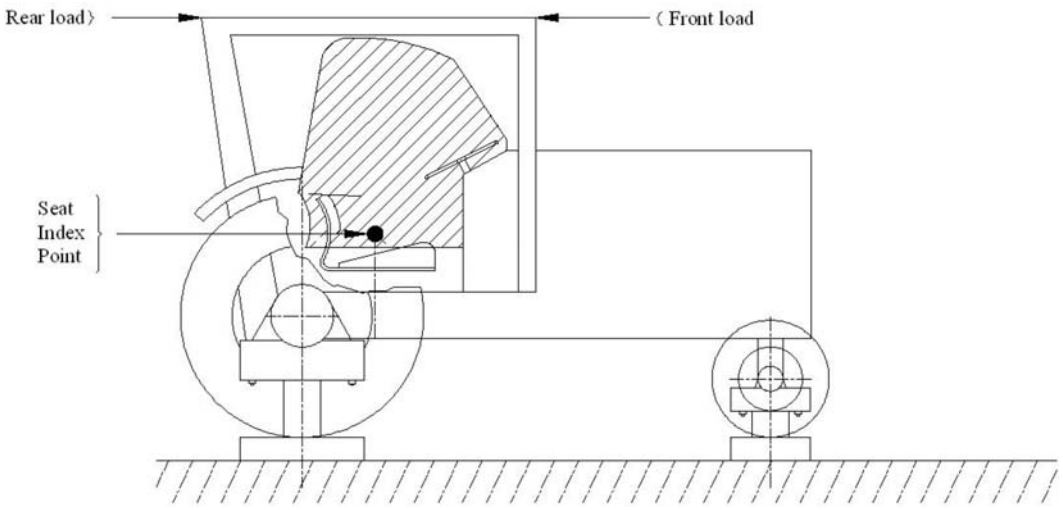
Figure 4.1

Front and rear load applications, Protective cab and rear roll bar frame

(Dimensions in mm)

Figure 4.1.a

Protective cab



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Figure 4.1.b

Rear roll bar frame

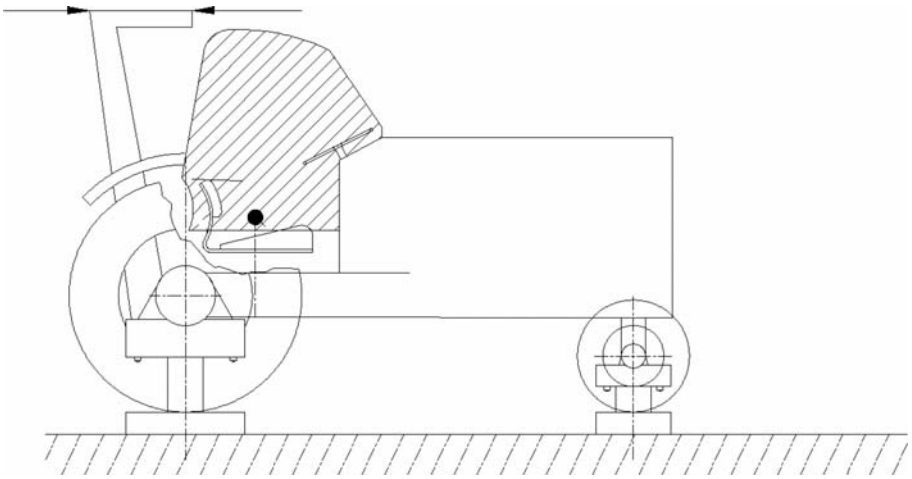
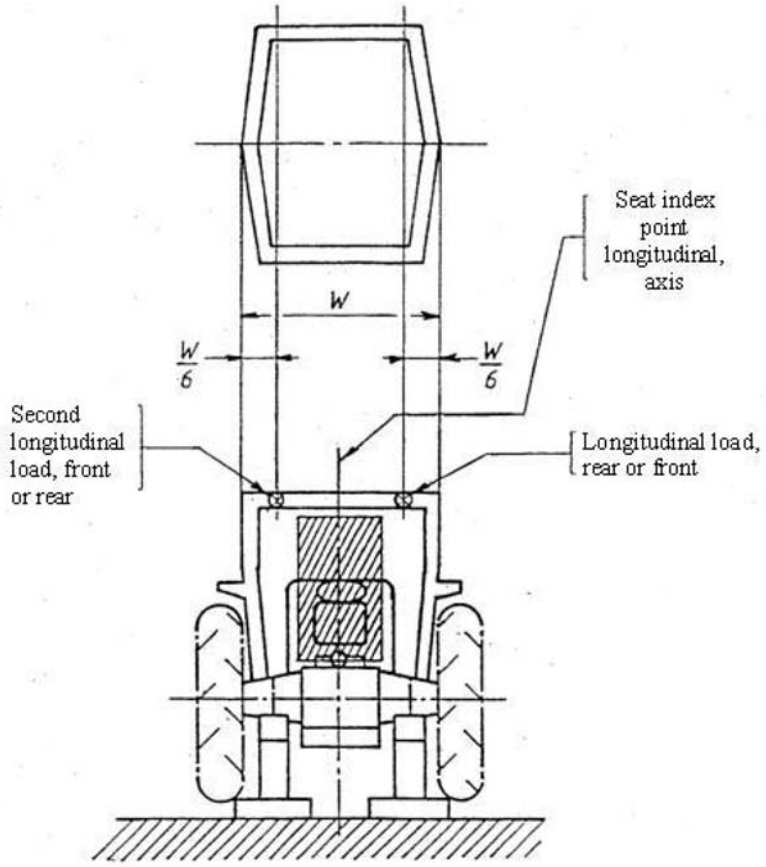


Figure 4.2

Longitudinal load applications



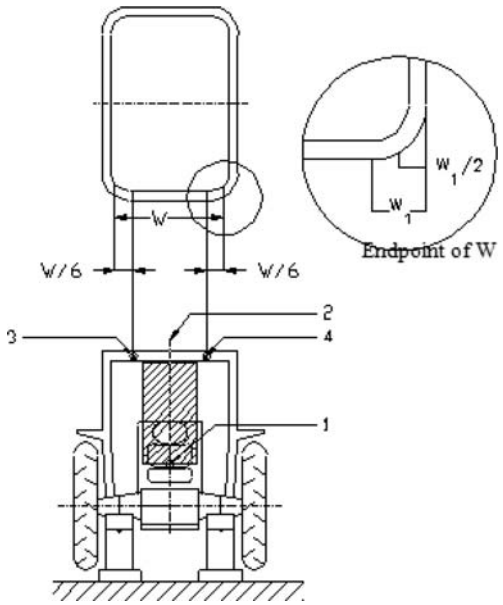
▼B

Figure 4.3

Examples of 'W' for ROPS with curved members

Figure 4.3.a

Four-post ROPS



Key:

1 — Seat index point

2 — SIP, longitudinal centre-plane

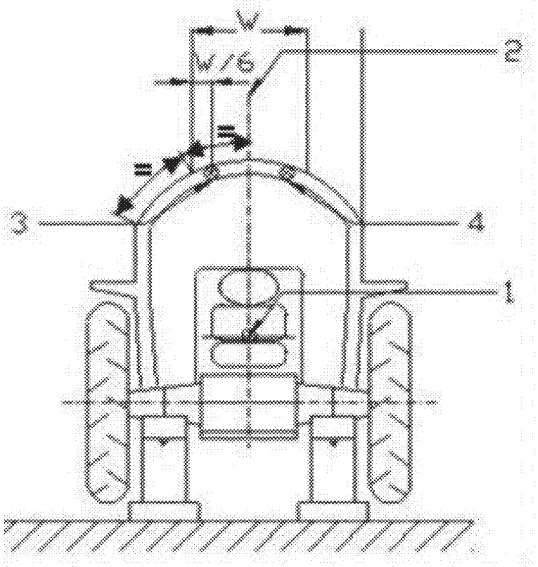
3 — Point of second longitudinal load application, front or rear

4 — Point of longitudinal load application, rear or front

▼M1

Figure 4.3.b

Two-post ROPS



KEY:

1 – Seat index point (SIP).

2 – SIP, longitudinal centre-plane.

3 – Point of second longitudinal load application, front or rear.

4 – Point of longitudinal load application, rear or front.

▼B

Figure 4.4

Side load application (side view), protective cab and rear roll bar frame

Figure 4.4.a

Protective cab

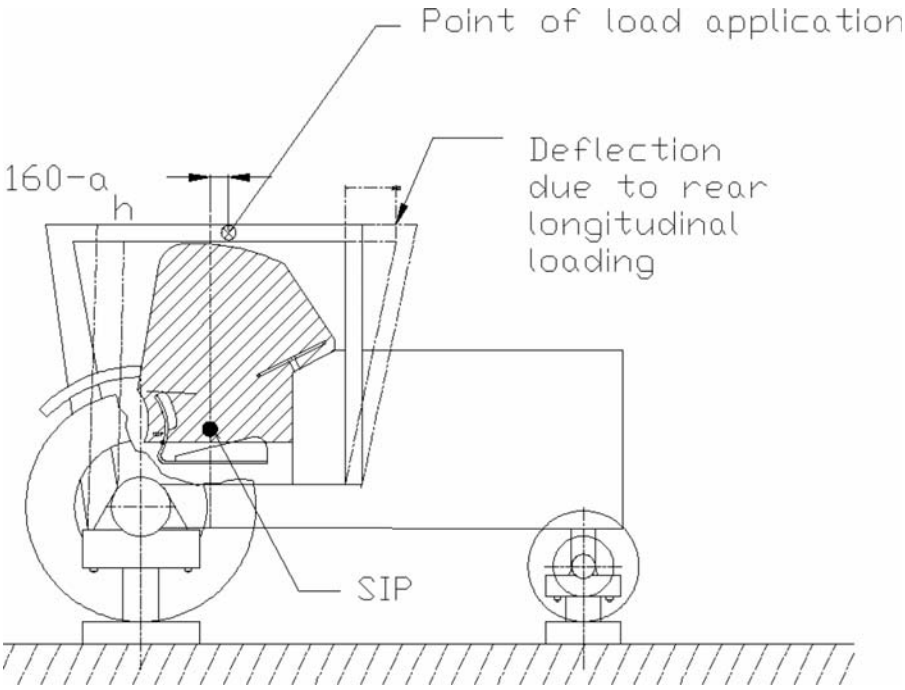
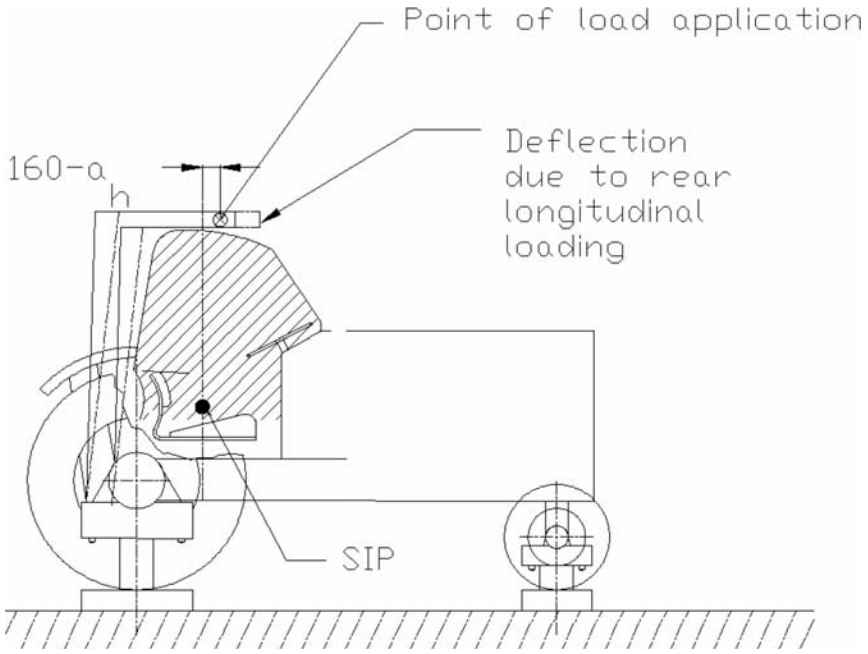


Figure 4.4.b

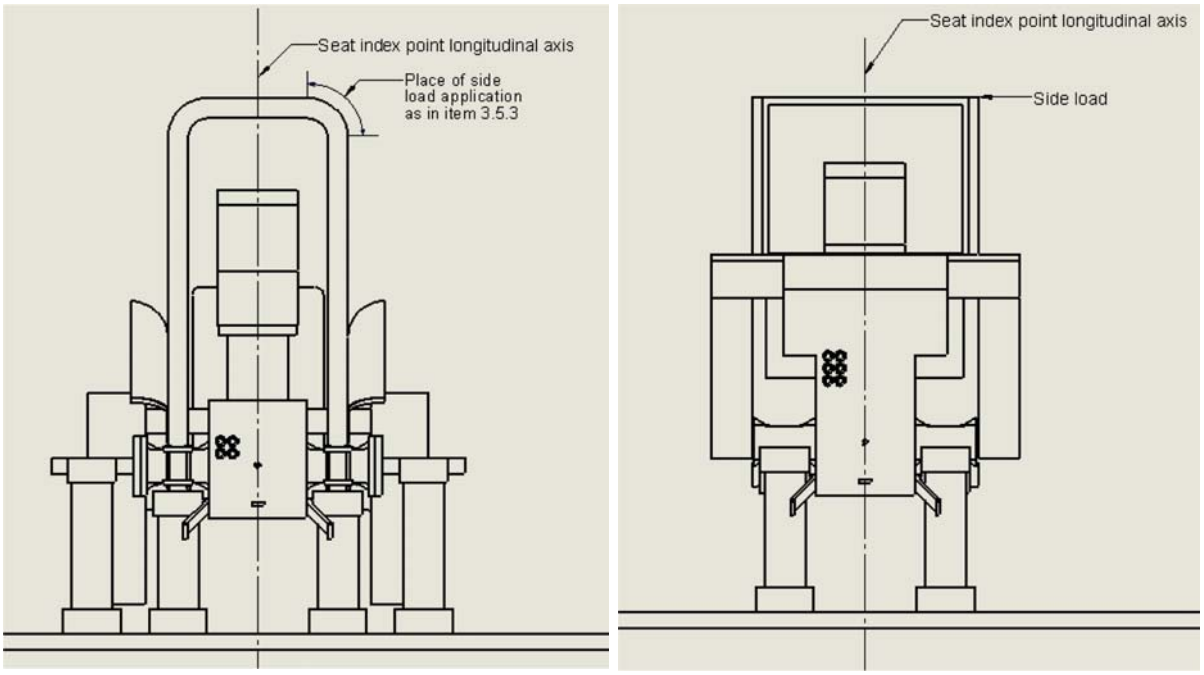
Rear roll bar frame



▼B

Figure 4.5

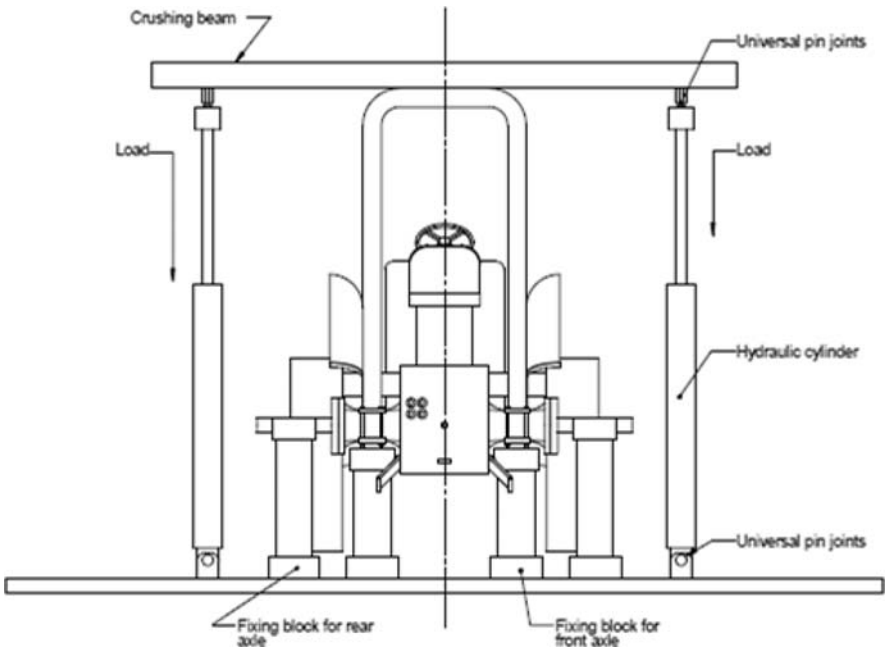
Side load application (rear view)



(a) (b)

Figure 4.6

Example of arrangement for crushing test



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Figure 4.7

Position of beam for front and rear crushing tests, protective cab and rear roll bar frame

Figure 4.7.a

Rear Crush

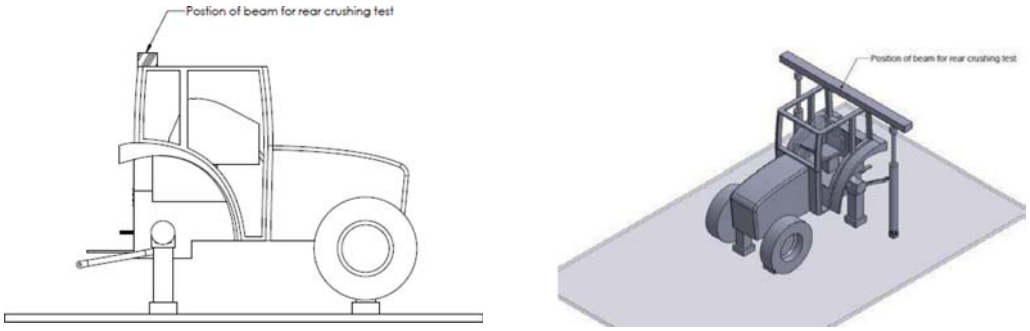


Figure 4.7.b

Front Crush

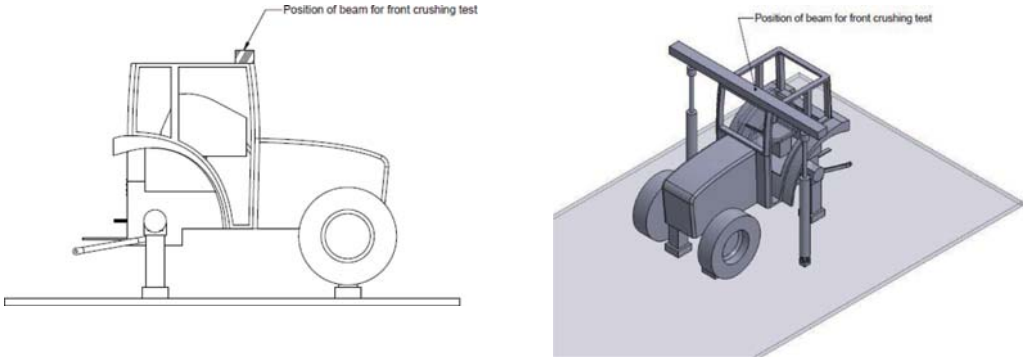
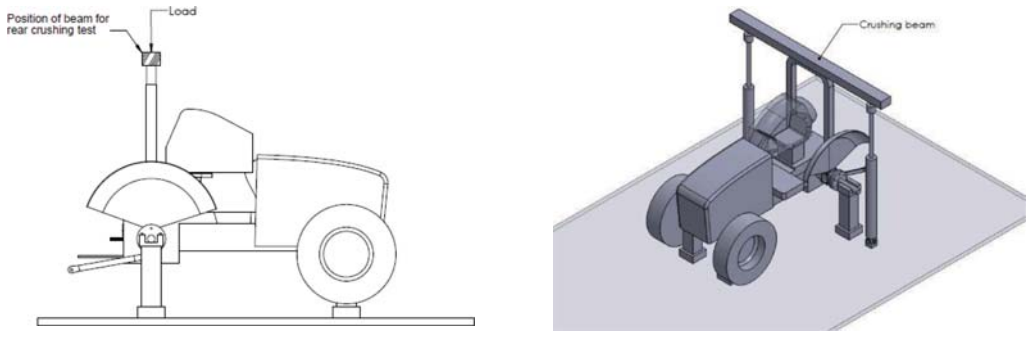


Figure 4.7.c

Crush test for rear roll bar



▼B

Figure 4.7.d

Protective cab

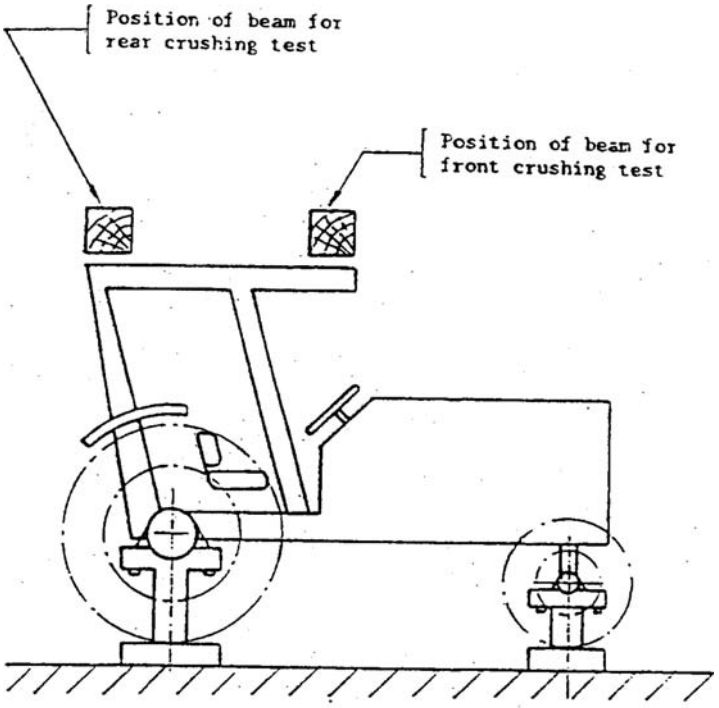
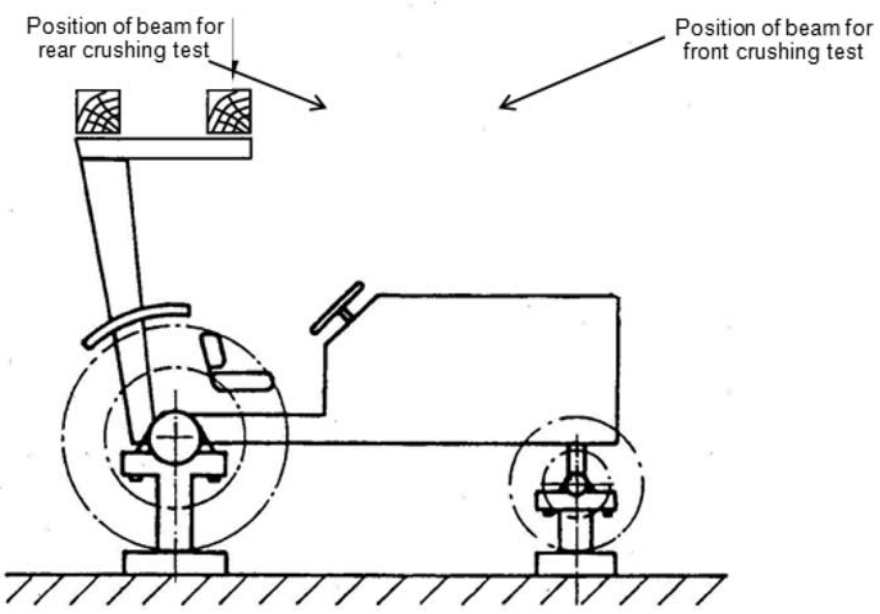


Figure 4.7.e

Rear roll bar frame



▼B

Figure 4.8

Position of beam for front crushing test when full crushing force not sustained in front

Figure 4.8.a

Protective cab

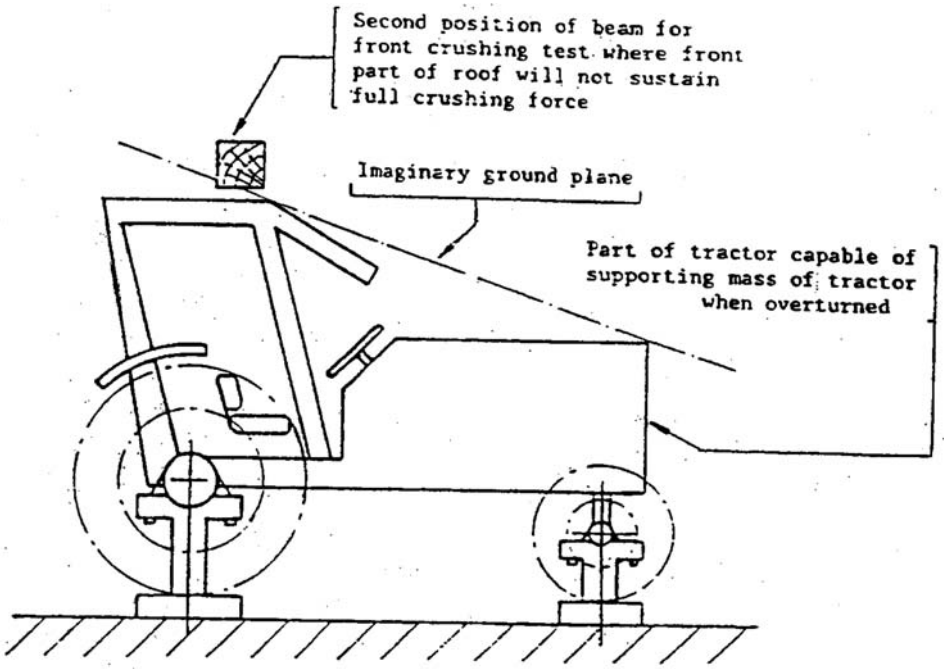
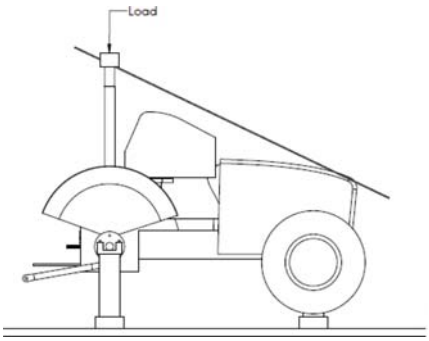
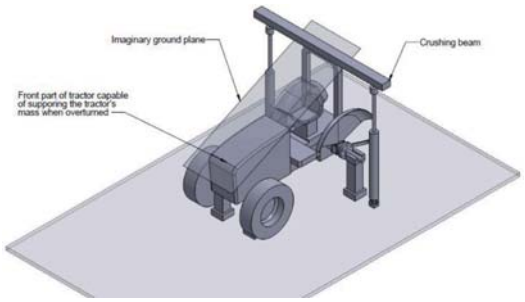


Figure 4.8.b

Rear roll bar frame





▼B

Figure 4.9

The crushing force is applied with the beam having its centre point passing in the vertical reference plane of the tractor (being also that of the seat and steering wheel)

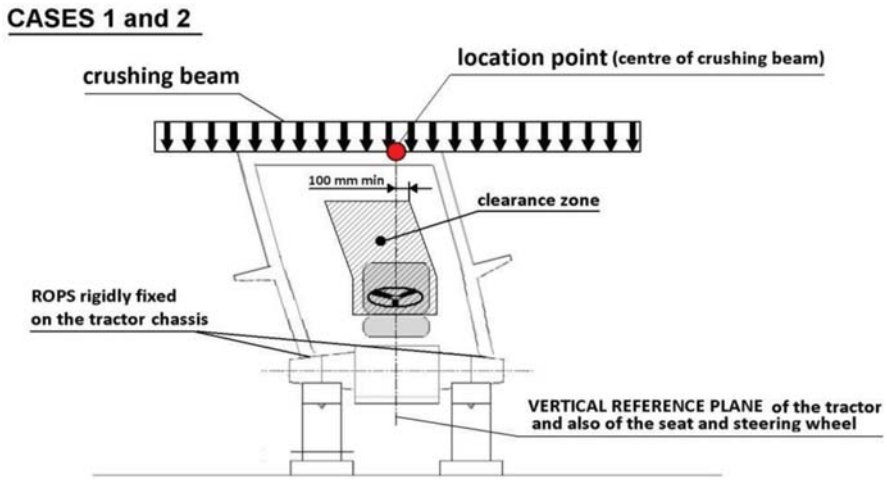
Case 1: when the ROPS, the seat and the steering wheel are rigidly fixed to the tractor body;

Case 2: when the ROPS is rigidly fixed to the tractor body, and the seat and the steering wheel are located on a floor (suspended or not) but they are **NOT** connected to the ROPS.

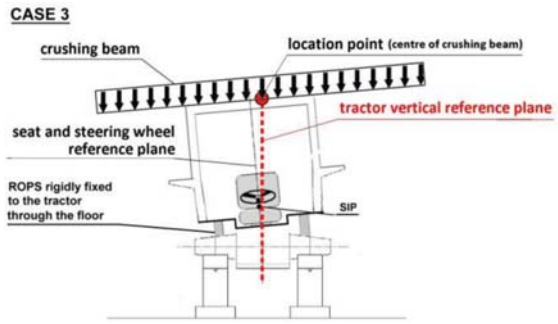
In these cases, the vertical reference plane referred to the seat and steering wheel includes normally also the centre of gravity of the tractor *during the execution of the entire series of loadings*.

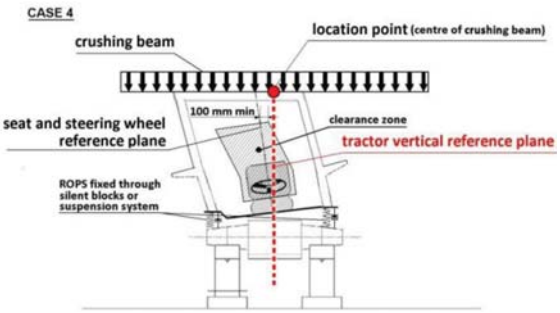
Figure 4.10

The crushing force is applied with the beam having its centre point passing only in the vertical reference plane of the tractor



Cases 3 and 4 can be defined, in which the ROPS is fixed to a platform, rigidly fixed (case 3) or suspended (case 4) in respect to the tractor chassis. *These joining or linkage solutions cause different movements to cabs and clearance zone as well as the vertical reference plane*.





▼B

Table 4.2

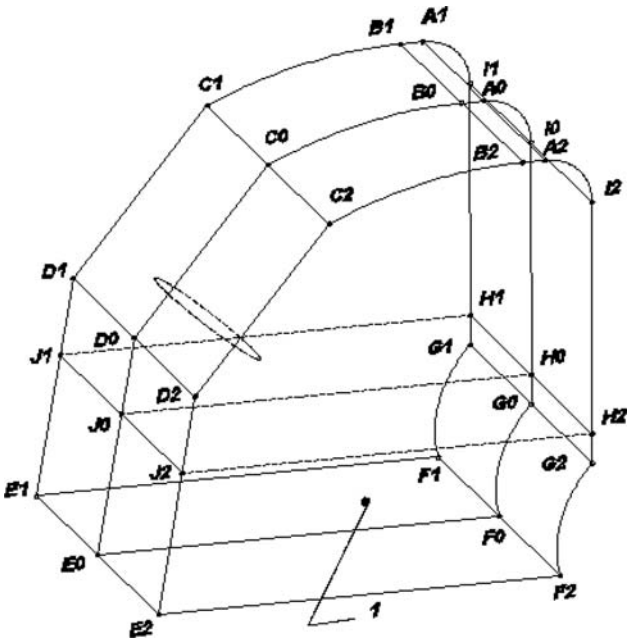
Dimensions of the clearance zone

Dimensions	mm	Remarks
A_1 A_0	100	minimum
B_1 B_0	100	minimum
F_1 F_0	250	minimum
F_2 F_0	250	minimum
G_1 G_0	250	minimum
G_2 G_0	250	minimum
H_1 H_0	250	minimum
H_2 H_0	250	minimum
J_1 J_0	250	minimum
J_2 J_0	250	minimum
E_1 E_0	250	minimum
E_2 E_0	250	minimum
D_0 E_0	300	minimum
J_0 E_0	300	minimum
A_1 A_2	500	minimum
B_1 B_2	500	minimum
C_1 C_2	500	minimum
D_1 D_2	500	minimum
I_1 I_2	500	minimum
F_0 G_0	—	depending on the tractor
I_0 G_0	—	
C_0 D_0	—	
E_0 F_0	—	

▼B

Figure 4.11

Clearance zone



Key:

1 — Seat index point

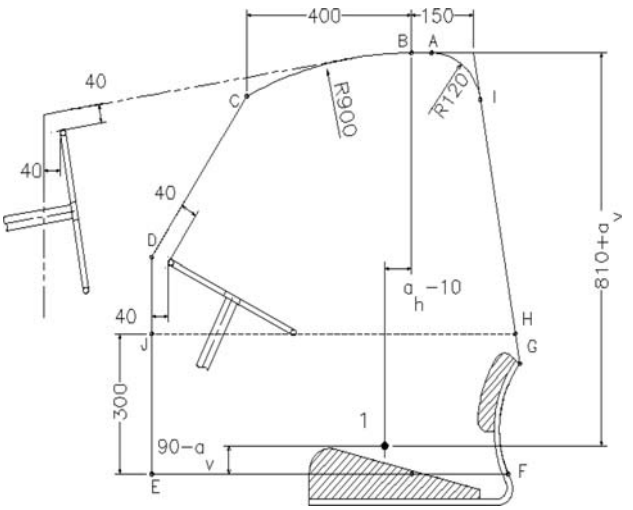
Note: for dimensions, see Table 4.2 above

Figure 4.12

Clearance zone

Figure 4.12.a

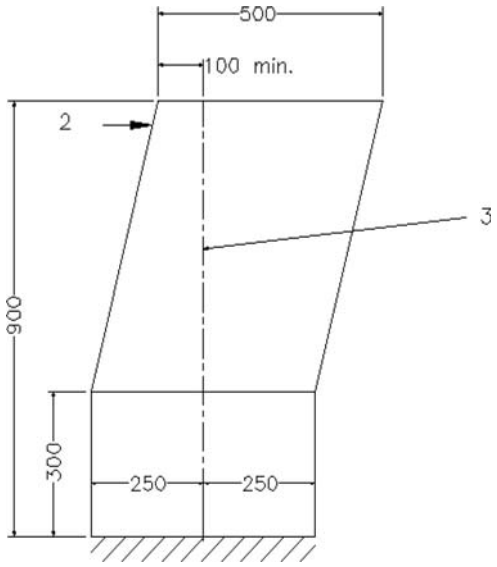
Side view section in reference plan



▼B

Figure 4.12.b

Rear or front view



Key:

1 — Seat index point

2 — Force

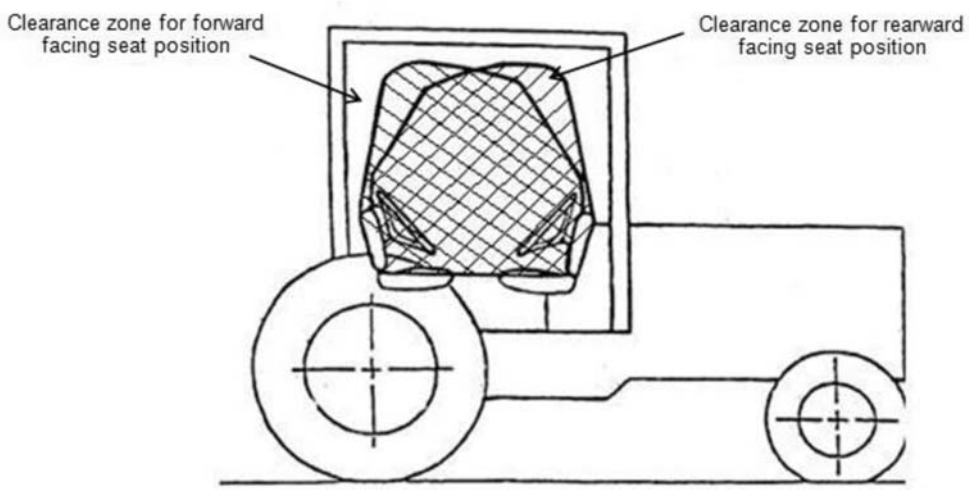
3 — Vertical reference plane

Figure 4.13

Clearance zone for tractor with reversible seat and steering wheel, protective cab and rear roll bar frame

Figure 4.13.a

Protective cab



▼B

Figure 4.13.b

Rear roll bar frame

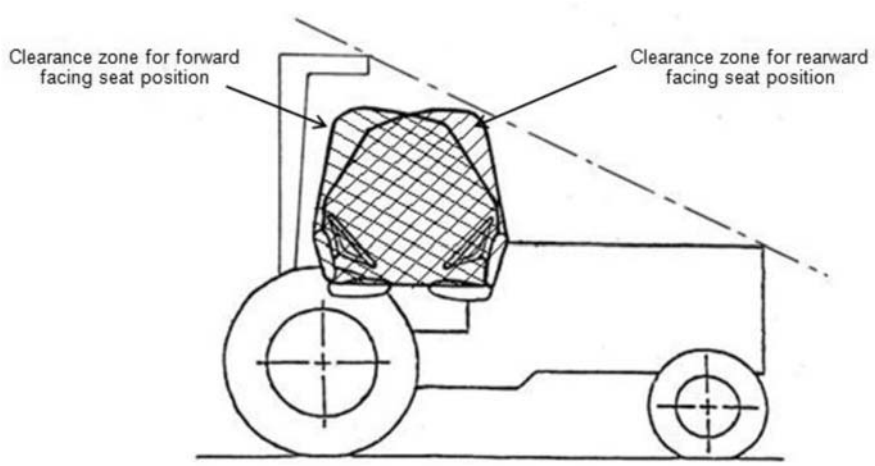
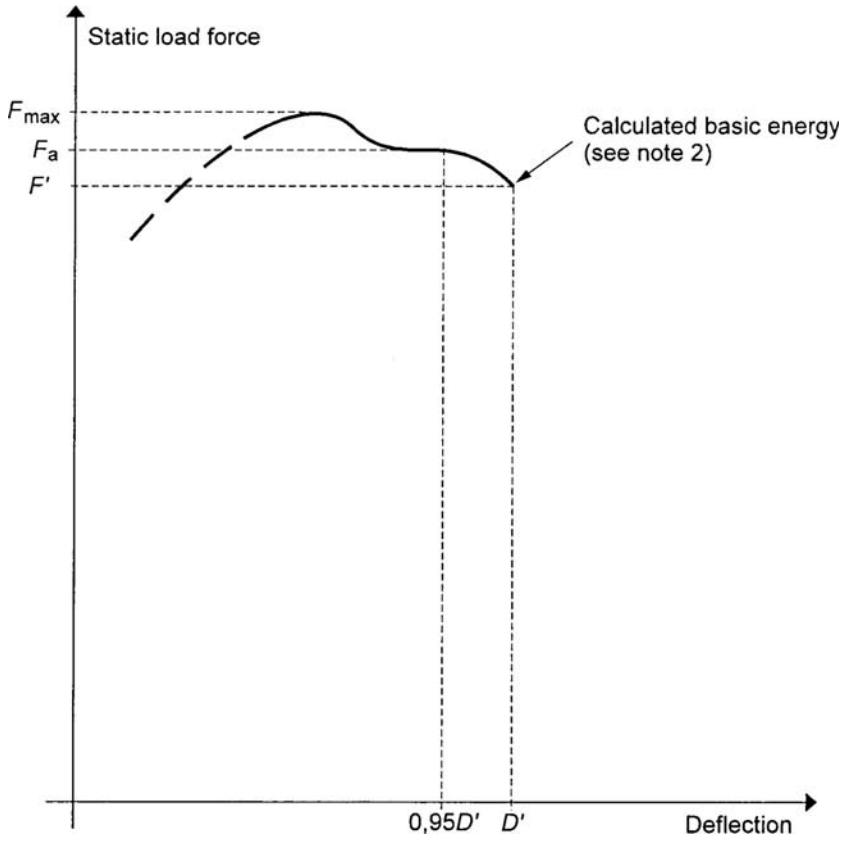


Figure 4.14

Force/deflection curve

Overload test not necessary



Notes:

1. Locate F_a in relation to 0,95 D'

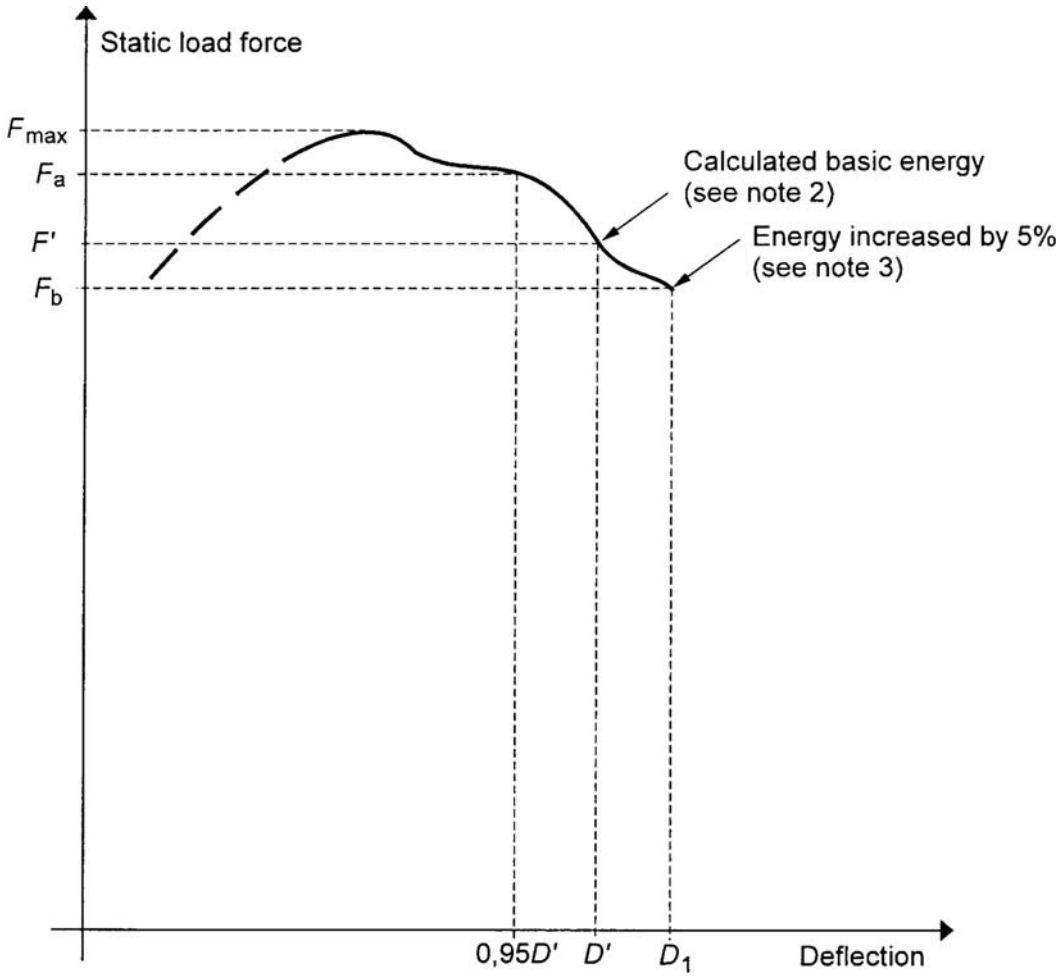
2. Overload test not necessary as $F_a \leq 1{,}03$ F'

▼B

Figure 4.15

Force/deflection curve

Overload test necessary



Notes:

1. Locate Fa in relation to 0,95 D'

2. Overload test necessary as $F_a > 1{,}03\ F'$

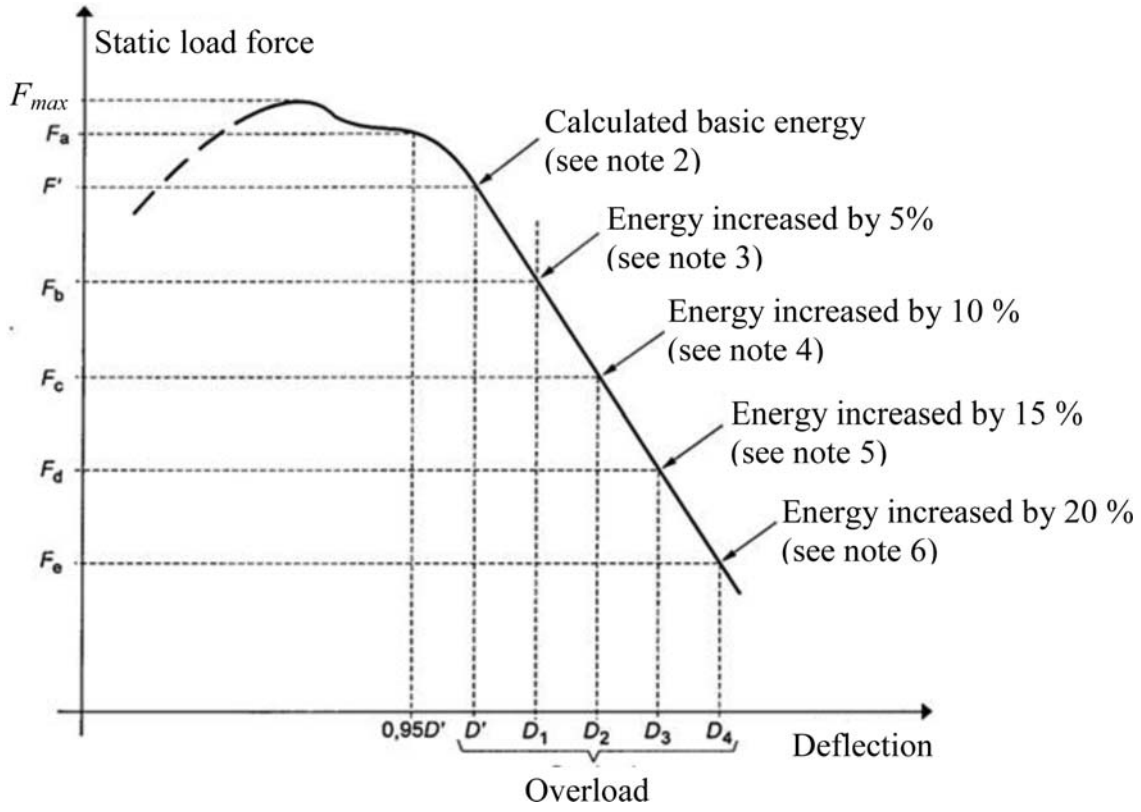
3. Overload test performance satisfactory as Fb > 0,97 F' and Fb > 0,8 F max

▼B

Figure 4.16

Force/deflection curve

Overload test to be continued



Notes:

1. Locate F_a in relation to 0,95 D'
2. Overload test necessary as $F_a > 1{,}03$ F'
3. $F_b < 0{,}97$ F' therefore further overload necessary
4. $F_c < 0{,}97$ Fb therefore further overload necessary
5. $F_d < 0{,}97$ Fc therefore further overload necessary
6. Overload test performance satisfactory, if Fe > 0,8 F max
7. Failure at any stage when load drops below 0,8 F max

Explanatory notes to Annex VIII

(1) Unless otherwise stated, the text of the requirements and the numbering set out in point B are identical with the text and numbering of the OECD standard Code for the official testing of protective structures on agricultural and forestry tractors (static test), OECD Code 4, Edition 2015 of July 2014.

(2) Users are reminded that the seat index point is determined according to ISO 5353:1995 and is a fixed point with respect to the tractor that does not move as the seat is adjusted away from the mid-position. For purposes of determining the clearance zone, the seat shall be placed in the rear and uppermost position.

(3) Permanent + elastic deflection measured at the point when the required energy level is obtained.

▼B

ANNEX IX

Requirements applying to roll-over protection structures (front mounted roll-over protective structures on narrow-track tractors)

A. GENERAL PROVISIONS

1. The Union requirements applying to roll-over protection structures (front mounted roll-over protective structures on narrow-track tractors) are set out in point B.

2. Tests may be performed in accordance with the static or alternatively the dynamic test procedures as set out in sections B1 and B2. The two methods are deemed equivalent.

3. In addition to the requirements set out in point 2, the requirements for foldable ROPS performance set out in section B3 shall be met.

4. In section B4 is set out the computer programme for determining the continuous or interrupted roll over behaviour which shall be used for the virtual testing.

B. REQUIREMENTS APPLYING TO ROLL-OVER PROTECTION STRUCTURES (FRONT MOUNTED ROLL-OVER PROTECTIVE STRUCTURES ON NARROW-TRACK TRACTORS)[1]

1. **Definitions**

1.1 [Not applicable]

1.2. *Roll-Over Protective Structure (ROPS)*

Roll-over protective structure (protective cab or frame), hereinafter called ‘protective structure’, means the structure on a tractor the essential purpose of which is to avoid or limit risks to the driver resulting from roll-over of the tractor during normal use.

The roll-over protective structure is characterized by the provision of space for a clearance zone large enough to protect the driver when seated 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.

1.3. *Track*

1.3.1. Preliminary definition: median plane of the wheel

The median plane of the wheel is equidistant from the two planes containing the periphery of the rims at their outer edges.

1.3.2. Definition of track

The vertical plane through the wheel axis intersects its median plane along a straight line which meets the supporting surface at one point. If A and B are the two points thus defined for the wheels on the same axle of the tractor, then the track width is the distance between points A and B. The track may be thus defined for both front and rear wheels. Where there are twin wheels, the track is the distance between two planes each being the median plane of the pairs of wheels.

▼B

1.3.3. Additional definition: median plane of the tractor

Take the extreme positions of points A and B for the tractor rear axle, which gives the maximum possible value for the track. The vertical plane at right angles to the line AB at its centre point is the median plane of the tractor.

1.4. *Wheelbase*

The distance between the vertical planes passing through the two lines AB as defined above, one for the front wheels and one for the rear-wheels.

1.5. *Determination of seat index point; seat location and adjustment for test*

1.5.1. Seat index point (SIP)[2]

The seat index point shall be determined in accordance with ISO 5353:1995

1.5.2. Seat location and adjustment for test

1.5.2.1. where the seat position is adjustable, the seat must be adjusted to its rear uppermost position;

1.5.2.2. where the inclination of the backrest is adjustable, it must be adjusted to the mid position;

1.5.2.3. where the seat is equipped with suspension, the latter must be blocked at mid-travel, unless this is contrary to the instructions clearly laid down by the seat manufacturer;

1.5.2.4. where the position of the seat is adjustable only lengthwise and vertically, the longitudinal axis passing through the Seat Index Point shall be parallel with the vertical longitudinal plane of the tractor passing through the centre of the steering wheel and not more than 100 mm from that plane.

1.6. *Clearance zone*

1.6.1. Reference vertical plane and line

The clearance zone (figure 6.1) is defined on the basis of a vertical reference plane and a reference line:

1.6.1.1. The reference plane is a vertical plane, generally longitudinal to the tractor and passing through the Seat Index Point 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 roll-over protective structure.

1.6.1.2. The reference line is the line contained in the reference plane that passes through a point located $140 + a_h$ rearward and $90 - a_v$ below the Seat Index Point and the first point on the steering wheel rim that it intersects when brought to the horizontal.

1.6.2. Determination of the clearance zone for tractors with a non-reversible seat

The clearance zone for tractors with a non-reversible seat is defined in 1.6.2.1 to 1.6.2.11 below and is bounded by the following planes, the tractor being on a horizontal surface, the seat adjusted and located as specified in sections 1.5.2.1 to 1.5.2.4[3], and the steering wheel, where adjustable, adjusted to the mid position for seated driving:

▼B

1.6.2.1. two vertical planes 250 mm on either side of the reference plane, these vertical planes extending 300 mm upwards from the plane defined in 1.6.2.8 below and longitudinally at least 550 mm in front of the vertical plane perpendicular to the reference plane passing (210 – a_h) mm in front of the Seat Index Point;

1.6.2.2. two vertical planes 200 mm on either side of the reference plane, these vertical planes extending 300 mm upwards from the plane defined in 1.6.2.8 below and longitudinally from the surface defined in 1.6.2.11 below to the vertical plane perpendicular to the reference plane passing (210 – a_h) mm in front of the Seat Index Point;

1.6.2.3. an inclined plane perpendicular to the reference plane, parallel with and 400 mm above the reference line, extending backwards to the point where it intersects the vertical plane which is perpendicular to the reference plane and which passes through a point (140 + a_h) mm rearward of the Seat Index Point;

1.6.2.4. an inclined plane, perpendicular to the reference plane which meets the plane defined in 1.6.2.3 above at its rearmost edge and rests on the top of the seat back rest;

1.6.2.5. a vertical plane perpendicular to the reference plane, passing at least 40 mm forward of the steering wheel and at least 760 – a_h forward of the Seat Index Point;

1.6.2.6. a cylindrical surface with its axis perpendicular to the reference plane, having a radius of 150 mm and tangential to the planes defined in 1.6.2.3 and 1.6.2.5;

1.6.2.7. two parallel inclined planes passing through the upper edges of the planes defined in 1.6.2.1 above with the inclined plane on the side where the impact is applied no closer than 100 mm to the reference plane above the zone of clearance;

1.6.2.8. a horizontal plane passing through a point 90 – a_v below the Seat Index Point;

1.6.2.9. two portions of the vertical plane perpendicular to the reference plane passing 210 – a_h forward of the Seat Index Point, both these part planes joining respectively the rearmost limits of the planes defined in 1.6.2.1 above to the foremost limits of the planes defined in 1.6.2.2 above;

1.6.2.10. two portions of the horizontal plane passing 300 mm above plane defined in 1.6.2.8 above, both these part planes joining respectively the uppermost limits of the vertical planes defined in 1.6.2.2 above to the lowermost limits of the oblique planes defined in 1.6.2.7 above;

1.6.2.11. a surface, curved if necessary, whose generating line is perpendicular to the reference plane and rests on the back of the seat backrest.

1.6.3. Determination of the clearance zone for tractors with a reversible driver's position

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

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the basis of above sections 1.6.1 and 1.6.2 for driver's position in normal position and on the basis of sections 1.6.1 and 1.6.2 of Annex X for driver's position in reverse position (see figure 6.2).

1.6.4. Optional seats

1.6.4.1. In case of tractors that could be fitted with optional seats, the envelope comprising the Seat Index Points of all options offered shall be used during the tests. The protective structure shall not enter the larger clearance zone which takes account of these different Seat Index Points.

1.6.4.2. In the case where a new seat option is offered after the test has been performed, a determination shall be made to see whether the clearance zone around the new SIP falls within the envelope previously established. If it does not, a new test must be performed.

1.6.4.3. Optional seat does not include a seat for a person in addition to the driver and from where the tractor cannot be controlled. The SIP shall not be determined because the definition of the clearance zone is in relation to the driver seat.

1.7. *Mass*

1.7.1. Unballasted / Unladen Mass

The mass of the tractor excluding optional accessories but including coolant, oils, fuel, tools plus the protective structure. Not included are optional front or rear weights, tyre ballast, mounted implements, mounted equipment or any specialised components;

1.7.2. Maximum Permissible Mass

The maximum mass of the tractor stated by the manufacturer to be technically permissible and declared on the vehicle's identification plate and/or in the Operator's Handbook;

1.7.3. Reference Mass

The mass, selected by the manufacturer, used in formulae to calculate the height of fall of the pendulum block, the energy inputs and crushing forces to be used in the tests. Must not be less than the unballasted mass and must be sufficient to ensure the Mass Ratio does not exceed 1,75 *(see Sections 1.7.4 and 2.1.3)*;

1.7.4. Mass Ratio

The ratio of $\left(\frac{\text{Max. Permissible Mass}}{\text{Reference Mass}}\right)$ This must not be greater than 1,75.

1.8. *Permissible measurement tolerances*

Linear dimension:		± 3 mm
except for:	- - tyre deflection:	± 1 mm
	- - structure deflection during horizontal loadings:	± 1 mm
	- - height of fall of the pendulum block:	± 1 mm
Masses:		± 0,2 % (of the sensor full scale)
Forces:		± 0,1 % (of the full scale)
Angles:		± 0,1°

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1.9. *Symbols*

a_h	(mm)	Half of the horizontal seat adjustment
a_v	(mm)	Half of the vertical seat adjustment
B	(mm)	Minimum overall width of the tractor;
B_b	(mm)	Maximum outer width of the protective structure;
D	(mm)	Deflection of the structure at the point of impact (dynamic tests) or at the point of, and in line with, the load application (static tests);
D'	(mm)	Deflection of the structure for the calculated energy required;
E_a	(J)	Strain energy absorbed at point when load is removed. Area contained within F-D curve;
E_i	(J)	Strain energy absorbed. Area under F-D curve;
E'_i	(J)	Strain energy absorbed after additional loading following a crack or tear;
E''_i	(J)	Strain energy absorbed in overload test in the event of the load having been removed before starting this overload test. Area under F-D curve;
E_{il}	(J)	Energy input to be absorbed during longitudinal loading;
E_{is}	(J)	Energy input to be absorbed during side loading;
F	(N)	Static load force;
F'	(N)	Loading force for calculated energy required, corresponding to E'_i ;
F-D		Force/deflection diagram;
F_i	(N)	Force applied to rear hard fixture;
F_{max}	(N)	Maximum static load force occurring during loading, with the exception of the overload;
F_v	(N)	Vertical crushing force;
H	(mm)	Falling height of the pendulum block (dynamic tests);
H'	(mm)	Falling height of the pendulum block for additional test (dynamic tests);
I	($kg.m^2$)	Tractor reference moment of inertia about the centre line of the rear wheels, whatever the mass of these rear wheels may be;
L	(mm)	Tractor reference wheelbase;
M	(kg)	Tractor reference mass during strength tests.

2. **Field of application**

2.1. This Annex shall apply to tractors having the following characteristics:

2.1.1. ground clearance of not more than 600 mm beneath the lowest points of the front and rear axles, allowing for the differential;

2.1.2. fixed or adjustable minimum track width with one of the axles less than 1 150 mm fitted with tyres of a larger size. It is assumed that the axle mounted with the wider tyres is set at a track width of not more than 1 150 mm. It must be possible to set the track width of the other axle in such a way that the outer edges of the narrower

▼B

tyres do not go beyond the outer edges of the tyres of the other axle. Where the two axles are fitted with rims and tyres of the same size, the fixed or adjustable track width of the two axles must be less than 1 150 mm;

2.1.3. mass greater than 400 kg but less than 3 500 kg, corresponding to the unladen mass of the tractor, including the roll-over protective structure and tyres of the largest size recommended by the manufacturer. The maximum permissible mass shall not exceed 5 250 kg and the Mass Ratio (Maximum Permissible Mass / Reference Mass) must not be greater than 1,75;

2.1.4. and being fitted with roll-over protective structures of the dual-pillar type mounted only in front of the Seat Index Point and characterised by a reduced clearance zone attributable to the tractor silhouette, thus rendering it inadvisable, under any circumstances, to impede access to the driving position but worthwhile retaining these structures (fold-down or not) in view of their undoubted ease of use.

2.2. It is recognised that there may be designs of tractors, for example, special forestry machines, such as forwarders and skidders, for which this Annex is not applicable.

B1. STATIC TEST PROCEDURE

3. **Rules and directions**

3.1. *Prior conditions for the strength tests*

3.1.1. Completion of two preliminary tests

The protective structure may only be subjected to the strength tests if both the Lateral Stability Test and the Non-Continuous Rolling Test have been satisfactorily completed (see flow diagram as figure 6.3).

3.1.2. Preparation for the preliminary tests

3.1.2.1. The tractor must be equipped with the protective structure in its safety position.

3.1.2.2. The tractor must be fitted with tyres having the greatest diameter indicated by the manufacturer and the smallest cross-section for tyres of that diameter. The tyres must not be liquid-ballasted and must be inflated to the pressure recommended for field work.

3.1.2.3. The rear wheels must be set to the narrowest track width; the front wheels must be set as closely as possible to the same track width. If it is possible to have two front track settings which differ equally from the narrowest rear track setting, the wider of these two front track settings must be selected.

3.1.2.4. All the tractor's tanks must be filled or the liquids must be replaced by an equivalent mass in the corresponding position.

3.1.2.5. All attachments used in the series production shall be fixed to the tractor in the normal position.

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3.1.3. Lateral stability test

3.1.3.1. The tractor, prepared as specified above, is placed on a horizontal plane so that the tractor front-axle pivot point or, in the case of an articulated tractor, the horizontal pivot point between the two axles can move freely.

3.1.3.2. Using a jack or a hoist, tilt the part of the tractor which is rigidly connected to the axle that bears more than 50 per cent of the tractor's weight, while constantly measuring the angle of inclination. This angle must be at least 38° at the moment when the tractor is resting in a state of unstable equilibrium on the wheels touching the ground. Perform the test once with the steering wheel turned to full right lock and once with the steering wheel turned to full left lock.

3.1.4. Non-continuous rolling test

3.1.4.1. General remarks

This test is intended to check whether a structure fitted to the tractor for the protection of the driver can satisfactorily prevent continuous roll-over of the tractor in the event of its overturning laterally on a slope with a gradient of 1 in 1.5 (figure 6.4).

Evidence of non-continuous rolling can be provided in accordance with one of the two methods described in 3.1.4.2 and 3.1.4.3.

3.1.4.2. Demonstration of non-continuous rolling behaviour by means of the overturning test

3.1.4.2.1. The overturning test must be carried out on a test slope at least four metres long (see figure 6.4). The surface must be covered with an 18-cm layer of a material that, as measured in accordance with Standards ASAE S313.3 FEB1999 and ASAE EP542 FEB1999 relating to soil cone penetrometer, has a cone penetration index of:

$$A = 235 \pm 20$$

or

$$B = 335 \pm 20$$

3.1.4.2.2. The tractor (prepared as described in paragraph 3.1.2) is tilted laterally with zero initial speed. For this purpose, it is placed at the start of the test slope in such a way that the wheels on the downhill side rest on the slope and the tractor's median plane is parallel with the contour lines. After striking the surface of the test slope, the tractor may lift itself from the surface by pivoting about the upper corner of the protective structure, but it must not roll over. It must fall back on the side which it first struck.

3.1.4.3. Demonstration of non-continuous rolling behaviour by calculation

3.1.4.3.1. For the purpose of verifying non-continuous rolling behaviour by calculation, the following characteristic tractor data must be ascertained (see figure 6.5):

B_0	(m)	Rear tyre width;
B_6	(m)	Width of protective structure between the right and left points of impact;

▼B

B_7	(m)	Width of engine bonnet;
D_0	(rad)	Front-axle swing angle from zero position to end of travel;
D_2	(m)	Height of front tyres under full axle load;
D_3	(m)	Height of rear tyres under full axle load;
H_0	(m)	Height of the front-axle pivot point;
H_1	(m)	Height of centre of gravity;
H_6	(m)	Height at the point of impact;
H_7	(m)	Height of engine bonnet;
L_2	(m)	Horizontal distance between the centre of gravity and front axle;
L_3	(m)	Horizontal distance between the centre of gravity and rear axle;
L_6	(m)	Horizontal distance between the centre of gravity and the leading point of intersection of the protective structure (to be preceded by a minus sign if this point lies in front of the plane of the centre of gravity);
L_7	(m)	Horizontal distance between the centre of gravity and the front corner of the engine bonnet;
M_c	(kg)	Tractor mass used for calculation;
Q	(kgm^2)	Moment of inertia about the longitudinal axis through the centre of gravity;
S	(m)	Rear track width. The sum of the track (S) and tyre (B_0) widths must be greater than the width B_6 of the protective structure.

3.1.4.3.2. For the purposes of calculation, the following simplifying assumptions can be made:

3.1.4.3.2.1. the stationary tractor overturns on a slope with a 1/1,5 gradient with a balanced front axle, as soon as the centre of gravity is vertically above the axis of rotation;

3.1.4.3.2.2. the axis of rotation is parallel to the tractor's longitudinal axis and passes through the centre of the contact surfaces of the downhill front and rear wheel;

3.1.4.3.2.3. the tractor does not slide downhill;

3.1.4.3.2.4. impact on the slope is partly elastic, with a coefficient of elasticity of:

$$U = 0,2$$

3.1.4.3.2.5. the depth of penetration into the slope and the deformation of the protective structure together amount to:

$$T = 0,2 \text{ m}$$

3.1.4.3.2.6. no other components of the tractor penetrate into the slope.

▼M1

3.1.4.3.3. The computer programme (BASIC) for determining the continuous or interrupted roll-over behaviour of a laterally overturning narrow-track tractor with a front-mounted roll-over protective structure is described in section B4, with examples 6.1 to 6.11.

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3.1.5. Measurement methods

3.1.5.1. Horizontal distances between the centre of gravity and rear (L_3) or front (L_2) axles

The distance between the rear and front axles on both sides of the tractor shall be measured in order to verify there is no steering angle.

The distances between the centre of gravity and the rear axle (L_3) or the front axle (L_2) shall be calculated from the mass distribution of the tractor between the rear and the front wheels.

3.1.5.2. Heights of rear (D_3) and front (D_2) tyres

The distance from the highest point of the tyre to the ground plane shall be measured (figure 6.5), and the same method shall be used for the front and rear tyres.

3.1.5.3. Horizontal distance between the centre of gravity and the leading point of intersection of the protective structure (L_6).

The distance between the centre of gravity and the leading point of intersection of the protective structure shall be measured (figures 6.6.a, 6.6.b and 6.6.c). If the protective structure is in front of the plane of the centre of gravity, the recorded measure will be preceded by a minus sign ($– L_6$).

3.1.5.4. Width of the protective structure (B_6)

The distance between the right and left points of impact of the two vertical posts of the structure shall be measured.

The point of impact is defined by the plane tangent to the protective structure passing through the line made by the top outer points of the front and rear tyres (figure 6.7).

3.1.5.5. Height of the protective structure (H_6)

The vertical distance from the point of impact of the structure to the ground plane shall be measured.

3.1.5.6. Height of the engine bonnet (H_7)

The vertical distance from the point of impact of the engine bonnet to the ground plane shall be measured.

The point of impact is defined by the plane tangent to the engine bonnet and the protective structure passing through the top outer points of the front tyre (figure 6.7). The measurement shall be made on both sides of the engine bonnet.

3.1.5.7. Width of the engine bonnet (B_7)

The distance between the two points of impact of the engine bonnet as defined previously shall be measured.

3.1.5.8. Horizontal distance between the centre of gravity and the front corner of the engine bonnet (L_7)

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The distance from the point of impact of the engine bonnet, as defined previously, to the centre of gravity shall be measured.

3.1.5.9. Height of the front-axle pivot point (H_0)

The vertical distance between the centre of the front-axle pivot point to the centre of axle of the front tyres (H_{01}) shall be included in the manufacturer's technical report and shall be checked.

The vertical distance from the centre of the front tyres axle to the ground plane (H_{02}) shall be measured (figure 6.8).

The height of the front-axle pivot (H_0) is the sum of both previous values.

3.1.5.10. Rear track width (S)

The minimum rear track width fitted with tyres of the largest size, as specified by the manufacturer, shall be measured (figure 6.9).

3.1.5.11. Rear tyre width (B_0)

The distance between the outer and the inner vertical planes of a rear tyre in its upper part shall be measured (figure 6.9).

3.1.5.12. Front axle swinging angle (D_0)

The largest angle defined by the swinging of the front axle from the horizontal position to the maximum deflection shall be measured on both sides of the axle, taking into account any end-stroke shock absorber. The maximum angle measured shall be used.

3.1.5.13. Tractor Mass

The tractor mass shall be determined according to the conditions specified in section 1.7.1.

3.2. *Conditions for testing the strength of protective structures and of their attachment to tractors*

3.2.1. General requirements

3.2.1.1. Test purposes

Tests made using special rigs are intended to simulate such loads as are imposed on a protective structure, when the tractor overturns. These tests enable observations to be made on the strength of the protective structure and any brackets attaching it to the tractor and any parts of the tractor which transmit the test load.

3.2.1.2. Test methods

Tests may be performed in accordance with the static procedure or the dynamic procedure (see Annex A). The two methods are deemed equivalent.

3.2.1.3. General rules governing preparation for tests

3.2.1.3.1. The protective structure must conform to the series production specifications. It shall be attached in accordance with the manufacturer's recommended method to one of the tractors for which it is designed.

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Note: A complete tractor is not required for the static strength test; however, the protective structure and parts of the tractor to which it is attached represent an operating installation, hereinafter referred to as 'the assembly'.

3.2.1.3.2. For both the static test and the dynamic test the tractor as assembled (or the assembly) must be fitted with all series production components which may affect the strength of the protective structure or which may be necessary for the strength test.

Components which may create a hazard in the clearance zone must also be fitted on the tractor (or the assembly) so that they may be examined to see whether the requirements of the Acceptance Conditions in 3.2.3 have been fulfilled.

All components of the tractor or the protective structure including weather protective must be supplied or described on drawings.

3.2.1.3.3. For the strength tests, all panels and detachable non-structural components must be removed so that they may not contribute to the strengthening of the protective structure.

3.2.1.3.4. The track width must be adjusted so that the protective structure will, as far as possible, not be supported by the tyres during the strength tests. If these tests are conducted in accordance with the static procedure, the wheels may be removed.

3.2.2. Tests

3.2.2.1. Sequence of tests according to the Static Procedure

The sequence of tests, without prejudice to the additional tests mentioned in sections 3.3.1.6, and 3.3.1.7 is as follows:

(1) **loading at the rear of the structure**

(see 3.3.1.1);

(2) **rear crushing test**

(see 3.3.1.4);

(3) **loading at the front of the structure**

(see 3.3.1.2);

(4) **loading at the side of the structure**

(see 3.3.1.3);

(5) **crushing at the front of the structure**

(see 3.3.1.5).

3.2.2.2. General requirements

3.2.2.2.1. If, during the test, any part of the tractor restraining equipment breaks or moves, the test shall be restarted.

3.2.2.2 2. No repairs or adjustments of the tractor or protective structure may be carried out during the tests.

3.2.2.2.3. The tractor gear box shall be in neutral and the brakes off during the tests.

3.2.2.2.4. If the tractor is fitted with a suspension system between the tractor body and the wheels, it shall be blocked during the tests.

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3.2.2.2.5. The side chosen for application of the first load on the rear of the structure shall be that which, in the opinion of the testing authorities, will result in the application of the series of loads under the most unfavourable conditions for the structure. The lateral load and the rear load shall be applied on both sides of the longitudinal median plane of the protective structure. The front load shall be applied on the same side of the longitudinal median plane of the protective structure as the lateral load.

3.2.3. Acceptance conditions

3.2.3.1. A protective structure is regarded as having satisfied the strength requirements if it fulfils the following conditions:

3.2.3.1.1. After each part-test it must be free from cracks or tears within the meaning of section 3.3.2.1 or

3.2.3.1.2. If, during one of the crushing tests, significant cracks or tears appear, an additional test, in accordance with section 3.3.1.7, must be applied immediately after the crushing which caused cracks or tears to appear;

3.2.3.1.3. during the tests other than the overload test, no part of the protective structure must enter the clearance zone as defined in 1.6;

3.2.3.1.4. during the tests other than the overload test, all parts of the clearance zone shall be secured by the structure, in accordance with 3.3.2.2;

3.2.3.1.5. during the tests the protective structure must not impose any constraints on the seat structure;

3.2.3.1.6. the elastic deflection, measured in accordance with 3.3.2.4 shall be less than 250 mm.

3.2.3.2. There shall be no accessories presenting a hazard for the driver. There shall be no projecting part or accessory which is liable to injure the driver should the tractor overturn, or any accessory or part which is liable to trap him — for example by the leg or the foot — as a result of the deflections of the structure.

3.2.4. [Not applicable]

3.2.5. Test apparatus and equipment

3.2.5.1. Static testing rig

3.2.5.1.1. The static testing rig must be designed in such a way as to permit thrusts or loads to be applied to the protective structure.

3.2.5.1.2. Provision must be made so that the load can be uniformly distributed normal to the direction of loading and along a flange having a length of one of the exact multiples of 50 between 250 and 700 mm. The stiff beam shall have a vertical face dimension of 150 mm. The edges of the beam in contact with the protective structure shall be curved with a maximum radius of 50 mm.

3.2.5.1.3. The pad shall be capable of being adjusted to any angle in relation to the load direction, in order to be able to follow the angular variations of the structure's load-bearing surface as the structure deflects.

3.2.5.1.4. Direction of the force (deviation from horizontal and vertical):

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— at start of test, under zero load: ± 2°;

— during test, under load: 10° above and 20° below the horizontal. These variations must be kept to a minimum.

3.2.5.1.5. The deflection rate shall be sufficiently slow, less than 5 mm/s so that the load may at all moments be considered as static.

3.2.5.2. Apparatus for measuring the energy absorbed by the structure

3.2.5.2.1. The force versus deflection curve shall be plotted in order to determine the energy absorbed by the structure. There is no need to measure the force and deflection at the point where the load is applied to the structure; however, force and deflection shall be measured simultaneously and co-linearly.

3.2.5.2.2. The point of origin of deflection measurements shall be selected so as to take account only of the energy absorbed by the structure and/or by the deflection of certain parts of the tractor. The energy absorbed by the deflection and/or the slipping of the anchoring must be ignored.

3.2.5.3. Means of anchoring the tractor to the ground

3.2.5.3.1. Anchoring rails with the requisite track width and covering the necessary area for anchoring the tractor in all the cases illustrated must be rigidly attached to a non-yielding base near the testing rig.

3.2.5.3.2. The tractor must be anchored to the rails by any suitable means (plates, wedges, wire ropes, jacks, etc.) so that it cannot move during the tests. This requirement shall be checked during the test, by means of the usual devices for measuring length.

If the tractor moves, the entire test shall be repeated, unless the system for measuring the deflections taken into account for plotting the force versus deflection curve is connected to the tractor.

3.2.5.4. Crushing rig

A rig as shown in figure 6.10 shall be capable of exerting a downward force on a protective structure through a rigid beam approximately 250 mm wide, connected to the load-applying mechanism by means of universal joints. Suitable axle stands must be provided so that the tractor tyres do not bear the crushing force.

3.2.5.5. Other measuring apparatus

The following measuring devices are also needed:

3.2.5.5.1. A device for measuring the elastic deflection (the difference between the maximum momentary deflection and the permanent deflection, see figure 6.11).

3.2.5.5.2. A device for checking that the protective structure has not entered the clearance zone and that the latter has remained within the structure's protection during the test (section 3.3.2.2).

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3.3. *Static test procedure*

3.3.1. Loading and crushing tests

3.3.1.1. Loading at the rear

3.3.1.1.1. The load shall be applied horizontally in a vertical plane parallel to the tractor's median plane.

The load application point shall be that part of the roll-over protective structure likely to hit the ground first in a rearward overturning accident, normally the upper edge. The vertical plane in which the load is applied shall be located at a distance of 1/6 of the width of the top of the protective structure inwards from a vertical plane, parallel to the median plane of the tractor, touching the outside extremity of the top of the protective structure.

If the structure is curved or protruding at this point, wedges enabling the load to be applied thereon shall be added, without thereby reinforcing the structure.

3.3.1.1.2. The assembly shall be lashed to the ground as described in 3.2.6.3.

3.3.1.1.3. The energy absorbed by the protective structure during the test shall be at least:

$$E_{i\,1} = 500 + 0{,}5\ M$$

3.3.1.1.4. For tractors with a reversible driver's position (reversible seat and steering wheel), the same formula shall apply.

3.3.1.2. Loading at the front

3.3.1.2.1. The load shall be applied horizontally, in a vertical plane parallel to the tractor's median plane and located at a distance of 1/6 of the width of the top of the protective structure inwards from a vertical plane, parallel to the median plane of the tractor, touching the outside extremity of the top of the protective structure.

The load application point shall be that part of the roll-over protective structure likely to hit the ground first if the tractor overturned sideways while travelling forward, normally the upper edge.

If the structure is curved or protruding at this point, wedges enabling the load to be applied thereon shall be added, without thereby reinforcing the structure.

3.3.1.2.2. The assembly shall be lashed to the ground as described in 3.2.5.3.

3.3.1.2.3. The energy absorbed by the protective structure during the test shall be at least:

$$E_{i\,1} = 500 + 0{,}5\ M$$

3.3.1.2.4. For tractors with a reversible driver's position (reversible seat and steering wheel), the energy shall be whichever is the higher of the above or either of the following as selected:

$$E_{i\,1} = 2{,}165 \times 10^{-7}\ M \times L^2$$

or

$$E_{i\,1} = 0{,}574\ I$$

▼B

3.3.1.3. Loading from the side

3.3.1.3.1. The side loading shall be applied horizontally, in a vertical plane perpendicular to the tractor's median plane. The load application point shall be that part of the roll-over protective structure likely to hit the ground first in a sideways overturning accident, normally the upper edge.

3.3.1.3.2. The assembly shall be lashed to the ground as described in 3.2.5.3.

3.3.1.3.3. The energy absorbed by the protective structure during the test shall be at least:

$$E_{i\,s} = 1{,}75\ M(B_6 + B)/2B$$

3.3.1.3.4. For tractors with a reversible driver's position (reversible seat and steering wheel), the energy shall be whichever is higher of the above or the following:

$$E_{i\,s} = 1{,}75\ M$$

3.3.1.4. Crushing at the rear

The beam shall be positioned over the rear uppermost structural member(s) and the resultant of crushing forces shall be located in the tractor's median plane. A force F_v shall be applied where:

$$F_v = 20\ M$$

The force F_v shall be maintained for five seconds after cessation of any visually detectable movement of the protective structure.

Where the rear part of the protective structure 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 protective structure with that part of the rear of the tractor capable of supporting the tractor when overturned.

The force shall then be removed, and the crushing beam repositioned over that part of the protective structure which would support the tractor when completely overturned. The crushing force F_v shall then be applied again.

3.3.1.5. Crushing at the front

The beam shall be positioned across the front uppermost structural member(s) and the resultant of crushing forces shall be located in the tractor's median plane. A force F_v shall be applied where:

$$F_v = 20\ M$$

The force F_v shall be maintained for five seconds after the cessation of any visually detectable movement of the protective structure.

Where the front part of the protective structure 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 protective structure with that part of the front of the tractor capable of supporting the tractor when overturned.

The force shall then be removed, and the crushing beam repositioned over that part of the protective structure which would support the tractor when completely overturned. The crushing force F_v shall then be applied again.

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3.3.1.6. Additional overload test (figures 6.14 to 6.16)

An overload test shall be carried out in all cases where the force decreases by more than 3 per cent during the last 5 per cent of the deflection reached when the energy required is absorbed by the structure (see figure 6.15).

The overload test involves the gradual increase of the horizontal load by increments of 5 per cent of the initial energy requirement up to a maximum of 20 per cent of energy added (see figure 6.16).

The overload test is satisfactory if, after each increase by 5, 10 or 15 per cent in the energy required, the force decreases by less than 3 per cent for a 5 per cent increment and remains greater than 0,8 F_{max}.

The overload test is satisfactory if, after the structure has absorbed 20 per cent of the added energy, the force exceeds 0,8 F_{max}.

Additional cracks or tears and/or entry into or lack of protection of the clearance zone due to elastic deflection are permitted during the overload test. However, after the removal of the load, the structure shall not enter the clearance zone, which shall be completely protected.

3.3.1.7. Additional crushing tests

If cracks or tears which cannot be considered as negligible appear during a crushing test, a second, similar crushing, but with a force of 1,2 F_v shall be applied immediately after the crushing test which caused the cracks or tears to appear.

3.3.2. Measurements to be made

3.3.2.1. Fractures and cracks

After each test all structural members, joints and attachment systems shall be visually examined for fractures or cracks, any small cracks in unimportant parts being ignored.

3.3.2.2. Entry into the clearance zone

During each test the protective structure shall be examined to see whether any part of it has entered the clearance zone as defined in 1.6 above.

Furthermore, the clearance zone shall not be outside the protection of the protective structure. For this purpose, it shall be considered to be outside the protection of the structure if any part of it would come in contact with flat ground if the tractor overturned towards the direction from which the test load is applied. For estimating this, the front and rear tyres and track width setting shall be the smallest standard fitting specified by the manufacturer.

3.3.2.3. Rear hard fixture tests

If the tractor is fitted with a rigid section, a housing or other hard fixture placed behind the driver's seat, this fixture shall be regarded as a protective point, in the event of sideways or rear overturning. This hard fixture placed behind the driver's seat shall be capable of withstanding, without breaking or entering the clearance zone, a downward force F_i, where:

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$$F_i = 15\ M$$

applied perpendicularly to the top of the frame in the central plane of the tractor. The initial angle of application of force shall be 40° calculated from a parallel to the ground as shown in figure 6.12. The minimum width of this rigid section shall be 500 mm (see figure 6.13).

In addition, it shall be sufficiently rigid and firmly attached to the rear of the tractor.

3.3.2.4. Elastic deflection under side loading

The elastic deflection shall be measured (810 + a_v) mm above the Seat Index Point, in the vertical plane in which the load is applied. For this measurement, any apparatus similar to that illustrated in figure 6.11 shall be used.

3.3.2.5. Permanent deflection

After the final crushing test the permanent deflection of the protective structure shall be recorded. For this purpose, before the start of the test, the position of the main roll-over protective structure members in relation to the Seat Index Point shall be recorded.

3.4. *Extension to other tractor models*

3.4.1. [Not applicable]

3.4.2. Technical extension

When technical modifications occur on the tractor, the protective structure or the method of attachment of the protective structure to the tractor, the testing station that has carried out the original test can issue a 'technical extension report' if the tractor and protective structure satisfied preliminary tests of lateral stability and non-continuous rolling as defined in 3.1.3 and 3.1.4 and if the rear hard fixture as described in paragraph 3.3.2.3., when fitted, has been tested in accordance with the procedure described in this paragraph (except 3.4.2.2.4) in the following cases:

3.4.2.1. Extension of the structural test results to other models of tractors

The impact or loading and crushing tests need not be carried out on each model of tractor, provided that the protective structure and tractor comply with the conditions referred to hereunder in 3.4.2.1.1 to 3.4.2.1.5.

3.4.2.1.1. The structure (including rear hard fixture) shall be identical to the one tested;

3.4.2.1.2. The required energy shall not exceed the energy calculated for the original test by more than 5 per cent;

3.4.2.1.3. The method of attachment and the tractor components to which the attachment is made shall be identical;

3.4.2.1.4. Any components such as mud-guards and bonnet that may provide support for the protective structure shall be identical;

3.4.2.1.5. The position and critical dimensions of the seat in the protective structure and the relative position of the protective structure on the tractor shall be such that the clearance zone would have remained

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within the protection of the deflected structure throughout all tests (this shall be checked by using the same reference of clearance zone as in the original test report, respectively Seat Reference Point [SRP] or Seat Index Point [SIP]).

3.4.2.2. Extension of the structural test results to modified models of the protective structure

This procedure has to be followed when the provisions of section 3.4.2.1 are not fulfilled, it may not be used when the method of attachment of the protective structure to the tractor does not remain of the same principle (e.g. rubber supports replaced by a suspension device):

3.4.2.2.1. Modifications having no impact on the results of the initial test (e.g. weld attachment of the mounting plate of an accessory in a non-critical location on the structure), addition of seats with different SIP location in the protective structure (subject to checking that the new clearance zone(s) remain(s) within the protection of the deflected structure throughout all tests).

3.4.2.2.2. Modifications having a possible impact on the results of the original test without calling into question the acceptability of the protective structure (e.g. modification of a structural component, modification of the method of attachment of the protective structure to the tractor). A validation test can be carried out and the test results will be drafted in the extension report.

The following limits for this type extension are fixed:

3.4.2.2.2.1. no more than 5 extension may be accepted without a validation test;

3.4.2.2.2.2. the results of the validation test will be accepted for extension if all the acceptance conditions of this Annex are fulfilled and:

— if the deflection measured after each impact test does not deviate from the deflection measured after each impact test in the original test report by more than ± 7 % (in the case of dynamic tests);

— if the force measured when the required energy level has been reached in the various horizontal load tests does not deviate from the force measured when the required energy has been reached in the original test by more than ± 7 % and the deflection measured[4] when the required energy level has been reached in the various horizontal load tests does not deviate from the deflection measured when the required energy has been reached in the original test report by more than ± 7 % (in the case of static tests).

3.4.2.2.2.3. more than one protective structure modification may be included in a single extension report if they represent different options of the same protective structure, but only one validation test can be accepted in a single extension report. The options not tested shall be described in a specific section of the extension report.

3.4.2.2.3. Increase of the reference mass declared by the manufacturer for a protective structure already tested. If the manufacturer wants to keep the same approval number it is possible to issue an extension report after having carried out a validation test (the limits of ± 7 % specified in 3.4.2.2.2.2 are not applicable in such a case).

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3.4.2.2.4. Modification of the rear hard fixture or addition of a new rear hard fixture. It has to be checked that the clearance zone remains within the protection of the deflected structure throughout all test taking into account the new or modified rear hard fixture. A validation of the rear hard fixture consisting in the test described in 3.3.2.3 has to be carried out and the test results will be drafted in the extension report.

3.5. [Not applicable]

3.6. *Cold weather performance of protective structures*

3.6.1. If the protective structure is claimed to have properties resistant to cold weather embrittlement, the manufacturer shall give details that shall be included in the report.

3.6.2. The following requirements and procedures are intended to provide strength and resistance to brittle fracture at reduced temperatures. It is suggested that the following minimum material requirements shall be met in judging the protective structure's suitability at reduced operating temperatures in those countries requiring this additional operating protection.

3.6.2.1. Bolts and nuts used to attach the protective structure to the tractor and used to connect structural parts of the protective structure shall exhibit suitable controlled reduced temperature toughness properties.

3.6.2.2. All welding electrodes used in the fabrication of structural members and mounts shall be compatible with the protective structure material as given in 3.6.2.3 below.

3.6.2.3. Steel materials for structural members of the protective structure shall be of controlled toughness material exhibiting minimum Charpy V-Notch impact energy requirements as shown in Table 6.1. Steel grade and quality shall be specified in accordance with ISO 630:1995.

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

Structural members of the protective structure made from materials other than steel shall have equivalent low temperature impact resistance.

3.6.2.4. When testing the Charpy V-Notch impact energy requirements, the specimen size shall be no less than the largest of the sizes stated in Table 6.1 that the material will permit.

3.6.2.5. The Charpy V-Notch tests shall be made in accordance with the procedure in ASTM A 370-1979, except for specimen sizes that shall be in accordance with the dimensions given in Table 6.1.

3.6.2.6. Alternatives to this procedure are the use of killed or semi-killed steel for which an adequate specification shall be provided. Steel grade and quality shall be specified in accordance with ISO 630:1995, Amd 1:2003.

3.6.2.7. Specimens are to be longitudinal and taken from flat stock, tubular or structural sections before forming or welding for use in the protective structure. Specimens from tubular or structural sections are to be taken from the middle of the side of greatest dimension and shall not include welds.

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Table 6.1.

Minimum Charpy V-notch impact energies

Specimen size	Energy at	Energy at
	– 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 × 3,5	6	15
10 × 3	6	15
10 × 2,5 (a)	5,5	14

(a) Indicates preferred size. Specimen size shall be no less than largest preferred size that the material permits.

(b) The energy requirement at – 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 steel.

3.7. [Not applicable]

Figure 6.1

Clearance zone

Dimensions in mm

Figure 6.1.a

Side view

Cross-section through the reference plane

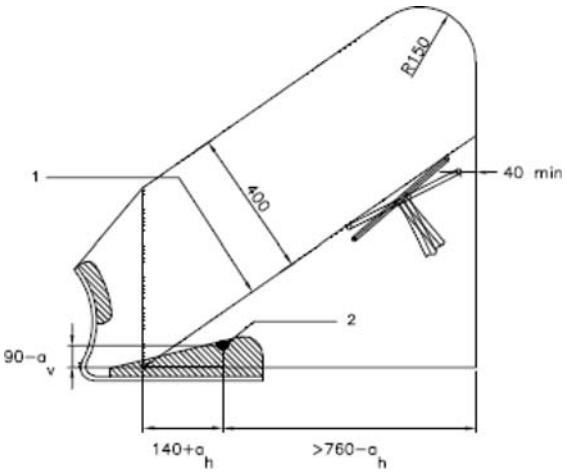
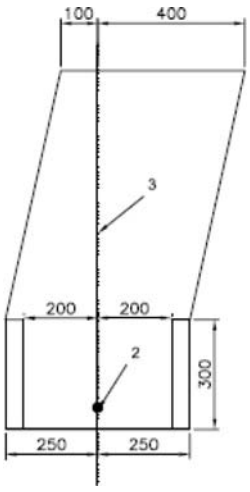


Figure 6.1.b

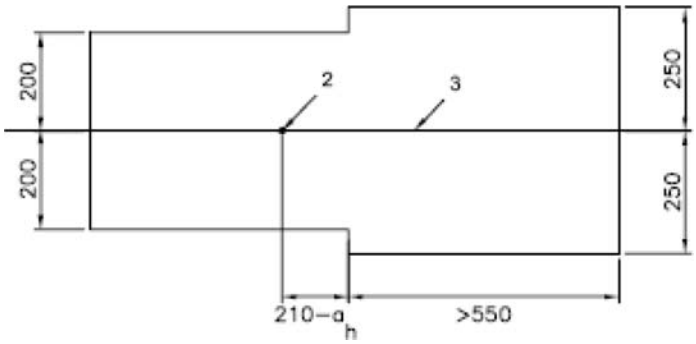
Rear view



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Figure 6.1.c

View from above



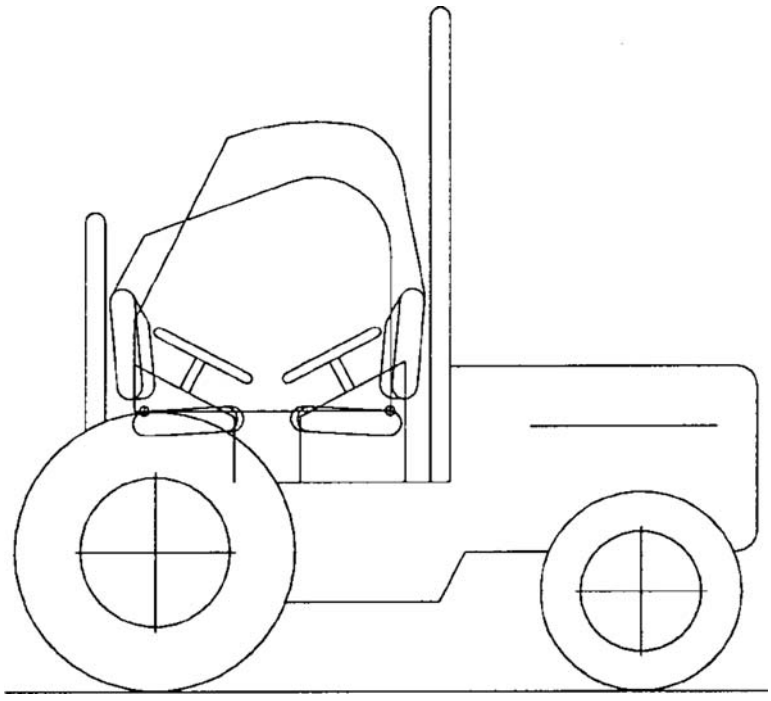
1 – Reference line

2 – Seat index point

3 – Reference plane

Figure 6.2

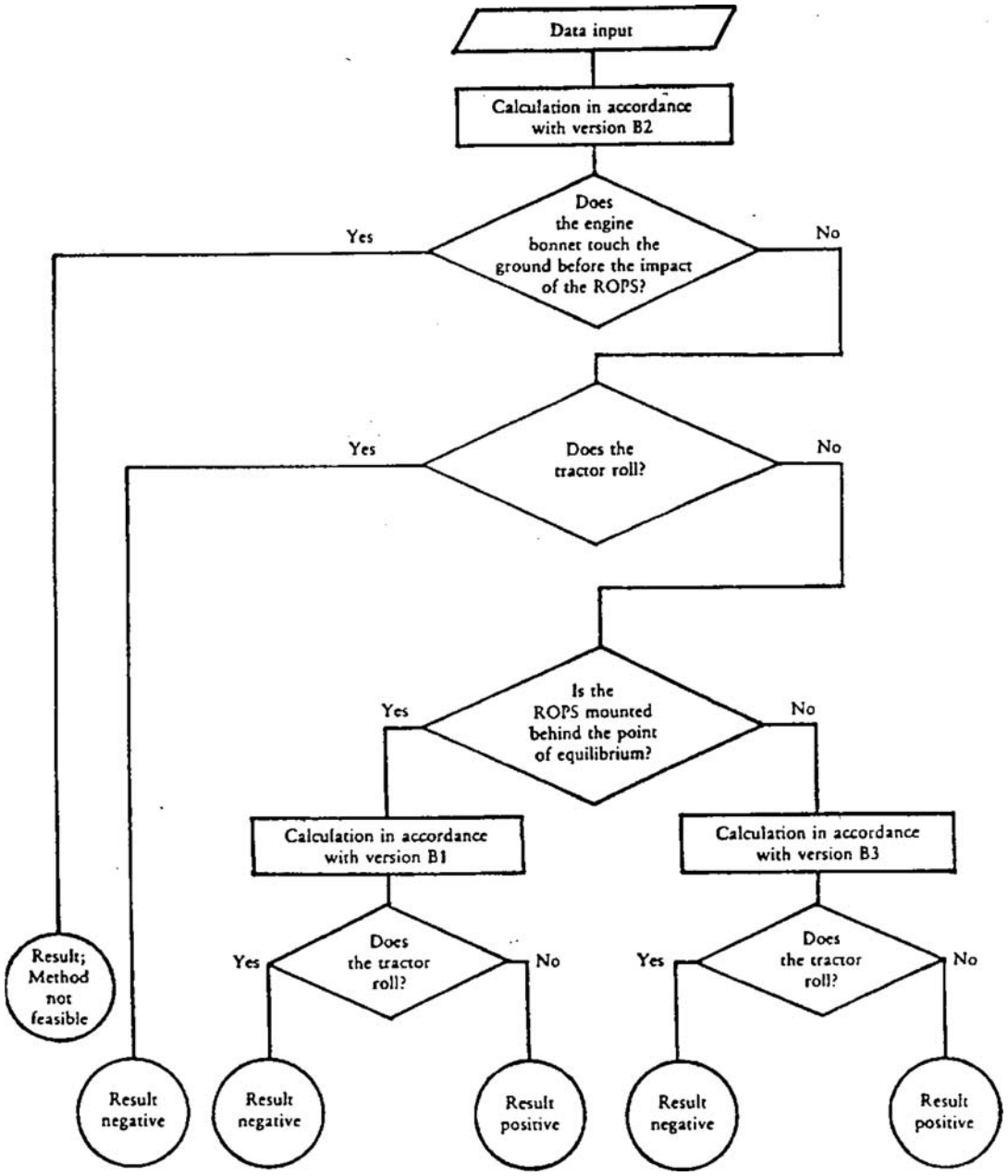
Clearance zone for tractors with reversible seat and steering wheel



▼B

Figure 6.3

Flow diagram for determining the continuous roll-over behaviour of a laterally overturning tractor with a front mounted roll-over protective structure (ROPS)



Version B1: Point of impact of ROPS behind longitudinally unstable equilibrium point

Version B2: Point of impact of ROPS near longitudinally unstable equilibrium point

Version B3: Point of impact of ROPS in front of longitudinally unstable equilibrium point

▼B

Figure 6.4

Rig for testing anti-roll properties on 1/1,5 gradient

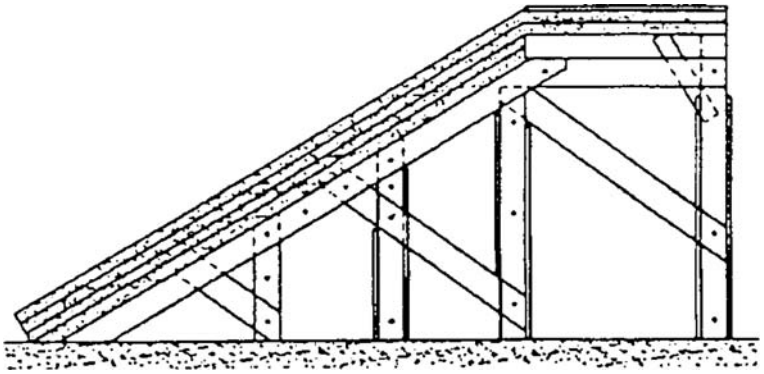
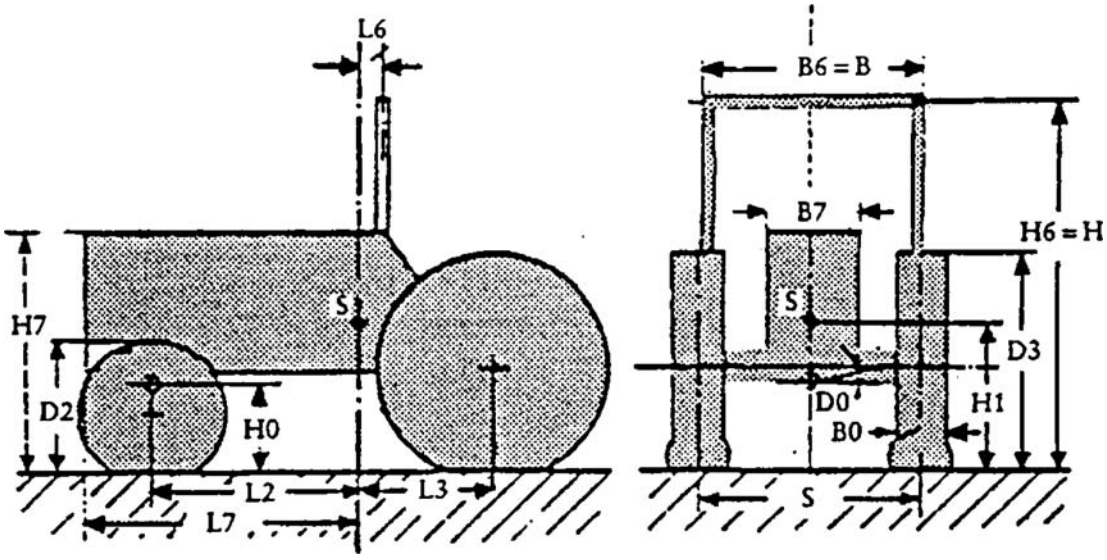


Figure 6.5

Data required for calculating the overturn of a tractor with triaxial rolling behaviour

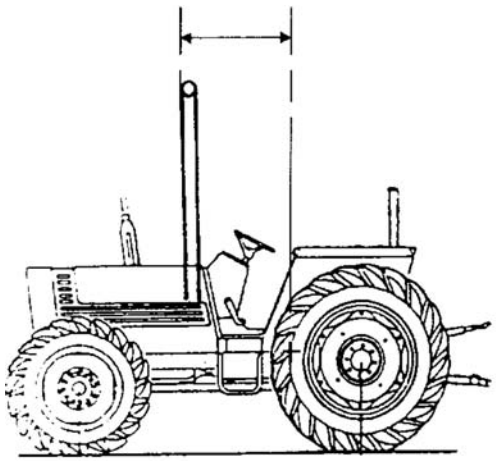


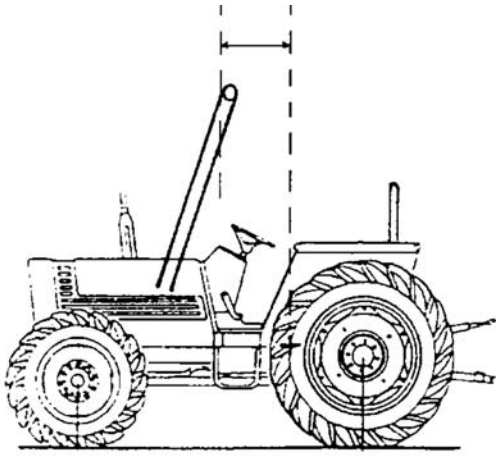
Note: D2 and D3 should be measured under full axle load

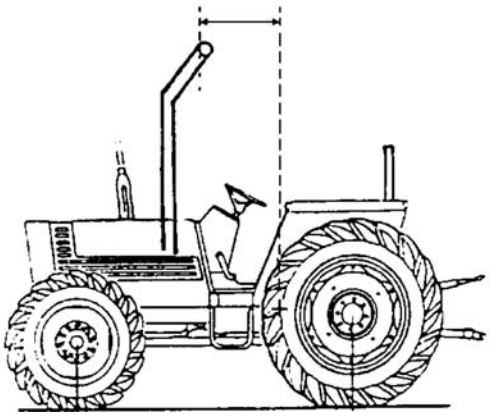
▼B

Figures 6.6.a, 6.6.b, 6.6.c

Horizontal distance between the centre of gravity and the leading point of intersection of the protective structure (L_6)



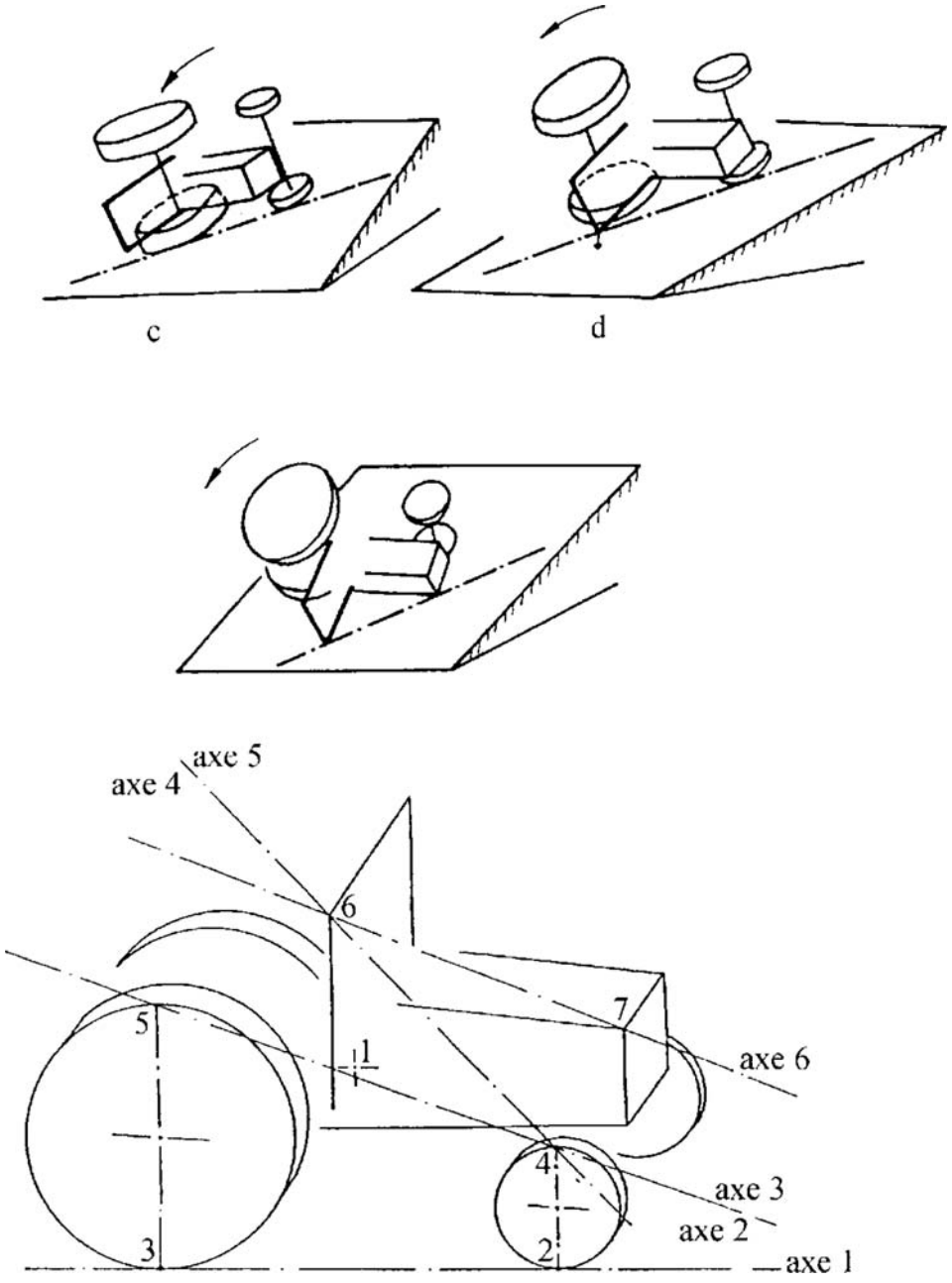




▼B

Figure 6.7

Determination of points of impact for measurement of width of protective structure (B_6) and height of engine bonnet (H_7)



▼B

Figure 6.8

Height of the front-axle pivot point (H_0)

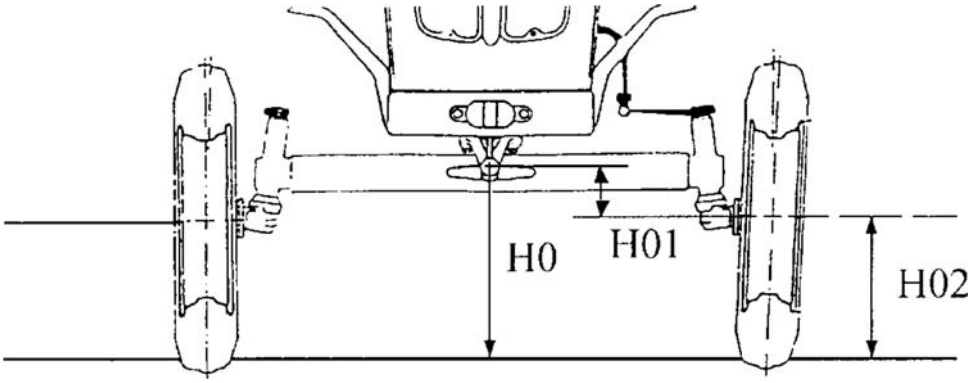
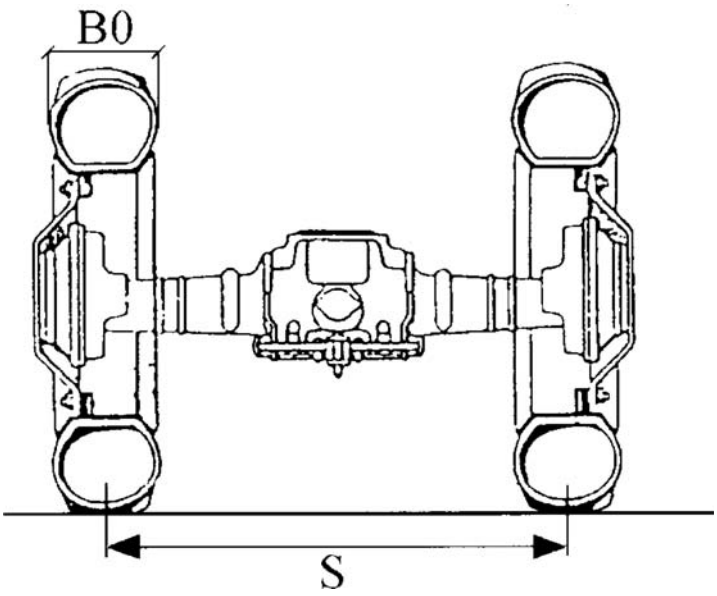


Figure 6.9

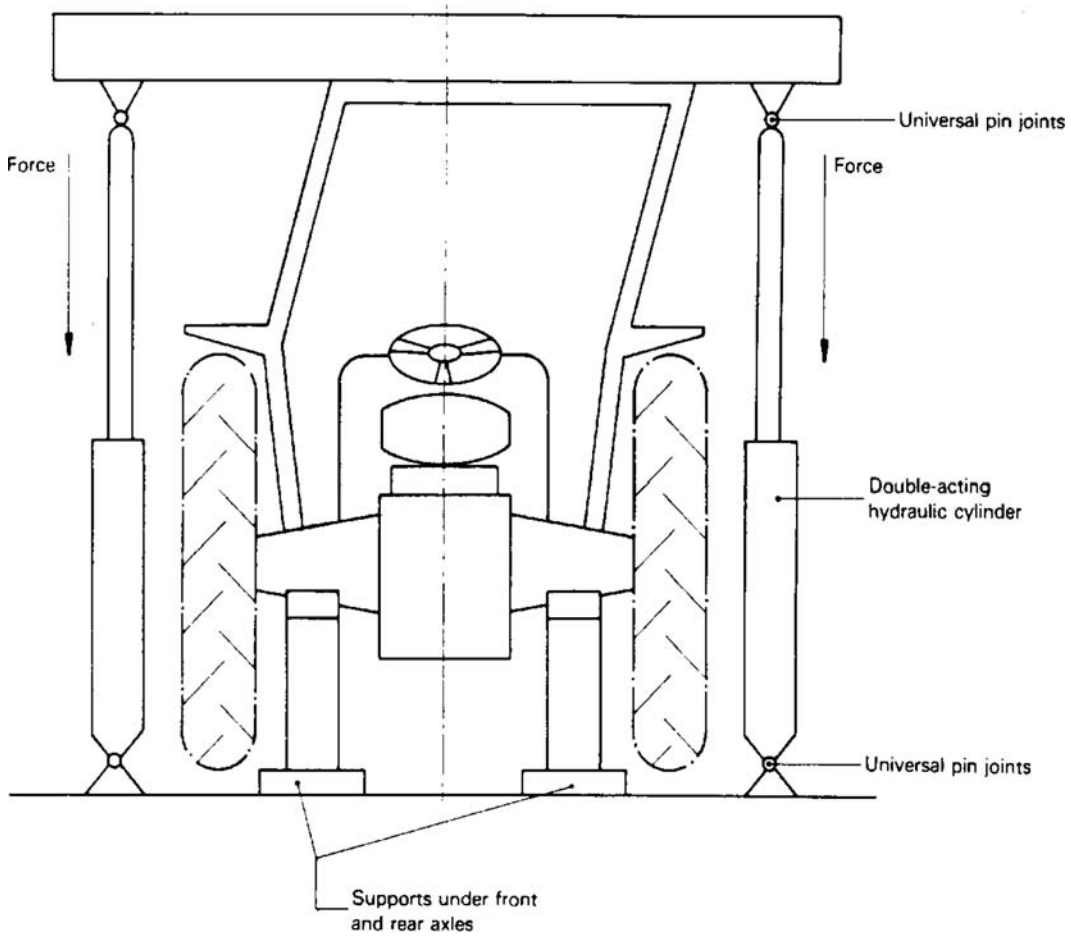
Rear track width (S) and Rear tyre width (B_0)



▼B

Figure 6.10

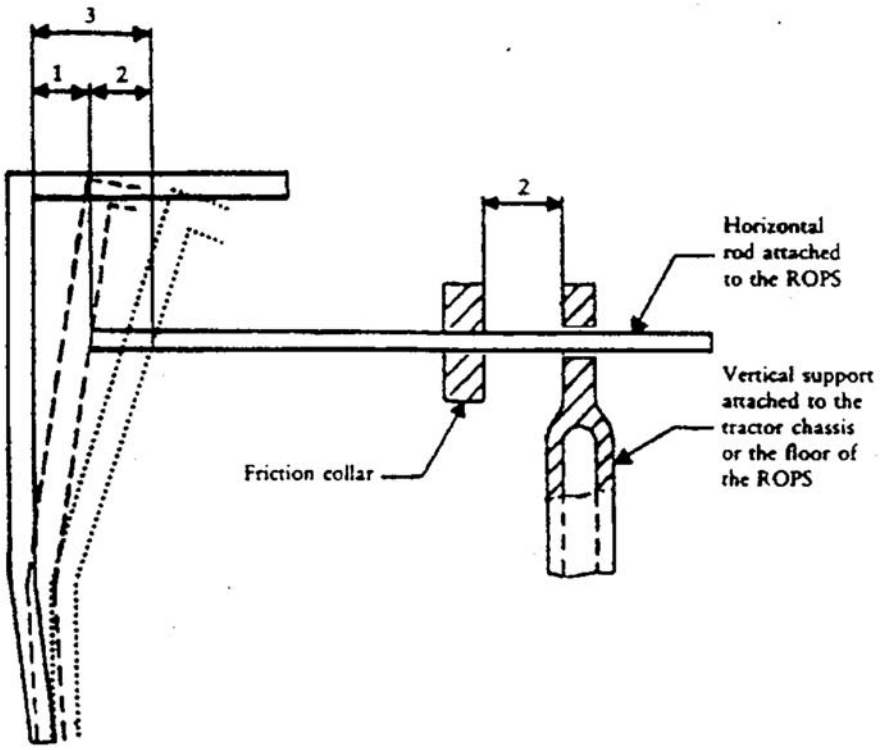
Example of crushing rig of the tractor



▼B

Figure 6.11

Example of apparatus for measuring elastic deflection



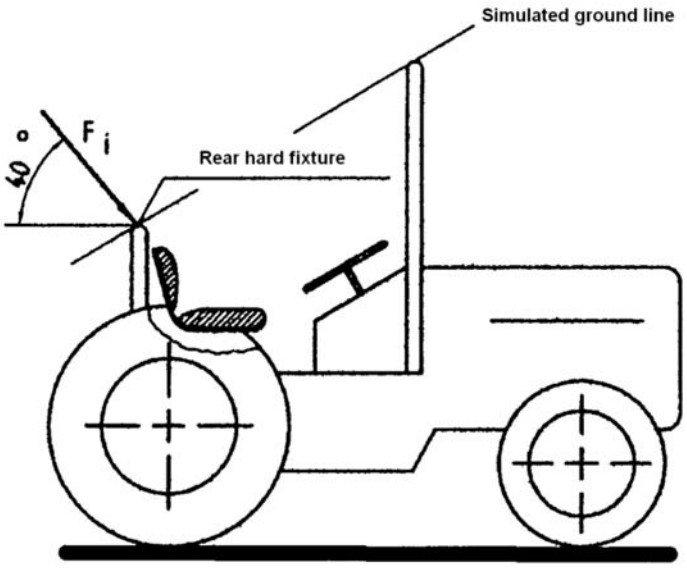
1 – Permanent deflection

2 – Elastic deflection

3 – Total deflection (permanent plus elastic)

Figure 6.12

Simulated ground line



▼B

Figure 6.13

Minimum width of the rear hard fixture

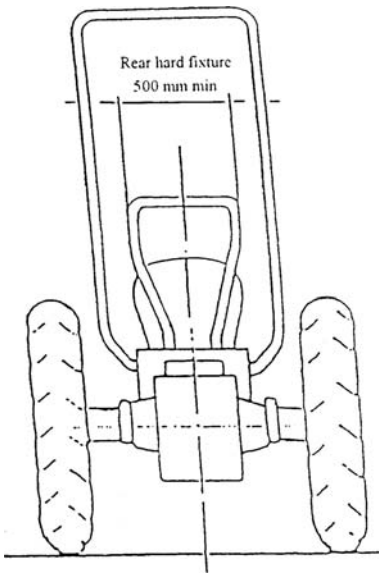
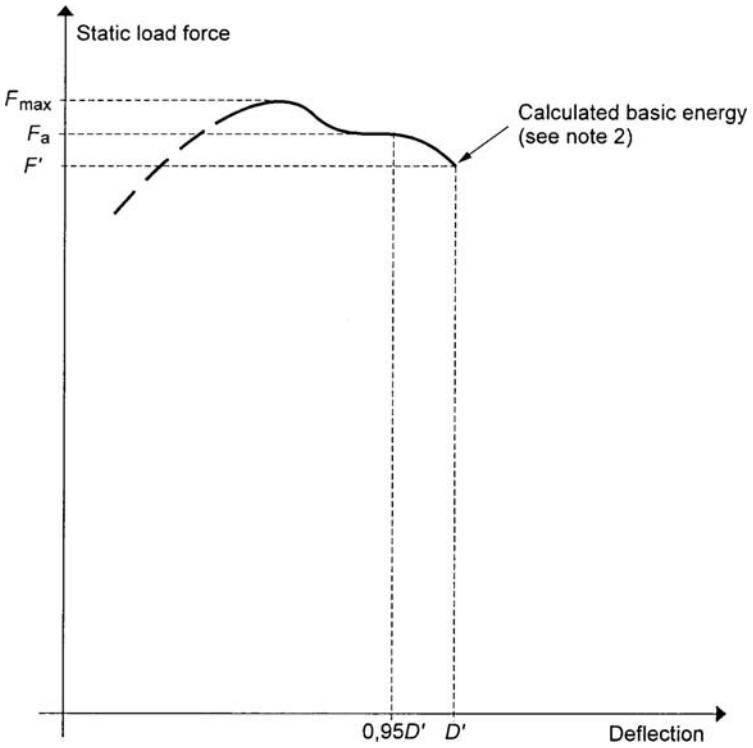


Figure 6.14

Force / deflection curve

Overload test not necessary



Notes:

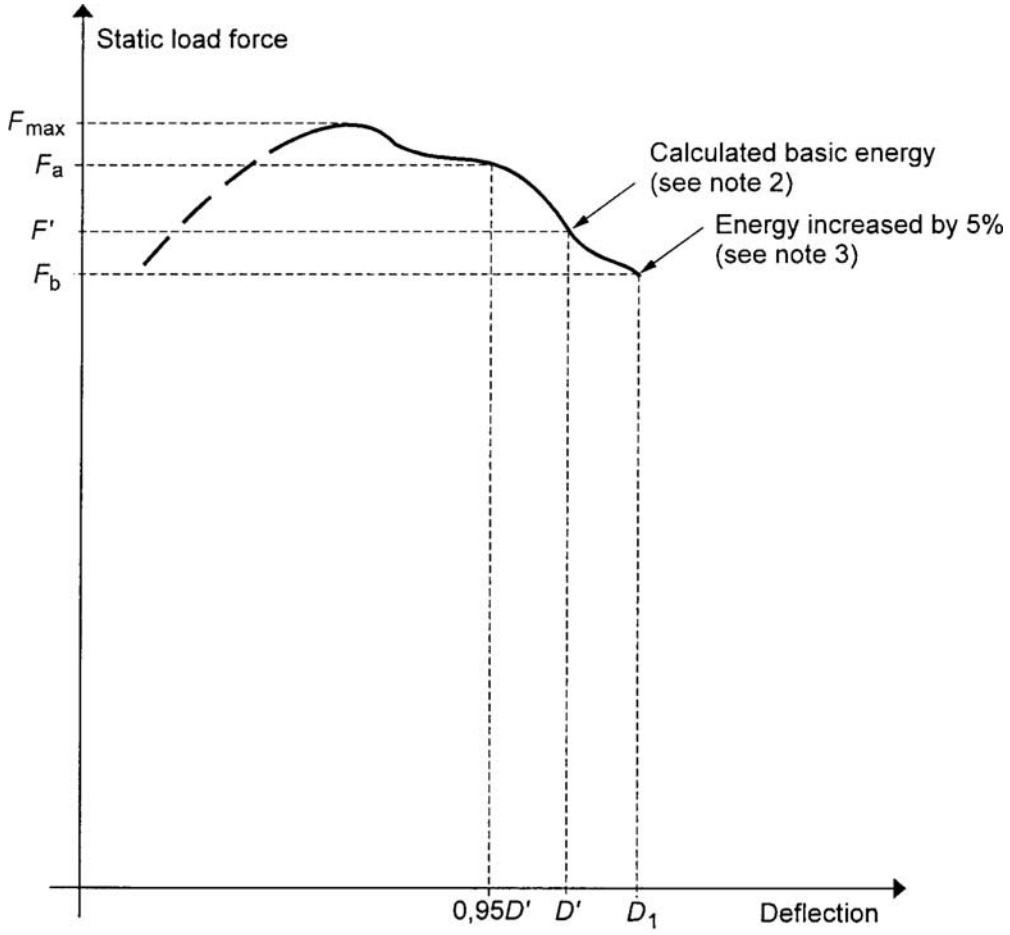
1. Locate F_a in relation to 0,95 D'
2. Overload test not necessary as $F_a \leq 1{,}03$ F'

▼B

Figure 6.15

Force / deflection curve

Overload test necessary



Notes:

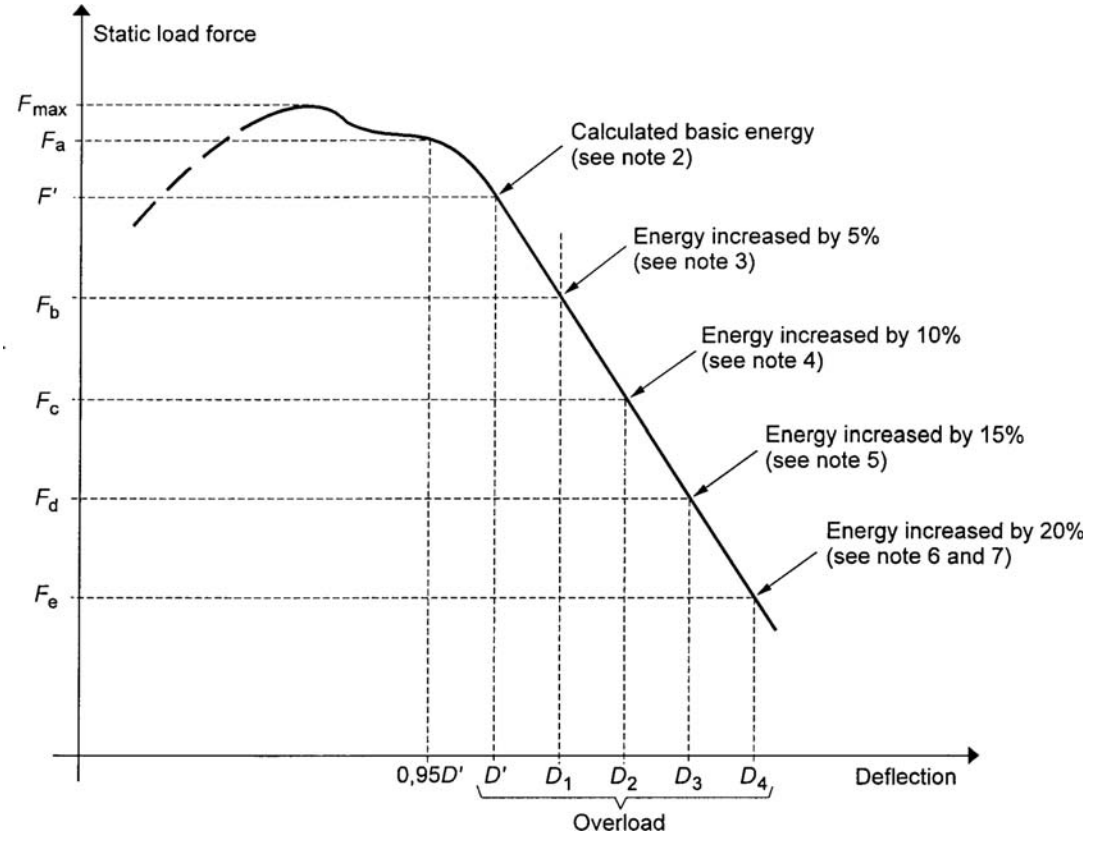
1. Locate Fa in relation to 0,95 D'
2. Overload test necessary as Fa > 1,03 F'
3. Overload test performance satisfactory as Fb > 0,97 F' and Fb > 0,8 F_{max}.

▼B

Figure 6.16

Force / deflection curve

Overload test to be continued



Notes:

1. Locate Fa in relation to 0,95 D'
2. Overload test necessary as $F_a > 1{,}03\ F'$
3. $F_b < 0{,}97\ F'$ therefore further overload necessary
4. $F_c < 0{,}97\ F_b$ therefore further overload necessary
5. $F_d < 0{,}97\ F_c$ therefore further overload necessary
6. Overload test performance satisfactory, if $F_e > 0{,}8\ F_{max}$
7. Failure at any stage when load drops below $0{,}8\ F_{max}$.

▼B

B2. ALTERNATIVE ‘DYNAMIC’ TEST PROCEDURE

This section sets out the Dynamic Testing Procedure alternative to the static test procedure set out in section B1.

4. **Rules and directions**

4.1. *Prior conditions for the strength tests*

See requirements stated for static testing.

4.2. *Conditions for testing the strength of protective structures and of their attachment to tractors*

4.2.1. General requirements

See requirements stated for static testing.

4.2.2. Tests

4.2.2.1. Sequence of tests according to the Dynamic Procedure

The sequence of tests, without prejudice to the additional tests mentioned in sections 4.3.1.6 and 4.3.1.7 is as follows:

(1) **impact at the rear of the structure**

(see 4.3.1.1);

(2) **rear crushing test**

(see 4.3.1.4);

(3) **impact at the front of the structure**

(see 4.3.1.2);

(4) **impact at the side of the structure**

(see 4.3.1.3);

(5) **crushing at the front of the structure**

(see 4.3.1.5).

4.2.2.2. General requirements

4.2.2.2.1. If, during the test, any part of the tractor restraining equipment breaks or moves, the test shall be restarted.

4.2.2.2.2. No repairs or adjustments of the tractor or protective structure may be carried out during the tests.

4.2.2.2.3. The tractor gear box shall be in neutral and the brakes off during the tests.

4.2.2.2.4. If the tractor is fitted with a suspension system between the tractor body and the wheels, it shall be blocked during the tests.

4.2.2.2.5. The side chosen for application of the first impact on the rear of the structure shall be that which, in the opinion of the testing authorities, will result in the application of the series of impacts or loads under the most unfavourable conditions for the structure. The lateral impact and the rear impact shall be applied on both sides of the longitudinal median plane of the protective structure. The front impact shall be applied on the same side of the longitudinal median plane of the protective structure as the lateral impact.

4.2.3. Acceptance conditions

4.2.3.1. A protective structure is regarded as having satisfied the strength requirements if it fulfils the following conditions:

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4.2.3.1.1. After each part-test it must be free from cracks or tears within the meaning of section 4.3.2.1 or

4.2.3.1.2. If, during one of the tests, significant cracks or tears appear, an additional test, as defined in sections 4.3.1.6 or 4.3.1.7, must be applied immediately after the impact or the crushing test which caused cracks or tears to appear;

4.2.3.1.3. during the tests other than the overload test, no part of the protective structure must enter the clearance zone as defined in 1.6;

4.2.3.1.4. during the tests other than the overload test, all parts of the clearance zone shall be secured by the structure, in accordance with 4.3.2.2;

4.2.3.1.5. during the tests the protective structure must not impose any constraints on the seat structure;

4.2.3.1.6. the elastic deflection, measured in accordance with 4.3.2.4 shall be less than 250 mm.

4.2.3.2. There shall be no accessories presenting a hazard for the driver. There shall be no projecting part or accessory which is liable to injure the driver should the tractor overturn, or any accessory or part which is liable to trap him — for example by the leg or the foot — as a result of the deflections of the structure.

4.2.4. [Not applicable]

4.2.5. Apparatus and equipment for dynamic tests

4.2.5.1. Pendulum block

4.2.5.1.1. A block acting as a pendulum must be suspended by two chains or wire ropes from pivot points not less than 6 m above the ground. Means must be provided for adjusting independently the suspended height of the block and the angle between the block and the supporting chains or wire ropes

4.2.5.1.2. The mass of the pendulum block must be 2 000 ± 20 kg excluding the mass of the chains or wire ropes which themselves must not exceed 100 kg. The length of the sides of the impact face must be 680 ± 20 mm (see figure 6.26). The block must be filled in such a way that the position of its centre of gravity is constant and coincides with the geometrical centre of the parallelepiped.

4.2.5.1.3. The parallelepiped must be connected to the system which pulls it backwards by an instantaneous release mechanism which is so designed and located as to enable the pendulum block to be released without causing the parallelepiped to oscillate about its horizontal axis perpendicular to the pendulum's plane of oscillation.

4.2.5.2. Pendulum supports

The pendulum pivot points must be rigidly fixed so that their displacement in any direction does not exceed 1 per cent of the height of fall.

4.2.5.3. Lashings

4.2.5.3.1. Anchoring rails with the requisite track width and covering the necessary area for lashing the tractor in all the cases illustrated (see figures 6.23, 6.24 and 6.25) must be rigidly attached to a non-yielding base beneath the pendulum.

▼B

4.2.5.3.2. The tractor shall be lashed to the rails by means of wire rope with round strand, fibre core, construction 6 × 19 in accordance with ISO 2408:2004 and a nominal diameter of 13 mm. The metal strands must have an ultimate tensile strength of 1 770 MPa.

4.2.5.3.3. The central pivot of an articulated tractor shall be supported and lashed down as appropriate for all tests. For the lateral impact test, the pivot shall also be propped from the side opposite the impact. The front and rear wheels need not be in line if this facilitates the attachment of the wire ropes in the appropriate manner.

4.2.5.4. Wheel prop and beam

4.2.5.4.1. A softwood beam of 150 mm square shall be used as a prop for the wheels during the impact tests (see figures 6.27, 6.28 and 6.29).

4.2.5.4.2. During the lateral impact tests, a softwood beam shall be clamped to the floor to brace the rim of the wheel opposite the side of impact (see figure 6.29).

4.2.5.5. Props and lashings for articulated tractors

4.2.5.5.1. Additional props and lashings must be used for articulated tractors. Their purpose is to ensure that the section of the tractor on which the protective structure is fitted is as rigid as that of a non-articulated tractor.

4.2.5.5.2. Additional specific details are given in the section 4.3.1 for the impact and crushing tests.

4.2.5.6. Tyre pressures and deflections

4.2.5.6.1. The tractor tyres shall not be liquid-ballasted and shall be inflated to the pressures prescribed by the tractor manufacturer for field work.

4.2.5.6.2. The lashings shall be tensioned in each particular case such that the tyres undergo a deflection equal to 12 per cent of the tyre wall height (distance between the ground and the lowest point of the rim) before tensioning.

4.2.5.7. Crushing rig

A rig as shown in figure 6.10 shall be capable of exerting a downward force on a protective structure through a rigid beam approximately 250 mm wide connected to the load-applying mechanism by means of universal joints. Suitable axle stands shall be provided so that the tractor tyres do not bear the crushing force.

4.2.5.8. Measuring apparatus

The following measuring apparatus is needed:

4.2.5.8.1. device for measuring the elastic deflection (the difference between the maximum momentary deflection and the permanent deflection, (see figure 6.11).

4.2.5.8.2. device for checking that the protective structure has not entered the clearance zone and that the latter has remained within the structure's protective during the test (see section 4.3.2.2).

▼B

4.3. *Dynamic test procedure*

4.3.1. Impact and crushing tests

4.3.1.1. Impact at the rear

4.3.1.1.1. The tractor shall be so placed in relation to the pendulum block that the block will strike the protective structure when the impact face of the block and the supporting chains or wire ropes are at an angle with the vertical plane A equal to M/100 with a 20° maximum, unless, during deflection, the protective structure at the point of contact forms a greater angle to the vertical. In this case the impact face of the block shall be adjusted by means of an additional support so that it is parallel to the protective structure at the point of impact at the moment of maximum deflection, the supporting chains or wire ropes remaining at the angle defined above.

The suspended height of the block shall be adjusted and necessary steps taken so as to prevent the block from turning about the point of impact.

The point of impact is that part of the protective structure likely to hit the ground first in a rearward overturning accident, normally the upper edge. The position of the centre of gravity of the block is 1/6 of the width of the top of the protective structure inwards from a vertical plan parallel to the median plane of the tractor touching the outside extremity of the top of the protective structure.

If the structure is curved or protruding at this point, wedges enabling the impact to be applied thereon must be added, without thereby reinforcing the structure.

4.3.1.1.2. The tractor must be lashed to the ground by means of four wire ropes, one at each end of both axles, arranged as indicated in figure 6.27. The spacing between the front and rear lashing points must be such that the wire ropes make an angle of less than 30° with the ground. The rear lashings must in addition be so arranged that the point of convergence of the two wire ropes is located in the vertical plane in which the centre of gravity of the pendulum block travels.

The wire ropes must be tensioned so that the tyres undergo the deflections given in 4.2.5.6.2. With the wire ropes tensioned, the wedging beam shall be placed in front of and tight against the rear wheels and then fixed to the ground.

4.3.1.1.3. If the tractor is of the articulated type, the point of articulation shall, in addition, be supported by a wooden block at least 100 mm square and firmly lashed to the ground.

4.3.1.1.4. The pendulum block shall be pulled back so that the height of its centre of gravity above that at the point of impact is given by one of the following two formulae, to be chosen according to the reference mass of the assembly subjected to the tests:

$$H = 25 + 0{,}07\ M$$

▼B

for tractor with a reference mass of less than 2 000 kg;

$$H = 125 + 0{,}02\ M$$

for tractor with a reference mass of more than 2 000 kg.

The pendulum block is then released and strikes the protective structure.

4.3.1.1.5. For tractors with a reversible driver's position (reversible seat and steering wheel), the same formulae shall apply.

4.3.1.2. Impact at the front

4.3.1.2.1. The tractor shall be so placed in relation to the pendulum block that the block will strike the protective structure when the impact face of the block and the supporting chains or wire ropes are at an angle with the vertical plane A equal to M/100 with a 20° maximum, unless, during deflection, the protective structure at the point of contact forms a greater angle to the vertical. In this case the impact face of the block shall be adjusted by means of an additional support so that it is parallel to the protective structure at the point of impact at the moment of maximum deflection, the supporting chains or wire ropes remaining at the angle defined above.

The suspended height of the pendulum block shall be adjusted and the necessary steps taken so as to prevent the block from turning about the point of impact.

The point of impact is that part of the protective structure likely to hit the ground first if the tractor overturned sideways while travelling forward, normally the upper edge. The position of the centre of gravity of the block is 1/6 of the width of the top of the protective structure inwards from a vertical plane parallel to the median plane of the tractor touching the outside extremity of the top of the protective structure.

If the structure is curved or protruding at this point, wedges enabling the impact to be applied thereon must be added, without thereby reinforcing the structure.

4.3.1.2.2. The tractor must be lashed to the ground by means of four wire ropes, one at each end of both axles, arranged as indicated in figure 6.28. The spacing between the front and rear lashing points must be such that the wire ropes make an angle of less than 30° with the ground. The rear lashings shall in addition be so arranged that the point of convergence of the two wire ropes is located in the vertical plane in which the centre of gravity of the pendulum block travels.

The wire ropes must be tensioned so that the tyres undergo the deflections given in 4.2.5.6.2. With the wire ropes tensioned, the wedging beam shall be placed behind and tight against the rear wheels and then fixed to the ground.

4.3.1.2.3. If the tractor is of the articulated type, the point of articulation shall, in addition, be supported by a wooden block at least 100 mm square and firmly lashed to the ground.

▼B

4.3.1.2.4. The pendulum block shall be pulled back so that the height of its centre of gravity above that at the point of impact is given by one of the following two formulae, to be chosen according to the reference mass of the assembly subjected to the tests:

$$H = 25 + 0{,}07\ M$$

for tractor with a reference mass of less than 2 000 kg.

$$H = 125 + 0{,}02\ M$$

for tractor with a reference mass of more than 2 000 kg.

The pendulum block is then released and strikes the protective structure.

4.3.1.2.5. For tractors with a reversible driver's position (reversible seat and steering wheel), the height shall be whichever is greater from the formula applied above and that selected below:

$$H = 2{,}165 \times 10^{-8}\ M \times L^2$$

or

$$H = 5{,}73 \times 10^{-2}\ I$$

4.3.1.3. Impact from the side

4.3.1.3.1. The tractor shall be so placed in relation to the pendulum block that the block will strike the protective structure when the impact face of the block and the supporting chains or wire ropes are vertical unless, during deflection, the protective structure at the point of contact forms an angle of less than 20° to the vertical. In this case the impact face of the block shall be adjusted by means of an additional support so that it is parallel to the protective structure at the point of impact at the moment of maximum deflection, the supporting chains or wire ropes remaining vertical on impact.

The suspended height of the pendulum block shall be adjusted and necessary steps taken so as to prevent the block from turning about the point of impact.

The point of impact shall be that part of the protective structure likely to hit the ground first in a sideways overturning accident.

4.3.1.3.2. The tractor wheels on the side which is to receive the impact must be lashed to the ground by means of wire ropes passing over the corresponding ends of the front and rear axles. The wire ropes must be tensioned to produce the tyre deflection values given in 4.2.5.6.2.

With the wire ropes tensioned, the wedging beam shall be placed on the ground, pushed tight against the tyres on the side opposite that which is to receive the impact and then fixed to the ground. It may be necessary to use two beams or wedges if the outer sides of the front and rear tyres are not in the same vertical plane. The prop shall then be placed as indicated in figure 6.29 against the rim of the most heavily loaded wheel opposite to the point of impact, pushed firmly against the rim and then fixed at its base. The length of the prop

▼B

shall be such that it makes an angle of 30° ± 3° with the ground when in position against the rim. In addition, its thickness shall, if possible, be between 20 and 25 times less than its length and between 2 and 3 times less than its width. The props shall be shaped at both ends as shown in the details on figure 6.29.

4.3.1.3.3. If the tractor is of the articulated type, the point of articulation shall in addition be supported by a wooden block at least 100 mm square and laterally supported by a device similar to the prop pushed against the rear wheel as in 4.3.1.3.2. The point of articulation shall then be lashed firmly to the ground.

4.3.1.3.4. The pendulum block shall be pulled back so that the height of its centre of gravity above that at the point of impact is given by one of the following two formulae, to be chosen according to the reference mass of the assembly subjected to the tests:

$$H = (25 + 0{,}20\ M)(B_6 + B)/2B$$

for tractor with a reference mass of less than 2 000 kg.

$$H = (125 + 0{,}15\ M)(B_6 + B)/2B$$

for tractor with a reference mass of more than 2 000 kg.

4.3.1.3.5. For reversible tractors, the height shall be whichever is greater of the results obtained from the formulae applicable above and below:

$$H = 25 + 0{,}2\ M$$

for tractor with a reference mass of less than 2 000 kg.

$$H = 125 + 0{,}15\ M$$

for tractor with a reference mass of more than 2 000 kg.

The pendulum block is then released and strikes the protective structure.

4.3.1.4. Crushing at the rear

All provisions are identical to those given in section 3.3.1.4 of Part B1.

4.3.1.5. Crushing at the front

All provisions are identical to those given in section 3.3.1.5 of Part B1.

▼B

4.3.1.6. Additional impact tests

If cracks or tears which cannot be considered negligible appear during an impact test, a second, similar test, but with a height of fall of:

$$H' = (H \times 10^{-1})(12 + 4a)(1 + 2a)^{-1}$$

shall be performed immediately after the impact tests causing these tears or cracks to appear, 'a' being the ratio of the permanent deformation (Dp) to the elastic deformation (De):

$$a = Dp/De$$

as measured at the point of impact. The additional permanent deformation due to the second impact shall not exceed 30 per cent of the permanent deformation due to the first impact.

In order to be able to carry out the additional test, it is necessary to measure the elastic deformation during all the impact tests.

4.3.1.7. Additional crushing tests

If during a crushing test, significant cracks or tears appear, a second, similar, crushing test, but with a force equal to 1,2 F_v shall be performed immediately after the crushing tests which caused these tears or cracks to appear.

4.3.2. Measurements to be made

4.3.2.1. Fractures and cracks

After each test all structural members, joints and fastening systems shall be visually examined for fractures or cracks, any small cracks in unimportant parts being ignored.

Any tears caused by the edges of the pendulum weight are to be ignored.

4.3.2.2. Entry into the clearance zone

During each test the protective structure shall be examined to see whether any part of it has entered the clearance zone round the driving seat as defined in 1.6.

Furthermore, the clearance zone shall not be outside the protection of the protective structure. For this purpose, it shall be considered to be outside the protection of the structure if any part of it would come in contact with flat ground if the tractor overturned towards the direction from which the test load is applied. For estimating this, the front and rear tyres and track width setting shall be the smallest standard fitting specified by the manufacturer.

4.3.2.3. Rear hard fixture tests

If the tractor is fitted with a rigid section, a housing or other hard fixture placed behind the driver's seat, this fixture shall be regarded as a protective point, in the event of sideways or rear overturning. This hard fixture placed behind the driver's seat shall be capable of withstanding, without breaking or entering the clearance zone, a downward force F_i where:

$$F_i = 15\ M$$

applied perpendicularly to the top of the frame in the central plane of the tractor. The initial angle of application of force shall be 40° calculated from a parallel to the ground as shown in figure 6.12. The minimum width of this rigid section shall be 500 mm (see figure 6.13).

▼B

In addition, it shall be sufficiently rigid and firmly attached to the rear of the tractor.

4.3.2.4. Elastic deflection (under side impact)

The elastic deflection is measured (810 + a_v) mm above the index point, in the vertical plane passing through the point of impact. For this measurement, apparatus similar to that illustrated in figure 6.11 shall be used.

4.3.2.5. Permanent deflection

After the final crushing test, the permanent deflection of the protective structure shall be recorded. For this purpose, before the start of the test, the position of the main roll-over protective structure members in relation to the Seat Index Point shall be used.

4.4. *Extension to other tractor models*

All provisions are identical to those given in section 3.4 of section B1 to this Annex.

4.5. [Not applicable]

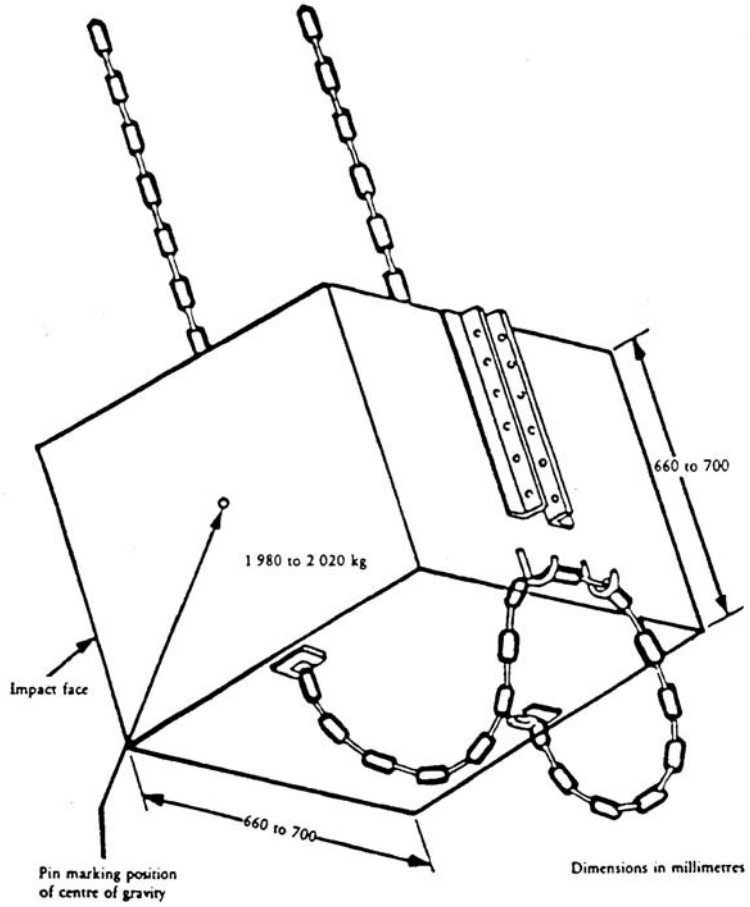
4.6. *Cold weather performance of protective structures*

All provisions are identical to those given in section 3.6 of section B1 to this Annex.

4.7. [Not applicable]

Figure 6.26

Pendulum block and its suspending chains or wire ropes



▼B

Figure 6.27

Example of tractor lashing (rear impact)

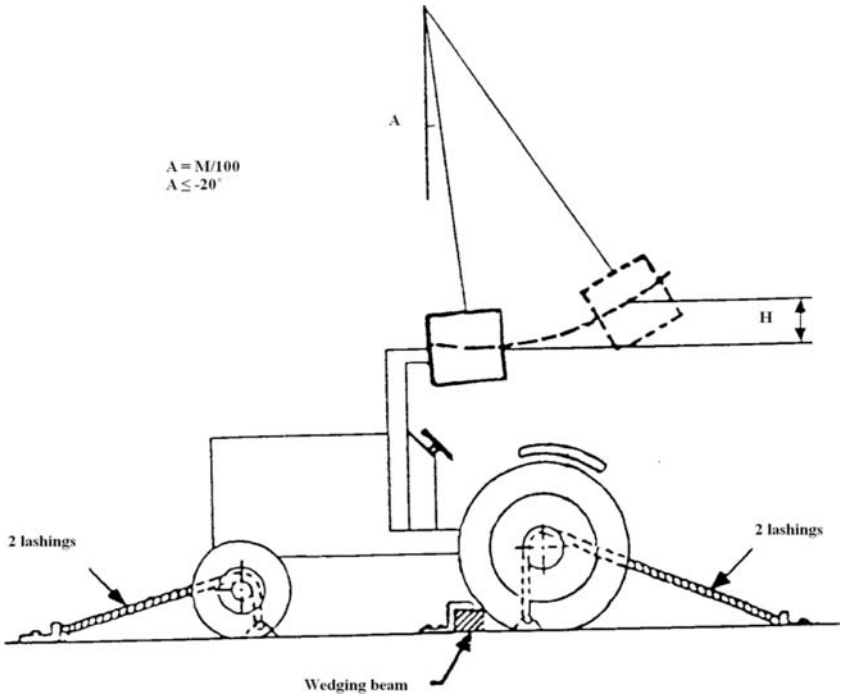
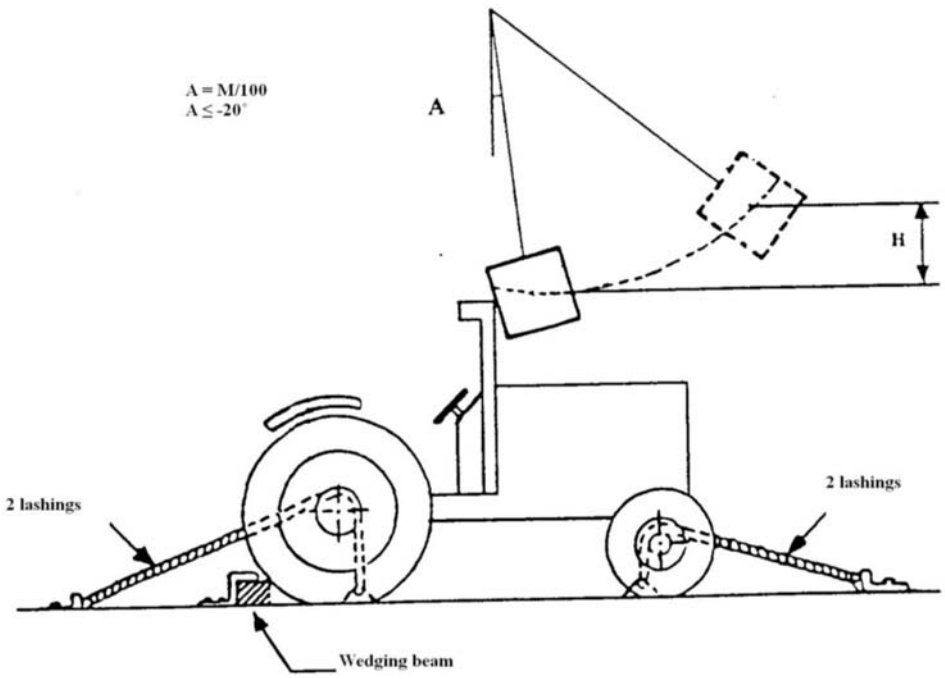


Figure 6.28

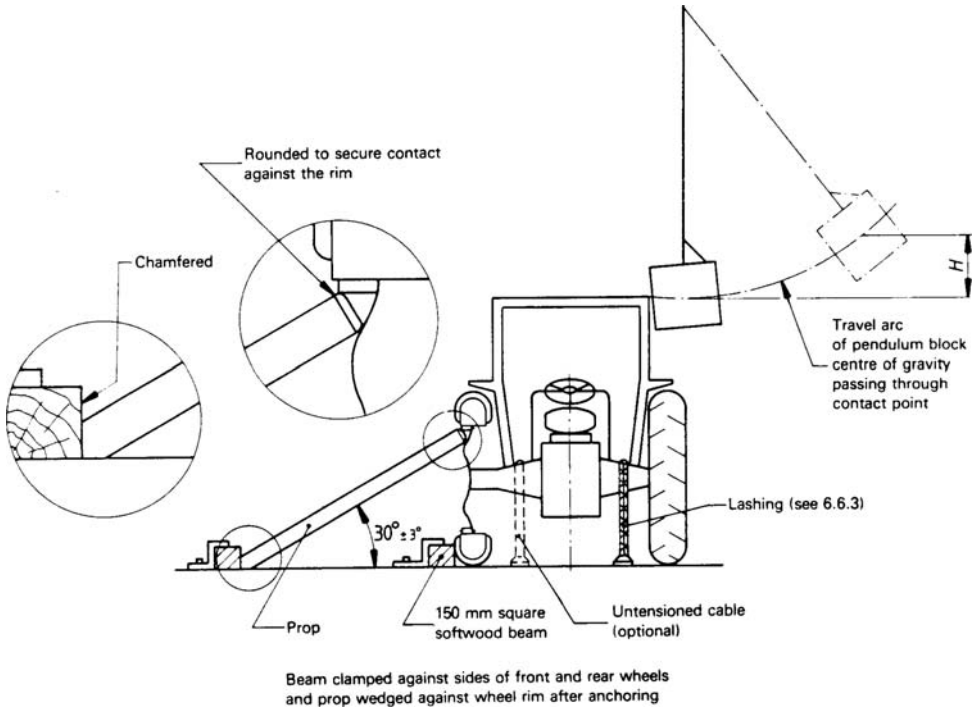
Example of tractor lashing (front impact)



▼B

Figure 6.29

Example of tractor lashing (side impact)



B3. REQUIREMENTS FOR FOLDABLE ROPS PERFORMANCE

5.1. *Scope*

This procedure provides minimum performance and tests requirements for front mounted foldable ROPS

5.2. Explanation of terms used in the performance testing:

5.2.1. *hand-operated foldable* ROPS is a front mounted dual pillar protective structure with hand raising/lowering directly managed by the operator (with or without partial assistance).

5.2.2. *automatic foldable* ROPS is a front mounted dual pillar protective structure with full assisted raising/lowering operations.

5.2.3. *locking system* is a device fitted to lock, by hand or automatically, the ROPS in the raised or lowered positions.

5.2.4. *grasping area* is defined by the manufacturer as a portion of the ROPS and/or additional handle fitted to the ROPS where the operator is allowed to carry out the raising/lowering operations.

5.2.5. *accessible part of the grasping area* is intended as the area where the ROPS is handled by the operator during the raising/lowering operations. This area shall be defined with regard to the geometric centre of cross sections of the grasping area.

5.2.6. *pinching point* is a dangerous point where parts move in relation to each other or to fixed parts in such a way as may cause persons or certain parts of their bodies to be pinched.

▼B

5.2.7. *shear point* is a dangerous point where parts move along each other or along other parts in such a way as may cause persons or certain parts of their bodies to be pinched or shorn

5.3. *Hand-operated foldable ROPS*

5.3.1. Prior conditions for the test

The manual handling shall be done by a standing operator with one or more grasps on grasping area of the roll-bar. This area has to be designed without sharp edges, sharp angles and rough surfaces likely to cause injury to the operator.

The grasping area shall be clearly and permanently identified (Figure 6.20).

This area could be on one or both sides of the tractor and could be a structural part of the roll-bar or additional handles. In this grasping area the manual handling to raise or lower the roll-bar shall not create shearing, pinching or uncontrollable movement hazards to the operator (Additional requirement).

Three accessible zones with different amount of allowed force are defined with respect to horizontal plane of the ground and the vertical planes tangent to the outer parts of the tractor that limit the position or the displacement of the operator (Figure 6.21).

Zone I: comfort zone

Zone II: accessible zone without forward leaning of the body

Zone III: accessible zone with forward leaning of the body

The position and the movement of the operator are limited by obstacles. These are parts of the tractor and are defined by vertical planes tangent to the external edges of the obstacle.

If the operator needs to move the feet during the manual handling of the roll-bar a displacement is allowed either within a parallel plane to the roll-bar trajectory or within just one more parallel plane to the previous one so as to overcome an obstacle. The overall displacement shall be considered as a combination of straits lines parallel and perpendicular to the roll-bar trajectory. A perpendicular displacement is accepted provided that the operator comes closer to the roll-bar. The accessible area shall be considered as the envelope of the different accessible zones (Figure 6.22).

The tractor must be fitted with tyres having the greatest diameter indicated by the manufacturer and the smallest cross-section for tyres of that diameter. The tyres must be inflated to the pressure recommended for field work.

The rear wheels must be set to the narrowest track width; the front wheels must be set as closely as possible to the same track width. If it is possible to have two front track settings which differ equally from the narrowest rear track setting, the wider of these two front track settings must be selected.

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5.3.2. Test procedure

Aim of the test is to measure the force necessary to raise or lower the roll-bar. The test will be carried out in static condition: no initial movement of the roll-bar. Each measurement of the force necessary to raise or lower the roll-bar shall be made in a direction tangent to the trajectory of the roll-bar and passing through the geometric centre of cross sections of the grasping area.

The grasping area is considered accessible when located within the accessible zones or the envelope of different accessible zones (Figure 6.23).

The force necessary to raise and lower the roll-bar shall be measured in different points that are within the accessible part of the grasping area (Figure 6.24).

The first measure is carried out at the extremity of the accessible part of the grasping area when the roll-bar is fully lowered (Point A). The second is defined according to the position of Point A after rotation of the roll-bar up to the top of the accessible part of the grasping area (Point A').

If in the second measure the roll-bar is not fully raised, an additional point shall be measured at the extremity of the accessible part of the grasping area when the roll-bar is fully raised (Point B).

If between the first two measures the trajectory of the first point crosses the limit between Zone I and Zone II a measurement shall be made at this crossing point (Point A'').

In order to measure the force in the required points, it is possible either to measure directly the value or to measure the torque needed to raise or lower the roll-bar so as to calculate the force.

5.3.3. Condition of acceptance

5.3.3.1. Force requirement

The force acceptable for the actuation of the ROPS depends on the accessible zone as shown in Table 6.2.

Table 6.2

Allowed forces

Zone	I	II	III
Acceptable force (N)	100	75	50

An increase of no more than 25 % of these acceptable forces is allowed when the roll-bar is fully lowered and fully raised.

An increase of no more than 50 % of these acceptable forces is allowed in the lowering operation.

5.3.3.2. Additional requirement

The manual handling to raise or lower the roll-bar shall not create shearing, pinching or uncontrollable movement hazards to the operator

A pinching point is not considered dangerous for the operator hands part if in the grasping area the safety distances between the roll-bar and fixed parts of the tractor are no less than 100 mm for hand, wrist, fist and 25 mm for finger (ISO 13854:1996). The safety distances shall be checked with respect to the mode of handling foreseen by the manufacturer in the operator's manual.

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5.4. *Hand locking system*

The device fitted to lock the ROPS in the upright/lowered position must be designed:

— to be handled by one standing operator and located in one of the accessible zones;

— to be hardly separated from the ROPS (for example captive pins as locking pins or retaining pins);

— to avoid any confusion in the locking operation (the proper location of the pins shall be indicated);

— to avoid unintentional removing or losing of parts.

If the devices employed to lock the ROPS in the upright/lowered position are pins they shall be inserted or removed freely. If to do this there is a need to apply a force on the roll-bar this shall comply with the requirements of points A and B (see point 5.3).

For all other locking devices, they shall be engineered according to an ergonomic approach for what concerns the shape and the force especially avoiding pinching or shearing hazards.

5.5. *Preliminary test of automatic locking system*

An automatic locking system fitted on hand-operated foldable ROPS shall be submitted to a preliminary test before the ROPS strength test.

The roll-bar shall be moved from the lower position to the upright locked position and back. These operations correspond to one cycle. 500 cycles shall be completed.

This could be done manually or with the use of external energy (hydraulic, pneumatic or electric actuators). In both cases the force shall be applied within a plane parallel to the trajectory of the roll-bar and passing through the grasping area, the angular speed of the roll-bar shall be roughly constant and less than 20 deg/s.

After the 500 cycles, the force applied when the roll-bar is in the upright position shall not exceed by more than 50 % the allowed force (Table 6.2).

The unlocking of the roll-bar shall be done following the operator manual.

After the completion of the 500 cycles there shall be no maintenance or adjustment on the locking system,

Note 1: The preliminary test could be applied to automatic foldable ROPS systems as well. The test should be carried out before the ROPS strength test.

Note 2: The preliminary test could be carried out by the manufacturer. In such a case the manufacturer shall provide the test station with a certificate stating that the test has been done according the test procedure and that there were no maintenance or adjustment on the locking system after the completion of the 500 cycles. The test station will check the performance of the device with one cycle from the lower position to the upright locked position and back.

▼B

Figure 6.20

Grasping area

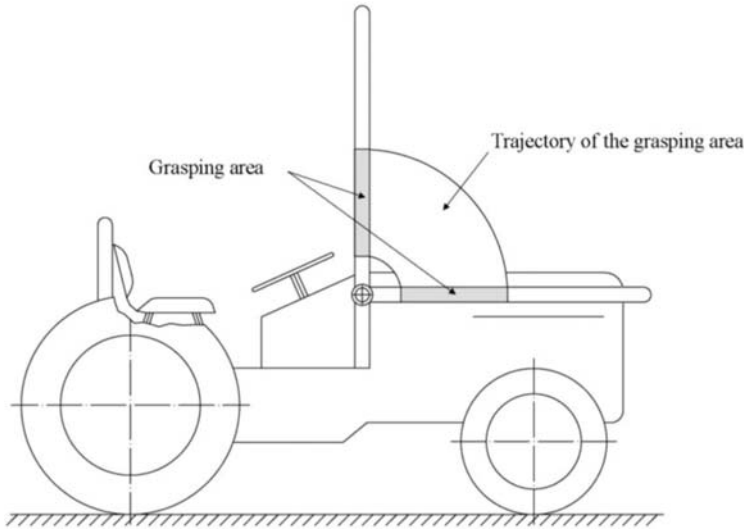
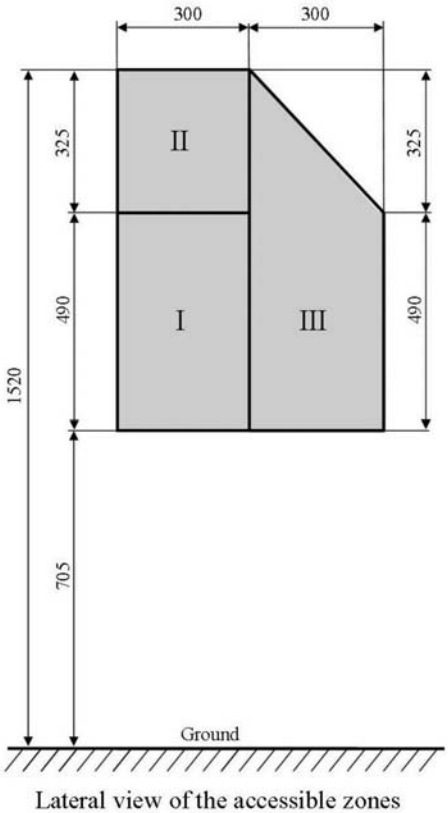


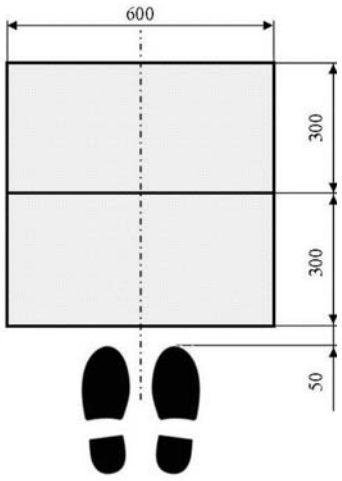
Figure 6.21

Accessible zones

(Dimensions in mm)



Lateral view of the accessible zones



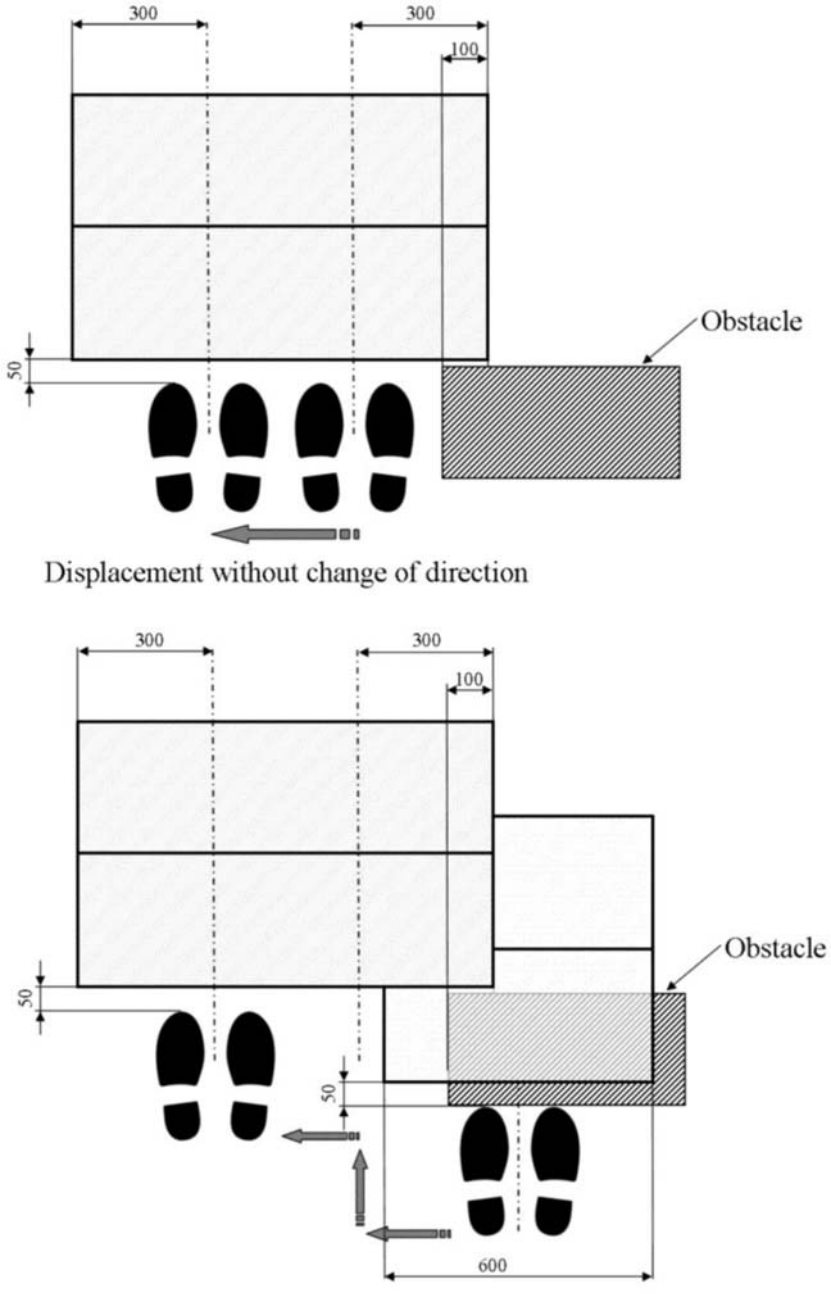
Top view of the accessible zones

▼B

Figure 6.22

Envelope of the accessible zones

(Dimensions in mm)



▼B

Figure 6.23

Accessible part of the grasping area

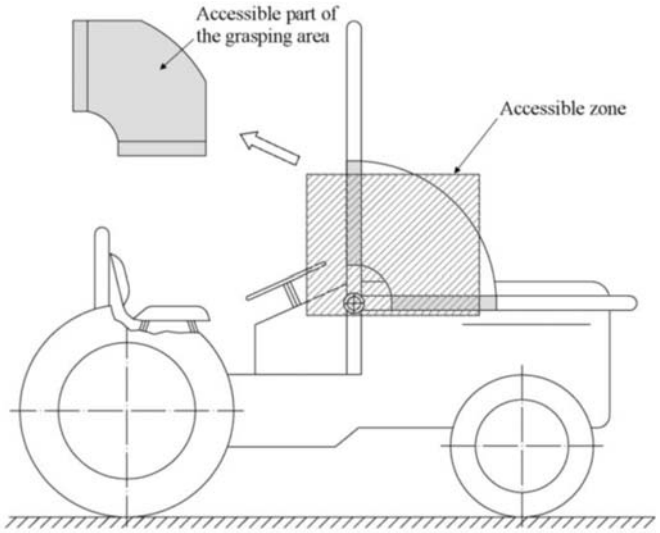
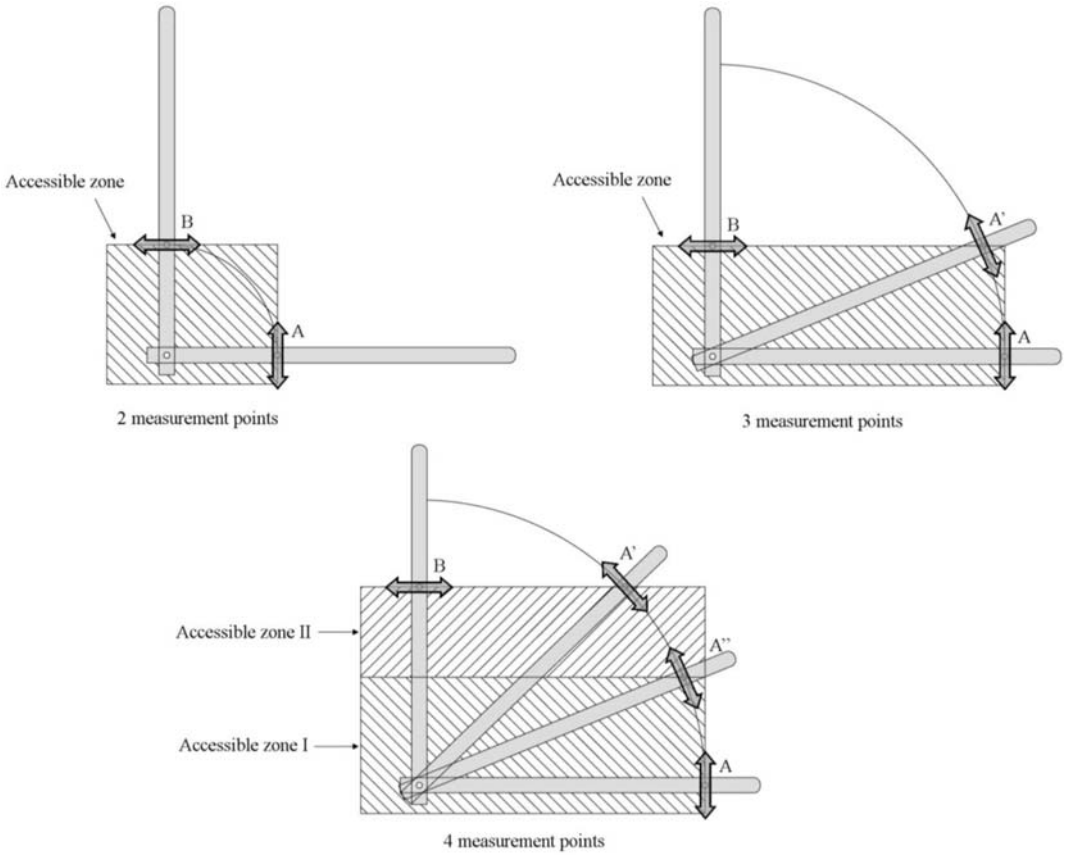


Figure 6.24

Points where the force requirement shall be measured



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B4. REQUIREMENTS FOR VIRTUAL TESTING

Computer programme[3] (BASIC) for determining the continuous or interrupted roll over behaviour in case of a laterally overturning narrow track tractor with a protective frame mounted in front of the driver's seat

Preliminary note:

The following programme is valid for its calculation methods. Presentation of the printed text as proposed (English language and layout) is indicative; the user will adapt the programme to available printing and other requirements specific to the testing station.

```
10 CLS

20 REM REFERENCE OF THE PROGRAM COD6ABAS.BAS 08/02/96

30 FOR I = 1 TO 10: LOCATE I, 1, 0: NEXT I

40 COLOR 14, 8, 4

50 PRINT "****************************************** ******************************************"

60 PRINT "* CALCULATION FOR DETERMINING THE NON-CONTINUOUS ROLLING BEHAVIOUR *"

70 PRINT "*OF A LATERAL OVERTURNING NARROW TRACTOR WITH A ROLL-OVER PROTECTIVE *"

80 PRINT "* STRUCTURE MOUNTED IN FRONT OF THE DRIVER'S SEAT *"

90 PRINT "****************************************** ******************************************"

100 A$ = INKEY$: IF A$ = "" THEN 100

110 COLOR 10, 1, 4

120 DIM F(25), C(25), CAMPO$(25), LON(25), B$(25), C$(25), X(6, 7), Y(6, 7), Z(6, 7)

130 DATA 6,10,10,14,14,17,19,21,11,11,12,12,13,13,14,14,15,15,16,16, 17,17,18,18,19

140 DATA 54,8,47,8,47,12,8,12,29,71,29,71,29,71,29,71,29,71,29,71,29 ,71,29,71,29

150 DATA 12,30,31,30,31,25,25,25,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9,9

160 FOR I = 1 TO 25: READ F(I): NEXT

170 FOR I = 1 TO 25: READ C(I): NEXT

180 FOR I = 1 TO 25: READ LON(I): NEXT

190 CLS

200 FOR I = 1 TO 5: LOCATE I, 1, 0: NEXT I

210 PRINT "In case of misprint, push on the enter key up to the last field"

220 PRINT :LOCATE 6, 44: PRINT " TEST NR: ": PRINT

230 LOCATE 8, 29: PRINT " FRONT MOUNTED- PROTECTIVE STRUCTURE:": PRINT
```

▼B

```
240 PRINT " MAKE: ": LOCATE 10, 40: PRINT " TYPE: ": PRINT

250 LOCATE 12, 29: PRINT " TRACTOR :": PRINT : PRINT " MAKE:"

260 LOCATE 14, 40: PRINT " TYPE: ": PRINT : PRINT

270 PRINT " LOCATION: ": PRINT

280 PRINT " DATE: ": PRINT : PRINT " ENGINEER:"

290 NC = 1: GOSUB 4400

300 PRINT : PRINT : PRINT " In case of misprint, it is possible to acquire the data again"

310 PRINT : INPUT " Do you wish to acquire again the data ? (Y/N)"; Z$

320 IF Z$ = "Y" OR Z$ = "y" THEN 190

330 IF Z$ = "N" OR Z$ = "n" THEN 340

340 FOR I=1 TO 3:LPRINT : NEXT: LPRINT ; " TEST NR: "; TAB(10); CAMPO$(1)

350 LPRINT : LPRINT TAB(24); " FRONT MOUNTED PROTECTIVE STRUCTURE:"

360 LL = LEN(CAMPO$(2) + CAMPO$(3))

370 LPRINT TAB(36 - LL / 2); CAMPO$(2) + " - " + CAMPO$(3) : LPRINT

380 LPRINT TAB(32); " OF THE NARROW TRACTOR": LL = LEN(CAMPO$(4) + CAMPO$(5))

390 LPRINT TAB(36 - LL / 2); CAMPO$(4) + " - " + CAMPO$(5) : LPRINT

400 CLS

410 PRINT "In case of mistype, push on the enter key up to the last field"

420 PRINT

430 FOR I = 1 TO 7: LOCATE I, 1, 0: NEXT

440 LOCATE 8, 1: PRINT " CHARACTERISTIC UNITS:"

450 LOCATE 8, 29: PRINT "LINEAR (m): MASS (kg):MOMENT OF INERTIA (kg×m2):"

460 LOCATE 9, 1: PRINT " ANGLE (radian)"

470 LPRINT : PRINT

480 PRINT "HEIGHT OF COG H1=": LOCATE 11, 29: PRINT""

490 LOCATE 11, 40: PRINT "H. DIST. COG-REAR AXLE L3="

500 LOCATE 11, 71: PRINT""

510 PRINT "H. DIST. COG-FRT AXLE L2=": LOCATE 12, 29: PRINT""

520 LOCATE 12, 40: PRINT "HEIGHT OF THE REAR TYRES D3="

530 LOCATE 12, 71: PRINT""

540 PRINT "HEIGHT OF THE FRT TYRES D2=": LOCATE 13, 29: PRINT""

550 LOCATE 13, 40: PRINT "OVERALL HEIGHT(PT IMPACT) H6="

560 LOCATE 13, 71: PRINT""

570 PRINT "H.DIST.COG-LEAD.PT INTER.L6=": LOCATE 14, 29: PRINT""
```

▼B

```
580 LOCATE 14, 40: PRINT "PROTECTIVE STRUCT. WIDTH B6="

590 LOCATE 14, 71: PRINT""

600 PRINT "HEIGHT OF THE ENG.B. H7=": LOCATE 15, 29: PRINT""

605 LOCATE 15, 40: PRINT "WIDTH OF THE ENG. B. B7="

610 LOCATE 15, 71: PRINT""

615 PRINT "H.DIST.COG-FRT COR.ENG.B.L7=": LOCATE 16, 29: PRINT""

620 LOCATE 16, 40: PRINT "HEIGHT FRT AXLE PIVOT PT H0="

630 LOCATE 16, 71: PRINT""

640 PRINT "REAR TRACK WIDTH S =": LOCATE 17, 29: PRINT""

650 LOCATE 17, 40: PRINT "REAR TYRE WIDTH B0="

660 LOCATE 17, 71: PRINT""

670 PRINT "FRT AXLE SWING ANGLE D0=": LOCATE 18, 29: PRINT""

680 LOCATE 18, 40: PRINT "TRACTOR MASS Mc ="

690 LOCATE 18, 71: PRINT""

700 PRINT "MOMENT OF INERTIA Q =": LOCATE 19, 29: PRINT""

710 LOCATE 19, 40: PRINT""

720 LOCATE 19, 71: PRINT " ": PRINT : PRINT

730 H1 = 0: L3 = 0: L2 = 0: D3 = 0: D2 = 0: H6 = 0: L6 = 0: B6 = 0

740 H7 = 0: B7 = 0: L7 = 0: H0 = 0: S = 0: B0 = 0: D = 0: Mc = 0: Q = 0

750 NC = 9: GOSUB 4400

760 FOR I = 1 TO 3: PRINT "": NEXT

770 H1 = VAL(CAMPO$(9)): L3 = VAL(CAMPO$(10)): L2 = VAL(CAMPO$(11))

780 D3 = VAL(CAMPO$(12)): D2 = VAL(CAMPO$(13)): H6 = VAL(CAMPO$(14))

790 L6 = VAL(CAMPO$(15)): B6 = VAL(CAMPO$(16)): H7 = VAL(CAMPO$(17))

800 B7 = VAL(CAMPO$(18)): L7 = VAL(CAMPO$(19)): H0 = VAL(CAMPO$(20))

810 S = VAL(CAMPO$(21)): B0 = VAL(CAMPO$(22)): D0 = VAL(CAMPO$(23))

820 Mc = VAL(CAMPO$(24)): Q = VAL(CAMPO$(25)): PRINT : PRINT

830 PRINT "In case of mistype, it is possible to acquire again the data": PRINT

840 INPUT " Do you wish to acquire again the data ? (Y/N)"; X$

850 IF X$ = "Y" OR X$ = "y" THEN 400

860 IF X$ = "n" OR X$ = "N" THEN 870

870 FOR I = 1 TO 3: LPRINT : NEXT
```

▼B

```
880 LPRINT TAB(20); "CHARACTERISTIC UNITS :": LOCATE 8, 29
890 LPRINT "LINEAR (m) : MASS (kg) : MOMENT OF INERTIA (kg×m2) : ANGLE (radian)"
900 LPRINT
910 LPRINT "HEIGHT OF THE COG H1=";
920 LPRINT USING "####.####"; H1;
930 LPRINT TAB(40); "H. DIST. COG-REAR AXLE L3=";
940 LPRINT USING "####.####"; L3
950 LPRINT "H.DIST. COG-FRT AXLE L2=";
960 LPRINT USING "####.####"; L2;
970 LPRINT TAB(40); "HEIGHT OF THE REAR TYRES D3=";
975 LPRINT USING "####.####"; D3
980 LPRINT "HEIGHT OF THE FRT TYRES D2=";
990 LPRINT USING "####.####"; D2;
1000 LPRINT TAB(40); "OVERALL HEIGHT(PT IMPACT)H6=";
1010 LPRINT USING "####.####"; H6
1020 LPRINT "H.DIST.COG-LEAD PT INTER.L6=";
1030 LPRINT USING "####.####"; L6;
1040 LPRINT TAB(40); "PROTECTIVE STRUCT. WIDTH B6=";
1050 LPRINT USING "####.####"; B6
1060 LPRINT "HEIGHT OF THE ENG.B. H7=";
1070 LPRINT USING "####.####"; H7;
1080 LPRINT TAB(40); "WIDTH OF THE ENG. B. B7=";
1090 LPRINT USING "####.####"; B7
1100 LPRINT "H.DIST.COG-FRT COR.ENG.B.L7=";
1110 LPRINT USING "####.####"; L7;
1120 LPRINT TAB(40); "HEIGHT FRT AXLE PIVOT PT H0=";
1130 LPRINT USING "####.####"; H0
1140 LPRINT "REAR TRACK WIDTH S =";
1150 LPRINT USING "####.####"; S;
1160 LPRINT TAB(40); "REAR TYRE WIDTH B0=";
1170 LPRINT USING "####.####"; B0
1180 LPRINT "FRT AXLE SWING ANGLE D0=";
1185 LPRINT USING "####.####"; D0;
1190 LPRINT TAB(40); "TRACTOR MASS Mc = ";
1200 LPRINT USING "####.###"; Mc
```

▼B

```
1210 LPRINT "MOMENT OF INERTIA Q =";
1215 LPRINT USING "####.####"; Q
1220 FOR I = 1 TO 10: LPRINT : NEXT
1230 A0 = .588: U = .2: T = .2: GOSUB 4860
1240 REM * THE SIGN OF L6 IS MINUS IF THE POINT LIES IN FRONT
1250 REM * OF THE PLANE OF THE CENTRE OF GRAVITY.
1260 IF B6 > S + B0 THEN 3715
1265 IF B7 > S + B0 THEN 3715
1270 G = 9.8
1280 REM ************************************ ****************************************
1290 REM *B2 VERSION (POINT OF IMPACT OF THE ROPS NEAR OF EQUILIBRIUM POINT)*
1300 REM ************************************ ****************************************
1310 B = B6: H = H6
1320 REM ..... POSITION OF CENTER OF GRAVITY IN TILTED POSITION .....
1330 R2 = SQR(H1 * H1 + L3 * L3)
1340 C1 = ATN(H1 / L3)
1350 L0 = L3 + L2
1360 L9 = ATN(H0 / L0)
1370 H9 = R2 * SIN(C1 - L9)
1380 W1 = H9 / TAN(C1 - L9)
1390 W2 = SQR(H0 * H0 + L0 * L0): S1 = S / 2
1400 F1 = ATN(S1 / W2)
1410 W3 = (W2 - W1) * SIN(F1)
1420 W4 = ATN(H9 / W3)
1430 W5 = SQR(H9 * H9 + W3 * W3) * SIN(W4 + D0)
1440 W6 = W3 - SQR(W3 * W3 + H9 * H9) * COS(W4 + D0)
1450 W7 = W1 + W6 * SIN(F1)
1460 W8 = ATN(W5 / W7)
1470 W9 = SIN(W8 + L9) * SQR(W5 * W5 + W7 * W7)
1480 W0 = SQR(W9 * W9 + (S1 - W6 * COS(F1)) ^ 2)
1490 G1 = SQR(((S + B0) / 2) ^ 2 + H1 * H1)
1500 G2 = ATN(2 * H1 / (S + B0))
1510 G3 = W0 - G1 * COS(A0 + G2)
1520 O0 = SQR(2 * Mc * G * G3 / (Q + Mc * (W0 + G1) * (W0 + G1) / 4))
1530 F2 = ATN(((D3 - D2) / L0) / (1 - ((D3 - D2) / (2 * L3 + 2 * L2)) ^ 2))
1540 L8 = -TAN(F2) * (H - H1)
```

▼B

```
1550 REM ..... COORDINATES IN POSITION 1 .....
1560 X(1, 1) = H1
1570 X(1, 2) = 0: X(1, 3) = 0
1580 X(1, 4) = (1 + COS(F2)) * D2 / 2
1590 X(1, 5) = (1 + COS(F2)) * D3 / 2
1600 X(1, 6) = H
1610 X(1, 7) = H7
1620 Y(1, 1) = 0
1630 Y(1, 2) = L2
1640 Y(1, 3) = -L3
1650 Y(1, 4) = L2 + SIN(F2) * D2 / 2
1660 Y(1, 5) = -L3 + SIN(F2) * D3 / 2
1670 Y(1, 6) = -L6
1680 Y(1, 7) = L7
1690 Z(1, 1) = (S + B0) / 2
1700 Z(1, 2) = 0: Z(1, 3) = 0: Z(1, 4) = 0: Z(1, 5) = 0
1710 Z(1, 6) = (S + B0) / 2 - B / 2
1720 Z(1, 7) = (S + B0) / 2 - B7 / 2
1730 O1 = 0: O2 = 0: O3 = 0: O4 = 0: O5 = 0: O6 = 0: O7 = 0: O8 = 0: O9 = 0
1740 K1 = Y(1, 4) * TAN(F2) + X(1, 4)
1750 K2 = X(1, 1)
1760 K3 = Z(1, 1)
1770 K4 = K1 - X(1, 1): DD1 = Q + Mc * K3 * K3 + Mc * K4 * K4
1780 O1 = (Q + Mc * K3 * K3 - U * Mc * K4 * K4 - (1 + U) * Mc * K2 * K4) * O0 / DD1
1790 REM .....TRANSFORMATION OF THE COORDINATES FROM THE POSITION 1 TO 2
1800 FOR K = 1 TO 7 STEP 1
1810 X(2, K) = COS(F2) * (X(1, K) - H1) + SIN(F2) * Y(1, K) - K4 * COS(F2)
1820 Y(2, K) = Y(1, K) * COS(F2) - (X(1, K) - H1) * SIN(F2)
1830 Z(2, K) = Z(1, K)
1840 NEXT K
1850 O2 = O1 * COS(F2)
1860 A2 = ATN(TAN(A0) / SQR(1 + (TAN(F2)) ^ 2 / (COS(A0)) ^ 2))
1870 C2 = ATN(Z(2, 6) / X(2, 6))
1880 T2 = T
1890 V0 = SQR(X(2, 6) ^ 2 + Z(2, 6) ^ 2)
1900 E1 = T2 / V0
1910 E2 = (V0 * Y(2, 4)) / (Y(2, 4) - Y(2, 6))
```

▼B

```
1920 T3 = E1 * E2

1930 E4 = SQR(X(2, 1) * X(2, 1) + Z(2, 1) * Z(2, 1))

1940 V6 = ATN(X(2, 1) / Z(2, 1))

1950 REM ..... ROTATION OF THE TRACTOR FROM THE POSITION 2 TO 3 .....

1960 FOR K = 1 TO 7 STEP 1

1970 IF Z(2, K) = 0 THEN 2000

1980 E3 = ATN(X(2, K) / Z(2, K))

1990 GOTO 2010

2000 E3 = -3.14159 / 2

2010 X(3, K) = SQR(X(2, K) * X(2, K) + Z(2, K) * Z(2, K)) * SIN(E3 + C2 + E1)

2020 Y(3, K) = Y(2, K)

2030 Z(3, K) = SQR(X(2, K) ^ 2 + Z(2, K) ^ 2) * COS(E3 + C2 + E1)

2040 NEXT K

2050 IF Z(3, 7) < 0 THEN 3680

2060 Z(3, 6) = 0

2070 Q3 = Q * (COS(F2)) ^ 2 + 3 * Q * (SIN(F2)) ^ 2

2080 V5 = (Q3 + Mc * E4 * E4) * O2 * O2 / 2

2090 IF -V6 > A2 THEN 2110

2100 GOTO 2130

2110 V7 = E4 * (1 - COS(-A2 - V6))

2120 IF V7 * Mc * G > V5 THEN 2320

2130 V8 = E4 * COS(-A2 - V6) - E4 * COS(-A2 - ATN(X(3, 1) / Z(3, 1)))

2140 O3 = SQR(2 * Mc * G * V8 / (Q3 + Mc * E4 * E4) + O2 * O2)

2150 K9 = X(3, 1)

2160 K5 = Z(3, 1)

2170 K6 = Z(3, 1) + E1 * V0

2180 K7 = V0 - X(3, 1)

2190 K8 = U: DD2 = Q3 + Mc * K6 * K6 + Mc * K7 * K7

2200 O4 = (Q3 + Mc * K5 * K6 - K8 * Mc * K7 * K7 - (1 + K8) * Mc * K9 * K7) * O3 / DD2

2210 N3 = SQR((X(3, 6) - X(3, 1)) ^ 2 + (Z(3, 6) - Z(3, 1)) ^ 2)

2220 N2 = ATN(-(X(3, 6) - X(3, 1)) / Z(3, 1))

2230 Q6 = Q3 + Mc * N3 ^ 2

2240 IF -N2 <= A2 THEN 2290

2250 N4 = N3 * (1 - COS(-A2 - N2))
```

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```
2260 N5 = (Q6) * O4 * O4 / 2
2270 IF N4 * Mc * G > N5 THEN 2320
2280 O9 = SQR(-2 * Mc * G * N4 / (Q6) + O4 * O4)
2290 GOSUB 3740
2300 GOSUB 4170
2310 GOTO 4330
2320 GOSUB 3740
2330 IF L6 > L8 THEN 2790
2340 REM *
2350 REM ************************************ ************************************************************
2355 REM *B3 VERSION (POINT OF IMPACT OF THE ROPS IN FRONT OF EQUILIBRIUM POINT)*
2360 REM ************************************ ************************************************************
2370 O3 = 0: O4 = 0: O5 = 0: O6 = 0: O7 = 0: O8 = 0: O9 = 0
2380 E2 = (V0 * Y(2, 5)) / (Y(2, 5) - Y(2, 6))
2390 T3 = E2 * E1
2400 Z(3, 6) = 0
2410 Q3 = Q * (COS(F2)) ^ 2 + 3 * Q * (SIN(F2)) ^ 2
2420 V5 = (Q3 + Mc * E4 * E4) * O2 * O2 / 2
2430 IF -V6 > A2 THEN 2450
2440 GOTO 2470
2450 V7 = E4 * (1 - COS(-A2 - V6))
2460 IF V7 * Mc * G > V5 THEN 2760
2470 V8 = E4 * COS(-A2 - V6) - E4 * COS(-A2 - ATN(X(3, 1) / Z(3, 1)))
2480 O3 = SQR((2 * Mc * G * V8) / (Q3 + Mc * E4 * E4) + O2 * O2)
2490 K9 = X(3, 1)
2500 K5 = Z(3, 1)
2510 K6 = Z(3, 1) + T3
2520 K7 = E2 - X(3, 1)
2530 K8 = U: DD2 = Q3 + Mc * K6 * K6 + Mc * K7 * K7
2540 O4 = (Q3 + Mc * K5 * K6 - K8 * Mc * K7 * K7 - (1 + K8) * Mc * K9 * K7) * O3 / DD2
2550 F3 = ATN(V0 / (Y(3, 5) - Y(3, 6)))
2560 O5 = O4 * COS(F3)
2570 REM ..... TRANSFORMATION OF THE COORDINATES FROM THE POSITION 3 TO 4 .....
2580 REM .....  POSITION 4
2590 FOR K = 1 TO 7 STEP 1
2600 X(4, K) = X(3, K) * COS(F3) + (Y(3, K) - Y(3, 5)) * SIN(F3)
2610 Y(4, K) = (Y(3, K) - Y(3, 5)) * COS(F3) - X(3, K) * SIN(F3)
2620 Z(4, K) = Z(3, K)
2630 NEXT K
2640 A4 = ATN(TAN(A0) / SQR(1 + (TAN(F2 + F3)) ^ 2 / (COS(A0)) ^ 2))
```

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```
2650 M1 = SQR(X(4, 1) ^ 2 + Z(4, 1) ^ 2)
2660 M2 = ATN(X(4, 1) / Z(4, 1))
2670 Q5 = Q * (COS(F2 + F3)) ^ 2 + 3 * Q * (SIN(F2 + F3)) ^ 2
2680 IF -M2 < A4 THEN 2730
2690 M3 = M1 * (1 - COS(-A4 - M2))
2700 M4 = (Q5 + Mc * M1 * M1) * O5 * O5 / 2
2710 IF M3 * Mc * G > M4 THEN 2760
2720 O9 = SQR(O5 * O5 - 2 * Mc * G * M3 / (Q5 + Mc * M1 * M1))
2730 GOSUB 3740
2740 GOSUB 4170
2750 GOTO 4330
2760 GOSUB 3740
2770 GOSUB 4240
2780 GOTO 4330
2790 REM ************************************** ************************************************
2795 REM *B1 VERSION (POINT OF IMPACT OF THE ROPS BEHIND OF EQUILIBRIUM POINT)*
2800 REM ************************************** ************************************************
2810 REM *
2820 O3 = 0: O4 = 0: O5 = 0: O6 = 0: O7 = 0: O8 = 0: O9 = 0
2830 Z(3, 6) = 0
2840 Q3 = Q * (COS(F2)) ^ 2 + 3 * Q * (SIN(F2)) ^ 2
2850 V5 = (Q3 + Mc * E4 * E4) * O2 * O2 / 2
2860 IF -V6 > A2 THEN 2880
2870 GOTO 2900
2880 V7 = E4 * (1 - COS(-A2 - V6))
2890 IF V7 * Mc * G > V5 THEN 3640
2900 V8 = E4 * COS(-A2 - V6) - E4 * COS(-A2 - ATN(X(3, 1) / Z(3, 1)))
2910 O3 = SQR(2 * Mc * G * V8 / (Q3 + Mc * E4 * E4) + O2 * O2)
2920 K9 = X(3, 1)
2930 K5 = Z(3, 1)
2940 K6 = Z(3, 1) + T3
2950 K7 = E2 - X(3, 1)
2960 K8 = U: DD2 = Q3 + Mc * K6 * K6 + Mc * K7 * K7
2970 O4 = (Q3 + Mc * K5 * K6 - K8 * Mc * K7 * K7 - (1 + K8) * Mc * K9 * K7) * O3 / DD2
2980 F3 = ATN(V0 / (Y(3, 4) - Y(3, 6)))
2990 O5 = O4 * COS(F3)
```

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```
3000 REM ..... TRANSFORMATION OF THE COORDINATES FROM 3 TO 4 .....
3010 FOR K = 1 TO 7 STEP 1
3020 X(4, K) = X(3, K) * COS(F3) + (Y(3, K) - Y(3, 4)) * SIN(F3)
3030 Y(4, K) = (Y(3, K) - Y(3, 4)) * COS(F3) - X(3, K) * SIN(F3)
3040 Z(4, K) = Z(3, K)
3050 NEXT K
3060 A4 = ATN(TAN(A0) / SQR(1 + (TAN(F2 + F3)) ^ 2 / (COS(A0)) ^ 2))
3070 C3 = ATN(Z(4, 7) / X(4, 7))
3080 C4 = 0
3090 C5 = SQR(X(4, 7) * X(4, 7) + Z(4, 7) * Z(4, 7))
3100 C6 = C4 / C5
3110 C7 = C5 * (Y(4, 6) - Y(4, 1)) / (Y(4, 6) - Y(4, 7))
3120 C8 = C6 * C7
3130 M1 = SQR(X(4, 1) ^ 2 + Z(4, 1) ^ 2)
3140 M2 = ATN(X(4, 1) / Z(4, 1))
3150 REM ..... ROTATION OF THE TRACTOR FROM THE POSITION 4 TO 5.....
3160 FOR K = 1 TO 7 STEP 1
3170 IF Z(4, K) <> 0 THEN 3200
3180 C9 = -3.14159 / 2
3190 GOTO 3210
3200 C9 = ATN(X(4, K) / Z(4, K))
3210 X(5, K) = SQR(X(4, K) ^ 2 + Z(4, K) ^ 2) * SIN(C9 + C3 + C6)
3220 Y(5, K) = Y(4, K)
3230 Z(5, K) = SQR(X(4, K) ^ 2 + Z(4, K) ^ 2) * COS(C9 + C3 + C6)
3240 NEXT K
3250 Z(5, 7) = 0
3260 Q5 = Q * (COS(F2 + F3)) ^ 2 + 3 * Q * (SIN(F2 + F3)) ^ 2
3270 IF -M2 > A4 THEN 3290
3280 GOTO 3320
3290 M3 = M1 * (1 - COS(-A4 - M2))
3300 M4 = (Q5 + Mc * M1 * M1) * O5 * O5 / 2
3310 IF M3 * Mc * G > M4 THEN 3640
3315 MM1 = M1 * COS(-A4 - ATN(X(5, 1) / Z(5, 1)))
3320 M5 = M1 * COS(-A4 - ATN(X(4, 1) / Z(4, 1))) - MM1
3330 O6 = SQR(2 * Mc * G * M5 / (Q5 + Mc * M1 * M1) + O5 * O5)
3340 M6 = X(5, 1)
3350 M7 = Z(5, 1)
3360 M8 = Z(5, 1) + C8
```

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```
3370 M9 = C7 - X(5, 1)
3380 N1 = U: DD3 = (Q5 + Mc * M8 * M8 + Mc * M9 * M9)
3390 O7 = (Q5 + Mc * M7 * M8 - N1 * Mc * M9 * M9 - (1 + N1) * Mc * M6 * M9) * O6 / DD3
3400 F5 = ATN(C5 / (Y(5, 6) - Y(5, 7)))
3410 A6 = ATN(TAN(A0) / SQR(1 + (TAN(F2 + F3 + F5)) ^ 2 / (COS(A0)) ^ 2))
3420 REM ..... TRANSFORMATION OF THE COORDINATES FROM THE POSITION 5 TO 6 .....
3430 FOR K = 1 TO 7 STEP 1
3440 X(6, K) = X(5, K) * COS(F5) + (Y(5, K) - Y(5, 6)) * SIN(F5)
3450 Y(6, K) = (Y(5, K) - Y(5, 6)) * COS(F5) - X(5, K) * SIN(F5)
3460 Z(6, K) = Z(5, K)
3470 NEXT K
3480 O8 = O7 * COS(-F5)
3490 N2 = ATN(X(6, 1) / Z(6, 1))
3500 N3 = SQR(X(6, 1) ^ 2 + Z(6, 1) ^ 2)
3510 Q6 = Q * (COS(F2 + F3 + F5)) ^ 2 + 3 * Q * (SIN(F2 + F3 + F5)) ^ 2
3520 IF -N2 > A6 THEN 3540
3530 GOTO 3580
3540 N4 = N3 * (1 - COS(-A6 - N2))
3550 N5 = (Q6 + Mc * N3 * N3) * O8 * O8 / 2
3560 P9 = (N4 * Mc * G - N5) / (N4 * Mc * G)
3570 IF N4 * Mc * G > N5 THEN 3640
3580 IF -N2 < A6 THEN 3610
3590 N6 = -N4
3600 O9 = SQR(2 * Mc * G * N6 / (Q6 + Mc * N3 * N3) + O8 * O8)
3610 GOSUB 3740
3620 GOSUB 4170
3630 GOTO 4330
3640 GOSUB 3740
3650 GOSUB 4240
3660 GOTO 4330
3670 REM
3680 IF Z(3, 7) > -.2 THEN 2060
3685 CLS : PRINT : PRINT : PRINT STRING$(80, 42): LOCATE 24, 30, 0
3690 PRINT "THE ENGINE BONNET TOUCHES THE GROUND BEFORE THE ROPS"
3695 LPRINT STRING$(80, 42)
3700 LPRINT "THE ENGINE BONNET TOUCHES THE GROUND BEFORE THE ROPS"
```

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```
3710 PRINT : PRINT "METHOD OF CALCULATION NOT FEASIBLE" : GOTO 3720

3715 CLS : PRINT : PRINT "METHOD OF CALCULATION NOT FEASIBLE"

3720 LPRINT "METHOD OF CALCULATION NOT FEASIBLE"

3725 LPRINT STRING$(80, 42)

3730 GOTO 4330

3740 REM ********************************** ******************************

3750 CLS : LOCATE 13, 15, 0: PRINT "VELOCITY O0="

3755 LOCATE 13, 31, 0: PRINT USING "#.###"; O0: LOCATE 13, 40, 0: PRINT "rad/s"

3760 LOCATE 14, 15, 0: PRINT "VELOCITY O1="

3765 LOCATE 14, 31, 0: PRINT USING "#.###"; O1

3770 LOCATE 15, 15, 0: PRINT "VELOCITY O2="

3775 LOCATE 15, 31, 0: PRINT USING "#.###"; O2

3780 LOCATE 16, 15, 0: PRINT "VELOCITY O3="

3785 LOCATE 16, 31, 0: PRINT USING "#.###"; O3

3790 LOCATE 17, 15, 0: PRINT "VELOCITY O4="

3795 LOCATE 17, 31, 0: PRINT USING "#.###"; O4

3800 LOCATE 18, 15, 0: PRINT "VELOCITY O5="

3805 LOCATE 18, 31, 0: PRINT USING "#.###"; O5

3810 LOCATE 19, 15, 0: PRINT "VELOCITY O6="

3815 LOCATE 19, 31, 0: PRINT USING "#.###"; O6

3820 LOCATE 20, 15, 0: PRINT "VELOCITY O7="

3825 LOCATE 20, 31, 0: PRINT USING "#.###"; O7

3830 LOCATE 21, 15, 0: PRINT "VELOCITY O8="

3835 LOCATE 21, 31, 0: PRINT USING "#.###"; O8

3840 LOCATE 22, 15, 0: PRINT "VELOCITY O9="

3845 LOCATE 22, 31, 0: PRINT USING "#.###"; O9

3850 LPRINT "VELOCITY O0=";

3860 LPRINT USING "#.###"; O0;

3870 LPRINT " rad/s";

3880 LPRINT TAB(40); "VELOCITY O1=";

3890 LPRINT USING "#.###"; O1;

3900 LPRINT " rad/s"

3910 LPRINT "VELOCITY O2=";

3920 LPRINT USING "#.###"; O2;
```

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```
3930 LPRINT " rad/s";
3940 LPRINT TAB(40); "VELOCITY O3=";
3950 LPRINT USING "#.###"; O3;
3960 LPRINT " rad/s"
3970 LPRINT "VELOCITY O4=";
3980 LPRINT USING "#.###"; O4;
3990 LPRINT " rad/s";
4000 LPRINT TAB(40); "VELOCITY O5=";
4010 LPRINT USING "#.###"; O5;
4020 LPRINT " rad/s"
4030 LPRINT "VELOCITY O6=";
4040 LPRINT USING "#.###"; O6;
4050 LPRINT " rad/s";
4060 LPRINT TAB(40); "VELOCITY O7=";
4070 LPRINT USING "#.###"; O7;
4080 LPRINT " rad/s"
4090 LPRINT "VELOCITY O8=";
4100 LPRINT USING "#.###"; O8;
4110 LPRINT " rad/s";
4120 LPRINT TAB(40); "VELOCITY O9=";
4130 LPRINT USING "#.###"; O9;
4140 LPRINT " rad/s"
4150 LPRINT
4160 RETURN
4170 PRINT STRING$(80, 42)
4180 LOCATE 24, 30, 0: PRINT "THE TILTING CONTINUES"
4190 PRINT STRING$(80, 42)
4200 LPRINT STRING$(80, 42)
4210 LPRINT TAB(30); "THE TILTING CONTINUES"
4220 LPRINT STRING$(80, 42)
4230 RETURN
4240 PRINT STRING$(80, 42)
4250 LOCATE 24, 30, 0: PRINT "THE ROLLING STOPS"
4260 PRINT STRING$(80, 42)
4270 LPRINT STRING$(80, 42)
4280 LPRINT TAB(30); "THE ROLLING STOPS"
```

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```
4290 LPRINT STRING$(80, 42)
4300 RETURN
4310 REM ********************************** ******************************
4320 REM ..... END OF THE CALCULATION .....
4330 FOR I = 1 TO 5: LPRINT : NEXT: LPRINT " LOCATION : "; CAMPO$(6): LPRINT
4340 LPRINT " DATE : "; CAMPO$(7): LPRINT
4350 LPRINT ; " ENGINEER : "; CAMPO$(8): LPRINT
4360 FOR I = 1 TO 4: LPRINT : NEXT: PRINT
4370 INPUT " Do you whish to carry out another test ? (Y/N)"; Y$
4380 IF Y$ = "Y" OR Y$ = "y" THEN 190
4390 IF Y$ = "N" OR Y$ = "n" THEN SYSTEM
4400 LOCATE F(NC), C(NC) + L, 1: A$ = INKEY$: IF A$ = "" THEN GOTO 4400
4410 IF LEN(A$) > 1 THEN GOSUB 4570: GOTO 4400
4420 A = ASC(A$)
4430 IF A = 13 THEN L = 0: GOTO 4450
4440 GOTO 4470
4450 IF NC < 8 OR NC > 8 AND NC < 25 THEN NC = NC + 1: GOTO 4400
4460 GOTO 4840
4470 IF A > 31 AND A < 183 THEN GOTO 4490
4480 BEEP: GOTO 4400
4490 IF L = LON(NC) THEN BEEP: GOTO 4400
4500 LOCATE F(NC), C(NC) + L: PRINT A$;
4510 L = L + 1
4520 IF L = 1 THEN B$(NC) = A$: GOTO 4540
4530 B$(NC) = B$(NC) + A$
4540 IF LEN(C$(NC)) > 0 THEN C$(NC) = RIGHT$(CAMPO$(NC), LEN(CAMPO$(NC)) - L)
4550 CAMPO$(NC) = B$(NC) + C$(NC)
4560 GOTO 4400
4570 REM * SLIDE
4580 IF LEN(A$) <> 2 THEN BEEP: RETURN
4590 C = ASC(RIGHT$(A$, 1))
4600 IF C = 8 THEN 4620
4610 GOTO 4650
4620 IF LEN(C$(NC)) > 0 THEN BEEP: RETURN
4630 IF L = 0 THEN BEEP: RETURN
4640 CAMPO$(NC) = LEFT$(CAMPO$(NC), LEN(CAMPO(NC)))
```

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```
4645 L = L - 1: PRINT A$: RETURN
4650 IF C = 30 THEN 4670
4660 GOTO 4700
4670 IF NC = 1 THEN BEEP: RETURN
4680 NC = NC - 1: L = 0
4690 RETURN
4700 IF C = 31 THEN 4720
4710 GOTO 4760
4720 IF NC <> 8 THEN 4740
4730 BEEP: RETURN
4740 NC = NC + 1: L = 0
4750 RETURN
4760 IF C = 29 THEN 4780
4770 GOTO 4800
4780 IF L = 0 THEN BEEP: RETURN
4790 L = L - 1: C$(NC) = RIGHT$(CAMPO$(NC), LEN(CAMPO$(NC)) - (L + 1))
4795 B$(NC) = LEFT$(CAMPO$(NC), L): LOCATE F(NC), C(NC) + L + 1: PRINT ""
4796 RETURN
4800 IF C = 28 THEN 4820
4810 GOTO 4400
4820 IF C$(NC) = "" THEN BEEP: RETURN
4830 L = L + 1: C$(NC) = RIGHT$(CAMPO$(NC), LEN(CAMPO$(NC)) - (L))
4835 B$(NC) = LEFT$(CAMPO$(NC), L): LOCATE F(NC), C(NC) + L, 1: PRINT ""
4840 RETURN
4850 RETURN
4860 FOR II = 1 TO 7
4870 X(1, II) = 0: X(2, II) = 0: X(3, II) = 0
4875 X(4, II) = 0: X(5, II) = 0: X(6, II) = 0
4880 Y(1, II) = 0: Y(2, II) = 0: Y(3, II) = 0
4885 Y(4, II) = 0: Y(5, II) = 0: Y(6, II) = 0
4890 Z(1, II) = 0: Z(2, II) = 0: Z(3, II) = 0
4895 Z(4, II) = 0: Z(5, II) = 0: Z(6, II) = 0
4900 NEXT II
4910 RETURN
4920 REM * THE SYMBOLS USED HERE ARE THE SAME AS IN THE CODE 6.
```

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Example 6.1

The tilting continues

TEST NR:

FRONT MOUNTED-OVER PROTECTIVE STRUCTURE OF THE NARROW TRACTOR:

Characteristic units:

LINEAR (m): MASS (kg):

MOMENT OF INERTIA (kgm^2): ANGLE (radian)

HEIGHT OF THE COG	H1 = 0.7620	H. DIST. COG-REAR AXLE	L3 = 0.8970
H. DIST. COG - FRONT AXLE	L2 = 1.1490	HEIGHT OF THE REAR TYRES	D3 = 1.2930
HEIGHT OF THE FRT TYRES	D2 = 0.8800	OVERALL HEIGHT(PT IMPACT)	H6 = 2.1000
H. DIST. COG-LEAD PT INTER.	L6 = 0.2800	PROTECTIVE STRUCT. WIDTH	B6 = 0.7780
HEIGHT OF THE ENG. B.	H7 = 1.3370	WIDTH OF THE ENG. B.	B7 = 0.4900
H. DIST. COG-FRT COR. ENG. B.	L7 = 1.6390	HEIGHT FRT AXLE PIVOT PT	H0 = 0.4450
REAR TRACK WIDTH	S = 1.1150	REAR TYRE WIDTH	B0 = 0.1950
FRT AXLE SWING ANGLE	D0 = 0.1570	TRACTOR MASS	Mc = 2565.000
MOMENT OF INERTIA	Q = 295.0000		

VELOCITY O0 = 3.881 rad/s	VELOCITY O1 = 1.078 rad/s
VELOCITY O2 = 1.057 rad/s	VELOCITY O3 = 2.134 rad/s
VELOCITY O4 = 0.731 rad/s	VELOCITY O5 = 0.000 rad/s
VELOCITY O6 = 0.000 rad/s	VELOCITY O7 = 0.000 rad/s
VELOCITY O8 = 0.000 rad/s	VELOCITY O9 = 0.000 rad/s

VELOCITY O0 = 3.881 rad/s	VELOCITY O1 = 1.078 rad/s
VELOCITY O2 = 1.057 rad/s	VELOCITY O3 = 2.134 rad/s
VELOCITY O4 = 1.130 rad/s	VELOCITY O5 = 0.993 rad/s
VELOCITY O6 = 0.810 rad/s	VELOCITY O7 = 0.629 rad/s
VELOCITY O8 = 0.587 rad/s	VELOCITY O9 = 0.219 rad/s

THE TILTING CONTINUES

Location: Date: Engineer:

▼B

Example 6.2

The rolling stops

TEST NR:

FRONT MOUNTED-OVER PROTECTIVE STRUCTURE OF THE NARROW TRACTOR:

Characteristic units:

LINEAR (m): MASS (kg):

MOMENT OF INERTIA (kgm^2): ANGLE (radian)

HEIGHT OF THE COG	H1 = 0.7653	H. DIST. COG-REAR AXLE	L3 = 0.7970
H. DIST. COG - FRONT AXLE	L2 = 1.1490	HEIGHT OF THE REAR TYRES	D3 = 1.4800
HEIGHT OF THE FRT TYRES	D2 = 0.8800	OVERALL HEIGHT(PT IMPACT)	H6 = 2.1100
H. DIST. COG-LEAD PT INTER.	L6 = -0.0500	PROTECTIVE STRUCT. WIDTH	B6 = 0.7000
HEIGHT OF THE ENG. B.	H7 = 1.3700	WIDTH OF THE ENG. B.	B7 = 0.8000
H. DIST. COG-FRT COR. ENG. B.	L7 = 1.6390	HEIGHT FRT AXLE PIVOT PT	H0 = 0.4450
REAR TRACK WIDTH	S = 1.1150	REAR TYRE WIDTH	B0 = 0.1950
FRT AXLE SWING ANGLE	D0 = 0.1570	TRACTOR MASS	Mc = 1800.000
MOMENT OF INERTIA	Q = 250.0000		

VELOCITY O0 = 3.840 rad/s	VELOCITY O1 = 0.281 rad/s
VELOCITY O2 = 0.268 rad/s	VELOCITY O3 = 1.586 rad/s
VELOCITY O4 = 0.672 rad/s	VELOCITY O5 = 0.000 rad/s
VELOCITY O6 = 0.000 rad/s	VELOCITY O7 = 0.000 rad/s
VELOCITY O8 = 0.000 rad/s	VELOCITY O9 = 0.000 rad/s

VELOCITY O0 = 3.840 rad/s	VELOCITY O1 = 0.281 rad/s
VELOCITY O2 = 0.268 rad/s	VELOCITY O3 = 1.586 rad/s
VELOCITY O4 = 0.867 rad/s	VELOCITY O5 = 0.755 rad/s
VELOCITY O6 = 1.218 rad/s	VELOCITY O7= 0.969 rad/s
VELOCITY O8 = 0.898 rad/s	VELOCITY O9 = 0.000 rad/s

THE ROLLING STOPS

Location: Date: Engineer:

▼B

Example 6.3

The rolling stops

TEST NR:

FRONT MOUNTED-OVER PROTECTIVE STRUCTURE OF THE NARROW TRACTOR:

Characteristic units:

LINEAR (m): MASS (kg):

MOMENT OF INERTIA (kgm^2): ANGLE (radian)

HEIGHT OF THE COG	H1 = 0.7180	H. DIST. COG-REAR AXLE	L3 = 0.8000
H. DIST. COG - FRONT AXLE	L2 = 1.1590	HEIGHT OF THE REAR TYRES	D3 = 1.5200
HEIGHT OF THE FRT TYRES	D2 = 0.7020	OVERALL HEIGHT(PT IMPACT)	H6 = 2.0040
H. DIST. COG-LEAD PT INTER.	L6 = -0.2000	PROTECTIVE STRUCT. WIDTH	B6 = 0.6400
HEIGHT OF THE ENG. B.	H7 = 1.2120	WIDTH OF THE ENG. B.	B7 = 0.3600
H. DIST. COG-FRT COR. ENG. B.	L7 = 1.6390	HEIGHT FRT AXLE PIVOT PT	H0 = 0.4400
REAR TRACK WIDTH	S = 0.9000	REAR TYRE WIDTH	B0 = 0.3150
FRT AXLE SWING ANGLE	D0 = 0.1740	TRACTOR MASS	Mc = 1780.000
MOMENT OF INERTIA	Q = 279.8960		

VELOCITY O0 = 3.884 rad/s	VELOCITY O1 = 0.107 rad/s
VELOCITY O2 = 0.098 rad/s	VELOCITY O3 = 0.000 rad/s
VELOCITY O4 = 0.000 rad/s	VELOCITY O5 = 0.000 rad/s
VELOCITY O6 = 0.000 rad/s	VELOCITY O7 = 0.000 rad/s
VELOCITY O8 = 0.000 rad/s	VELOCITY O9 = 0.000 rad/s

VELOCITY O0 = 3.884 rad/s	VELOCITY O1 = 0.107 rad/s
VELOCITY O2 = 0.098 rad/s	VELOCITY O3 = 0.000 rad/s
VELOCITY O4 = 0.000 rad/s	VELOCITY O5 = 0.000 rad/s
VELOCITY O6 = 0.000 rad/s	VELOCITY O7 = 0.000 rad/s
VELOCITY O8 = 0.000 rad/s	VELOCITY O9 = 0.000 rad/s

THE ROLLING STOPS

Location: Date: Engineer:

▼B

Example 6.4

The rolling stops

TEST NR:

FRONT MOUNTED-OVER PROTECTIVE STRUCTURE OF THE NARROW TRACTOR:

Characteristic units:

LINEAR (m): MASS (kg):

MOMENT OF INERTIA (kgm^2): ANGLE (radian)

HEIGHT OF THE COG	H1 = 0.7180	H. DIST. COG-REAR AXLE	L3 = 0.8110
H. DIST. COG - FRONT AXLE	L2 = 1.1590	HEIGHT OF THE REAR TYRES	D3 = 1.2170
HEIGHT OF THE FRT TYRES	D2 = 0.7020	OVERALL HEIGHT(PT IMPACT)	H6 = 2.1900
H. DIST. COG-LEAD PT INTER.	L6 = -0.3790	PROTECTIVE STRUCT. WIDTH	B6 = 0.6400
HEIGHT OF THE ENG. B.	H7 = 1.2120	WIDTH OF THE ENG. B.	B7 = 0.3600
H. DIST. COG-FRT COR. ENG. B.	L7 = 1.6390	HEIGHT FRT AXLE PIVOT PT	H0 = 0.4400
REAR TRACK WIDTH	S = 0.9000	REAR TYRE WIDTH	B0 = 0.3150
FRT AXLE SWING ANGLE	D0 = 0.1740	TRACTOR MASS	Mc = 1780.000
MOMENT OF INERTIA	Q = 279.8960		

VELOCITY O0 = 3.884 rad/s	VELOCITY O1 = 1.540 rad/s
VELOCITY O2 = 1.488 rad/s	VELOCITY O3 = 2.162 rad/s
VELOCITY O4 = 0.405 rad/s	VELOCITY O5 = 0.000 rad/s
VELOCITY O6 = 0.000 rad/s	VELOCITY O7 = 0.000 rad/s
VELOCITY O8 = 0.000 rad/s	VELOCITY O9 = 0.000 rad/s

VELOCITY O0 = 3.884 rad/s	VELOCITY O1 = 1.540 rad/s
VELOCITY O2 = 1.488 rad/s	VELOCITY O3 = 2.162 rad/s
VELOCITY O4 = 0.414 rad/s	VELOCITY O5 = 0.289 rad/s
VELOCITY O6 = 0.000 rad/s	VELOCITY O7= 0.000 rad/s
VELOCITY O8 = 0.000 rad/s	VELOCITY O9 = 0.000 rad/s

THE ROLLING STOPS

Location: Date: Engineer:

▼B

Example 6.5

The tilting continues

TEST NR:

FRONT MOUNTED-OVER PROTECTIVE STRUCTURE OF THE NARROW TRACTOR:

Characteristic units:

LINEAR (m): MASS (kg):

MOMENT OF INERTIA (kgm^2): ANGLE (radian)

HEIGHT OF THE COG	H1 = 0.7660	H. DIST. COG-REAR AXLE	L3 = 0.7970
H. DIST. COG - FRONT AXLE	L2 = 1.1490	HEIGHT OF THE REAR TYRES	D3 = 1.4800
HEIGHT OF THE FRT TYRES	D2 = 0.8800	OVERALL HEIGHT(PT IMPACT)	H6 = 2.1100
H. DIST. COG-LEAD PT INTER.	L6 = -0.2000	PROTECTIVE STRUCT. WIDTH	B6 = 0.7000
HEIGHT OF THE ENG. B.	H7 = 1.3700	WIDTH OF THE ENG. B.	B7 = 0.8000
H. DIST. COG-FRT COR. ENG. B.	L7 = 1.6390	HEIGHT FRT AXLE PIVOT PT	H0 = 0.4450
REAR TRACK WIDTH	S = 1.1150	REAR TYRE WIDTH	B0 = 0.9100
FRT AXLE SWING ANGLE	D0 = 0.1570	TRACTOR MASS	Mc = 1800.000
MOMENT OF INERTIA	Q = 250.0000		

VELOCITY O0 = 2.735 rad/s	VELOCITY O1 = 1.271 rad/s
VELOCITY O2 = 1.212 rad/s	VELOCITY O3 = 2.810 rad/s
VELOCITY O4 = 1.337 rad/s	VELOCITY O5 = 0.000 rad/s
VELOCITY O6 = 0.000 rad/s	VELOCITY O7 = 0.000 rad/s
VELOCITY O8 = 0.000 rad/s	VELOCITY O9 = 0.000 rad/s

THE TILTING CONTINUES

Location: Date: Engineer:

▼B

Example 6.6

The tilting continues

TEST NR:

FRONT MOUNTED-OVER PROTECTIVE STRUCTURE OF THE NARROW TRACTOR:

Characteristic units:

LINEAR (m): MASS (kg):

MOMENT OF INERTIA (kgm^2): ANGLE (radian)

HEIGHT OF THE COG	H1 = 0.7653	H. DIST. COG-REAR AXLE	L3 = 0.7970
H. DIST. COG - FRONT AXLE	L2 = 1.1490	HEIGHT OF THE REAR TYRES	D3 = 1.2930
HEIGHT OF THE FRT TYRES	D2 = 0.8800	OVERALL HEIGHT(PT IMPACT)	H6 = 1.9600
H. DIST. COG-LEAD PT INTER.	L6 = -0.4000	PROTECTIVE STRUCT. WIDTH	B6 = 0.7000
HEIGHT OF THE ENG. B.	H7 = 1.3700	WIDTH OF THE ENG. B.	B7 = 0.8750
H. DIST. COG-FRT COR. ENG. B.	L7 = 1.6390	HEIGHT FRT AXLE PIVOT PT	H0 = 0.4450
REAR TRACK WIDTH	S = 1.1150	REAR TYRE WIDTH	B0 = 0.1950
FRT AXLE SWING ANGLE	D0 = 0.1570	TRACTOR MASS	Mc = 1800.000
MOMENT OF INERTIA	Q = 275.0000		

VELOCITY O0 = 3.815 rad/s	VELOCITY O1 = 1.130 rad/s
VELOCITY O2 = 1.105 rad/s	VELOCITY O3 = 2.196 rad/s
VELOCITY O4 = 0.786 rad/s	VELOCITY O5 = 0.000 rad/s
VELOCITY O6 = 0.000 rad/s	VELOCITY O7 = 0.000 rad/s
VELOCITY O8 = 0.000 rad/s	VELOCITY O9 = 0.000 rad/s
VELOCITY O0 = 3.815 rad/s	VELOCITY O1 = 1.130 rad/s
VELOCITY O2 = 1.105 rad/s	VELOCITY O3 = 2.196 rad/s
VELOCITY O4 = 0.980 rad/s	VELOCITY O5 = 0.675 rad/s
VELOCITY O6 = 0.000 rad/s	VELOCITY O7 = 0.000 rad/s
VELOCITY O8 = 0.000 rad/s	VELOCITY O9 = 0.548 rad/s

THE TILTING CONTINUES

Location: Date: Engineer:

▼B

Example 6.7

Method of calculation not feasible

TEST NR:

FRONT MOUNTED-OVER PROTECTIVE STRUCTURE OF THE NARROW TRACTOR:

Characteristic units:

LINEAR (m): MASS (kg):

MOMENT OF INERTIA (kgm^2): ANGLE (radian)

HEIGHT OF THE COG	H1 = 0.7620	H. DIST. COG-REAR AXLE	L3 = 0.7970
H. DIST. COG - FRONT AXLE	L2 = 1.1490	HEIGHT OF THE REAR TYRES	D3 = 1.5500
HEIGHT OF THE FRT TYRES	D2 = 0.8800	OVERALL HEIGHT(PT IMPACT)	H6 = 2.1000
H. DIST. COG-LEAD PT INTER.	L6 = -0.4780	PROTECTIVE STRUCT. WIDTH	B6 = 0.7780
HEIGHT OF THE ENG. B.	H7 = 1.5500	WIDTH OF THE ENG. B.	B7 = 0.9500
H. DIST. COG-FRT COR. ENG. B.	L7 = 1.6390	HEIGHT FRT AXLE PIVOT PT	H0 = 0.4450
REAR TRACK WIDTH	S = 1.1150	REAR TYRE WIDTH	B0 = 0.1950
FRT AXLE SWING ANGLE	D0 = 0.1570	MOMENT OF INERTIA	Q = 200.0000
TRACTOR MASS	Mc = 1800.000		

THE ENGINE BONNET TOUCHES THE GROUND BEFORE THE ROPS

METHOD OF CALCULATION NOT FEASIBLE

Location: Date: Engineer:

▼B

Example 6.8

The rolling stops

TEST NR:

FRONT MOUNTED-OVER PROTECTIVE STRUCTURE OF THE NARROW TRACTOR:

Characteristic units:

LINEAR (m): MASS (kg):

MOMENT OF INERTIA (kgm^2): ANGLE (radian)

HEIGHT OF THE COG	H1 = 0.7180	H. DIST. COG-REAR AXLE	L3 = 0.8110
H. DIST. COG - FRONT AXLE	L2 = 1.1590	HEIGHT OF THE REAR TYRES	D3 = 1.2170
HEIGHT OF THE FRT TYRES	D2 = 0.7020	OVERALL HEIGHT(PT IMPACT)	H6 = 2.0040
H. DIST. COG-LEAD PT INTER.	L6 = -0.3790	PROTECTIVE STRUCT. WIDTH	B6 = 0.6400
HEIGHT OF THE ENG. B.	H7 = 1.2120	WIDTH OF THE ENG. B.	B7 = 0.3600
H. DIST. COG-FRT COR. ENG. B.	L7 = 1.6390	HEIGHT FRT AXLE PIVOT PT	H0 = 0.4400
REAR TRACK WIDTH	S = 0.9000	REAR TYRE WIDTH	B0 = 0.3150
FRT AXLE SWING ANGLE	D0 = 0.1740	TRACTOR MASS	Mc = 1780.000
MOMENT OF INERTIA	Q = 279.8960		

VELOCITY O0 = 3.884 rad/s	VELOCITY O1 = 1.540 rad/s
VELOCITY O2 = 1.488 rad/s	VELOCITY O3 = 2.313 rad/s
VELOCITY O4 = 0.581 rad/s	VELOCITY O5 = 0.000 rad/s
VELOCITY O6 = 0.000 rad/s	VELOCITY O7 = 0.000 rad/s
VELOCITY O8 = 0.000 rad/s	VELOCITY O9 = 0.000 rad/s

VELOCITY O0 = 3.884 rad/s	VELOCITY O1 = 1.540 rad/s
VELOCITY O2 = 1.488 rad/s	VELOCITY O3 = 2.313 rad/s
VELOCITY O4 = 0.633 rad/s	VELOCITY O5 = 0.373 rad/s
VELOCITY O6 = 0.000 rad/s	VELOCITY O7 = 0.000 rad/s
VELOCITY O8 = 0.000 rad/s	VELOCITY O9 = 0.000 rad/s

THE ROLLING STOPS

Location: Date: Engineer:

▼B

Example 6.9

The tilting continues

TEST NR:

FRONT MOUNTED-OVER PROTECTIVE STRUCTURE OF THE NARROW TRACTOR:

Characteristic units:

LINEAR (m): MASS (kg):

MOMENT OF INERTIA (kgm^2): ANGLE (radian)

HEIGHT OF THE COG	H1 = 0.7620	H. DIST. COG-REAR AXLE	L3 = 0.7970
H. DIST. COG - FRONT AXLE	L2 = 1.1490	HEIGHT OF THE REAR TYRES	D3 = 1.2930
HEIGHT OF THE FRT TYRES	D2 = 0.8800	OVERALL HEIGHT(PT IMPACT)	H6 = 1.9670
H. DIST. COG-LEAD PT INTER.	L6 = -0.3000	PROTECTIVE STRUCT. WIDTH	B6 = 0.7700
HEIGHT OF THE ENG. B.	H7 = 1.3500	WIDTH OF THE ENG. B.	B7 = 0.9500
H. DIST. COG-FRT COR. ENG. B.	L7 = 1.6390	HEIGHT FRT AXLE PIVOT PT	H0 = 0.4450
REAR TRACK WIDTH	S = 1.1150	REAR TYRE WIDTH	B0 = 0.1950
FRT AXLE SWING ANGLE	D0 = 0.1570	TRACTOR MASS	Mc = 1800.000
MOMENT OF INERTIA	Q = 300.0000		

VELOCITY O0 = 3.790 rad/s	VELOCITY O1 = 1.159 rad/s
VELOCITY O2 = 1.133 rad/s	VELOCITY O3 = 2.118 rad/s
VELOCITY O4 = 0.801 rad/s	VELOCITY O5 = 0.000 rad/s
VELOCITY O6 = 0.000 rad/s	VELOCITY O7 = 0.000 rad/s
VELOCITY O8 = 0.000 rad/s	VELOCITY O9 = 0.000 rad/s

VELOCITY O0 = 3.790 rad/s	VELOCITY O1 = 1.159 rad/s
VELOCITY O2 = 1.133 rad/s	VELOCITY O3 = 2.118 rad/s
VELOCITY O4 = 0.856 rad/s	VELOCITY O5 = 0.562 rad/s
VELOCITY O6 = 0.000 rad/s	VELOCITY O7 = 0.000 rad/s
VELOCITY O8 = 0.000 rad/s	VELOCITY O9 = 0.205 rad/s

THE TILTING CONTINUES

Location: Date: Engineer:

▼B

Example 6.10

The tilting continues

TEST NR:

FRONT MOUNTED-OVER PROTECTIVE STRUCTURE OF THE NARROW TRACTOR:

Characteristic units:

LINEAR (m): MASS (kg):

MOMENT OF INERTIA (kgm^2): ANGLE (radian)

HEIGHT OF THE COG	H1 = 0.7653	H. DIST. COG-REAR AXLE	L3 = 0.7970
H. DIST. COG - FRONT AXLE	L2 = 1.1490	HEIGHT OF THE REAR TYRES	D3 = 1.3800
HEIGHT OF THE FRT TYRES	D2 = 0.8800	OVERALL HEIGHT(PT IMPACT)	H6 = 1.9600
H. DIST. COG-LEAD PT INTER.	L6 = -0.3000	PROTECTIVE STRUCT. WIDTH	B6 = 0.7000
HEIGHT OF THE ENG. B.	H7 = 1.3700	WIDTH OF THE ENG. B.	B7 = 0.8900
H. DIST. COG-FRT COR. ENG. B.	L7 = 1.6390	HEIGHT FRT AXLE PIVOT PT	H0 = 0.4450
REAR TRACK WIDTH	S = 1.1150	REAR TYRE WIDTH	B0 = 0.1950
FRT AXLE SWING ANGLE	D0 = 0.1570	TRACTOR MASS	Mc = 1800.000
MOMENT OF INERTIA	Q = 275.0000		

VELOCITY O0 = 3.815 rad/s	VELOCITY O1 = 0.748 rad/s
VELOCITY O2 = 0.724 rad/s	VELOCITY O3 = 1.956 rad/s
VELOCITY O4 = 0.808 rad/s	VELOCITY O5 = 0.000 rad/s
VELOCITY O6 = 0.000 rad/s	VELOCITY O7 = 0.000 rad/s
VELOCITY O8 = 0.000 rad/s	VELOCITY O9 = 0.407 rad/s

THE TILTING CONTINUES

Location: Date: Engineer:

▼B

Example 6.11

The rolling stops

TEST NR:

FRONT MOUNTED-OVER PROTECTIVE STRUCTURE OF THE NARROW TRACTOR:

Characteristic units:

LINEAR (m): MASS (kg):

MOMENT OF INERTIA (kgm^2): ANGLE (radian)

EIGHT OF THE COG	H1 = 0.7653	H. DIST. COG-REAR AXLE	L3 = 0.7970
H. DIST. COG - FRONT AXLE	L2 = 1.1490	HEIGHT OF THE REAR TYRES	D3 = 1.4800
HEIGHT OF THE FRT TYRES	D2 = 0.9000	OVERALL HEIGHT(PT IMPACT)	H6 = 1.9600
H. DIST. COG-LEAD PT INTER.	L6 = -0.4000	PROTECTIVE STRUCT. WIDTH	B6 = 0.7000
HEIGHT OF THE ENG. B.	H7 = 1.3700	WIDTH OF THE ENG. B.	B7 = 0.8000
H. DIST. COG-FRT COR. ENG. B.	L7 = 1.6390	HEIGHT FRT AXLE PIVOT PT	H0 = 0.4450
REAR TRACK WIDTH	S = 1.1150	REAR TYRE WIDTH	B0 = 0.1950
FRT AXLE SWING ANGLE	D0 = 0.1570	TRACTOR MASS	Mc = 1800.000
MOMENT OF INERTIA	Q = 250.0000		

VELOCITY O0 = 3.840	VELOCITY O1 = 0.246
VELOCITY O2 = 0.235	VELOCITY O3 = 0.000
VELOCITY O4 = 0.000	VELOCITY O5 = 0.000
VELOCITY O6 = 0.000	VELOCITY O7 = 0.000
VELOCITY O8 = 0.000	VELOCITY O9 = 0.000

VELOCITY O0 = 3.840	VELOCITY O1 = 0.246
VELOCITY O2 = 0.235	VELOCITY O3 = 0.000
VELOCITY O4 = 0.000	VELOCITY O5 = 0.000
VELOCITY O6 = 0.000	VELOCITY O7 = 0.000
VELOCITY O8 = 0.000	VELOCITY O9 = 0.000

THE ROLLING STOPS

Location: Date: Engineer:

▼B

Explanatory notes to Annex IX:

(1) Unless the numbering of sections B2 and B3 which has been harmonised with the whole Annex, the text of the requirements and the numbering set out in point B are identical with the text and numbering of the OECD standard code for the official testing of front mounted roll-over protective structures on narrow-track wheeled agricultural and forestry tractors, OECD Code 6, Edition 2015 of July 2014.

(2) Users are reminded that the seat index point is determined according to ISO 5353:1995 and is a fixed point with respect to the tractor that does not move as the seat is adjusted away from the mid-position. For purposes of determining the clearance zone, the seat shall be placed in the rear and uppermost position.

(3) The programme and the examples are available on the OECD website.

(4) Permanent + elastic deflection measured at the point when the required energy level is obtained.

▼B

ANNEX X

Requirements applying to roll-over protection structures (rear mounted roll-over protective structures on narrow-track tractors)

A. GENERAL PROVISIONS

1. The Union requirements applying to roll-over protection structures (rear mounted roll-over protective structures on narrow track tractors) are set out in point B.

2. Tests may be performed in accordance with the static or alternatively the dynamic test procedures as set out in sections B1 and B2. The two methods are deemed equivalent.

B. REQUIREMENTS APPLYING TO ROLL-OVER PROTECTION STRUCTURES (REAR MOUNTED ROLL-OVER PROTECTIVE STRUCTURES ON NARROW TRACK TRACTORS)[1]

1. **Definitions**

1.1. [Not applicable]

1.2. *Roll-Over Protective Structure (ROPS)*

Roll-over protective structure (protective cab or frame), hereinafter called 'protective structure', means the structure on a tractor the essential purpose of which is to avoid or limit risks to the driver resulting from roll-over of the tractor during normal use.

The roll-over protective structure is characterized by the provision of space for a clearance zone large enough to protect the driver when seated 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.

1.3. *Track*

1.3.1. Preliminary definition: median plane of the wheel or track.

The median plane of the wheel is equidistant from the two planes containing the periphery of the rims or tracks at their outer edges.

1.3.2. Definition of track

The vertical plane through the wheel axis intersects its median plane along a straight line which meets the supporting surface at one point. If **A** and **B** are the two points thus defined for the wheels on the same axle of the tractor, then the track width is the distance between points **A** and **B**. The track may be thus defined for both front and rear wheels. Where there are twin wheels, the track is the distance between two planes each being the median plane of the pairs of wheels. For track-laying tractors, the track is the distance between the median planes of the tracks.

1.3.3. Additional definition: median plane of the tractor

Take the extreme positions of points **A** and **B** for the tractor rear axle, which gives the maximum possible value for the track. The vertical plane at right angles to the line **AB** at its centre point is the median plane of the tractor.

▼B

1.4. *Wheelbase*

The distance between the vertical planes passing through the two lines **AB** as defined above, one for the front wheels and one for the rear-wheels.

1.5. *Determination of seat index point; Seat location and adjustment for test*

1.5.1. Seat index point (SIP)[(2)]

The seat index point shall be determined in accordance with ISO 5353:1995

1.5.2. Seat location and adjustment for test

1.5.2.1. where the seat position is adjustable, the seat must be adjusted to its rear uppermost position;

1.5.2.2. where the inclination of the backrest is adjustable, it must be adjusted to the mid position;

1.5.2.3. where the seat is equipped with suspension, the latter must be blocked at mid-travel, unless this is contrary to the instructions clearly laid down by the seat manufacturer;

1.5.2.4. where the position of the seat is adjustable only lengthwise and vertically, the longitudinal axis passing through the Seat Index Point shall be parallel with the vertical longitudinal plane of the tractor passing through the centre of the steering wheel and not more than 100 mm from that plane.

1.6. *Clearance zone*

1.6.1. Reference plane

The clearance zone is illustrated in figures 7.1 and 7.2. The zone is defined in relation to the reference plane and the Seat Index Point. The reference plane is a vertical plane, generally longitudinal to the tractor and passing through the Seat Index Point 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 roll-over protective structure. The clearance zone shall be defined on the basis of Sections 1.6.2 and 1.6.3.

1.6.2. Determination of the clearance zone for tractors with a non-reversible seat

The clearance zone for tractors with a non-reversible seat is defined in 1.6.2.1 to 1.6.2.13 below and is bounded by the following planes, the tractor being on a horizontal surface, the seat adjusted and located as specified in Sections 1.5.2.1 to 1.5.2.4[(2)], and the steering wheel, where adjustable, adjusted to the mid position for seated driving:

1.6.2.1. a horizontal plane A_1 B_1 B_2 A_2, (810 + a_v) mm above the Seat Index Point with line B_1B_2 located (a_h-10) mm behind the SIP;

1.6.2.2. an inclined plane H_1 H_2 G_2 G_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;

1.6.2.3. a cylindrical surface A_1 A_2 H_2 H_1 perpendicular to the reference plane, having a radius of 120 mm, tangential to the planes defined in 1.6.2.1 and 1.6.2.2 above;

▼B

1.6.2.4. a cylindrical surface B_1 C_1 C_2 B_2, perpendicular to the reference plane, having a radius of 900 mm extending forward for 400 mm and tangential to the plane defined in 1.6.2.1 above along line B_1B_2;

1.6.2.5. an inclined plane C_1 D_1 D_2 C_2, perpendicular to the reference plane, joining the surface defined in 1.6.2.4 above 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 1.6.2.4 above;

1.6.2.6. a vertical plane D_1 K_1 E_1 E_2 K_2 D_2 perpendicular to the reference plane 40 mm forward of the external edge of the steering wheel;

1.6.2.7. a horizontal plane E_1 F_1 P_1 N_1 N_2 P_2 F_2 E_2 passing through a point (90-a_v) mm below the Seat Index Point;

1.6.2.8. a surface G_1 L_1 M_1 N_1 N_2 M_2 L_2 G_2, if necessary curved from the bottom limit of the plane defined in 1.6.2.2 above to the horizontal plane defined in 1.6.2.7 above, perpendicular to the reference plane, and in contact with the seat backrest throughout its length;

1.6.2.9. two vertical planes K_1 I_1 F_1 E_1 and K_2 I_2 F_2 E_2 parallel to the reference plane, 250 mm either side of the reference plane, and bounded at the top 300 mm above the plane defined in 1.6.2.7 above;

1.6.2.10. two inclined and parallel planes A_1 B_1 C_1 D_1 K_1 I_1 L_1 G_1 H_1 and A_2 B_2 C_2 D_2 K_2 I_2 L_2 G_2 H_2 starting from the upper edge of the planes defined in 1.6.2.9 above and joining the horizontal plane defined in 1.6.2.1 above at least 100 mm from the reference plane on the side where the loading is applied;

1.6.2.11. two portions of vertical planes Q_1 P_1 N_1 M_1 and Q_2 P_2 N_2 M_2 parallel to the reference plane, 200 mm either side of the reference plane, and bounded towards the top 300 mm above the horizontal plane defined in 1.6.2.7 above

1.6.2.12. two portions of I_1 Q_1 P_1 F_1 and I_2 Q_2 P_2 F_2 of a vertical plane, perpendicular to the reference plane and passing (210-a_h) mm in front of the SIP;

1.6.2.13. two portions I_1 Q_1 M_1 L_1 and I_2 Q_2 M_2 L_2 of the horizontal plane passing 300 mm above the plane defined in 1.6.2.7 above.

1.6.3. Determination of the clearance zone for tractors with a reversible driver's position

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

1.6.3.1. If the protective structure is a of a rear two-post type, for each position of the steering wheel and of the seat, the clearance zone shall respectively be defined on the basis of above sections 1.6.1 and 1.6.2 for driver's position in normal position, and on the basis of sections 1.6.1 and 1.6.2 of Annex IX for driver's position in reverse position (see figure 7.2.a).

▼B

1.6.3.2. If the protective structure is of another type, for each position of the steering wheel and of the seat, the clearance zone shall be defined on the basis of sections 1.6.1 and 1.6.2 of this Annex (see figure 7.2.b).

1.6.4. Optional seats

1.6.4.1. In case of tractors that could be fitted with optional seats, the envelope comprising the Seat Index Points of all options offered shall be used during the tests. The protective structure shall not enter the larger clearance zone which takes account of these different Seat Index Points.

1.6.4.2. In the case where a new seat option is offered after the test has been performed, a determination shall be made to see whether the clearance zone around the new SIP falls within the envelope previously established. If it does not, a new test must be performed.

1.6.4.3. Optional seat does not include a seat for a person in addition to the driver and from where the tractor cannot be controlled. The SIP shall not be determined because the definition of the clearance zone is in relation to the driver seat.

1.7. *Mass*

1.7.1. Unballasted/Unladen Mass

The mass of the tractor excluding optional accessories but including coolant, oils, fuel, tools plus the protective structure. Not included are optional front or rear weights, tyre ballast, mounted implements, mounted equipment or any specialised components;

1.7.2. Maximum Permissible Mass

The maximum mass of the tractor stated by the manufacturer to be technically permissible and declared on the vehicle's identification plate and/or in the Operator's Handbook;

1.7.3. Reference Mass

The mass, selected by the manufacturer, used in formulae to calculate the height of fall of the pendulum block, the energy inputs and crushing forces to be used in the tests. Must not be less than the unballasted mass and must be sufficient to ensure the Mass Ratio does not exceed 1,75 *(see Section 1.7.4)*;

1.7.4. Mass Ratio

The ratio of $\left(\frac{\text{Max. Permissible Mass}}{\text{Reference Mass}}\right)$ This must not be greater than 1,75

1.8. *Permissible measurement tolerances*

Linear dimension:		± 3 mm
except for:	– tyre deflection:	± 1 mm
	– structure deflection during horizontal loadings:	± 1 mm
	– height of fall of the pendulum block:	± 1 mm
Masses:		± 0,2 % (of the sensor full scale)
Forces:		± 0,1 % (of the sensor full scale)
Angles:		± 0,1°

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1.9. *Symbols*

a_h	(mm)	Half of the horizontal seat adjustment
a_v	(mm)	Half of the vertical seat adjustment
B	(mm)	Minimum overall width of the tractor;
B_6	(mm)	Maximum outer width of the protective structure;
D	(mm)	Deflection of the structure at the point of impact (dynamic tests) or at the point of, and in line with, the load application (static tests);
D'	(mm)	Deflection of the structure for the calculated energy required;
E_a	(J)	Strain energy absorbed at point when load is removed. Area contained within **F-D** curve;
E_i	(J)	Strain energy absorbed. Area under F-D curve;
E'_i	(J)	Strain energy absorbed after additional loading following a crack or tear;
E''_i	(J)	Strain energy absorbed in overload test in the event of the load having been removed before starting this overload test. Area under F-D curve;
E_{il}	(J)	Energy input to be absorbed during longitudinal loading;
E_{is}	(J)	Energy input to be absorbed during side loading;
F	(N)	Static load force;
F'	(N)	Loading force for calculated energy required, corresponding to E'_i ;
F-D		Force/deflection diagram;
F_{max}	(N)	Maximum static load force occurring during loading, with the exception of the overload;
F_v	(N)	Vertical crushing force;
H	(mm)	Falling height of the pendulum block (dynamic tests);
H'	(mm)	Falling height of the pendulum block for additional test (dynamic tests);
I	(kgm^2)	Tractor reference moment of inertia about the centre line of the rear wheels, whatever the mass of these rear wheels may be;
L	(mm)	Tractor reference wheelbase;
M	(kg)	Tractor reference mass during strength tests.

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2. **Field of application**

2.1. This Annex shall is applicable to tractors having at least two axles for pneumatic tyred wheels or having tracks instead of wheels and having the following characteristics:

2.1.1. ground clearance of not more than 600 mm beneath the lowest points of the front and rear axles, allowing for the differential;

2.1.2. fixed or adjustable minimum track width with one of the axles less than 1 150 mm fitted with tyres of a larger size. It is assumed that the axle mounted with the wider tyres is set at a track width of not more than 1 150 mm. It must be possible to set the track width of the other axle in such a way that the outer edges of the narrower tyres do not go beyond the outer edges of the tyres of the other axle. Where the two axles are fitted with rims and tyres of the same size, the fixed or adjustable track width of the two axles must be less than 1 150 mm;

2.1.3. mass greater than 400 kg unladen but including the roll-over protective structure and tyres of the largest size recommended by the manufacturer. For tractors with a reversible driver's position (reversible seat and steering wheel), the unladen mass shall be less than 3 500 kg and the maximum permissible mass shall not exceed 5 250 kg. For all tractors, the Mass Ratio *(Maximum Permissible Mass / Reference Mass)* must not be greater than 1,75.

2.1.4. roll-over protective structure of the rollbar, frame or cab type, mounted partly or entirely behind the Seat Index Point and having a zone of clearance whose upper limit is $(810 + a_v)$ mm above the seat index point in order to provide a sufficiently large area or unobstructed space for the protection of the driver.

2.2. It is recognised that there may be designs of tractors, for example, special forestry machines, such as forwarders and skidders, for which this Annex is not applicable.

B1 STATIC TEST PROCEDURE

3. **Rules and directions**

3.1. *Conditions for testing the strength of protective structures and of their attachment to tractors*

3.1.1. General requirements

3.1.1.1. Test purposes

Tests made using special rigs are intended to simulate such loads as are imposed on a protective structure, when the tractor overturns. These tests enable observations to be made on the strength of the protective structure and any brackets attaching it to the tractor and any parts of the tractor which transmit the test load.

3.1.1.2. Test methods

Tests may be performed in accordance with the static procedure or the dynamic procedure (see Annex II). The two methods are deemed equivalent.

3.1.1.3. General rules governing preparation for tests

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3.1.1.3.1. The protective structure must conform to the series production specifications. It shall be attached in accordance with the manufacturer's recommended method to one of the tractors for which it is designed.

Note: A complete tractor is not required for the static strength test; however, the protective structure and parts of the tractor to which it is attached represent an operating installation, hereinafter referred to as 'the assembly'.

3.1.1.3.2. For both the static test and the dynamic test the tractor as assembled (or the assembly) must be fitted with all series production components which may affect the strength of the protective structure or which may be necessary for the strength test.

Components which may create a hazard in the clearance zone must also be fitted on the tractor (or the assembly) so that they may be examined to see whether the requirements of the Acceptance Conditions in 3.1.3 have been fulfilled. All components of the tractor or the protective structure including weather protective must be supplied or described on drawings.

3.1.1.3.3. For the strength tests, all panels and detachable non-structural components must be removed so that they may not contribute to the strengthening of the protective structure.

3.1.1.3.4. The track width must be adjusted so that the protective structure will, as far as possible, not be supported by the tyres or the tracks during the strength tests. If these tests are conducted in accordance with the static procedure, the wheels or tracks may be removed.

3.1.2. Tests

3.1.2.1. Sequence of tests according to the Static Procedure

The sequence of tests, without prejudice to the additional tests mentioned in sections 3.2.1.6, and 3.2.1.7 is as follows:

(1) **loading at the rear of the structure**

(see 3.2.1.1);

(2) **rear crushing test**

(see 3.2.1.4);

(3) **loading at the front of the structure**

(see 3.2.1.2);

(4) **loading at the side of the structure**

(see 3.2.1.3);

(5) **crushing at the front of the structure**

(see 3.2.1.5).

3.1.2.2. General requirements

3.1.2.2.1. If, during the test, any part of the tractor restraining equipment breaks or moves, the test shall be restarted.

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3.1.2.2.2. No repairs or adjustments of the tractor or protective structure may be carried out during the tests.

3.1.2.2.3. The tractor gear box shall be in neutral and the brakes off during the tests.

3.1.2.2.4. If the tractor is fitted with a suspension system between the tractor body and the wheels, it shall be blocked during the tests.

3.1.2.2.5. The side chosen for application of the first load on the rear of the structure shall be that which, in the opinion of the testing authorities, will result in the application of the series of loads under the most unfavourable conditions for the structure. The lateral load and the rear load shall be applied on both sides of the longitudinal median plane of the protective structure. The front load shall be applied on the same side of the longitudinal median plane of the protective structure as the lateral load.

3.1.3. Acceptance conditions

3.1.3.1. A protective structure is regarded as having satisfied the strength requirements if it fulfils the following conditions:

3.1.3.1.1. during static testing, at the point when the energy required is attained in each horizontal load test prescribed or in the overload test the force must be greater than 0,8 F;

3.1.3.1.2. if during the test, cracks or tears appear as a result of the application of the crushing force, an additional crushing test as defined in 3.2.1.7 must be performed immediately after the crushing test which caused these cracks or tears to appear;

3.1.3.1.3. during the tests other than the overload test, no part of the protective structure must enter the clearance zone as defined in 1.6;

3.1.3.1.4. during the tests other than the overload test, all parts of the clearance zone shall be secured by the structure, in accordance with 3.2.2.2;

3.1.3.1.5. during the tests the protective structure must not impose any constraints on the seat structure;

3.1.3.1.6. the elastic deflection, measured in accordance with 3.2.2.3 shall be less than 250 mm.

3.1.3.2. There shall be no accessories presenting a hazard for the driver. There shall be no projecting part or accessory which is liable to injure the driver should the tractor overturn, or any accessory or part which is liable to trap him — for example by the leg or the foot — as a result of the deflections of the structure.

3.1.4. [Not applicable]

3.1.5. Test apparatus and equipment

3.1.5.1. Static testing rig

3.1.5.1.1. The static testing rig must be designed in such a way as to permit thrusts or loads to be applied to the protective structure.

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3.1.5.1.2. Provision must be made so that the load can be uniformly distributed normal to the direction of loading and along a flange having a length of one of the exact multiples of 50 between 250 and 700 mm. The stiff beam shall have a vertical face dimension of 150 mm. The edges of the beam in contact with the protective structure shall be curved with a maximum radius of 50 mm.

3.1.5.1.3. The pad shall be capable of being adjusted to any angle in relation to the load direction, in order to be able to follow the angular variations of the structure's load-bearing surface as the structure deflects.

3.1.5.1.4. Direction of the force (deviation from horizontal and vertical):

— at start of test, under zero load: ± 2°;

— during test, under load: 10° above and 20° below the horizontal. These variations must be kept to a minimum.

3.1.5.1.5. The deflection rate shall be sufficiently slow, less than 5 mm/s so that the load may at all moments be considered as static.

3.1.5.2. Apparatus for measuring the energy absorbed by the structure

3.1.5.2.1. The force versus deflection curve shall be plotted in order to determine the energy absorbed by the structure. There is no need to measure the force and deflection at the point where the load is applied to the structure; however, force and deflection shall be measured simultaneously and co-linearly.

3.1.5.2.2. The point of origin of deflection measurements shall be selected so as to take account only of the energy absorbed by the structure and/or by the deflection of certain parts of the tractor. The energy absorbed by the deflection and/or the slipping of the anchoring must be ignored.

3.1.5.3. Means of anchoring the tractor to the ground

3.1.5.3.1. Anchoring rails with the requisite track width and covering the necessary area for anchoring the tractor in all the cases illustrated must be rigidly attached to a non-yielding base near the testing rig.

3.1.5.3.2. The tractor must be anchored to the rails by any suitable means (plates, wedges, wire ropes, jacks, etc.) so that it cannot move during the tests. This requirement shall be checked during the test, by means of the usual devices for measuring length.

If the tractor moves, the entire test shall be repeated, unless the system for measuring the deflections taken into account for plotting the force versus deflection curve is connected to the tractor.

3.1.5.4. Crushing rig

A rig as shown in figure 7.3 shall be capable of exerting a downward force on a protective structure through a rigid beam approximately 250 mm wide, connected to the load-applying mechanism by means of universal joints. Suitable axle stands must be provided so that the tractor tyres do not bear the crushing force.

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3.1.5.5. Other measuring apparatus

The following measuring devices are also needed:

3.1.5.5.1. device for measuring the elastic deflection (the difference between the maximum momentary deflection and the permanent deflection, see figure 7.4).

3.1.5.5.2. device for checking that the protective structure has not entered the clearance zone and that the latter has remained within the structure's protective during the test (section 3.2.2.2).

3.2. *Static test procedure*

3.2.1. Loading and crushing tests

3.2.1.1. Loading at the rear

3.2.1.1.1. The load shall be applied horizontally, in a vertical plane parallel to the tractor's median plane.

The load application point shall be that part of the roll-over protective structure likely to hit the ground first in a rearward overturning accident, normally the upper edge. The vertical plane in which the load is applied shall be located at a distance of 1/6 of the width of the top of the protective structure inwards from a vertical plane, parallel to the median plane of the tractor, touching the outside extremity of the top of the protective structure.

If the structure is curved or protruding at this point, wedges enabling the load to be applied thereon shall be added, without thereby reinforcing the structure.

3.2.1.1.2. The assembly shall be lashed to the ground as described in 3.1.6.3.

3.2.1.1.3. The energy absorbed by the protective structure during the test shall be at least:

$$E_{il} = 2{,}165 \times 10^{-7} M\, L^2$$

or

$$E_{il} = 0{,}574 \times I$$

3.2.1.1.4. For tractors with a reversible driver's position (reversible seat and steering wheel), the energy shall be whichever is the higher of the formula selected above or the following:

$$E_{il} = 500 + 0{,}5\ M$$

3.2.1.2. Loading at the front

3.2.1.2.1. The load shall be applied horizontally in a vertical plane parallel to the tractor's median plane. The point of application shall be that part of the protective structure likely to hit the ground first if the tractor overturns sideways while travelling forward, i.e. normally the upper edge. The point of application of the load shall be 1/6 of the width of the top of the protective structure inwards from a vertical plane parallel to the median plane of the tractor touching the outside extremity of the top of the protective structure.

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If the structure is curved or protruding at this point, wedges enabling the load to be applied thereon shall be added, without thereby reinforcing the structure.

3.2.1.2.2. The assembly shall be lashed to the ground as described in 3.1.6.3.

3.2.1.2.3. The energy absorbed by the protective structure during the test shall be at least:

$$E_{il} = 500 + 0{,}5\ M$$

3.2.1.2.4. In case of tractors with a reversible driver's position (reversible seat and steering wheel):

— if the protective structure is a rear two-post rollbar the preceding formula shall also apply;

— for other types of protective structures, the energy shall be whichever is the higher of the above or either of the following as selected:

$$E_{il} = 2{,}165 \times 10^{-7} M\ L^2$$

or

$$E_{il} = 0{,}574\ I$$

3.2.1.3. Loading from the side

3.2.1.3.1. The side loading shall be applied horizontally, in a vertical plane perpendicular to the tractor's median plane passing 60 mm in front of the Seat Index Point, the seat being at the mid position of the longitudinal adjustment. The load application point shall be that part of the roll-over protective structure likely to hit the ground first in a sideways overturning accident, normally the upper edge.

3.2.1.3.2. The assembly shall be lashed to the ground as described in 3.1.6.3.

3.2.1.3.3. The energy absorbed by the protective structure during the test shall be at least:

$$E_{is} = 1{,}75\ M$$

3.2.1.3.4. For tractors with a reversible driver's position (reversible seat and steering wheel), the load application point shall be in the plane at right angles to the median plane and passing at the midpoint of the segment joining the two Seat Index Points defined by joining the two different positions of the seat. For protective structures having a two-post system, the load shall be located on one of the two posts.

3.2.1.3.5. In case of tractors with a reversible driver's position (reversible seat and steering wheel) where the protective structure is a rear two-post rollbar, the energy shall be whichever is higher of the following:

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$$E_{is} = 1{,}75\ M$$

or

$$E_{is} = 1{,}75\ M(B_6 + B)/2B$$

3.2.1.4. Crushing at the rear

The beam shall be positioned over the rear uppermost structural member(s) and the resultant of crushing forces shall be located in the tractor's median plane A force F_v shall be applied where:

$$F_v = 20\ M$$

The force F_v shall be maintained for five seconds after the cessation of any visually detectable movement of the protective structure.

Where the rear part of the protective structure 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 protective structure with that part of the rear of the tractor capable of supporting the tractor when overturned.

The force shall then be removed, and the crushing beam repositioned over that part of the protective structure which would support the tractor when completely overturned. The crushing force F_v shall then be applied again.

3.2.1.5. Crushing at the front

The beam shall be positioned across the front uppermost structural member(s) and the resultant of crushing forces shall be located in the tractor's median plane. A force F_v shall be applied where:

$$F_v = 20\ M$$

The force F_v shall be maintained for five seconds after the cessation of any visually detectable movement of the protective structure.

Where the front part of the protective structure 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 protective structure with that part of the front of the tractor capable of supporting the tractor when overturned.

The force shall then be removed, and the crushing beam repositioned over that part of the protective structure which would support the tractor when completely overturned. The crushing force F_v shall then be applied again.

3.2.1.6. Additional overload test (figures 7.5 to 7.7)

An overload test shall be carried out in all cases where the force decreases by more than 3 per cent during the last 5 per cent of the deflection reached when the energy required is absorbed by the structure (see figure 7.6).

The overload test involves the gradual increase of the horizontal load by increments of 5 per cent of the initial energy requirement up to a maximum of 20 per cent of energy added (see figure 7.7).

The overload test is satisfactory if, after each increase by 5, 10 or 15 per cent in the energy required, the force decreases by less than 3 per cent for a 5 per cent increment and remains greater than 0,8 F_{max}.

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The overload test is satisfactory if, after the structure has absorbed 20 per cent of the added energy, the force exceeds 0,8 F_{max}.

Additional cracks or tears and/or entry into or lack of protective of the clearance zone due to elastic deflection are permitted during the overload test. However, after the removal of the load, the structure shall not enter the clearance zone, which shall be completely protected.

3.2.1.7. Additional crushing tests

If cracks or tears which cannot be considered as negligible appear during a crushing test, a second, similar crushing, but with a force of 1,2 F_v shall be applied immediately after the crushing test which caused the cracks or tears to appear.

3.2.2. Measurements to be made

3.2.2.1. Fractures and cracks

After each test all structural members, joints and attachment systems shall be visually examined for fractures or cracks, any small cracks in unimportant parts being ignored.

3.2.2.2. Entry into the clearance zone

During each test the protective structure shall be examined to see whether any part of it has entered a clearance zone as defined in 1.6 above.

Furthermore, the clearance zone shall not be outside the protection of the protective structure. For this purpose it is considered to be outside the protection of the roll-over protective structure if any part of it would have come in contact with the ground plane if the tractor had overturned in the direction from which the impact came. For this purpose the front and rear tyres and track setting are assumed to be the smallest specified by the manufacturer.

3.2.2.3. Elastic deflection under side loading

The elastic deflection shall be measured (810 + a_v) mm above the Seat Index Point, in the vertical plane in which the load is applied. For this measurement, any apparatus similar to that illustrated in figure 7.4 may be used.

3.2.2.4. Permanent deflection

After the final crushing test, the permanent deflection of the protective structure shall be recorded. For this purpose, before the start of the test, the position of the main roll-over protective structure members in relation to the Seat Index Point shall be used.

3.3. *Extension to other tractor models*

3.3.1. [Not applicable]

3.3.2. Technical extension

When technical modifications occur on the tractor, the protective structure or the method of attachment of the protective structure to the tractor, the testing station that has carried out the original test can issue a ‘technical extension report’ in the following cases:

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3.3.2.1. Extension of the structural test results to other models of tractors

Loading and crushing tests need not be carried out on each model of tractor, provided that the protective structure and tractor comply with the conditions referred to hereunder 3.3.2.1.1 to 3.3.2.1.5.

3.3.2.1.1. The structure shall be identical to the one tested;

3.3.2.1.2. The required energy shall not exceed the energy calculated for the original test by more than 5 per cent; the 5 % limit shall also apply to extensions in the case of substituting tracks for wheels on the same tractor;

3.3.2.1.3. The method of attachment and the tractor components to which the attachment is made shall be identical;

3.3.2.1.4. Any components such as mud-guards and bonnet that may provide support for the protective structure shall be identical;

3.3.2.1.5. The position and critical dimensions of the seat in the protective structure and the relative position of the protective structure on the tractor shall be such that the clearance zone would have remained within the protection of the deflected structure throughout all tests (this shall be checked by using the same reference of clearance zone as in the original test report, respectively Seat Reference Point [SRP] or Seat Index Point [SIP]).

3.3.2.2. Extension of the structural test results to modified models of the protective structure

This procedure has to be followed when the provisions of paragraph 3.3.2.1 are not fulfilled, it may not be used when the method of attachment of the protective structure to the tractor does not remain of the same principle (e.g. rubber supports replaced by a suspension device):

3.3.2.2.1. Modifications having no impact on the results of the initial test (e.g. weld attachment of the mounting plate of an accessory in a non-critical location on the structure), addition of seats with different SIP location in the protective structure (subject to checking that the new clearance zone(s) remain(s) within the protection of the deflected structure throughout all tests).

3.3.2.2.2. Modifications having a possible impact on the results of the original test without calling into question the acceptability of the protective structure (e.g. modification of a structural component, modification of the method of attachment of the protective structure to the tractor). A validation test can be carried out and the test results will be drafted in the extension report.

The following limits for this type extension are fixed:

3.3.2.2.2.1. no more than 5 extension may be accepted without a validation test;

3.3.2.2.2.2. the results of the validation test will be accepted for extension if all the acceptance conditions of this Annex are fulfilled and:

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— if the deflection measured after each impact test does not deviate from the deflection measured after each impact test in the original test report by more than ± 7 % (in case of a dynamic test);

— if the force measured when the required energy level has been reached in the various horizontal load tests does not deviate from the force measured when the required energy has been reached in the original test by more than ± 7 % and the deflection measured[3] when the required energy level has been reached in the various horizontal load tests does not deviate from the deflection measured when the required energy has been reached in the original test by more than ± 7 % (in case of a static test).

3.3.2.2.2.3. more than one protective structure modifications may be included in a single extension report if they represent different options of the same protective structure, but only one validation test can be accepted in a single extension report. The options not tested shall be described in a specific section of the extension report.

3.3.2.2.3. Increase of the reference mass declared by the manufacturer for a protective structure already tested. If the manufacturer wants to keep the same approval number it is possible to issue an extension report after having carried out a validation test (the limits of ± 7 % specified in 3.3.2.2.2.2 are not applicable in such a case).

3.4. [Not applicable]

3.5. *Cold weather performance of protective structures*

3.5.1. If the protective structure is claimed to have properties resistant to cold weather embrittlement, the manufacturer shall give details that shall be included in the report.

3.5.2. The following requirements and procedures are intended to provide strength and resistance to brittle fracture at reduced temperatures. It is suggested that the following minimum material requirements shall be met in judging the protective structure's suitability at reduced operating temperatures in those countries requiring this additional operating protection.

3.5.2.1. Bolts and Nuts used to attach the protective structure to the tractor and used to connect structural parts of the protective structure shall exhibit suitable controlled reduced temperature toughness properties.

3.5.2.2. All welding electrodes used in the fabrication of structural members and mounts shall be compatible with the protective structure material as given in 3.5.2.3 below.

3.5.2.3. Steel materials for structural members of the protective structure shall be of controlled toughness material exhibiting minimum Charpy V-Notch impact energy requirements as shown in Table 7.1. Steel grade and quality shall be specified in accordance with ISO 630:1995.

Steel with an as-rolled thickness less than 2.5 mm and with a carbon content less than 0,2 per cent is considered to meet this requirement.

Structural members of the protective structure made from materials other than steel shall have equivalent low temperature impact resistance.

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3.5.2.4. When testing the Charpy V-Notch impact energy requirements, the specimen size shall be no less than the largest of the sizes stated in Table 7.1 that the material will permit.

3.5.2.5. The Charpy V-Notch tests shall be made in accordance with the procedure in ASTM A 370-1979, except for specimen sizes that shall be in accordance with the dimensions given in

Table 7.1

Minimum Charpy V-notch impact energies

Specimen size	Energy at	Energy at
	– 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 × 3,5	6	15
10 × 3	6	15
10 × 2,5 (a)	5,5	14

(a) Indicates preferred size. Specimen size shall be no less than largest preferred size that the material permits.

(b) The energy requirement at – 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 steel.

3.5.2.6. Alternatives to this procedure are the use of killed or semi-killed steel for which an adequate specification shall be provided. Steel grade and quality shall be specified in accordance with ISO 630:1995, Amd 1:2003.

3.5.2.7. Specimens are to be longitudinal and taken from flat stock, tubular or structural sections before forming or welding for use in the protective structure. Specimens from tubular or structural sections are to be taken from the middle of the side of greatest dimension and shall not include welds.

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3.6. [Not applicable]

Figure 7.1

Clearance zone

Dimensions in mm

Figure 7.1.a

Side view

Section in reference plan

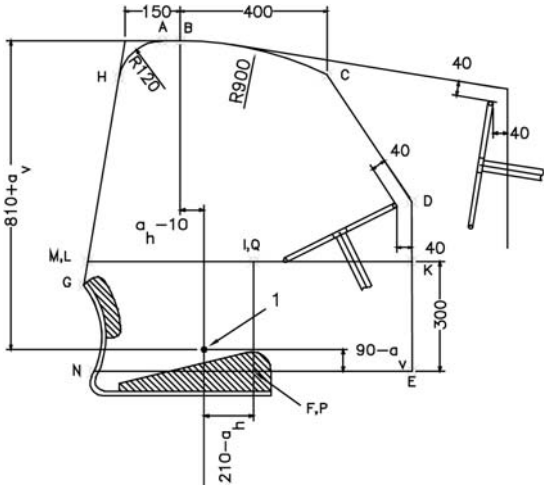


Figure 7.1.b

Rear view

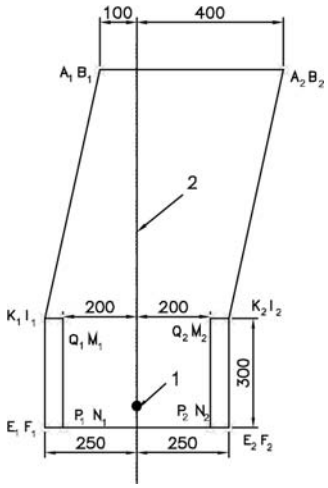
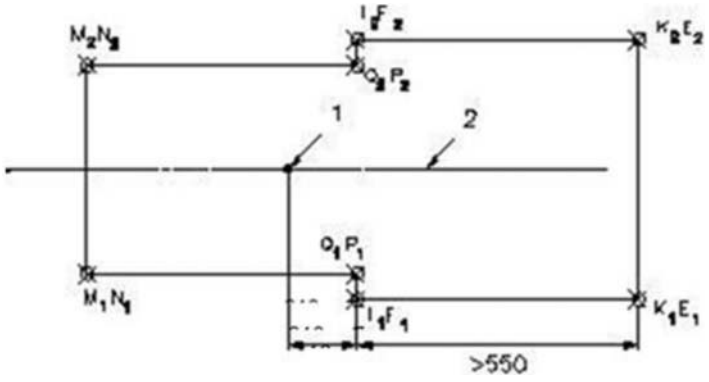


Figure 7.1.c

Seen from above



1 – Seat index point

2 – Reference plane

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Figure 7.2.a

Clearance zone for tractors with reversible seat position: two-post rollbar

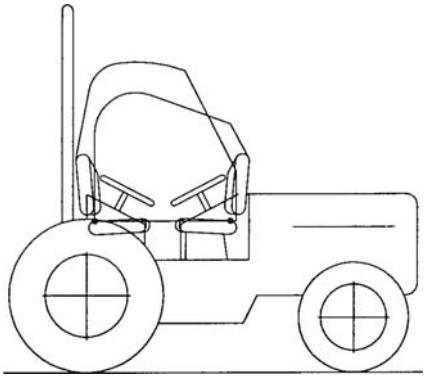


Figure 7.2.b

Clearance zone for tractors with reversible seat position: other types of ROPS

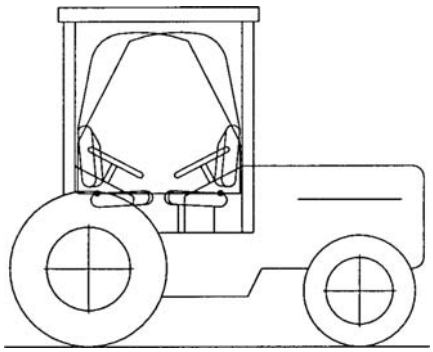
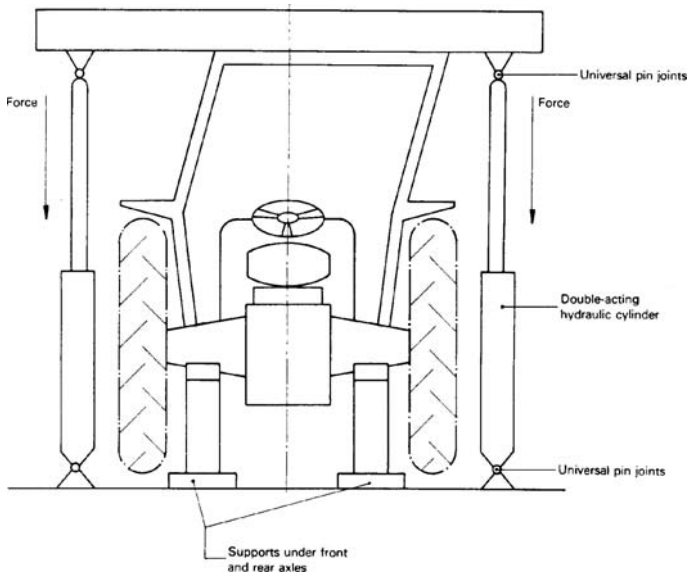


Figure 7.3

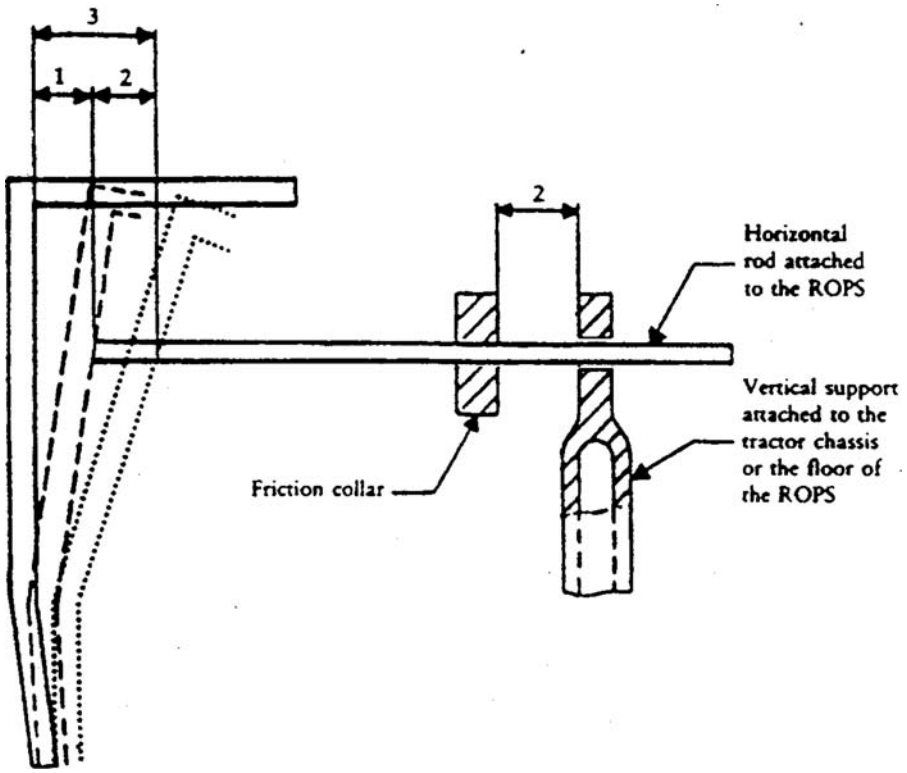
Example of crushing rig of the tractor



▼B

Figure 7.4

Example of apparatus for measuring elastic deflection



1 – Permanent deflection

2 – Elastic deflection

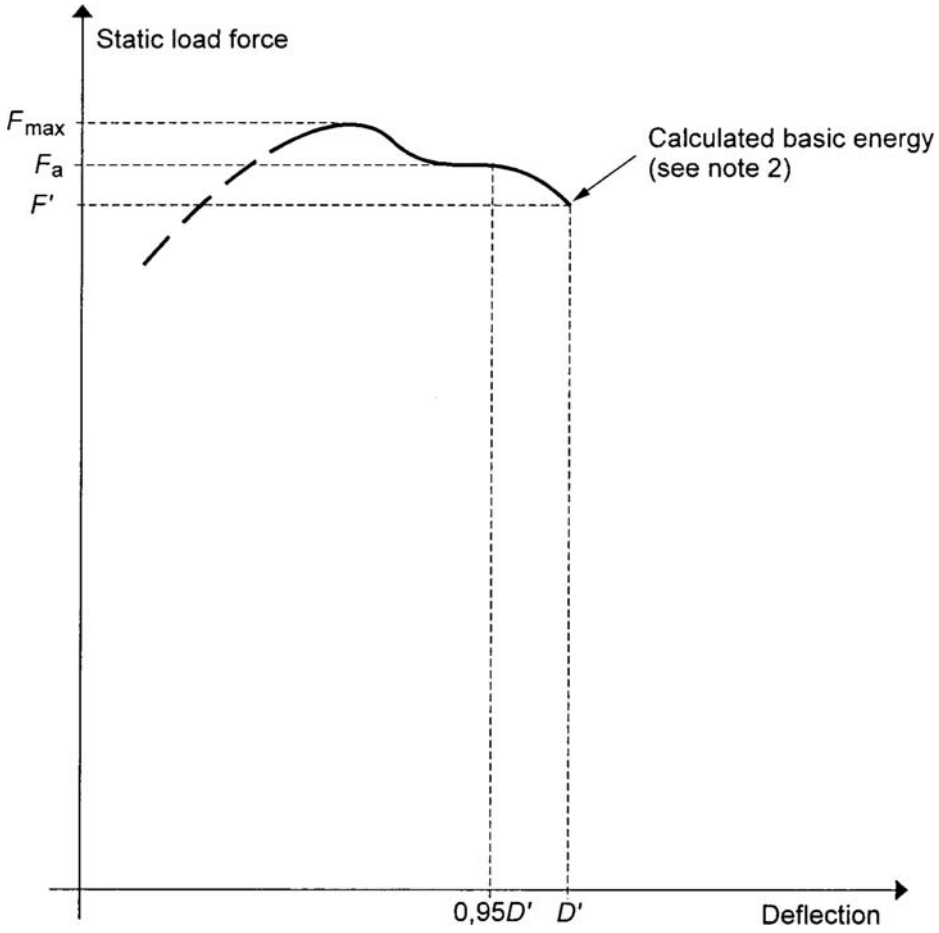
3 – Total deflection (permanent plus elastic)

▼B

Figure 7.5

Force/deflection curve

Overload test not necessary



Notes:

1. Locate F_a in relation to 0,95 D'

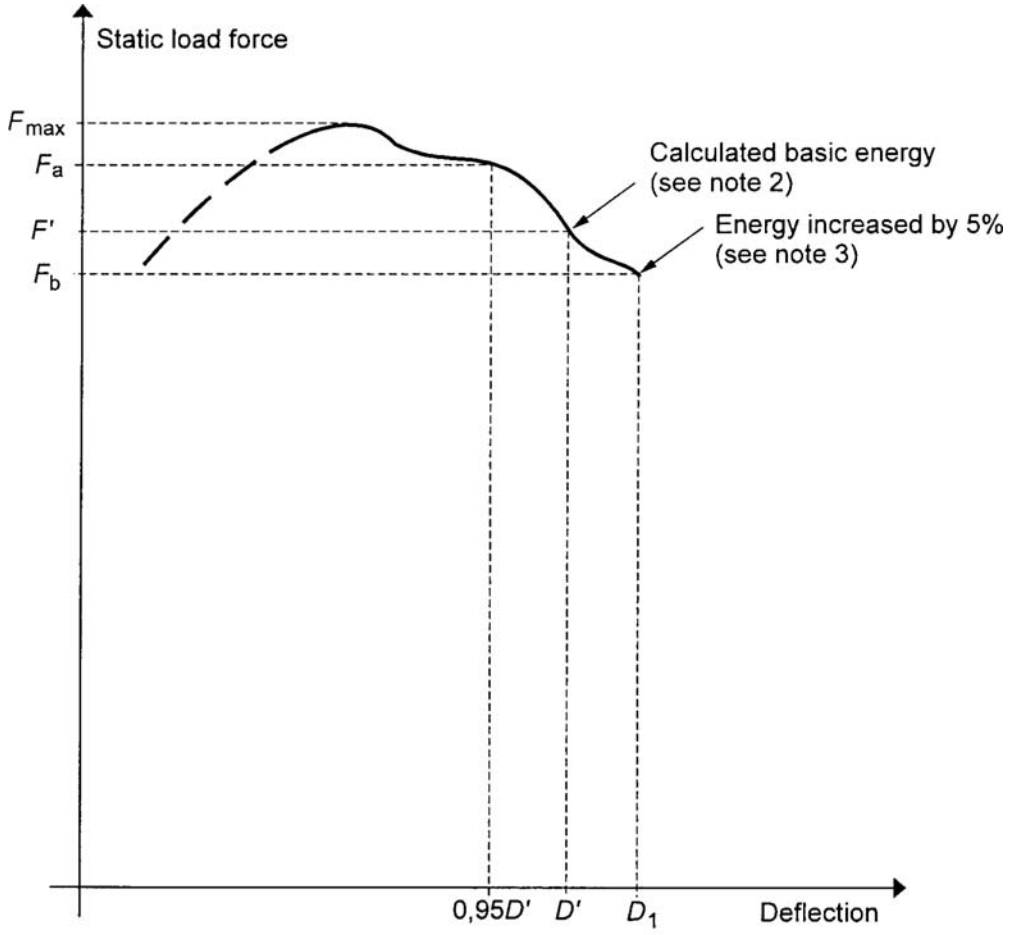
2. Overload test not necessary as $F_a \leq 1{,}03$ F'

▼B

Figure 7.6

Force / deflection curve

Overload test necessary



Notes:

1. Locate F_a in relation to 0,95 D'

2. Overload test necessary as $F_a > 1{,}03\ F'$

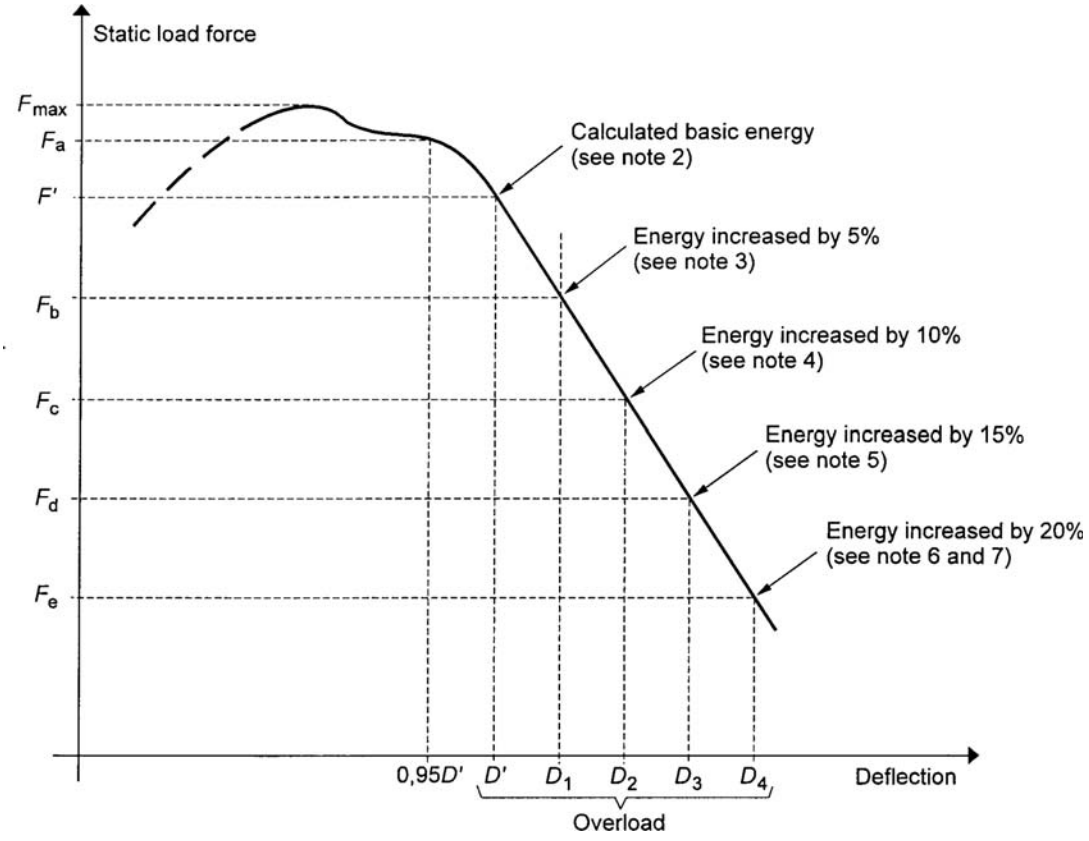
3. Overload test performance satisfactory as $F_b > 0{,}97\ F'$ and $F_b > 0{,}8\ F_{max}$.

▼B

Figure 7.7

Force/deflection curve

Overload test to be continued



Notes:

1. Locate F_a in relation to 0,95 D'

2. Overload test necessary as $F_a > 1{,}03\ F'$

3. $F_b < 0{,}97\ F'$ therefore further overload necessary

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

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

6. Overload test performance satisfactory, if $F_e > 0{,}8\ F_{max}$

7. Failure at any stage when load drops below $0{,}8\ F_{max}$.

▼B

B2. ALTERNATIVE DYNAMIC TEST PROCEDURE

This section sets out the dynamic testing procedure alternative to the static test procedure set out in section B1.

4. **Rules and directions**

4.1. *Conditions for testing the strength of protective structures and of their attachment to tractors*

4.1.1. General requirements

See requirements stated for static testing in section B1

4.1.2. Tests

4.1.2.1. Sequence of tests according to the Dynamic Procedure

The sequence of tests, without prejudice to the additional tests mentioned in sections 4.2.1.6 and 4.2.1.7 is as follows:

(1) **impact at the rear of the structure**

(see 4.2.1.1);

(2) **rear crushing test**

(see 4.2.1.4);

(3) **impact at the front of the structure**

(see 4.2.1.2);

(4) **impact at the side of the structure**

(see 4.2.1.3);

(5) **crushing at the front of the structure**

(see 4.2.1.5).

4.1.2.2. General requirements

4.1.2.2.1. If, during the test, any part of the tractor restraining equipment breaks or moves, the test shall be restarted.

4.1.2.2.2. No repairs or adjustments of the tractor or protective structure may be carried out during the tests.

4.1.2.2.3. The tractor gear box shall be in neutral and the brakes off during the tests.

4.1.2.2.4. If the tractor is fitted with a suspension system between the tractor body and the wheels, it shall be blocked during the tests.

4.1.2.2.5. The side chosen for application of the first impact on the rear of the structure shall be that which, in the opinion of the testing authorities, will result in the application of the series of impacts or loads under the most unfavourable conditions for the structure. The lateral impact and the rear impact shall be applied on both sides of the longitudinal median plane of the protective structure. The front impact shall be applied on the same side of the longitudinal median plane of the protective structure as the lateral impact.

▼B

4.1.3. Acceptance conditions

4.1.3.1. A protective structure is regarded as having satisfied the strength requirements if it fulfils the following conditions:

4.1.3.1.1. after each test it shall be free from tears or cracks, as defined in 4.2.1.2.1. If significant tears or cracks appear during the test, an additional impact test or crushing test as defined in 4.2.1.6 or 4.2.1.7 must be performed immediately after the test which caused these tears or cracks to appear;

4.1.3.1.2. during the tests other than the overload test, no part of the protective structure must enter the clearance zone as defined in 1.6;

4.1.3.1.3. during the tests other than the overload test, all parts of the clearance zone shall be secured by the structure, in accordance with 4.2.2.2;

4.1.3.1.4. during the tests the protective structure must not impose any constraints on the seat structure;

4.1.3.1.5. the elastic deflection, measured in accordance with 4.2.2.3 shall be less than 250 mm.

4.1.3.2. There shall be no accessories presenting a hazard for the driver. There shall be no projecting part or accessory which is liable to injure the driver should the tractor overturn, or any accessory or part which is liable to trap him — for example by the leg or the foot — as a result of the deflections of the structure.

4.1.4. [Not applicable]

4.1.5. Apparatus and equipment for dynamic tests

4.1.5.1. Pendulum block

4.1.5.1.1. A block acting as a pendulum must be suspended by two chains or wire ropes from pivot points not less than 6 m above the ground. Means must be provided for adjusting independently the suspended height of the block and the angle between the block and the supporting chains or wire ropes.

4.1.5.1.2. The mass of the pendulum block must be 2 000 ± 20 kg excluding the mass of the chains or wire ropes which themselves must not exceed 100 kg. The length of the sides of the impact face must be 680 ± 20 mm (see figure 7.18). The block must be filled in such a way that the position of its centre of gravity is constant and coincides with the geometrical centre of the parallelepiped.

4.1.5.1.3. The parallelepiped must be connected to the system which pulls it backwards by an instantaneous release mechanism which is so designed and located as to enable the pendulum block to be released without causing the parallelepiped to oscillate about its horizontal axis perpendicular to the pendulum's plane of oscillation.

4.1.5.2. Pendulum supports

The pendulum pivot points must be rigidly fixed so that their displacement in any direction does not exceed 1 per cent of the height of fall.

▼B

4.1.5.3. Lashings

4.1.5.3.1. Anchoring rails with the requisite track width and covering the necessary area for lashing the tractor in all the cases illustrated (see figures 7.19, 7.20 and 7.21) must be rigidly attached to a non-yielding base beneath the pendulum.

4.1.5.3.2. The tractor shall be lashed to the rails by means of wire rope with round strand, fibre core, construction 6 × 19 in accordance with ISO 2408:2004 and a nominal diameter of 13 mm. The metal strands must have an ultimate tensile strength of 1 770 MPa.

4.1.5.3.3. The central pivot of an articulated tractor shall be supported and lashed down as appropriate for all tests. For the lateral impact test, the pivot shall also be propped from the side opposite the impact. The front and rear wheels or tracks need not be in line if this facilitates the attachment of the wire ropes in the appropriate manner.

4.1.5.4. Wheel prop and beam

4.1.5.4.1. A softwood beam of 150 mm square shall be used as a prop for the wheels during the impact tests (see figures 7.19, 7.20 and 7.21).

4.1.5.4.2. During the lateral impact tests, a softwood beam shall be clamped to the floor to brace the rim of the wheel opposite the side of impact (see figure 7.21).

4.1.5.5. Props and lashings for articulated tractors

4.1.5.5.1. Additional props and lashings must be used for articulated tractors. Their purpose is to ensure that the section of the tractor on which the protective structure is fitted is as rigid as that of a non-articulated tractor.

4.1.5.5.2. Additional specific details are given in section 4.2.1 for the impact and crushing tests.

4.1.5.6. Tyre pressures and deflections

4.1.5.6.1. The tractor tyres shall not be liquid-ballasted and shall be inflated to the pressures prescribed by the tractor manufacturer for field work.

4.1.5.6.2. The lashings shall be tensioned in each particular case such that the tyres undergo a deflection equal to 12 per cent of the tyre wall height (distance between the ground and the lowest point of the rim) before tensioning.

4.1.5.7. Crushing rig

A rig as shown in figure 7.3 shall be capable of exerting a downward force on a protective structure through a rigid beam approximately 250 mm wide connected to the load-applying mechanism by means of universal joints. Suitable axle stands shall be provided so that the tractor tyres do not bear the crushing force.

4.1.5.8. Measuring apparatus

The following measuring apparatus is needed:

4.1.5.8.1. device for measuring the elastic deflection (the difference between the maximum momentary deflection and the permanent deflection, see figure 7.4).

▼B

4.1.5.8.2. device for checking that the protective structure has not entered the clearance zone and that the latter has remained within the structure's protective during the test (see section 4.2.2.2).

4.2. *Dynamic test procedure*

4.2.1. Impact and crushing tests

4.2.1.1. Impact at the rear

4.2.1.1.1. The tractor shall be so placed in relation to the pendulum block that the block will strike the protective structure when the impact face of the block and the supporting chains or wire ropes are at an angle with the vertical plane A equal to M/100 with a 20° maximum, unless, during deflection, the protective structure at the point of contact forms a greater angle to the vertical. In this case the impact face of the block shall be adjusted by means of an additional support so that it is parallel to the protective structure at the point of impact at the moment of maximum deflection, the supporting chains or wire ropes remaining at the angle defined above.

The suspended height of the block shall be adjusted and necessary steps taken so as to prevent the block from turning about the point of impact.

The point of impact is that part of the protective structure likely to hit the ground first in a rearward overturning accident, normally the upper edge. The position of the centre of gravity of the block is 1/6 of the width of the top of the protective structure inwards from a vertical plane parallel to the median plane of the tractor touching the outside extremity of the top of the protective structure.

If the structure is curved or protruding at this point, wedges enabling the impact to be applied thereon must be added, without thereby reinforcing the structure.

4.2.1.1.2. The tractor must be lashed to the ground by means of four wire ropes, one at each end of both axles, arranged as indicated in figure 7.19. The spacing between the front and rear lashing points must be such that the wire ropes make an angle of less than 30° with the ground. The rear lashings must in addition be so arranged that the point of convergence of the two wire ropes is located in the vertical plane in which the centre of gravity of the pendulum block travels.

The wire ropes must be tensioned so that the tyres undergo the deflections given in 4.1.5.6.2. With the wire ropes tensioned, the wedging beam shall be placed in front of and tight against the rear wheels and then fixed to the ground.

4.2.1.1.3. If the tractor is of the articulated type, the point of articulation shall, in addition, be supported by a wooden block at least 100 mm square and firmly lashed to the ground.

4.2.1.1.4. The pendulum block shall be pulled back so that the height of its centre of gravity above that at the point of impact is given by one of the following two formulae:

▼B

$$H = 2{,}165 \times 10^{-8} M\, L^2$$

or

$$H = 5{,}73 \times 10^{-2} I$$

The pendulum block is then released and strikes the protective structure.

4.2.1.1.5. For tractors with a reversible driver's position (reversible seat and steering wheel), the height shall be whichever is greater of either of the above or either of the following:

$$H = 25 + 0{,}07\ M$$

for tractor with a reference mass of less than 2 000 kg;

$$H = 125 + 0{,}02\ M$$

for tractor with a reference mass of more than 2 000 kg.

4.2.1.2. Impact at the front

4.2.1.2.1. The tractor shall be so placed in relation to the pendulum block that the block will strike the protective structure when the impact face of the block and the supporting chains or wire ropes are at an angle with the vertical plane A equal to M/100 with a 20° maximum, unless, during deflection, the protective structure at the point of contact forms a greater angle to the vertical. In this case the impact face of the block shall be adjusted by means of an additional support so that it is parallel to the protective structure at the point of impact at the moment of maximum deflection, the supporting chains or wire ropes remaining at the angle defined above.

The suspended height of the pendulum block shall be adjusted and the necessary steps taken so as to prevent the block from turning about the point of impact.

The point of impact is that part of the protective structure likely to hit the ground first if the tractor overturned sideways while travelling forward, normally the upper edge. The position of the centre of gravity of the block is 1/6 of the width of the top of the protective structure inwards from a vertical plane parallel to the median plane of the tractor touching the outside extremity of the top of the protective structure.

If the structure is curved or protruding at this point, wedges enabling the impact to be applied thereon must be added, without thereby reinforcing the structure.

4.2.1.2.2. The tractor must be lashed to the ground by means of four wire ropes, one at each end of both axles, arranged as indicated in figure 7.20. The spacing between the front and rear lashing points must be such that the wire ropes make an angle of less than 30° with the ground. The rear lashings must in addition be so arranged that the point of convergence of the two wire ropes is located in the vertical plane in which the centre of gravity of the pendulum block travels.

▼B

The wire ropes must be tensioned so that the tyres undergo the deflections given in 4.1.5.6.2. With the wire ropes tensioned, the wedging beam shall be placed behind and tight against the rear wheels and then fixed to the ground.

4.2.1.2.3. If the tractor is of the articulated type, the point of articulation shall, in addition, be supported by a wooden block at least 100 mm square and firmly lashed to the ground.

4.2.1.2.4. The pendulum block shall be pulled back so that the height of its centre of gravity above that at the point of impact is given by one of the following two formulae, to be chosen according to the reference mass of the assembly subjected to the tests:

$$H = 25 + 0{,}07\ M$$

for tractor with a reference mass of less than 2 000 kg;

$$H = 125 + 0{,}02\ M$$

for tractor with a reference mass of more than 2 000 kg.

The pendulum block is then released and strikes the protective structure.

4.2.1.2.5. In case of tractors with a reversible driver's position (reversible seat and steering wheel):

— if the protective structure is a rear two-post rollbar, the above formula shall apply;

— for other types of protective structure, the height shall be whichever is greater from the formula applied above and that selected below:

$$H = 2{,}165 \times 10^{-8} M\ L^2$$

or

$$H = 5{,}73 \times 10^{-2} I$$

The pendulum block is then released and strikes the protective structure.

4.2.1.3. Impact from the side

4.2.1.3.1. The tractor shall be so placed in relation to the pendulum block that the block will strike the protective structure when the impact face of the block and the supporting chains or wire ropes are vertical unless, during deflection, the protective structure at the point of contact forms an angle of less than 20° to the vertical. In this case the impact face of the block shall be adjusted by means of an additional support so that it is parallel to the protective structure at the point of impact at the moment of maximum deflection, the supporting chains or wire ropes remaining vertical on impact.

4.2.1.3.2. The suspended height of the pendulum block shall be adjusted and necessary steps taken so as to prevent the block from turning about the point of impact.

▼B

4.2.1.3.3. The point of impact shall be that part of the protective structure likely to hit the ground first in a sideways overturning accident, normally the upper edge. Unless it is certain that another part of this edge would hit ground first, the point of impact shall be in the plane at right angles to the median plane and passing 60 mm in front of the Seat Index Point, the seat being set at the mid position of longitudinal adjustment.

4.2.1.3.4. For tractors with a reversible driver's position (reversible seat and steering wheel), the point of impact shall be in the plane at right angles to the median plane and passing at the midpoint of the segment joining the two Seat Index Points defined by joining the two different positions of the seat. For protective structures having a two-post system, the impact shall be located on one of the two posts.

4.2.1.3.5. The tractor wheels on the side which is to receive the impact must be lashed to the ground by means of wire ropes passing over the corresponding ends of the front and rear axles. The wire ropes must be tensioned to produce the tyre deflection values given in 4.1.5.6.2.

With the wire ropes tensioned, the wedging beam shall be placed on the ground, pushed tight against the tyres on the side opposite that which is to receive the impact and then fixed to the ground. It may be necessary to use two beams or wedges if the outer sides of the front and rear tyres are not in the same vertical plane. The prop shall then be placed as indicated in figure 7.21 against the rim of the most heavily loaded wheel opposite to the point of impact, pushed firmly against the rim and then fixed at its base. The length of the prop shall be such that it makes an angle of 30° ± 3° with the ground when in position against the rim. In addition, its thickness shall, if possible, be between 20 and 25 times less than its length and between 2 and 3 times less than its width. The props shall be shaped at both ends as shown in the details on figure 7.21.

4.2.1.3.6. If the tractor is of the articulated type, the point of articulation shall in addition be supported by a wooden block at least 100 mm square and laterally supported by a device similar to the prop pushed against the rear wheel as in 4.2.1.3.5. The point of articulation shall then be lashed firmly to the ground.

4.2.1.3.7. The pendulum block shall be pulled back so that the height of its centre of gravity above that at the point of impact is given by one of the following two formulae, to be chosen according to the reference mass of the assembly subjected to the tests:

$$H = 25 + 0{,}20\ M$$

for tractors with a reference mass of less than 2 000 kg;

$$H = 125 + 0{,}15\ M$$

for tractors with a reference mass of more than 2 000 kg.

▼B

4.2.1.3.8. In case of tractors with a reversible driver's position (reversible seat and steering wheel):

— if the protective structure is a rear two-post rollbar, the selected height shall be whichever is greater from the formulae applicable above and below:

$$H = (25 + 0{,}20\ M)\ (B_6 + B)/2B$$

for tractor with a reference mass of less than 2 000 kg;

$$H = (125 + 0{,}15\ M)\ (B_6 + B)/2B$$

for tractor with a reference mass of more than 2 000 kg.

— for other types of protective structures, the selected height shall be whichever is greater from the formulae applicable above and below:

$$H = 25 + 0{,}20\ M$$

for tractor with a reference mass less than 2 000 kg;

$$H = 125 + 0{,}15\ M$$

for tractor with a reference mass of more than 2 000 kg.

The pendulum block is then released and strikes the protective structure.

4.2.1.4. Crushing at the rear

All provisions are identical to those given in point 3.2.1.4 of section B1 to this Annex.

4.2.1.5. Crushing at the front

All provisions are identical to those given in section 3.2.1.5 of section B1 to this Annex.

▼M1

4.2.1.6. Additional impact tests

If cracks or tears which cannot be considered negligible appear during an impact test, a second, similar test, but with a height of fall of:

$$H' = (H \times 10^{-1})(12 + 4a)(1 + 2a)^{-1}$$

shall be performed immediately after the impact tests causing these tears or cracks to appear, 'a' being the ratio of the permanent deformation (Dp) to the elastic deformation (De):

$$a = Dp/De$$

as measured at the point of impact. The additional permanent deformation due to the second impact shall not exceed 30 per cent of the permanent deformation due to the first impact.

In order to be able to carry out the additional test, it is necessary to measure the elastic deformation during all the impact tests.

▼B

4.2.1.7. Additional crushing tests

If during a crushing test, significant cracks or tears appear, a second, similar, crushing test, but with a force equal to 1,2 F_v shall be performed immediately after the crushing tests which caused these tears or cracks to appear.

4.2.2. Measurements to be made

4.2.2.1. Fractures and cracks

After each test all structural members, joints and fastening systems shall be visually examined for fractures or cracks, any small cracks in unimportant parts being ignored.

Any tears caused by the edges of the pendulum weight are to be ignored.

4.2.2.2. Entry into the clearance zone

During each test the protective structure shall be examined to see whether any part it has entered a clearance zone round the driving seat as defined in 1.6.

Furthermore, the clearance zone shall not be outside the protection of the protective structure. For this purpose, it shall be considered to be outside the protection of the structure if any part of it would come in contact with flat ground if the tractor overturned towards the direction from which the test load is applied. For estimating this, the front and rear tyres and track width setting shall be the smallest standard fitting specified by the manufacturer.

4.2.2.3. Elastic deflection (under side impact)

The elastic deflection shall be measured (810 + av) mm above the Seat Index Point, in the vertical plane in which the load is applied. For this measurement, any apparatus similar to that illustrated in figure 7.4 may be used.

4.2.2.4. Permanent deflection

After the final crushing test, the permanent deflection of the protective structure shall be recorded. For this purpose, before the start of the test, the position of the main roll-over protective structure members in relation to the Seat Index Point shall be used.

4.3. *Extension to other tractor models*

All provisions are identical to those given in section 3.3 of section B1 to this Annex.

4.4. [Not applicable]

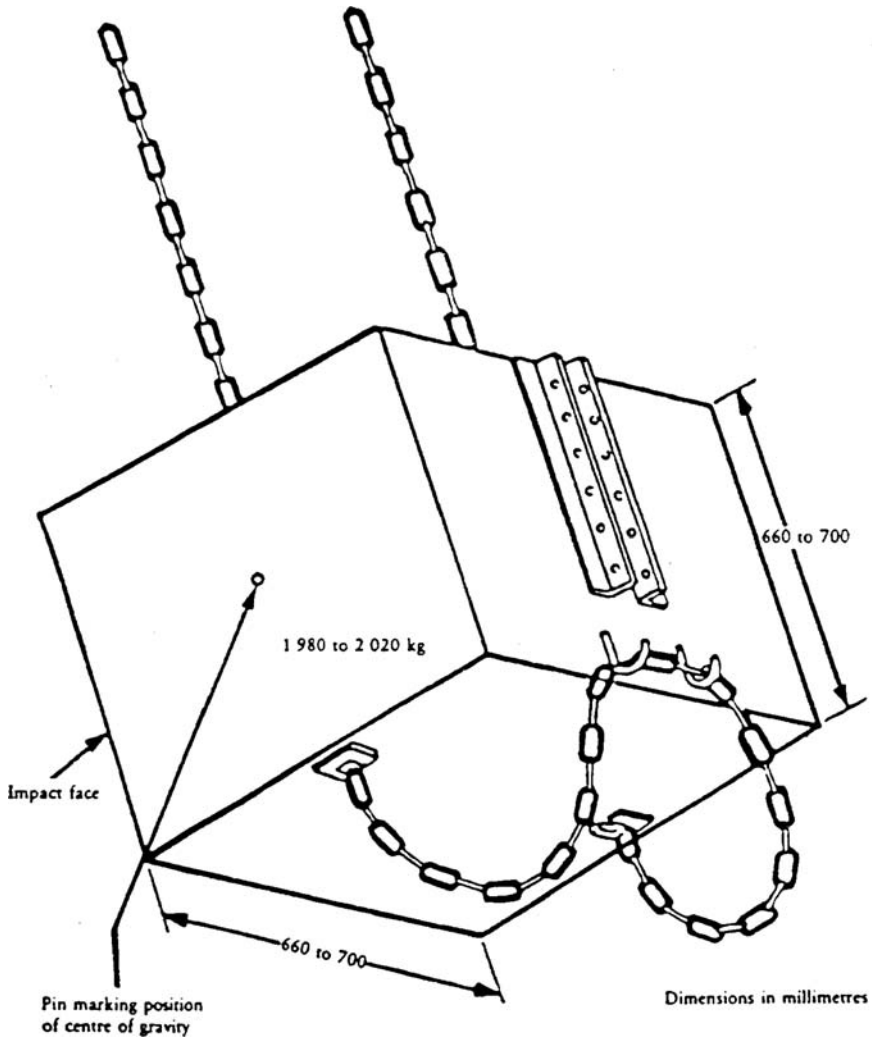
4.5. *Cold weather performance of protective structures*

All provisions are identical to those given in section 3.5 of section B1 to this Annex.

▼B

Figure 7.18

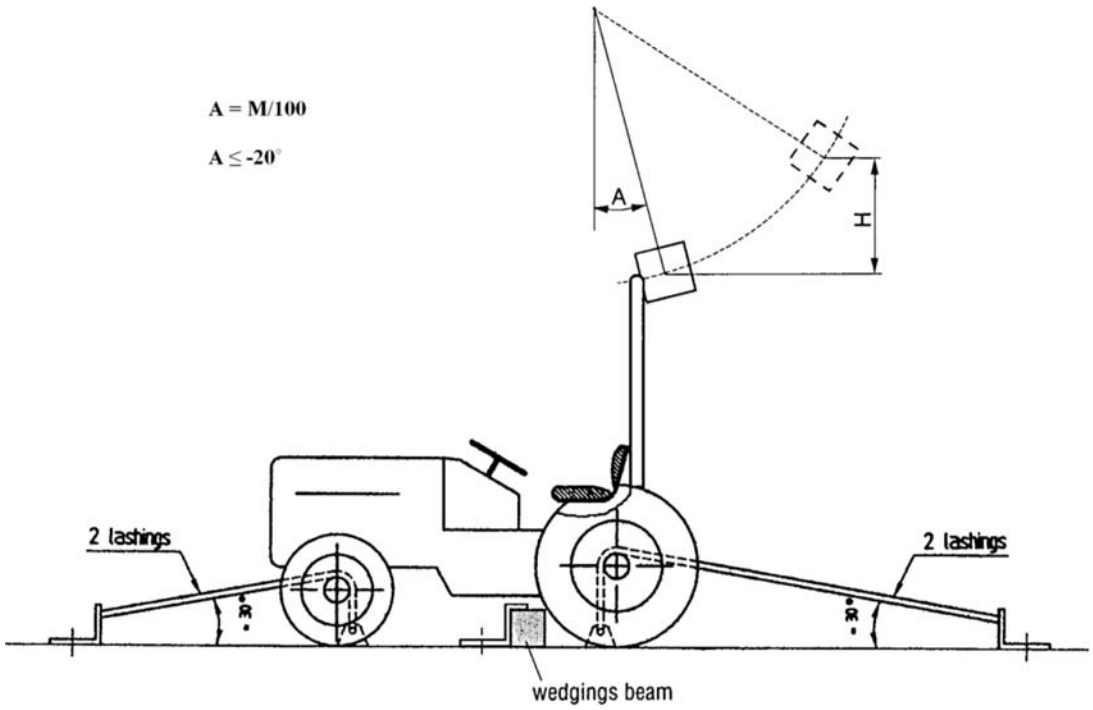
Pendulum block and its suspending chains or wire ropes



▼B

Figure 7.19

Example of tractor lashing (rear impact)



▼B

Figure 7.20

Example of tractor lashing (front impact)

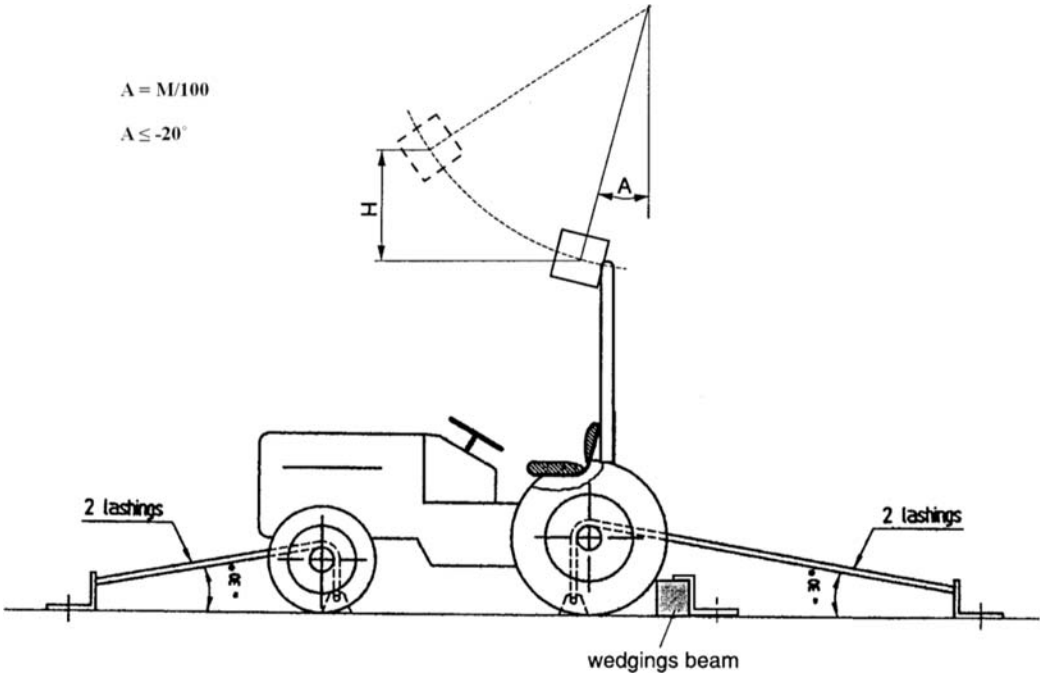
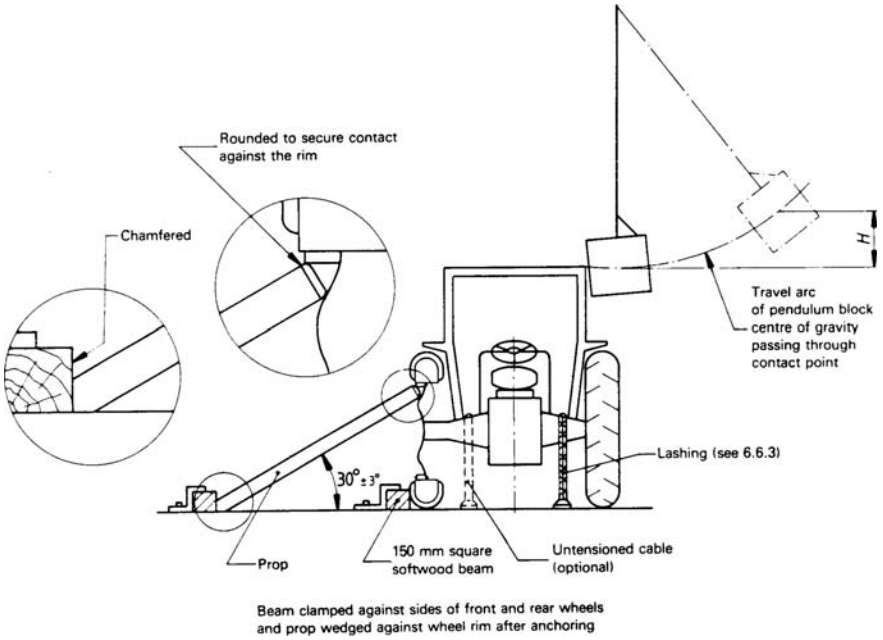


Figure 7.21

Example of tractor lashing (side impact)



▼B

Explanatory notes to Annex X

(1) Unless the numbering of section B2 which has been harmonised with the whole Annex, the text of the requirements and the numbering set out in point B are identical with the text and numbering of the OECD standard code for the official testing of rear mounted roll-over protective structures on narrow-track wheeled agricultural and forestry tractors, OECD Code 7, Edition 2015 of July 2014.

(2) Users are reminded that the seat index point is determined according to ISO 5353:1995 and is a fixed point with respect to the tractor that does not move as the seat is adjusted away from the mid-position. For purposes of determining the clearance zone, the seat shall be placed in the rear and uppermost position.

(3) Permanent + elastic deflection measured at the point when the required energy level is obtained.

▼B

ANNEX XI

Requirements applying to falling objects protection structures

A. GENERAL PROVISION

1. The Union requirements applying to falling objects protection structures are set out in sections B and C.

2. Vehicles of categories T and C equipped for forestry applications shall comply with the requirements laid down in section B.

3. All other vehicles of categories T and C, if equipped with falling objects protection structures, shall comply with the requirements laid down in section B or C.

B. REQUIREMENTS APPLYING TO FALLING OBJECTS PROTECTION STRUCTURES FOR VEHICLES OF CATEGORIES T AND C EQUIPPED FOR FORESTRY APPLICATIONS

Vehicles of categories T and C equipped for forestry applications shall comply with the requirements laid down in ISO 8083:2006 (level I or level II).

C. REQUIREMENTS APPLYING TO FALLING OBJECTS PROTECTION STRUCTURES FOR ALL OTHER VEHICLES OF CATEGORIES T AND C FITTED WITH SUCH STRUCTURES [1]

1. **Definitions**

1.1. [Not applicable]

1.2. *Falling Object Protective Structure (FOPS)*

Assembly providing reasonable overhead protection to an operator in driving position from falling objects.

1.3. *Safety zone*

1.3.1. Clearance zone

For tractors equipped with ROPS tested in accordance with Annexes VI, VIII, IX and X to this Regulation the safety zone shall comply with the specifications of the Clearance Zone as described in point 1.6 of each of these Annexes.

1.3.2. Deflection-Limiting Volume (DLV)

For tractors equipped with ROPS tested in accordance with Annex VII to this Regulation the safety zone shall comply with the Deflection-Limiting Volume (DLV), as described in ISO 3164:1995.

In the event the tractor has a reversible driver's position (reversible seat and steering wheel), the safety zone shall be the combined envelope of the two DLVs defined by the two different positions of the steering wheel and the seat.

1.3.3. Top area of the safety zone

Respectively the top plane of the DLV or the surface defined by points I_1, A_1, B_1, C_1, C_2, B_2, A_2, I_2 of clearance zone for Annexes VI and VIII to this Regulation; the plane described in 1.6.2.3 and 1.6.2.4 of Annex IX to this Regulation; and the surface defined by points H_1, A_1, B_1, C_1, C_2, B_2, A_2, H_2 for Annex X to this Regulation.

▼B

1.4. Permissible measurement tolerances

Distance ± 5 % of maximum deflection measured, or ± 1 mm

Mass ± 0,5 %

2. **Field of application**

2.1. This section is applicable to agricultural tractors having at least two axles for pneumatic tyred wheels or having tracks instead of wheels.

2.2. This Annex establishes test procedures and performance requirements for those tractors exposed to potential hazards of falling objects encountered carrying out some agricultural tasks during their normal operation.

3. **Rules and directions**

3.1. *General regulations*

3.1.1. The protective structure may be manufactured either by the tractor manufacturer or by an independent firm. In either case the test is only valid for the model of tractor on which the test is carried out. The protective structure must be retested for each model of tractor to which it is to be fitted. However, testing stations may certify that the strength tests are also valid for tractor models derived from the original model by modifications to the engine, transmission and steering and front suspension (see below 3.4: Extension to other tractor models). On the other hand, more than one protective structure may be tested for any one model of tractor.

3.1.2. The protective structure submitted for test shall include at least all components which transfer loading from the impact location of the drop test object to the safety zone. The protective structure submitted for test shall be either (i) rigidly attached to the test bench at its normal mounting locations (see Figure 10.3 — Minimum Test Configuration), or (ii) attached to the tractor chassis in the normal manner, by means of any brackets, mountings or suspension components used in normal production, and to other parts of the tractor that may be affected by loads imposed by the protective structure (see Figures 10.4(a) & 10.4(b)). The vehicle chassis shall be mounted rigidly to the test bay floor.

3.1.3. A protective structure may be designed solely to protect the driver in the event of an object falling. Onto this structure it may be possible to fit weather protection for the driver, of a more or less temporary nature. The driver will usually remove this in warm weather. There are protective structures, however, in which the cladding is permanent and warm weather ventilation provided by windows or flaps. As the cladding may add to the strength of the structure and if removable may well be absent when an accident occurs, all parts that can be so taken away by the driver shall be removed for the purpose of the test. Doors, roof hatch and windows that can be opened shall be either removed or fixed in the open position for the test, so that they do not add to the strength of the protective structure. It shall be noted whether, in this position, they would create a hazard for the driver in the event of an object falling.

Throughout the remainder of these rules, reference will only be made to testing the protective structure. It must be understood that this includes cladding not of a temporary nature.

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A description of any temporary cladding supplied is to be included in the specifications. All glass or similar brittle material shall be removed prior to the test. Tractor and protective structure components which might sustain needless damage during the test and which do not affect the strength of the protective structure or its dimensions may be removed prior to the test if the manufacturer wishes. No repairs or adjustment may be carried out during the test. Several identical samples can be provided by the manufacturer if several drop tests are required.

3.1.4. Should the same structure be used for FOPS and ROPS evaluations the FOPS test shall precede the ROPS tests (according to Annexes VI, VII, VIII, IX, or X to this Regulation), the removal of impact dents or replacement of the FOPS cover is permitted.

3.2. *Apparatus and procedures*

3.2.1. Apparatus

3.2.1.1. Drop test object

The drop test object shall be a spherical object dropped from a height sufficient to develop the energy of 1 365 J, the drop height being defined as a function of its mass. The test object, whose impact surface shall have properties to protect against deformation during testing, shall be a solid steel or ductile iron sphere with a typical mass of 45 ± 2 kg and a diameter between 200 and 250 mm (Table 10.1).

Table 10.1

Energy level, safety zone and drop test object selection

Energy level (J)	Safety zone	Drop object	Dimensions (mm)	Mass (kg)
1 365	Clearance zone (*)	Sphere	200 ≤ Diameter ≤ 250	45 ± 2
1 365	DLV (**)	Sphere	200 ≤ Diameter ≤ 250	45 ± 2

(*) For tractors the ROPS of which is to be tested according to Annexes VI, VIII IX or X to this Regulation.
(**) For tractors the ROPS of which is to be tested according to Annex VII to this Regulation.

Test Facility apparatus is also required to provide:

3.2.1.2. Means of raising the drop test object to the required height;

3.2.1.3. Means of releasing the drop test object so that it drops without restrain;

3.2.1.4. Surface of such firmness that it is not penetrated by the machine or test bed under the loading of the drop test;

3.2.1.5. Means of determining whether the FOPS enters the safety zone during the drop test. This may be either of the following:

— a safety zone template, placed upright, made of a material which will indicate any penetration by the FOPS; grease or other suitable material may be put on the lower surface of the FOPS cover to indicate such penetration;

▼B

— a dynamic instrumentation system of sufficient frequency response to indicate the expected deflection of the FOPS with respect to the safety zone.

3.2.1.6. Safety zone requirements:

The safety zone template, if any, shall be fixed firmly to the same part of the tractor as the operator's seat and shall remain there during the entire formal test period.

3.2.2. Procedure

The drop test procedure shall consist of the following operations, in the order listed.

3.2.2.1. Place the drop test object (3.2.1.1) on the top of the FOPS, at the location designated in 3.2.2.2.

3.2.2.2. When the safety zone is represented by the clearance zone the point of impact shall be at a location which is within the vertical projection of the clearance zone and is furthest removed from major structural members (Figure 10.1).

When the safety zone is represented by the DLV, the impact location shall be entirely within the vertical projection of the safety zone, in that volume's upright position, on to the top of the FOPS. It is intended that the selection of impact location shall include at least one within the vertical projection of the top plane area of the safety zone.

Two cases have to be considered:

3.2.2.2.1. Case 1: Where major, upper, horizontal members of the FOPS do not enter the vertical projection of the safety zone on to the top of the FOPS.

The impact location shall be as close as possible to the centroid of the upper FOPS structure (Figure 10.2 — Case 1).

3.2.2.2.2. Case 2: Where major, upper, horizontal members of the FOPS enter the vertical projection of the safety zone on to the top of the FOPS.

When the covering material of all the surface areas above the safety zone is of uniform thickness, the impact location shall be in the surface of greatest area, this being the largest section of vertical projected area of the safety zone which does not include major, upper, horizontal members. The impact location shall be at that point, within the surface of greatest area, which has the least possible distance from the centroid of the top of the FOPS (Figure 10.2 — Case 2).

3.2.2.3. Irrespective of whether the safety zone is represented by the clearance zone or the DLV, where different materials or different thicknesses are used in different areas above the safety zone, each area shall be subjected to a drop test. If several drop tests are required, several identical samples of the FOPS (or parts of it) could be provided by the manufacturer (one for each drop test). If design features, such as openings for windows or equipment, or variations in cover material or thickness, indicate a more vulnerable location within the vertical projection of the safety zone, the drop location should be adjusted to that location. In addition, if openings in the FOPS cover are intended to be filled with devices or equipment to provide adequate protection, those devices or equipment shall be in place during the drop test.

▼B

3.2.2.4. Raise the drop test object vertically to a height above the position indicated in 3.2.2.1 and 3.2.2.2 to develop the energy of 1 365 J.

3.2.2.5. Release the drop object so that it falls without restraint onto the FOPS.

3.2.2.6. As it is unlikely that the free fall will result in the drop test object hitting at the location as specified in 3.2.2.1 and 3.2.2.2, the following limits are placed on deviations.

3.2.2.7. The impact point of the drop test object shall be entirely within a circle of 100 mm radius whose centre shall coincide with the vertical centre line of the drop test object as positioned according to 3.2.2.1 and 3.2.2.2).

3.2.2.8. There is no limitation on location or attitude of subsequent impacts due to rebound.

3.3. Performance requirements

The safety zone shall not be entered into by any part of the protective structure under the first or subsequent impacts of the drop test object. Should the drop test object penetrate the FOPS, it shall be considered to have failed that test.

Note 1: In the case of multilayer protective structure all the layers including the innermost layer shall be considered.

Note 2: The drop test object is considered to have penetrated the protective structure when at least half of the sphere volume has penetrated the innermost layer.

The FOPS shall completely cover and overlap the vertical projection of the safety zone.

If the tractor is to be equipped with a FOPS fitted on an approved ROPS, the testing station which performed the ROPS test will normally be the only one allowed to carry out the FOPS test and to require for the approval.

3.4. Extension to other tractor models

3.4.1. [Not applicable]

3.4.2. Technical extension

If the test was carried out with the minimum components required (as in Figure 10.3), then the testing station that has carried out the original test can issue a ‘technical extension report’ in the following cases: [see 3.4.2.1]

If the test was carried out including the attachments / mountings of the protective structure to the tractor/chassis (as in Figure 10.4), then when technical modifications occur on the tractor, to the protective structure or to the method of attachment of the protective structure to the vehicle chassis, the testing station that has carried out the original test can issue a ‘technical extension report’ in the following cases: [see 3.4.2.1]

▼B

3.4.2.1. Extension of the structural test results to other models of tractors

The impact test needs not to be carried out on each model of tractor, provided that the protective structure and tractor comply with the conditions referred to hereunder 3.4.2.1.1 to 3.4.2.1.3.

3.4.2.1.1. The structure shall be identical to the one tested;

3.4.2.1.2. If the test carried out included the method of attachment to the vehicle chassis, the tractor attachment components/ protective structure mountings shall be identical;

3.4.2.1.3. The position and critical dimensions of the seat in the protective structure and the relative position of the protective structure on the tractor shall be such that the safety zone would have remained within the protection of the deflected structure throughout all tests (this shall be checked by using the same reference of clearance zone as in the original test report, respectively Seat Reference Point [SRP] or Seat Index Point [SIP]).

3.4.2.2. Extension of the structural test results to modified models of the protective structure

This procedure has to be followed when the provisions of paragraph 3.4.2.1 are not fulfilled, it shall not be used when the method of attachment of the protective structure to the tractor does not remain of the same principle (e.g. rubber supports replaced by a suspension device):

Modifications having no impact on the results of the initial test (e.g. weld attachment of the mounting plate of an accessory in a non-critical location on the structure), addition of seats with different SRP or SIP location in the protective structure (subject to checking that the new safety zone(s) remain(s) within the protection of the deflected structure throughout all tests).

More than one protective structure modifications may be included in a single extension report if they represent different options of the same protective structure. The options not tested shall be described in a specific section of the extension report.

3.4.3. In any case the test report shall contain a reference to the original test report.

3.5. [Not applicable]

3.6. *Cold weather performance of protective structures*

3.6.1. If the protective structure is claimed to have properties resistant to cold weather embrittlement, the manufacturer shall give details that shall be included in the report.

3.6.2. The following requirements and procedures are intended to provide strength and resistance to brittle fracture at reduced temperatures. It is suggested that the following minimum material requirements shall be met in judging the protective structure's suitability at reduced operating temperatures in those countries requiring this additional operating protection:

3.6.2.1. Bolts and nuts used to attach the protective structure to the tractor and used to connect structural parts of the protective structure shall exhibit suitable controlled reduced temperature toughness properties.

▼B

3.6.2.2. All welding electrodes used in the fabrication of structural members and mounts shall be compatible with the protective structure material as given in 3.8.2.3 below.

3.6.2.3. Steel materials for structural members of the protective structure shall be of controlled toughness material exhibiting minimum Charpy V-Notch impact requirements as shown in Table 10.2. Steel grade and quality shall be specified in accordance with ISO 630:1995, Amd 1:2003.

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

Structural members of the protective structure made from materials other than steel shall have an impact resistance equivalent to the one required for steel materials

3.6.2.4. When testing the Charpy V-Notch impact energy requirements, the specimen size shall be no less than the largest of the sizes stated in Table 1 that the material will permit

3.6.2.5. The Charpy V-Notch tests shall be made in accordance with the procedure in ASTM A 370-1979, except for specimen sizes that shall be in accordance with the dimensions given in Table 10.2.

3.6.2.6. Alternatives to this procedure are the use of killed or semi-killed steel for which an adequate specification shall be provided. Steel grade and quality shall be specified in accordance with ISO 630:1995, Amd 1:2003.

3.6.2.7. Specimens are to be longitudinal and taken from flat stock, tubular or structural sections before forming or welding for use in the protective structure. Specimens from tubular or structural sections are to be taken from the middle of the side of greatest dimension and shall not include welds.

Table 10.2

Impact Energy - Minimum Charpy V-Notch impact energy requirements for protective structure material at specimen temperatures of – 20 °C and – 30 °C

Specimen size	Energy at	Energy at
	– 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

▼B

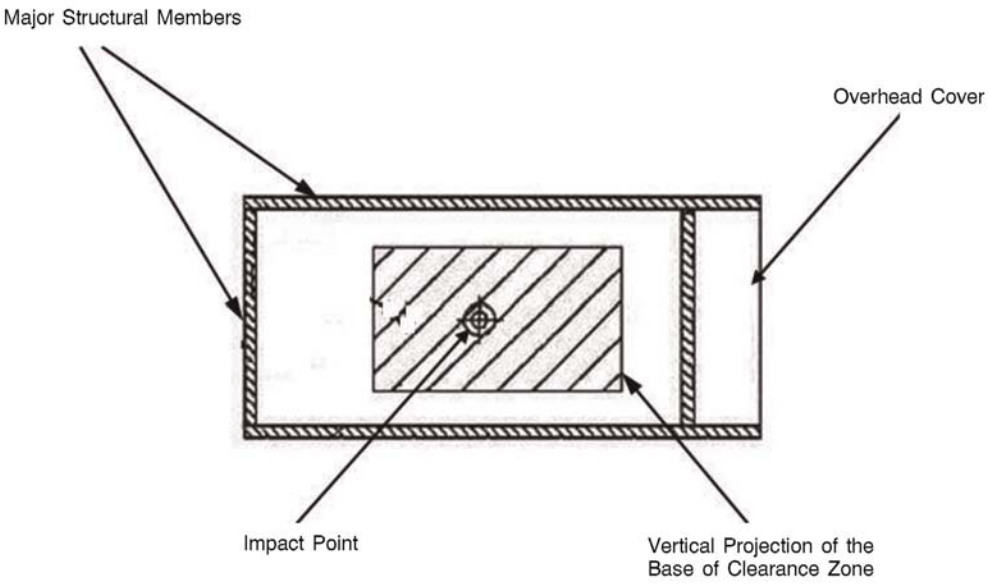
Specimen size	Energy at	Energy at
	– 30 °C	– 20 °C
mm	J	J (b)
10 × 3,5	6	15
10 × 3	6	15
10 × 2,5 (a)	5,5	14

(a) Indicates preferred size. Specimen size shall be no less than largest preferred size that the material permits.

(b) The energy requirement at – 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 steel.

Figure 10.1

Impact point referred to the clearance zone



▼B

Figure 10.2

Drop test impact points referred to the DLV

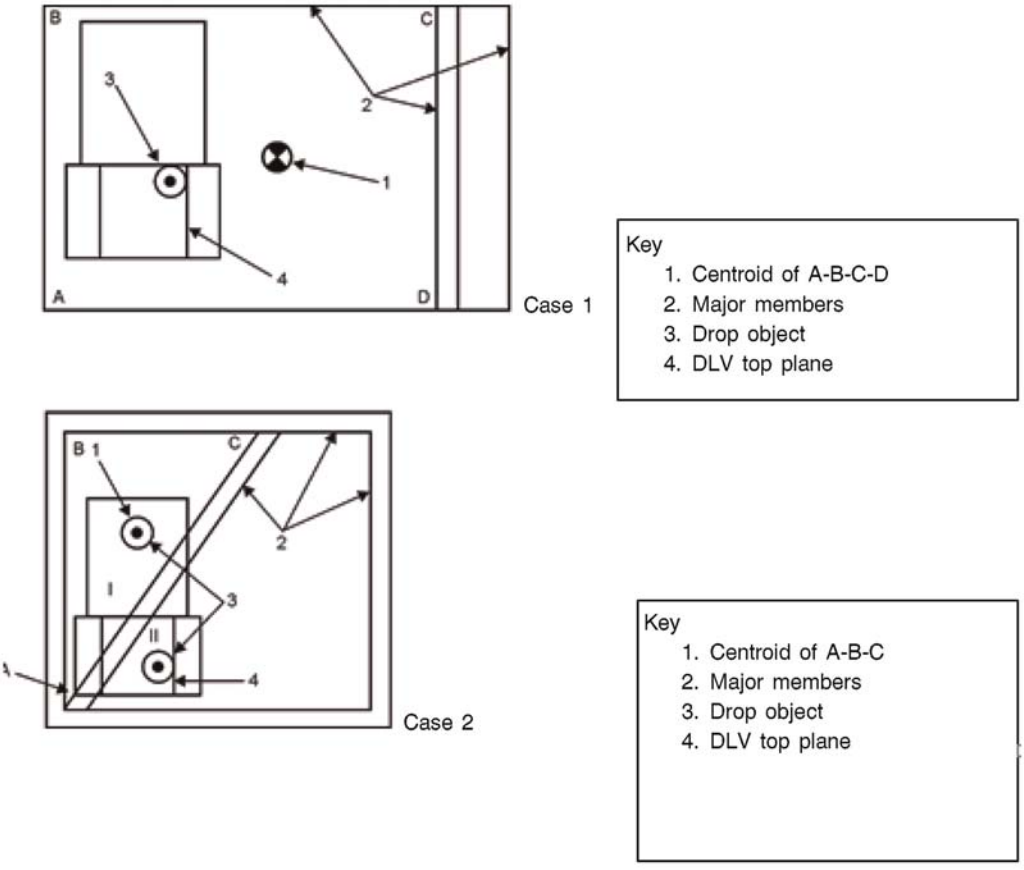


Figure 10.3



▼B

Figure 10.4

FOPS test configurations when attached to the vehicle chassis

Figure 10.4a

By mountings attachments

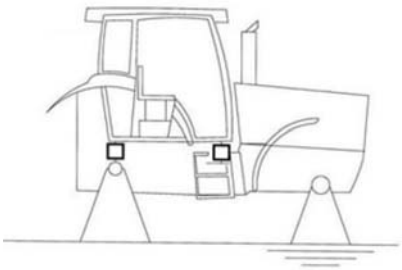
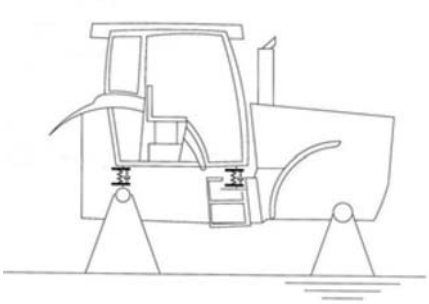


Figure 10.4b

By suspension components



Explanatory notes to Annex XI

(1) Unless otherwise stated, the text of the requirements and the numbering set out in section C are identical with the text and numbering of the OECD standard code for the official testing of falling object protective structures on agricultural and forestry tractors, OECD Code 10, Edition 2015 of July 2014.

▼B

ANNEX XII

Requirements applying to passenger seats

1. **Requirements**

1.1. Passenger seats, if provided, shall comply with the requirements laid down in EN 15694:2009 and with the requirements of point 2.4 of Annex XIV.

1.2. A vehicle equipped with a straddle seat and handlebars, and with an unladen mass, in running order excluding the mass of the driver, of less than 400 kg, and designed to carry a passenger shall meet the technical requirements for ATV Type II vehicle passenger seats in EN 15997:2011, as an alternative to EN 15694:2009.

▼B

ANNEX XIII

Requirements applying to the driver's exposure to noise level

1. **General requirements**

1.1. Unit of measurement

Noise level LA shall be measured in dB with A-weighting, expressed as dB(A).

1.2. Noise level limits

Agricultural and forestry wheeled and track-laying tractors shall have a level driver's exposure to noise level within the following limits:

90 dB(A) in accordance with test method 1 as set out in section 2,

or

86 dB(A) in accordance with test method 2 as set out in section 3.

▼M1

1.3. Measuring apparatus

A precision quality sound level meter shall be used meeting the requirements of the International Electrotechnical Commission Standards IEC 61672-1:2013 Electroacoustics - Sound level meters - Part 1: Specifications. Measurement shall be carried out with a frequency weighting network in conformity with curve A and set to give slow response as is described in the IEC publication.

1.3.1. The equipment shall be calibrated frequently and, if possible, before each measuring session.

1.3.2. An adequate technical description of measuring equipment shall be given in the test report.

1.3.3. In the case of variable readings, the average of the maximum values shall be taken.

▼B

2. **Test method 1**

2.1. Conditions of measurement

Measurements shall be made under the following conditions:

2.1.1. the tractor must be unladen, i.e. without optional accessories, but must include coolant, lubricant, full fuel tank, tools and driver. The latter may not wear any abnormally thick clothing, scarf or hat. There may be no object on the tractor likely to distort the noise level;

2.1.2. the tyres must be inflated to the pressure recommended by the tractor manufacturer, the engine, transmission and drive axles must be at normal running temperature and radiator blinds when fitted must be kept open during measurements;

2.1.3. if it is liable to affect the noise level, extra equipment powered by the engine or self-powered such as windscreen wipers, warm air fan or power take-off, may not be in operation when measurements are being made; parts which normally operate at the same time as the engine, such as the engine cooling fan, must be in operation when measurements are being made;

▼B

2.1.4. the test area must be in an open and sufficiently silent location; it may take the form, for instance, of an open space of 50-metre radius, having a central part with a radius of at least 20 m which is practically level, or of a level section having a solid track with as flat a surface and as few gullies as possible. The track must be as clean and dry as possible (e.g. free of gravel, leaves, snow, etc.). Slopes and irregularities are acceptable only if the variations in noise level caused by them lie within the error tolerances of the measuring equipment

2.1.5. the surface of the track must be such as not to cause excessive tyre noise;

2.1.6. the weather must be fine and dry with little or no wind.

The driver-perceived ambient noise level due to the wind or other sources of noise must be at least 10 dB(A) below the noise level of the tractor;

2.1.7. if a vehicle is used for measurements, it must be towed or driven at a sufficient distance from the tractor to avoid all interference. During measurements no object interfering with the measurements or reflective surfaces may be located within 20 m of each side of the test track or less than 20 m to the front or rear of the tractor. This condition can be considered fulfilled if the variations in noise level thus caused remain within the error tolerances; if not, the measurements must be discontinued for the duration of the interference;

2.1.8. all measurements in a given series must be carried out on the same track.

2.1.9. Vehicles of category C with steel tracks shall be tested on a layer of humid sand as specified by paragraph 5.3.2 of ISO 6395:2008.

2.2. Method of measurement

2.2.1. The microphone must be located 250 mm to the side of the centre plane of the seat, the side being that on which the higher noise level is encountered.

▼M1

The microphone diaphragm must face forward and the centre of the microphone must be 790 mm above and 150 mm forward of the Seat Reference Point (S) described in Appendix 8 to Annex XIV. Excessive vibration of the microphone must be avoided.

▼B

2.2.2. The maximum noise level in dB(A) shall be determined as follows:

2.2.2.1. all openings (e.g. doors, windows) in tractors having a closed series-produced cab structure must be closed during an initial series of measurements;

2.2.2.1.1. during a second series of measurements, they must be left open, provided that, when open, they do not create a road safety hazard, but fold-down or fold-up windscreens must remain closed;

2.2.2.2. noise must be measured using slow sound-level meter response at the load corresponding to the maximum noise in the gear giving the forward speed nearest to 7,5 km/h, or 5 km/h for tractors on steel tracks.

▼B

The governor control lever must be fully open. Starting with no load, the load applied must be increased until the maximum noise level is found. After each increase of load, time must be allowed for the noise level to stabilise before making the measurement;

2.2.2.3. noise must be measured using slow sound-level meter response at the load corresponding to the maximum noise in any gear other than that referred to in point 2.2.2.2 in which the noise level recorded is at least 1 dB(A) above that recorded in the gear referred to in point 2.2.2.2.

The governor control lever must be fully open. Starting with no load, the load applied must be increased until the maximum noise level is found. After each increase of load, time must be allowed for the noise level to stabilise before making the measurement;

2.2.2.4. noise must be measured at the maximum design speed of the unladen tractor.

2.3. Content of the test report

2.3.1. For T category tractors and C category tractors with rubber tracks, the test report shall include noise-level measurements carried out under the following conditions:

2.3.1.1. in the gear giving the speed nearest to 7,5 km/h;

2.3.1.2. in any gear, if the conditions described in point 2.2.2.3 are fulfilled;

2.3.1.3. at maximum design speed.

2.3.2. For C category tractors with steel tracks, the test report shall include noise-level measurements carried out under the following conditions:

2.3.2.1. in the gear giving the speed nearest to 5 km/h;

2.3.2.2. at standstill of the tractor.

2.4. Assessment criteria

2.4.1. For T category tractors and C category tractors with rubber tracks, The measurements described in points 2.2.2.1, 2.2.2.2, 2.2.2.3 and 2.2.2.4 may not exceed the values laid down in point 1.2.

2.4.2. For C category tractors with steel tracks, the measurement described in point 2.3.2.2 may not exceed the values laid down in point 1.2. The measurements described in points 2.3.2.1 and 2.3.2.2 shall be included in the test report.

3. **Test method 2**

3.1. Conditions of measurement

Measurements shall be made under the following conditions:

3.1.1. the tractor must be unladen, i.e. without optional accessories, but must include coolant, lubricant; full fuel tank, tools and driver. The latter may not wear any abnormally thick clothing, scarf or hat. There may be no object on the tractor likely to distort the noise level;

▼B

3.1.2. the tyres must be inflated to the pressure recommended by the tractor manufacturer, the engine, transmission and drive axles must be at normal running temperature and, if the engine has cooling louvres, these must remain completely open;

3.1.3. if it is liable to affect the noise level, extra equipment powered by the engine or self-powered such as windscreen wipers, warm air fan or power take-off, for example, may not be in operation when measurements are being made; parts which normally operate at the same time as the engine, such as the engine cooling fan, for example, must be in operation when measurements are being made;

3.1.4. the test area must be in an open and sufficiently silent location: it may take the form, for instance, of an open space of 50-metre radius, having a central part with a radius of at least 20 m which is practically level, or of a level section having a solid track with as flat a surface and as few gullies as possible. The track must be as clean and dry as possible (e.g. free of gravel, leaves, snow, etc.). Slopes and irregularities are acceptable only if the variations in noise level caused by them lie within the error tolerances of the measuring equipment;

3.1.5. the surface of the track must be such as not to cause excessive tyre noise;

3.1.6. the weather must be fine and dry with little or no wind.

The driver-perceived ambient noise level due to the wind or other sources of noise must be at least 10 dB(A) below the noise level of the tractor;

3.1.7. if a vehicle is used for measurements, it must be towed or driven at a sufficient distance from the tractor to avoid all interference. During measurements no object interfering with the measurements or reflective surfaces may be located within 20 m of each side of the test track or less than 20 m to the front or rear of the tractor. This condition can be considered fulfilled if the variations in noise level thus caused remain within the error tolerances; if not, the measurements must be discontinued for the duration of the interference;

3.1.8. all measurements in a given series must be carried out on the same track.

3.1.9. Vehicles of category C with steel tracks shall be tested on a layer of humid sand as specified by paragraph 5.3.2 of ISO 6395:2008.

3.2. Method of measurement

3.2.1. The microphone must be located 250 mm to the side of the central plane of the seat, the side being that on which the higher noise level is encountered.

▼M1

The microphone diaphragm must face forward and the centre of the microphone must be 790 mm above and 150 mm forward of the Seat Reference Point (S) described in Appendix 8 to Annex XIV. Excessive vibration of the microphone must be avoided.

▼B

3.2.2. Noise level shall be determined as follows

3.2.2.1. the tractor must travel along the section at the same test speed at least three times for at least 10 seconds;

3.2.2.2. all openings (e.g. doors, windows) in tractors having a closed series-produced cab structure must be closed during an initial series of measurements;

3.2.2.2.1. during a second series of measurements they must be left open, provided that when open they do not create a road safety hazard, but fold-down or fold-up windscreens must remain closed;

3.2.2.3. noise must be measured at the maximum rpm using slow sound-level meter response i.e. in the gear giving the speed nearest to 7,5 km/h at the rated rpm. The tractor must be unladen when measurements are being made

3.3. Content of the test report

For C category tractors on steel tracks, the test report shall include noise-level measurements carried out under the following conditions:

3.3.1. in the gear giving the speed nearest to 5 km/h;

3.3.2. at standstill of the tractor.

3.4. Assessment criteria

3.4.1. For T category tractors and C category tractors with rubber tracks, the measurements described in points 3.2.2.2 and 3.2.2.3 may not exceed the values laid down in Point 1.2.

3.4.2. For C category tractors with steel tracks, the measurement described in point 3.3.2 may not exceed the values laid down in Point 1.2. The measurements described in points 3.3.1 and 3.3.2 shall be included in the test report.

▼B

ANNEX XIV

Requirements applying to the driving seat

LIST OF APPENDICES

Appendix Number	Appendix title
1	Determination of the characteristics curves of the suspension system and the load adjustment range (point 3.5.1)
2	Test on standard roadway Table of elevation ordinates in relation to a basic level defining the surface of each strip of the roadway (point 3.5.3.2.1)
3	Set-value signals for the test-stand inspection of the driver's seat on Category A (Class I) tractors (point 3.5.3.1.1)
4a	Set-value signals for the test-stand inspection of the driver's seat on Category A (Class II) tractors (point 3.5.3.1.1)
4b	Set-value signals for the test-stand testing of drivers' seats for category A tractors in class III (point 3.5.3.1.1)
5	Test stand (point 3.5.3.1); example of construction (dimensions in mm)
6	Characteristic of the filter of the vibration measuring instrument (point 2.5.3.3.5)
7	Driver's seat installation requirements for EU type-approval of a tractor
8	Method for determining the seat reference point (S)

1. **Definitions**

For the purpose of this Annex the following definitions shall apply:

1.1. 'Seat surface' means the almost horizontal area of the seat which supports the driver when seated.

1.2. 'Lateral seat supports' means the devices or forms of the seat surface which prevent the driver from sliding sideways.

1.3. 'Seat armrests' means the devices on either side of the seat which support the driver's arms when he is seated.

1.4. 'Depth of the seat surface' means the horizontal distance between the Seat Reference Point (S) and the front edge of the seat surface.

1.5. 'Width of the seat surface' means the horizontal distance between the outside edges of the seat surface measured in a plane perpendicular to the median plane of the seat.

▼B

1.6. ‘Load adjustment range’ means the range between the two loads corresponding to the mean positions in the suspension system curves plotted for the heaviest and lightest driver.

1.7. ‘Suspension travel’ means the vertical distance between the highest position and the position at a given moment of a point situated on the seat surface 200 mm in front of the Seat Reference Point (S) in the median longitudinal plane.

1.8. ‘Vibration’ means the vertical movement up and down of the driver’s seat.

1.9. ‘Vibration acceleration (a)’ means the second differential of the vibration displacement with respect to time.

1.10. ‘Rms value of the acceleration (a_{eff})’ means the square root of the mean square of the accelerations.

1.11. ‘Weighted vibration acceleration (a_w)’ means the weighted vibration acceleration determined with the help of a weighting filter in accordance with point 3.5.3.3.5.2.

a_{wS}	=	rms value of the weighted seat vibration acceleration measured during a bench test or a standard roadway test;
a_{wB}	=	rms value of the weighted vibration acceleration measured at the seat attachment during a bench test;
a_{wB}*	=	reference rms value of the weighted vibration acceleration measured at the seat attachment;
a_{wS}*	=	corrected rms value of the weighted seat vibration acceleration measured during a bench test;
a_{wF}*	=	rms value of the weighted vibration acceleration measured at the seat attachment during a standard roadway test.

1.12. ‘Vibration ratio’ means the ratio of the weighted vibration acceleration measured on the driver’s seat to that measured at the seat attachment in accordance with point 3.5.3.3.2.

1.13. ‘Vibration class’ means the class or group of tractors which show the same vibration characteristics.

1.14. ‘Category A tractor’ means a tractor which can be assigned to a given vibration class by reason of similar design features.

The characteristics of these tractors are as follows:

number of axles: two having wheels or rubber tracks on at least one axle

▼B

suspension: unsuspended rear axle

Category A tractors shall be divided up into three classes:

▼M1

Class I	tractors having an unladen mass of up to 3 600 kg;

▼B

Class II	tractors having an unladen mass of 3 600 — 6 500 kg;
Class III	tractors having an unladen mass of more than 6 500 kg.

1.15. ‘Category B tractor’ means a tractor which cannot be assigned to a vibration class in Category A.

1.16. ‘Seats of the same type’ means seats which do not differ in any essential respects; the only aspects in which the seats may differ being as follows:

— dimensions;

— position and inclination of the backrest;

— inclination of the seat surface;

— longitudinal and vertical adjustment of the seat.

2. **General requirements**

2.1. The driver’s seat must be designed to ensure a comfortable position for the driver when controlling and manoeuvring the tractor, and to afford him the utmost protection as regards health and safety.

2.2. The seat must be adjustable in the longitudinal direction and in the height without the use of a tool.

2.3. The seat must be designed to reduce shocks and vibration. It must therefore be well sprung, have good vibration absorption and provide adequate support at the rear and sides.

The lateral support is considered adequate if the seat is designed to prevent the driver’s body from slipping sideways.

2.3.1. The seat must be suitable for persons of different mass. Any adjustment necessary in order to comply with this requirement must be carried out without the use of tools.

2.4. The seat surface, the backrest, the lateral supports and, where fitted, the removable, folding or fixed armrests, must be padded and the coating material must be washable.

2.5. The Seat Reference Point (S) must be calculated in the manner specified in Appendix 8.

2.6. Save as otherwise provided, the measurements and tolerances must comply with the following requirements:

▼B

2.6.1. the measurements given must be expressed in whole units, if necessary rounded off to the nearest whole number of units;

2.6.2. the instruments used for making measurements must enable the measured value to be rounded off to the nearest whole unit and must be accurate within the following tolerance limits:

▼M1

— for length measurements: ± 0,5 %,

▼B

— for angle measurements: ± 1°,

— for determination of the mass of the tractor: ± 20 kg,

— for measurement of tyre pressure: ± 0,1 bar;

2.6.3. for all data relating to dimensions, a tolerance of ± 5 % is allowed.

2.7. The seat must undergo the following tests, carried out on the same seat and in the order indicated below:

2.7.1. determination of the suspension characteristics and the range of adjustment to the driver's mass;

2.7.2. determination of lateral stability;

2.7.3. Determination of vertical vibration characteristics.

2.7.4. Determination of the damping characteristics in the resonance range.

2.8. If the seat is manufactured so that it can revolve about a vertical axis, then tests are carried out with the seat facing the forward position, locked in a position parallel with the median longitudinal plane of the tractor.

2.9. The seat undergoing the above tests must possess the same characteristics with respect to construction and fittings as the seats in series production.

2.10. Before the tests are carried out, the seat must have been run in by the manufacturer.

2.11. A test report, which confirms that the seat has completed all the specified tests without damage and which includes details of the seat vibration characteristics, must be prepared by the test laboratory.

2.12. Seats tested for Class I tractors are suitable only for tractors of that class, whereas seats tested for Class II tractors are suitable for Class I or Class II tractors and seats tested for class III tractors are suitable for class II and III tractors.

2.13. A vehicle equipped with a straddle seat and handlebars is deemed to comply with the requirements of points 2.2 to 2.7 where the straddle seat allows the operator to adjust his position on the seat so that he can effectively operate the control devices and where the vehicle passes the vibration test on the standard roadway as defined in point 3.5.3.

▼B

2.14. As an alternative to the provisions of point 3.5, for vehicles of category C with steel tracks, the vibrations transmitted to the driver may be measured according to the specifications of paragraph 5.3.2 of ISO 6395:2008 with the unladen vehicle travelling over a layer of humid sand at a constant speed of 5 km/h (± 0,5 km/h) and with the engine at rated speed. The measurement shall be done following specifications of point 3.5.3.3.

3. **Special requirements**

3.1. Seat surface dimensions

3.1.1. The depth of the seat surface, measured parallel to and at a distance of 150 mm from the median longitudinal plane of the seat, must be 400 ± 50 mm (see figure 1).

3.1.2. The width of the seat surface, measured perpendicular to the median plane of the seat, 150 mm in front of the Seat Reference Point (S) and at not more than 80 mm above that point, must be at least 450 mm (see figure 1).

3.1.3. The depth and width of the surface of seats intended for tractors in which the minimum rear-wheel track width does not exceed 1 150 mm may be reduced to not less than 300 and 400 mm respectively if the design of the tractor prevents compliance with the requirements of points 3.1.1 and 3.1.2.

3.2. Position and inclination of the backrest

3.2.1. The upper edge of the backrest of the seat must be at least 260 mm above the Seat Reference Point (S) (see figure 1).

3.2.2. The backrest must have an inclination of 10 ± 5° (see figure 1).

3.3. Inclination of the seat surface

3.3.1. The inclination towards the rear (see angle α in figure 1) of the surface of the loaded cushion must be 3 to 12° in relation to the horizontal, measured with the loading device in accordance with Appendix 8.

3.4. Seat adjustment (see figure 1)

3.4.1. The seat must be adjustable in the longitudinal direction over a minimum distance of:

— 150 mm for tractors with a minimum rear-wheel track width of more than 1 150 mm,

— 60 mm for tractors with a minimum rear-wheel track width of 1 150 mm or less.

3.4.2. The seat must be adjustable in the vertical direction over a minimum distance of:

— 60 mm for tractors with a minimum rear-wheel track width of more than 1 150 mm,

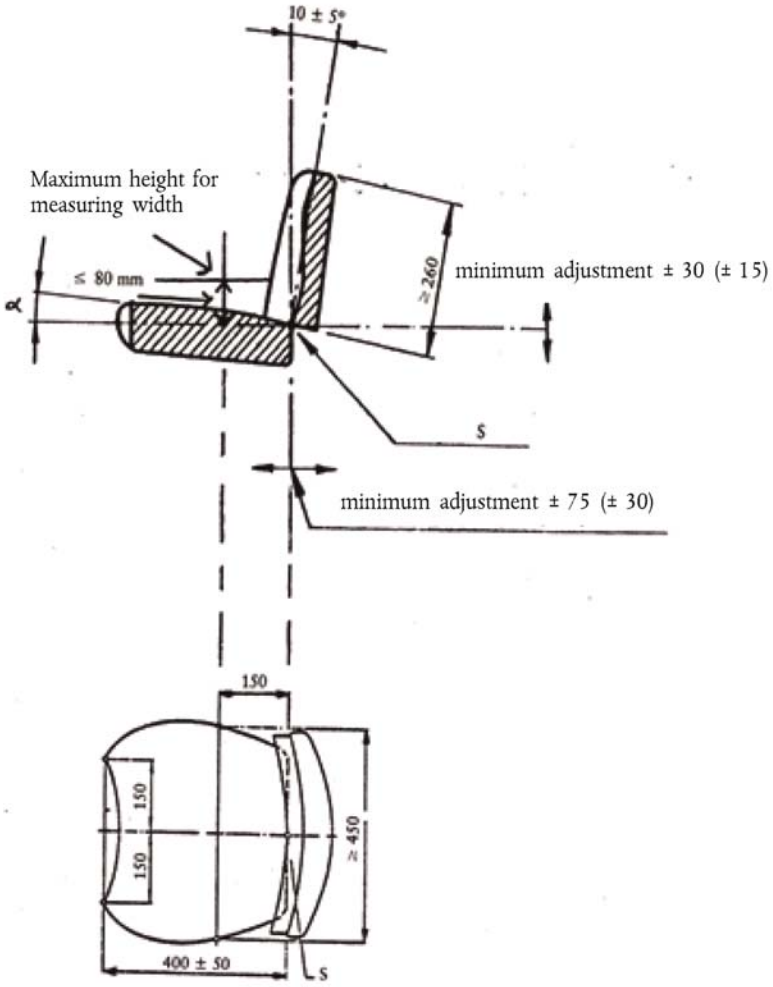
— 30 mm for tractors with a minimum rear-wheel track width of 1 150 mm or less.

▼B

3.4.3. As an alternative to the requirements set out in points 3.4.1 and 3.4.2, vehicles not equipped with an adjustable seat shall be equipped with a steering column and pedal(s) adjustable in the longitudinal and vertical directions over the minimum distances set out in points 3.4.1. to 3.4.2.

Figure 1

Special requirements of the driver's seat



(Dimensions in millimetres)

3.5. Seat tests

3.5.1. Determination of the suspension characteristics and the range of adjustment to the driver's mass.

3.5.1.1. The suspension characteristics are determined by a static test. The range of adjustment to the driver's mass is calculated from the suspension characteristics. These calculations are not necessary in the case of seats that cannot be manually adjusted to the driver's mass.

3.5.1.2. The seat is mounted on a test stand or on a tractor and a load applied to it, either directly or by means of a special device; this load must not differ by more than 5 N from the nominal load. The measuring

▼B

error for the suspension travel shall not exceed ± 1 mm. The load must be applied in accordance with the procedure laid down in the Appendix 8.

3.5.1.3. A complete characteristic curve representing the deflection of the suspension system must be plotted from zero load to maximum load, and back to zero. The load graduations at which the suspension travel is measured must not exceed 100 N; at least eight measurement points must be plotted at approximately equal intervals in the suspension travel. The point taken as the maximum load should be either that at which no further suspension travel can be measured, or a load of 1 500 N. After each application or removal of the load, the suspension travel must be measured 200 mm in front of the Seat Reference Point (S) in the median longitudinal plane of the seat surface. After application or removal of the load, the seat must be allowed to return to its at-rest position.

3.5.1.4. In the case of seats with a mass adjustment scale, the characteristic curves representing the deflection of the suspension system are plotted at mass adjustments for drivers having a mass of 50 and 120 kg. In the case of seats without a mass adjustment scale and with adjustment stops, measurements are taken at the lowest and the highest mass adjustment. In the case of seats without a mass adjustment scale or adjustment stops, the adjustment must be so selected that:

3.5.1.4.1. for the lower mass adjustment limit, the seat just returns to the top of the suspension travel when the load is removed, and

3.5.1.4.2. for the upper mass adjustment limit, the load of 1 500 N depresses the seat to the lowest limit of the suspension travel.

3.5.1.5. The mean position of the suspension system is the position which the seat assumes when it is depressed by half the full travel of the suspension system.

3.5.1.6. Since the characteristic curves of the suspension system are generally hysteresis loops, the load must be determined by drawing a centre line through the loop (see definition of point 1.6. and sections A and B of Appendix 1).

3.5.1.7. To determine the limits of the adjustment range as a function of the driver's mass, the vertical forces determined in accordance with point 3.5.1.6 for points A and B (see Appendix 1) must be multiplied by the scale factor 0,13 kg/N.

3.5.2. Determination of lateral stability

3.5.2.1. The seat must be set for the upper limit of the weight adjustment and connected to the test stand or to the tractor in such a way that its base plate rests on a rigid plate (test stand) not smaller than the base plate itself.

3.5.2.2. A test load of 1 000 N is applied to the surface or cushion of the seat. The point of application must lie 200 mm in front of the Seat Reference Point (S) and alternately on the two sides 150 mm from the plane of symmetry through the seat.

▼B

3.5.2.3. During application of the load, the variation in the lateral angle of inclination of the seat surface is measured in the end settings for horizontal and vertical seat adjustment. The permanent deformation close to the point of application of the load is not to be taken into consideration.

3.5.3. Determination of the vertical vibration characteristics

The seat vibration is determined by tests on a test stand and/or a standard roadway depending on whether the seat is intended for a class (or classes) of Category A tractor or for a Category B tractor.

3.5.3.1. Testing on the test stand

3.5.3.1.1. The test stand must simulate the vertical vibrations at the point of attachment of the driver's seat. The vibrations are generated by means of an electro-hydraulic device. The set values to be used are either those specified in Appendices 3, 4a and 4b for the class of tractor in question or the double-integrated acceleration signals recorded at the seat attachment of a Category B tractor moving at a speed of 12 ± 0,5 km/h on a standard roadway as defined in point 3.5.3.2.1. To generate the vibrations, an uninterrupted double run of the set values must be used.

The transition from the end of the sequence of acceleration signals recorded on the standard roadway in the first run to the start of the second run must be smooth and jolt-free. The measurements must not be made during the first run of the set values or of the acceleration signals. More values than the 700 laid down in Appendices 3 and 4a and 4b may be used if these values were calculated, for example, with a cubic Spline function from the original 700 values.

3.5.3.1.2. Besides an attachment for the test seat, the platform must contain a steering wheel and footrest. Its configuration must be as shown in Appendix 5.

3.5.3.1.3. The test stand must have a high degree of flexural and torsional rigidity and its bearings and guides must have no more than the technically necessary clearance. If the platform is carried on an oscillating arm, the dimension R must be not less than 2 000 mm (see Appendix 5). The magnitude of the vibration ratio at frequencies between 0,5 and 5,0 Hz shall be within the range 1,00 ± 0,05, measured at intervals not exceeding 0,5 Hz. The phase shift shall not vary by more than 20° throughout the same frequency range.

3.5.3.2. Testing on a standard roadway

3.5.3.2.1. The roadway consists of two parallel strips spaced according to the wheel track of the tractor. Both strips must be made of a rigid material, such as wood or concrete, and be formed either of blocks set in a base structure or of a continuous smooth surface. The longitudinal profile of each track strip is defined by the ordinates of elevation in relation to a base level; these ordinates are shown in the tables in Appendix 2. With regard to the roadway, the elevation is defined at intervals of 16 cm along each strip.

▼B

The roadway must be firmly set in the ground and the distance between the strips must deviate only slightly over its entire length; the tractor's wheels must be fully supported at all times. Where the strips are formed of blocks, these must be 6 to 8 cm thick, with a distance of 16 cm between the centres of the blocks. The length of the standard roadway shall be 100 m.

The measurements must begin as soon as the axis of the rear axle of the tractor is perpendicular to point D = 0 on the roadway, and end as soon as the axis of the front axle of the tractor is perpendicular to point D = 100 of the test roadway (see the table in Appendix 2).

3.5.3.2.2. Measurements shall be taken at a speed of 12 ± 0,5 km/h.

The prescribed speed must be maintained without the use of brakes. The vibrations must be measured on the seat and at the point where the seat is attached to the tractor, with a light and a heavy driver.

The speed of 12 km/h must be reached after a run-up track has been traversed. The surface of this run-up track must be flat and must join the standard roadway without any change in level.

3.5.3.2.3. The seat must be set for the driver's mass in accordance with the manufacturer's instructions

3.5.3.2.4. The tractor must be fitted with a protective frame and/or cab unless of a type for which this equipment is not required. It must not carry any ancillary equipment. Moreover, there must be no ballast on the wheels or framework, and no fluid in the tyres.

3.5.3.2.5. The tyres used during the test must have the standard dimensions and ply-rating, as specified in the manufacturer's instructions. The depth of the tread must not be less than 65 % of the depth of a new tread.

3.5.3.2.6. The side-walls of the tyres must not be damaged. The pressure of the tyre must correspond to the arithmetical mean of the reference pressures recommended by the tyre manufacturer. The wheel track must correspond to that used under normal working conditions for the tractor model on which the seat is fitted.

▼M1

3.5.3.2.7. The measurements at the point of seat attachment and on the seat itself shall be made during the same run.

For measuring and recording the vibrations, an accelerometer, a measuring amplifier and a magnetic tape recorder, electronic system for data acquisition or direct-reading vibration meter shall be used. The specifications laid down in points 3.5.3.3.2 to 3.5.3.3.6 shall apply to those instruments.

▼B

3.5.3.3. Specifications for tests on roadway and test stand

3.5.3.3.1. Driver's mass

The tests must be carried out with two drivers: one with a total mass of 59 ± 1 kg, of which not more than 5 kg may be carried in a weighting belt around the body; the other with a mass of 98 ± 5 kg with a maximum mass of 8 kg in the weighting belt.

▼B

3.5.3.3.2. Position of the accelerometer

To measure the vibrations transmitted to the driver, an accelerometer is fixed on a flat plate with a diameter of 250 ± 50 mm, the central part of which must be rigid up to a diameter of 75 mm and must include a rigid device to protect the accelerometer. This plate must be placed in the middle of the seat surface between the seat and the driver and have a non-slip surface.

To measure the vibrations at the seat attachment, an accelerometer must be fixed near to this attachment at a point not more than 100 mm from the median longitudinal plane of the tractor and not outside the vertical projection of the seat surface on the tractor.

3.5.3.3.3. Measurement of vibration acceleration

The accelerometer and the associated amplifying and transmitting equipment must respond to vibrations with an r.m.s. value of 0,05 m/s^2, and be capable of measuring vibrations with an r.m.s. value of 5 m/s^2 and a crest factor (ratio of peak to r.m.s. value) of 3 without distortion and with a maximum error of ± 2,5 % over the range 1 to 80 Hz.

▼M1

3.5.3.3.4. Magnetic tape recorder or electronic data acquisition system

If a tape recorder or electronic system for data acquisition is used, it must have a maximum reproduction error of ± 3,5 % in a frequency range of 1 to 80 Hz, including change of tape speed during replay for analysis.

▼B

3.5.3.3.5. Vibration meter

3.5.3.3.5.1. Vibrations of more than 10 Hz may be disregarded. It is therefore permissible to connect upstream of the measuring instrument a low-pass filter with a cut-out frequency of about 10 Hz and an attenuation of 12 dB per octave.

3.5.3.3.5.2. This instrument must incorporate an electronic weighting filter between the sensor and the integrator device. The filter must correspond to the curve shown in Appendix 6 and the margin of error must be ± 0,5 dB in the 2 to 4 Hz frequency band and ± 2 dB for the other frequencies.

3.5.3.3.5.3. The electronic measuring device must be capable of indicating either:

— the integral (I) of the square of the weighted vibration acceleration (a_w) for a test time (T) $I = (\int_o^T)(a_w)^2 dt$

— or the square root of that integral

— or directly the r.m.s. value of the weighted vibration acceleration

(a_{weff}) $a_{weff} = \sqrt[2]{I/T} = (\sqrt[2]{I}/\sqrt[2]{T})$

The inaccuracy of the entire system for measuring the rms value of the acceleration must not exceed ± 5 % of the measured value.

▼B

3.5.3.3.6. Calibration

All instruments must be regularly calibrated.

3.5.3.3.7. Evaluation of vibration tests

3.5.3.3.7.1. During each test, the weighted vibration acceleration for the whole test time must be determined with the vibration meter specified in point 3.5.3.3.5.

3.5.3.3.7.2. The test report must give the arithmetic mean value of the rms values of the weighted seat vibration acceleration (a_{wS}) for both the light driver and the heavy driver. The test report must also give the ratio of the arithmetic mean of the rms values of the weighted vibration acceleration measured on the seat (a_{wS}) to the arithmetic mean of the rms values of the weighted vibration acceleration measured at the seat attachment (a_{wB}). This ratio shall be given to two decimal places.

3.5.3.3.7.3. The ambient temperature during the vibration test must be measured and shown in the report.

3.5.4. Vibration test for tractor seats in accordance with their intended use

3.5.4.1. A seat intended for use on a class (or classes) of Category A tractors must be tested on a vibration stand using the appropriate set value signals.

3.5.4.2. A seat intended for use on a type of Category B tractor must be tested on a standard roadway with a tractor of that type. However, a simulation test may also be carried out using a set value signal corresponding to the acceleration curve which was determined during the standard roadway test with the type of tractor for which the seat is intended.

3.5.4.3. A seat intended for use only on a particular type of Category A tractor may also be tested in accordance with the requirements of 3.5.4.2. In this case, component type-approval will be granted only for the type of tractor for which the test seat is intended.

3.5.5. Procedure used for determining the weighted vibration acceleration of seats intended for Category A tractors

3.5.5.1. The test on the vibration test stand shall be carried out in accordance with point 3.5.3.1. the value a_{wB} actually occurring at the seat attachment during measurement must be determined. In the case of deviations from the reference value:

a^*_{wB} =	2,05 m/s^2 for class I, category A tractors.
a^*_{wB} =	1,5 m/s^2 for class II, category A tractors.
a^*_{wB} =	1,3 m/s^2 for class III, category A tractors.

The acceleration a_{wS} measured at the driver's seat must be corrected in accordance with the following equation: $(a_{wS}{}^*) = (a_{wS})(a(_{wB}{}^*)/(a_{wB}))$

▼B

3.5.5.2. For each of the two drivers provided for in point 3.5.3.3.1, the weighted acceleration of the vibratory movement shall be measured at the seat for 28 seconds in the case of classes I and III, and for 31 seconds in the case of class II. The measurement must begin at the set value signal corresponding to t = 0 seconds and end at the set value signal corresponding to t = 28 or 31 seconds (see table in Appendices 3, 4a and 4b). At least two test runs must be carried out. The measured values must not deviate from the arithmetical mean by more than ± 5 %. Each complete set point sequence must be reproduced in 28 or 31 ± 0,5 s.

3.5.6. Procedure used for determining the weighted vibration acceleration of seats intended for Category B tractors

3.5.6.1. In accordance with the requirements of points 3.5.4.2, the seat vibration tests are not applicable to a class of tractors, but only to each tractor type for which the seat is intended.

3.5.6.2. The standard roadway test must be carried out in accordance with the requirements of points 3.5.3.2 and 3.5.3.3. The vibration acceleration measured on the driver's seat (a_{wS}) need not be corrected. At least two test runs must be carried out on the standard roadway. The measured values must not deviate from the arithmetic mean by more than ± 10 %.

3.5.6.3. If a bench test is conducted, it must be carried out in association with a standard roadway test pursuant to the requirements of points 3.5.3.1 and 3.5.3.3.

3.5.6.4. The vibration test stand shall be adjusted in such a way that the rms value of the weighted vibration acceleration recorded at the seat attachment (a_{wB}) deviates by less than ± 5 % from the rms value of the weighted vibration acceleration at the seat attachment recorded on the standard roadway (a^*_{wF}).

In the event of deviations from the value (a_{wF}*) measured at the seat attachment during the test run, the weighted vibration acceleration recorded at the driver's seat during the test on the test stand must be corrected as follows: $(a^*_{wS}) = (a_{wS})((a^*_{wF})/(a_{wB}))$

Each of the tests on the test stand must be carried out twice. The measured values must not deviate from the arithmetic mean by more than ± 5 %.

3.5.7. Test for determining the damping characteristics in the resonance range

3.5.7.1. This test is carried out on the test stand as specified in point 3.5.3.1. However, account must be taken of the following:

3.5.7.2. Instead of the set values specified in the second paragraph of point 3.5.3.1.1 (see Appendices 3, 4a and 4b), sinusoidal oscillations of ± 15 mm amplitude with a frequency of 0,5 to 2 Hz are generated. The frequency range is to be run through with a constant rate of frequency change in not less than 60 seconds or at intervals no

▼B

greater than 0,05 Hz with increasing frequency, and in an identical manner with decreasing frequency. During this measurement, it is permissible to filter the signals emitted by the accelerometers through a bandpass filter with cut-off frequencies of 0,5 and 2,0 Hz.

3.5.7.3. The seat is to be loaded with a ballast of 40 kg in the first test and with a mass of 80 kg in the second test; the ballast is to be applied on the device illustrated in Figure 1 of Appendix 8, with the same line of action of the force as when determining the Seat Reference Point (S).

3.5.7.4. The ratio of the rms values of the vibration acceleration on the seat surface a_{wS} to those at the seat attachment a_{wB}: $V = (a_{wS})/(a_{wB})$

is to be determined in the frequency range from 0,5 to 2,0 Hz at intervals no greater than 0,05 Hz.

3.5.7.5. The ratio measured must be given in the test report to two decimal places.

▼M1

4. **Additional conditions for EU component type-approval of a seat**

To be granted EU component type-approval, a seat shall, in addition to fulfilling the requirements set out in sections 2 and 3, satisfy the following conditions:

(a) the range of adjustment as a function of the driver's mass extends from at least 50 to 120 kg;

(b) the change in the angle of inclination measured during the lateral stability test does not exceed 5^{o};

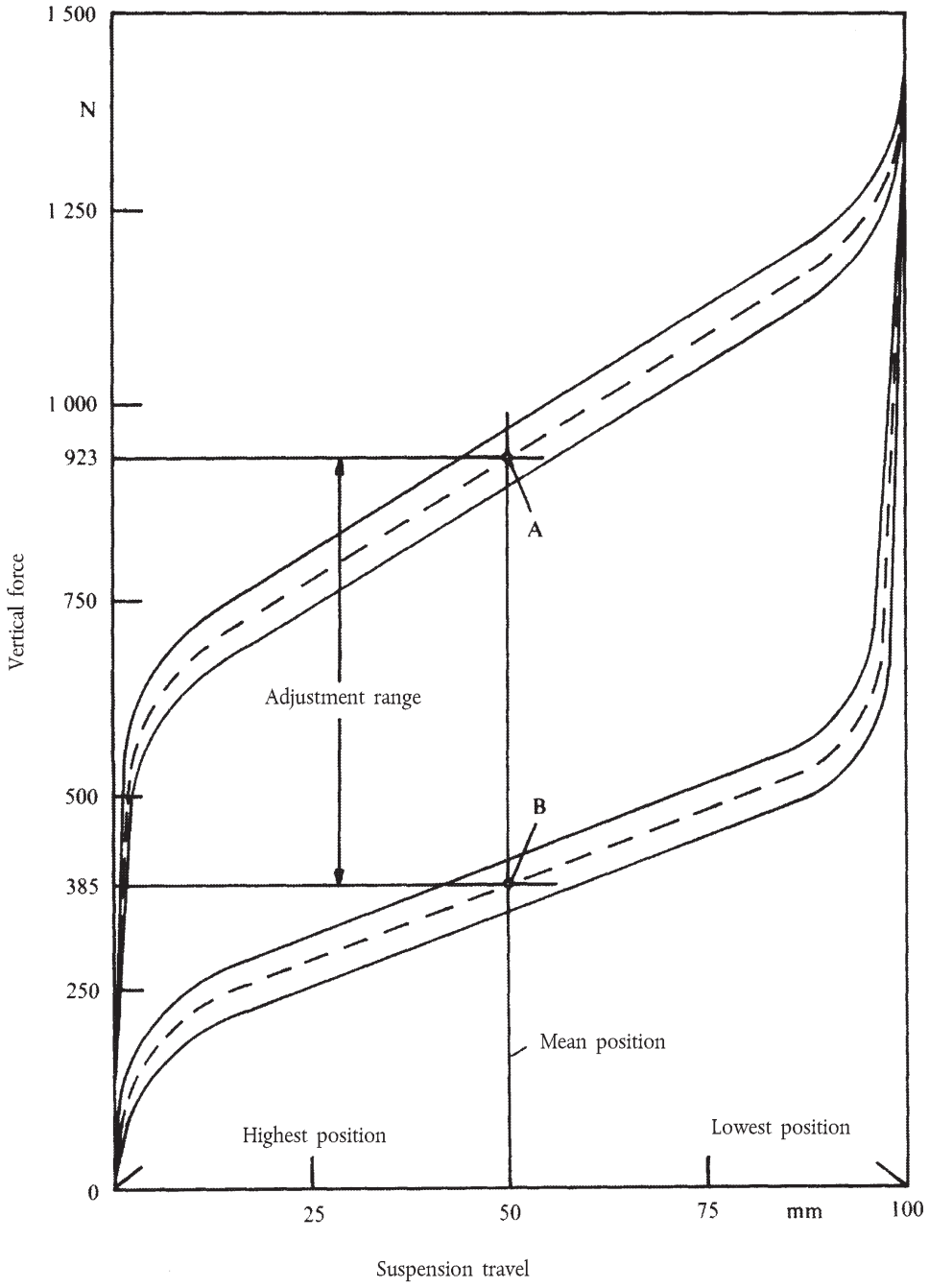
(c) neither of the two values set in point 3.5.3.3.7.2 exceed 1,25 m/s^2;

(d) the ratio referred to in points 3.5.7.4 and 3.5.7.5 does not exceed the value of 2.

▼B

Appendix 1

Determination of the characteristics curves of the suspension system and the load adjustment range (point 3.5.1)



▼B

Appendix 2

Test on standard roadway

Table of elevation ordinates in relation to a basic level defining the surface of each strip of the roadway (point 3.5.3.2.1)

D = distance from the beginning of the standard roadway (in metres)

L = ordinate of the left-hand strip (mm)

R = ordinate of the right-hand strip (mm)

D	L	R	D	L	R	D	L	R	D	L	R	D	L	R
0	115	140	4·48	100	100	9·12	110	100	13·76	70	75	18·40	70	75
0·16	110	125	4·64	100	90	9·28	125	90	13·92	70	90	18·56	75	75
0·32	110	140	4·90	90	90	9·44	120	100	14·08	70	100	18·72	95	75
0·48	115	135	4·96	90	90	9·60	135	95	14·24	70	110	18·88	90	75
0·64	120	135	5·12	95	90	9·76	120	95	14·40	65	95	19·04	90	70
0·80	120	125	5·28	95	70	9·92	120	95	14·56	65	100	19·20	95	70
0·96	125	135	5·44	95	65	10·08	120	95	14·72	65	90	19·36	85	70
1·12	120	125	5·60	90	50	10·24	115	85	14·88	65	90	19·52	85	75
1·28	120	115	5·76	95	50	10·40	115	90	15·04	65	85	19·68	75	85
1·44	115	110	5·92	85	50	10·56	115	85	15·20	55	85	19·84	85	85
1·60	110	100	6·08	85	55	10·72	115	90	15·36	65	85	20·00	75	90
1·76	110	110	6·24	75	55	10·88	120	90	15·52	65	85	20·16	85	85
1·92	110	110	6·40	75	55	11·04	110	75	15·68	55	75	20·32	75	70
2·08	115	115	6·56	70	65	11·20	110	75	15·84	55	85	20·48	70	75
2·24	110	110	6·72	75	75	11·36	100	85	16·00	65	75	20·64	65	75
2·40	100	110	6·88	65	75	11·52	110	85	16·16	55	85	20·80	70	75
2·56	100	100	7·04	65	85	11·68	95	90	16·32	50	75	20·96	65	75
2·72	95	110	7·20	65	90	11·84	95	90	16·48	55	75	21·12	70	75
2·88	95	95	7·36	75	95	12·00	95	85	16·64	65	75	21·28	70	85
3·04	90	95	7·52	75	100	12·16	100	95	16·80	65	75	21·44	70	85
3·20	90	100	7·68	95	95	12·32	100	90	16·96	65	85	21·60	70	90
3·36	85	100	7·84	115	110	12·48	95	85	17·12	65	70	21·76	75	95
3·52	90	100	8·00	115	100	12·64	95	85	17·28	65	65	21·92	75	95
3·68	90	115	8·16	125	110	12·80	95	90	17·44	65	75	22·08	75	90
3·84	95	110	8·32	110	100	12·96	85	90	17·60	65	75	22·24	85	90
4·00	90	110	8·48	110	100	13·12	85	85	17·76	50	75	22·40	85	95
4·16	90	95	8·64	110	95	13·28	75	90	17·92	55	85	22·58	90	85
4·32	95	100	8·80	110	95	13·44	75	95	18·08	55	85	22·72	90	85
			8·96	110	95	13·60	75	90	18·24	65	85	22·88	95	85

▼B

D	L	R	D	L	R	D	L	R	D	L	R	D	L	R
23·04	95	85	28·96	75	90	34·88	115	90	40·80	95	75	46·72	85	90
23·20	100	85	29·12	75	75	35·04	115	100	40·96	95	75	46·88	85	85
23·36	100	75	29·28	75	75	35·20	120	100	41·12	95	75	47·04	90	85
23·52	110	85	29·44	70	75	35·36	120	100	41·28	90	90	47·20	75	85
23·68	110	85	29·60	75	75	35·52	135	95	41·44	90	95	47·36	65	75
23·84	110	85	29·76	75	85	35·68	135	95	41·60	85	95	47·52	70	70
24·00	100	75	29·92	85	75	35·84	135	95	41·76	85	100	47·68	70	75
24·16	100	75	30·08	75	75	36·00	135	90	41·92	90	100	47·84	70	75
24·32	95	70	30·24	85	75	36·16	120	75	42·08	90	95	48·00	75	85
24·48	100	70	30·40	75	75	36·32	115	75	42·24	85	100	48·16	90	95
24·64	100	70	30·56	70	75	36·48	110	70	42·40	85	110	48·32	95	95
24·80	115	75	30·72	75	75	36·64	100	65	42·56	95	110	48·48	100	120
24·96	110	75	30·88	85	75	36·80	110	55	42·72	95	115	48·64	110	100
25·12	110	85	31·04	90	75	36·96	115	55	42·88	95	115	48·30	115	100
25·28	100	75	31·20	90	85	37·12	100	50	43·04	100	100	48·96	115	115
25·44	110	95	31·36	100	75	37·28	115	50	43·20	100	95	49·12	120	115
25·60	100	95	31·52	100	75	37·44	110	50	43·36	100	95	49·28	120	110
25·76	115	100	31·68	120	85	37·60	100	65	43·52	100	90	49·44	115	95
25·92	115	100	31·84	115	75	37·76	90	55	43·68	110	95	49·60	115	90
26·08	110	95	32·00	120	85	37·92	95	55	43·84	100	100	49·76	115	90
26·24	115	95	32·16	120	85	38·08	90	35	44·00	110	90	49·92	110	95
26·40	110	95	32·32	135	90	38·24	90	35	44·16	100	85	50·08	110	100
26·56	100	95	32·48	145	95	38·40	110	35	44·32	110	90	50·24	100	110
26·72	100	95	32·64	160	95	38·56	100	35	44·48	110	85	50·40	100	120
26·88	100	100	32·80	165	90	38·72	115	35	44·64	100	85	50·56	95	120
27·04	100	95	32·96	155	90	38·88	100	35	44·80	100	90	50·72	95	115
27·20	100	95	33·12	145	90	39·04	100	35	44·96	95	90	50·88	95	120
27·36	110	90	33·28	140	95	39·20	110	30	45·12	90	95	51·04	95	120
27·52	115	90	33·44	140	85	39·36	110	45	45·28	90	100	51·20	90	135
27·68	115	85	33·60	140	85	39·52	110	50	45·44	95	100	51·36	95	125
27·84	110	90	33·76	125	75	39·68	100	55	45·60	90	90	51·52	95	120
28·00	110	85	33·92	125	75	39·84	110	50	45·76	85	90	51·68	100	120
28·16	110	85	34·08	115	85	40·00	90	55	45·92	75	90	51·84	100	120
28·32	100	85	34·24	120	75	40·16	85	55	46·08	85	90	52·00	100	120
28·48	100	90	34·40	125	75	40·32	90	65	46·24	75	90	52·16	100	125
28·64	90	85	34·56	115	85	40·48	90	65	46·40	75	90	52·32	110	125
28·80	90	75	34·72	115	75	40·64	90	70	46·54	75	90	52·48	110	125

▼B

D	L	R
52·64	100	125
52·80	100	120
52·96	100	120
53·12	110	115
53·28	100	110
53·44	110	110
53·60	95	110
53·76	95	110
53·92	100	110
54·08	95	100
54·24	100	100
54·40	100	100
54·56	100	100
54·72	95	100
54·88	100	100
55·04	100	115
55·20	110	115
55·36	100	110
55·52	110	100
55·68	100	110
55·84	100	110
56·00	100	110
56·16	95	115
56·32	90	110
56·48	95	110
56·64	95	110
56·80	90	100
56·96	100	100
57·12	100	95
57·28	95	100
57·44	100	100
57·60	95	115
57·76	85	110
57·92	90	115
58·08	90	110
58·24	90	100
58·40	85	95

D	L	R
58·56	90	95
58·72	85	90
58·88	90	90
59·04	90	95
59·20	90	115
59·36	90	115
59·52	90	115
59·68	85	110
59·84	75	110
60·00	90	115
60·16	90	120
60·32	90	120
60·48	90	120
60·64	95	120
60·80	95	120
60·96	90	120
61·12	90	115
61·28	95	110
61·44	95	110
61·60	100	100
61·76	110	100
61·92	100	100
62·08	100	100
62·24	95	100
62·40	95	100
62·56	95	100
62·72	90	100
62·88	90	100
63·04	90	100
63·20	90	90
63·36	90	90
63·52	85	90
63·68	85	90
63·84	75	85
64·00	75	85
64·16	75	75
64·32	75	75

D	L	R
64·48	70	75
64·64	70	70
64·80	70	55
64·96	70	45
65·12	65	55
65·28	65	55
65·44	65	65
65·60	55	70
65·76	55	75
65·92	55	75
66·08	55	75
66·24	55	85
66·46	55	85
66·56	65	90
66·72	70	90
66·88	70	110
67·04	65	100
67·20	55	100
67·36	65	100
67·52	50	100
67·68	50	85
67·84	50	90
68·00	50	100
68·16	55	100
68·32	55	95
68·48	65	90
68·64	50	85
68·80	50	70
68·96	50	70
69·12	50	65
69·28	50	55
69·44	45	50
69·60	35	50
69·76	35	55
69·92	35	65
70·08	35	65

D	L	R
70·24	35	65
70·40	35	55
70·58	45	55
70·72	50	55
70·88	50	50
71·04	50	45
71·20	50	45
71·36	50	50
71·52	45	45
71·68	45	55
71·84	55	65
72·00	55	65
72·16	70	65
72·32	70	75
72·48	75	85
72·64	75	85
72·80	75	90
72·96	85	95
73·12	90	100
73·28	90	110
73·44	90	115
73·60	90	120
73·76	90	115
73·92	90	115
74·08	110	115
74·24	100	100
74·40	100	110
74·56	100	110
74·72	95	115
74·88	95	120
75·04	95	125
75·20	95	135
75·36	100	135
75·52	100	140
75·68	100	140
75·84	100	140
76·00	110	135

D	L	R
76·16	100	125
76·32	100	125
76·48	100	125
76·64	110	125
76·80	115	125
76·96	120	125
77·12	120	125
77·28	120	135
77·44	110	125
77·60	100	125
77·76	120	135
77·92	120	125
78·03	120	125
78·24	115	125
78·40	115	120
78·56	115	120
78·72	110	120
78·88	100	120
79·04	100	120
79·20	95	120
79·36	95	120
79·52	95	125
79·68	95	125
79·84	100	120
80·00	95	125
80·16	95	125
80·32	95	125
80·48	100	120
80·64	100	125
80·80	100	125
80·96	110	125
81·12	115	135
81·28	110	140
81·44	115	140
81·60	110	140
81·76	115	140
81·92	110	140

▼B

D	L	R
82·08	110	140
82·24	110	135
82·40	110	135
82·56	100	125
87·72	110	125
82·88	110	125
83·04	100	125
83·20	100	120
83·36	100	125
83·52	100	120
83·68	100	135
83·84	95	140
84·00	100	135
84·16	110	140
84·32	110	140
84·48	110	140
84·64	110	140
84·80	120	155
84·96	115	145
85·12	115	155
85·28	120	160
85·44	120	165
85·60	120	160

D	L	R
85·76	125	165
85·92	135	160
86·08	135	160
86·24	125	155
86·40	125	155
86·56	120	145
86·72	120	145
86·98	110	140
87·04	110	140
87·20	110	140
87·36	110	140
87·52	110	140
87·68	100	135
87·84	100	135
88·00	100	135
88·16	100	125
88·32	110	120
88·48	115	120
88·64	110	120
88·80	110	125
88·96	100	125
89·12	100	125
89·28	95	125

D	L	R
89·44	95	125
89·60	100	120
89·76	100	135
89·92	110	140
90·08	110	135
90·24	110	140
90·40	100	145
90·56	100	155
90·72	110	155
90·88	110	155
91·04	100	155
91·20	110	155
91·36	110	160
91·52	115	160
91·68	110	155
91·84	115	155
92·00	115	140
92·16	115	155
92·32	120	155
92·48	125	145
92·64	125	155
92·80	125	155
92·96	120	155

D	L	R
93·12	120	145
93·28	120	145
93·44	115	145
93·60	120	145
93·76	115	140
93·92	115	140
94·08	115	140
94·24	115	140
94·40	115	140
94·56	115	140
94·72	115	135
94·88	115	135
95·04	110	135
95·20	110	135
95·36	110	135
95·52	115	135
95·68	100	140
95·84	95	135
96·00	100	125
96·16	95	125
96·32	95	125
96·48	95	125
96·64	110	125

D	L	R
96·80	95	120
96·96	95	120
97·12	95	120
97·28	95	110
97·44	100	115
97·60	110	120
97·76	110	115
97·92	100	115
98·08	95	115
98·24	100	115
98·40	95	115
98·52	100	115
98·72	100	110
98·88	110	100
99·04	95	95
99·20	90	100
99·36	90	100
93·52	75	110
99·68	75	115
99·84	75	115
100·00	75	110

▼B

Appendix 3

Set-value signals for the test-stand inspection of the driver's seat on Category A (Class I) tractors (point 3.5.3.1.1)

PS = set point

a = amplitude of the required value signal in 10^{-4} m,

t = measurement time in seconds

When the sequence of signals is repeated in the table for 701 points, points 700 and 0 coincide in time at an amplitude of a = 0:

PS No	a 10^{-4} m	t s
0	0 000	0
1	0 344	0·04
2	0 333	0·08
3	0 272	
4	0 192	
5	0 127	
6	0 115	
7	0 169	
8	0 243	
9	0 298	
10	0 320	
11	0 270	
12	0 191	
13	0 124	
14	0 057	
15	0 027	
16	0 004	
17	– 0 013	
18	– 0 039	
19	– 0 055	
20	– 0 056	
21	– 0 059	
22	– 0 068	
23	– 0 104	
24	– 0 134	
25	– 0 147	1·0
26	– 0 144	
27	– 0 143	
28	– 0 155	
29	– 0 179	
30	– 0 181	
31	– 0 155	
32	– 0 139	
33	– 0 141	
34	– 0 170	
35	– 0 221	
36	– 0 259	
37	– 0 281	
38	– 0 268	
39	– 0 258	
40	– 0 285	
41	– 0 348	
42	– 0 437	
43	– 0 509	
44	– 0 547	
45	– 0 562	
46	– 0 550	
47	– 0 550	
48	– 0 576	
49	– 0 622	
50	– 0 669	2·0
51	– 0 689	
52	– 0 634	
53	– 0 542	
54	– 0 429	
55	– 0 314	
56	– 0 282	
57	– 0 308	
58	– 0 373	
59	– 0 446	
60	– 0 469	
61	– 0 465	
62	– 0 417	
63	– 0 352	
64	– 0 262	
65	– 0 211	
66	– 0 180	
67	– 0 182	
68	– 0 210	
69	– 0 222	
70	– 0 210	
71	– 0 186	
72	– 0 141	
73	– 0 088	
74	– 0 033	
75	0 000	3·0
76	0 001	
77	– 0 040	
78	– 0 098	
79	– 0 130	
80	– 0 115	
81	– 0 068	
82	– 0 036	
83	– 0 032	
84	– 0 050	
85	– 0 052	
86	– 0 039	
87	– 0 011	
88	0 014	
89	0 041	
90	0 054	
91	0 040	
92	0 006	
93	– 0 000	
94	0 025	
95	0 065	
96	0 076	
97	0 054	
98	– 0 016	
99	– 0 066	
100	– 0 048	4·0
101	– 0 011	
102	0 061	
103	0 131	
104	0 168	
105	0 161	
106	0 131	
107	0 086	
108	0 067	
109	0 088	
110	0 110	
111	0 148	
112	0 153	
113	0 139	
114	0 119	
115	0 099	
116	0 091	
117	0 078	
118	0 059	
119	0 062	
120	0 072	
121	0 122	
122	0 155	
123	0 191	
124	0 184	
125	0 143	5·0
126	0 087	
127	0 029	
128	0 010	
129	0 025	
130	0 074	
131	0 106	
132	0 115	
133	0 090	
134	0 048	
135	0 038	
136	0 066	
137	0 116	

▼B

PS No	a 10^{-4} m	t s
138	0 180	
139	0 229	
140	0 212	
141	0 157	
142	0 097	
143	0 055	
144	0 073	
145	0 175	
146	0 287	
147	0 380	
148	0 406	
149	0 338	
150	0 238	6·0
151	0 151	
152	0 080	
153	0 090	
154	0 146	
155	0 196	
156	0 230	
157	0 222	
158	0 184	
159	0 147	
160	0 115	
161	0 114	
162	0 140	
163	0 198	
164	0 257	
165	0 281	
166	0 276	
167	0 236	
168	0 201	
169	0 167	
170	0 145	
171	0 135	
172	0 165	
173	0 242	

PS No	a 10^{-4} m	t s
174	0 321	
175	0 399	7·0
176	0 411	
177	0 373	
178	0 281	
179	0 179	
180	0 109	
181	0 094	
182	0 136	
183	0 206	
184	0 271	
185	0 267	
186	0 203	
187	0 091	
188	0 009	
189	0 006	
190	0 074	
191	0 186	
192	0 280	
193	0 342	
194	0 330	
195	0 265	
196	0 184	
197	0 118	
198	0 105	
199	0 128	
200	0 174	8·0
201	0 215	
202	0 229	
203	0 221	
204	0 199	
205	0 164	
206	0 162	
207	0 174	
208	0 210	
209	0 242	

PS No	a 10^{-4} m	t s
210	0 270	
211	0 285	
212	0 285	
213	0 258	
214	0 223	
215	0 194	
216	0 165	
217	0 132	
218	0 106	
219	0 077	
220	0 065	
221	0 073	
222	0 099	
223	0 114	
224	0 111	
225	0 083	9·0
226	0 026	
227	– 0 028	
228	– 0 052	
229	– 0 069	
230	– 0 077	
231	– 0 067	
232	– 0 095	
233	– 0 128	
234	– 0 137	
235	– 0 144	
236	– 0 131	
237	– 0 155	
238	– 0 208	
239	– 0 266	
240	– 0 285	
241	– 0 276	
242	– 0 205	
243	– 0 110	
244	– 0 020	
245	0 041	

PS No	a 10^{-4} m	t s
246	0 053	
247	0 020	
248	0 016	
249	0 041	
250	0 090	10·0
251	0 136	
252	0 151	
253	0 123	
254	0 070	
255	0 034	
256	– 0 001	
257	– 0 010	
258	– 0 031	
259	– 0 061	
260	– 0 086	
261	– 0 104	
262	– 0 103	
263	– 0 093	
264	– 0 074	
265	– 0 056	
266	– 0 039	
267	– 0 000	
268	0 033	
269	0 067	
270	0 097	
271	0 085	
272	0 034	
273	0 002	
274	– 0 050	
275	– 0 080	11·0
276	– 0 096	
277	– 0 121	
278	– 0 116	
279	– 0 092	
280	– 0 060	
281	– 0 018	

PS No	a 10^{-4} m	t s
282	– 0 011	
283	– 0 052	
284	– 0 143	
285	– 0 241	
286	– 0 330	
287	– 0 343	
288	– 0 298	
289	– 0 235	
290	– 0 203	
291	– 0 249	
292	– 0 356	
293	– 0 448	
294	– 0 486	
295	– 0 444	
296	– 0 343	
297	– 0 240	
298	– 0 215	
299	– 0 277	
300	– 0 399	12·0
301	– 0 527	
302	– 0 585	
303	– 0 569	
304	– 0 479	
305	– 0 363	
306	– 0 296	
307	– 0 299	
308	– 0 374	
309	– 0 466	
310	– 0 528	
311	– 0 520	
312	– 0 432	
313	– 0 320	
314	– 0 244	
315	– 0 237	
316	– 0 310	
317	– 0 413	

▼B

PS No	a 10^{-4} m	t s
318	– 0 462	
319	– 0 456	
320	– 0 351	
321	– 0 181	
322	– 0 045	
323	0 013	
324	– 0 037	
325	– 0 160	13·0
326	– 0 247	
327	– 0 258	
328	– 0 187	
329	– 0 069	
330	0 044	
331	0 078	
332	0 061	
333	– 0 012	
334	– 0 102	
335	– 0 127	
336	– 0 103	
337	– 0 045	
338	0 039	
339	0 094	
340	0 107	
341	0 058	
342	– 0 011	
343	– 0 078	
344	– 0 093	
345	– 0 068	
346	– 0 025	
347	0 021	
348	0 008	
349	– 0 016	
350	– 0 038	14·0
351	– 0 024	
352	0 041	
353	0 135	
354	0 196	
355	0 171	
356	0 053	
357	– 0 111	
358	– 0 265	
359	– 0 348	
360	– 0 336	
361	– 0 258	
362	– 0 155	
363	– 0 059	
364	– 0 056	
365	– 0 123	
366	– 0 187	
367	– 0 218	
368	– 0 136	
369	0 012	
370	0 149	
371	0 212	
372	0 153	
373	0 021	
374	– 0 104	
375	– 0 160	15·0
376	– 0 142	
377	– 0 027	
378	0 099	
379	0 186	
380	0 174	
381	0 085	
382	– 0 031	
383	– 0 086	
384	– 0 069	
385	0 012	
386	0 103	
387	0 164	
388	0 129	
389	0 047	
390	– 0 055	
391	– 0 097	
392	– 0 056	
393	0 043	
394	0 162	
395	0 220	
396	0 205	
397	0 129	
398	0 053	
399	0 022	
400	0 052	16·0
401	0 114	
402	0 175	
403	0 191	
404	0 172	
405	0 138	
406	0 092	
407	0 052	
408	0 051	
409	0 025	
410	0 001	
411	– 0 026	
412	– 0 065	
413	– 0 073	
414	– 0 038	
415	– 0 001	
416	0 029	
417	0 030	
418	– 0 005	
419	– 0 045	
420	– 0 068	
421	– 0 093	
422	– 0 075	
423	– 0 067	
424	– 0 051	
425	– 0 049	17·0
426	– 0 059	
427	– 0 077	
428	– 0 107	
429	– 0 143	
430	– 0 141	
431	– 0 142	
432	– 0 106	
433	– 0 080	
434	– 0 050	
435	– 0 030	
436	– 0 014	
437	– 0 017	
438	– 0 031	
439	– 0 037	
440	– 0 068	
441	– 0 113	
442	– 0 167	
443	– 0 203	
444	– 0 191	
445	– 0 135	
446	– 0 047	
447	0 028	
448	0 032	
449	– 0 031	
450	– 0 108	18·0
451	– 0 157	
452	– 0 155	
453	– 0 081	
454	– 0 012	
455	0 053	
456	0 085	
457	0 054	
458	0 002	
459	– 0 026	
460	– 0 034	
461	– 0 014	
462	0 031	
463	0 061	
464	0 098	
465	0 123	
466	0 103	
467	0 078	
468	0 046	
469	0 042	
470	0 044	
471	0 072	
472	0 109	
473	0 133	
474	0 138	
475	0 125	19·0
476	0 095	
477	0 105	
478	0 129	
479	0 181	
480	0 206	
481	0 200	
482	0 168	
483	0 140	
484	0 149	
485	0 186	
486	0 237	
487	0 242	
488	0 207	
489	0 130	
490	0 055	
491	0 015	
492	0 014	
493	0 036	
494	0 054	
495	0 056	
496	0 022	
497	– 0 032	

▼B

PS No	a 10^{-4} m	t s
498	– 0 076	
499	– 0 108	
500	– 0 099	20·0
501	– 0 029	
502	0 051	
503	0 138	
504	0 199	
505	0 213	
506	0 184	
507	0 139	
508	0 062	
509	0 027	
510	0 030	
511	0 067	
512	0 146	
513	0 247	
514	0 314	
515	0 330	
516	0 289	
517	0 224	
518	0 179	
519	0 184	
520	0 216	
521	0 229	
522	0 210	
523	0 130	
524	0 062	
525	0 006	21·0
526	– 0 004	
527	0 004	
528	0 018	
529	0 031	
530	0 020	
531	0 014	
532	– 0 011	
533	– 0 022	

PS No	a 10^{-4} m	t s
534	– 0 029	
535	– 0 042	
536	– 0 066	
537	– 0 120	
538	– 0 188	
539	– 0 241	
540	– 0 252	
541	– 0 243	
542	– 0 212	
543	– 0 183	
544	– 0 170	
545	– 0 189	
546	– 0 233	
547	– 0 286	
548	– 0 311	
549	– 0 280	
550	– 0 215	22·0
551	– 0 128	
552	– 0 038	
553	– 0 018	
554	– 0 024	
555	– 0 052	
556	– 0 055	
557	– 0 033	
558	0 013	
559	0 061	
560	0 079	
561	0 060	
562	0 024	
563	– 0 013	
564	– 0 027	
565	– 0 018	
566	0 011	
567	0 064	
568	0 111	
569	0 171	

PS No	a 10^{-4} m	t s
570	0 238	
571	0 285	
572	0 295	
573	0 261	
574	0 201	
575	0 145	23·0
576	0 142	
577	0 163	
578	0 222	
579	0 284	
580	0 334	
581	0 342	
582	0 301	
583	0 240	
584	0 205	
585	0 216	
586	0 257	
587	0 326	
588	0 363	
589	0 380	
590	0 358	
591	0 303	
592	0 273	
593	0 341	
594	0 249	
595	0 252	
596	0 245	
597	0 244	
598	0 225	
599	0 212	
600	0 180	24·0
601	0 160	
602	0 130	
603	0 118	
604	0 104	
605	0 081	

PS No	a 10^{-4} m	t s
606	0 040	
607	– 0 004	
608	– 0 040	
609	– 0 057	
610	– 0 049	
611	– 0 021	
612	0 011	
613	0 033	
614	0 038	
615	0 027	
616	0 019	
617	0 024	
618	0 040	
619	0 069	
620	0 082	
621	0 086	
622	0 068	
623	0 056	
624	0 036	
625	0 006	25·0
626	– 0 015	
627	– 0 049	
628	– 0 071	
629	– 0 075	
630	– 0 078	
631	– 0 074	
632	– 0 069	
633	– 0 094	
634	– 0 116	
635	– 0 150	
636	– 0 178	
637	– 0 188	
638	– 0 198	
639	– 0 194	
640	– 0 187	
641	– 0 170	

PS No	a 10^{-4} m	t s
642	– 0 161	
643	– 0 154	
644	– 0 140	
645	– 0 115	
646	– 0 055	
647	0 001	
648	0 049	
649	0 085	
650	0 094	26·0
651	0 071	
652	0 039	
653	– 0 001	
654	– 0 027	
655	– 0 025	
656	0 000	
657	0 028	
658	0 045	
659	0 019	
660	– 0 032	
661	– 0 101	
662	– 0 162	
663	– 0 198	
664	– 0 193	
665	– 0 149	
666	– 0 096	
667	– 0 075	
668	– 0 086	
669	– 0 151	
670	– 0 246	
671	– 0 329	
672	– 0 382	
673	– 0 392	
674	– 0 340	
675	– 0 286	27·0
676	– 0 249	
677	– 0 245	

▼B

PS No	a 10^{-4} m	t s
678	– 0 298	
679	– 0 348	
680	– 0 366	
681	– 0 330	
682	– 0 247	

PS No	a 10^{-4} m	t s
683	– 0 175	
684	– 0 135	
685	– 0 149	
686	– 0 165	
687	– 0 178	

PS No	a 10^{-4} m	t s
688	– 0 142	
689	– 0 097	
690	– 0 067	
691	– 0 051	
692	– 0 071	

PS No	a 10^{-4} m	t s
693	– 0 101	
694	– 0 110	
695	– 0 091	
696	– 0 043	
697	0 020	

PS No	a 10^{-4} m	t s
698	0 061	
699	0 064	
700	0 036	28·0

▼B

Appendix 4a

Set-value signals for the test-stand inspection of the driver's seat on Category A (Class II) tractors (point 3.5.3.1.1)

PS = set point

a = amplitude of the required value signal in 10^{-4} m

t = measurement time in seconds

When the sequence of signals is repeated in the table for 701 points, points 700 and 0 coincide in time at an amplitude of a = 0:

PS No	a 10^{-4} m	t s	PS No	a 10^{-4} m	t s	PS No	a 10^{-4} m	t s	PS No	a 10^{-4} m	t s	PS No	a 10^{-4} m	t s
0	0 000	0	26	0 050		52	– 0 180		78	– 0 124		104	– 0 045	
1	0 156	0·04	27	0 055		53	– 0 081		79	– 0 143		105	– 0 126	
2	0 147	0·08	28	0 078		54	– 0 000		80	– 0 129		106	– 0 191	
3	0 144		29	0 120		55	– 0 011		81	– 0 091		107	– 0 223	
4	0 162		30	0 184		56	– 0 070		82	– 0 045		108	– 0 206	
5	0 210		31	0 209		57	– 0 168		83	– 0 004		109	– 0 168	
6	0 272		32	0 224		58	– 0 256		84	– 0 004		110	– 0 122	
7	0 336		33	0 206		59	– 0 307		85	– 0 016		111	– 0 095	
8	0 382		34	0 157		60	– 0 302		86	– 0 047		112	– 0 101	
9	0 404		35	0 101		61	– 0 249		87	– 0 080		113	– 0 114	
10	0 408		36	0 049		62	– 0 157		88	– 0 083		114	– 0 161	
11	0 376		37	– 0 002		63	– 0 056		89	– 0 080		115	– 0 212	
12	0 324		38	– 0 038		64	0 013		90	– 0 060		116	– 0 254	
13	0 275		39	– 0 068		65	0 044		91	– 0 029		117	– 0 273	
14	0 226		40	– 0 088		66	0 025		92	– 0 013		118	– 0 258	
15	0 176		41	– 0 100		67	– 0 026		93	– 0 004		119	– 0 211	
16	0 141		42	– 0 110		68	– 0 077		94	– 0 039		120	– 0 169	
17	0 126		43	– 0 151		69	– 0 115		95	– 0 100		121	– 0 125	
18	0 144		44	– 0 183		70	– 0 131		96	– 0 171		122	– 0 115	
19	0 180		45	– 0 234		71	– 0 102		97	– 0 218		123	– 0 127	
20	0 205		46	– 0 303		72	– 0 031		98	– 0 226		124	– 0 156	
21	0 198		47	– 0 364		73	0 035		99	– 0 190		125	– 0 185	5·0
22	0 184		48	– 0 410		74	0 078		100	– 0 116	4·0	126	– 0 232	
23	0 138		49	– 0 407		75	0 057	3·0	101	– 0 054		127	– 0 256	
24	0 102		50	– 0 367	2·0	76	0 000		102	– 0 001		128	– 0 260	
25	0 068	1·0	51	– 0 289		77	– 0 069		103	– 0 001		129	– 0 260	

▼B

PS No	a 10^{-4} m	t s
130	– 0 247	
131	– 0 228	
132	– 0 204	
133	– 0 192	
134	– 0 179	
135	– 0 144	
136	– 0 128	
137	– 0 117	
138	– 0 131	
139	– 0 154	
140	– 0 164	
141	– 0 160	
142	– 0 128	
143	– 0 059	
144	0 015	
145	0 074	
146	0 034	
147	0 042	
148	– 0 034	
149	– 0 101	
150	– 0 147	6·0
151	– 0 141	
152	– 0 091	
153	– 0 031	
154	0 017	
155	0 027	
156	– 0 012	
157	– 0 058	
158	– 0 127	
159	– 0 151	
160	– 0 125	
161	– 0 049	
162	0 045	
163	0 104	

PS No	a 10^{-4} m	t s
164	0 122	
165	0 104	
166	0 046	
167	– 0 018	
168	– 0 047	
169	– 0 036	
170	0 016	
171	0 145	
172	0 257	
173	0 330	
174	0 330	
175	0 258	7·0
176	0 138	
177	0 034	
178	– 0 037	
179	– 0 030	
180	0 026	
181	0 141	
182	0 216	
183	0 243	
184	0 188	
185	0 079	
186	– 0 015	
187	– 0 047	
188	– 0 008	
189	0 091	
190	0 230	
191	0 340	
192	0 381	
193	0 332	
194	0 225	
195	0 099	
196	0 014	
197	– 0 012	

PS No	a 10^{-4} m	t s
198	0 033	
199	0 131	
200	0 247	8·0
201	0 335	
202	0 348	
203	0 314	
204	0 239	
205	0 161	
206	0 124	
207	0 139	
208	0 218	
209	0 328	
210	0 405	
211	0 426	
212	0 403	
213	0 314	
214	0 191	
215	0 088	
216	0 025	
217	0 030	
218	0 087	
219	0 173	
220	0 240	
221	0 274	
222	0 250	
223	0 182	
224	0 077	
225	– 0 019	9·0
226	– 0 075	
227	– 0 061	
228	– 0 033	
229	0 011	
230	0 042	
231	0 025	

PS No	a 10^{-4} m	t s
232	– 0 021	
233	– 0 078	
234	– 0 142	
235	– 0 197	
236	– 0 225	
237	– 0 217	
238	– 0 196	
239	– 0 133	
240	– 0 038	
241	0 052	
242	0 128	
243	0 168	
244	0 164	
245	0 169	
246	0 170	
247	0 188	
248	0 210	
249	0 220	
250	0 210	10·0
251	0 185	
252	0 149	
253	0 100	
254	0 057	
255	0 035	
256	0 006	
257	– 0 000	
258	0 010	
259	0 034	
260	0 047	
261	0 047	
262	0 031	
263	0 028	
264	0 036	
265	0 072	

PS No	a 10^{-4} m	t s
266	0 125	
267	0 188	
268	0 216	
269	0 189	
270	0 119	
271	0 031	
272	– 0 026	
273	– 0 059	
274	– 0 052	
275	– 0 009	11·0
276	0 039	
277	0 081	
278	0 107	
279	0 079	
280	0 023	
281	– 0 044	
282	– 0 121	
283	– 0 168	
284	– 0 172	
285	– 0 147	
286	– 0 119	
287	– 0 114	
288	– 0 155	
289	– 0 217	
290	– 0 287	
291	– 0 243	
292	– 0 341	
293	– 0 289	
294	– 0 217	
295	– 0 157	
296	– 0 150	
297	– 0 193	
298	– 0 248	
299	– 0 319	

▼B

PS No	a 10^{-4} m	t s
300	– 0 371	12·0
301	– 0 378	
302	– 0 354	
303	– 0 309	
304	– 0 264	
305	– 0 241	
306	– 0 236	
307	– 0 264	
308	– 0 262	
309	– 0 282	
310	– 0 275	
311	– 0 278	
312	– 0 285	
313	– 0 302	
314	– 0 318	
315	– 0 316	
316	– 0 293	
317	– 0 238	
318	– 0 154	
319	– 0 070	
320	– 0 021	
321	– 0 029	
322	– 0 075	
323	– 0 138	
324	– 0 189	
325	– 0 193	13·0
326	– 0 153	
327	– 0 095	
328	– 0 012	
329	0 033	
330	0 069	
331	0 064	
332	0 000	
333	– 0 074	

PS No	a 10^{-4} m	t s
334	– 0 147	
335	– 0 164	
336	– 0 142	
337	– 0 067	
338	– 0 001	
339	0 057	
340	0 080	
341	0 040	
342	– 0 010	
343	– 0 096	
344	– 0 148	
345	– 0 164	
346	– 0 134	
347	– 0 060	
348	0 038	
349	0 136	
350	0 195	14·0
351	0 170	
352	0 077	
353	– 0 067	
354	– 0 212	
355	– 0 321	
356	– 0 356	
357	– 0 339	
358	– 0 277	
359	– 0 189	
360	– 0 119	
361	– 0 100	
362	– 0 124	
363	– 0 170	14·0
364	– 0 193	
365	– 0 173	
366	– 0 105	
367	– 0 000	

PS No	a 10^{-4} m	t s
368	0 075	
369	0 092	
370	0 074	
371	0 011	
372	– 0 049	
373	– 0 082	
374	– 0 076	
375	– 0 039	15·0
376	0 010	
377	0 053	
378	0 078	
379	0 068	
380	0 033	
381	0 004	
382	– 0 000	
383	– 0 013	
384	– 0 003	
385	0 000	
386	– 0 001	
387	– 0 010	
388	– 0 023	
389	– 0 019	
390	0 014	
391	0 060	
392	0 093	
393	0 117	
394	0 137	
395	0 123	
396	0 098	
397	0 075	
398	0 055	
399	0 062	
400	0 087	16·0
401	0 113	

PS No	a 10^{-4} m	t s
402	0 126	
403	0 139	
404	0 119	
405	0 080	
406	0 023	
407	– 0 043	
408	– 0 099	
409	– 0 121	
410	– 0 090	
411	– 0 009	
412	0 072	
413	0 120	
414	0 111	
415	0 049	
416	– 0 021	
417	– 0 098	
418	– 0 136	
419	– 0 117	
420	– 0 072	
421	– 0 020	
422	0 038	
423	0 061	
424	0 026	
425	– 0 016	17·0
426	– 0 090	
427	– 0 151	
428	– 0 171	
429	– 0 150	
430	– 0 080	
431	– 0 001	
432	0 064	
433	0 113	
434	0 109	
435	0 089	

PS No	a 10^{-4} m	t s
436	0 016	
437	– 0 040	
438	– 0 098	
439	– 0 142	
440	– 0 147	
441	– 0 112	
442	– 0 028	
443	0 058	
444	0 118	
445	0 124	
446	0 080	
447	0 006	
448	– 0 052	
449	– 0 068	
450	– 0 050	18·0
451	– 0 000	
452	0 063	
453	0 129	
454	0 155	
455	0 156	
456	0 111	
457	0 069	
458	0 049	
459	0 036	
460	0 056	
461	0 100	
462	0 143	
463	0 178	
464	0 193	
465	0 178	
466	0 136	
467	0 087	
468	0 050	
469	0 041	

▼B

PS No	a 10^{-4} m	t s
470	0 067	
471	0 117	
472	0 165	
473	0 188	
474	0 178	
475	0 171	19·0
476	0 154	
477	0 141	
478	0 137	
479	0 146	
480	0 177	
481	0 231	
482	0 282	
483	0 314	
484	0 287	
485	0 222	
486	0 138	
487	0 050	
488	– 0 003	
489	0 001	
490	0 041	
491	0 095	
492	0 124	
493	0 112	
494	0 060	
495	– 0 022	
496	– 0 112	
497	– 0 161	
498	– 0 153	
499	– 0 087	
500	0 030	20·0
501	0 127	
502	0 197	
503	0 203	

PS No	a 10^{-4} m	t s
504	0 147	
505	0 060	
506	– 0 027	
507	– 0 103	
508	– 0 096	
509	– 0 026	
510	0 062	
511	0 198	
512	0 275	
513	0 293	
514	0 244	
515	0 149	
516	0 056	
517	0 005	
518	– 0 001	
519	0 023	
520	0 035	
521	0 063	
522	0 034	
523	– 0 009	
524	– 0 074	
525	– 0 154	21·0
526	– 0 203	
527	– 0 204	
528	– 0 167	
529	– 0 119	
530	– 0 077	
531	– 0 068	
532	– 0 094	
533	– 0 168	
534	– 0 254	
535	– 0 337	
536	– 0 383	
537	– 0 400	

PS No	a 10^{-4} m	t s
538	– 0 391	
539	– 0 365	
540	– 0 346	
541	– 0 342	
542	– 0 372	
543	– 0 398	
544	– 0 431	
545	– 0 464	
546	– 0 459	
547	– 0 425	
548	– 0 354	
549	– 0 259	
550	– 0 187	22·0
551	– 0 174	
552	– 0 182	
553	– 0 211	
554	– 0 241	
555	– 0 228	
556	– 0 192	
557	– 0 131	
558	– 0 066	
559	– 0 050	
560	– 0 065	
561	– 0 117	
562	– 0 164	
563	– 0 191	
564	– 0 165	
565	– 0 109	
566	– 0 025	
567	0 081	
568	0 163	
569	0 191	
570	0 164	
571	0 089	

PS No	a 10^{-4} m	t s
572	– 0 004	
573	– 0 075	
574	– 0 099	
575	– 0 054	23·0
576	0 024	
577	0 126	
578	0 203	
579	0 223	
580	0 200	
581	0 113	
582	0 026	
583	– 0 008	
584	– 0 003	
585	0 057	
586	0 149	
587	0 236	
588	0 290	
589	0 299	
590	0 244	
591	0 192	
592	0 145	
593	0 095	
594	0 090	
595	0 111	
596	0 151	
597	0 186	
598	0 185	
599	0 165	
600	0 120	24·0
601	0 057	
602	0 008	
603	– 0 022	
604	– 0 044	
605	– 0 062	

PS No	a 10^{-4} m	t s
606	– 0 070	
607	– 0 061	
608	– 0 057	
609	– 0 044	
610	– 0 040	
611	– 0 037	
612	– 0 028	
613	– 0 017	
614	– 0 006	
615	0 011	
616	0 032	
617	0 045	
618	0 050	
619	0 039	
620	0 036	
621	0 027	
622	0 025	
623	0 006	
624	0 000	
625	– 0 012	25·0
626	– 0 040	
627	– 0 047	
628	– 0 058	
629	– 0 070	
630	– 0 076	
631	– 0 098	
632	– 0 103	
633	– 0 127	
634	– 0 158	
635	– 0 158	
636	– 0 163	
637	– 0 182	
638	– 0 177	
639	– 0 184	

▼B

PS No	a 10^{-4} m	t s
640	– 0 201	
641	– 0 199	
642	– 0 187	
643	– 0 145	
644	– 0 092	
645	– 0 040	
646	0 017	
647	0 044	
648	0 061	
649	0 029	
650	– 0 018	26·0
651	– 0 078	
652	– 0 129	

PS No	a 10^{-4} m	t s
653	– 0 135	
654	– 0 110	
655	– 0 039	
656	0 008	
657	0 019	
658	– 0 033	
659	– 0 102	
660	– 0 194	
661	– 0 264	
662	– 0 292	
663	– 0 261	
664	– 0 210	
665	– 0 147	

PS No	a 10^{-4} m	t s
666	– 0 092	
667	– 0 089	
668	– 0 138	
669	– 0 248	
670	– 0 360	
671	– 0 455	
672	– 0 497	
673	– 0 473	
674	– 0 393	
675	– 0 294	27·0
676	– 0 230	
677	– 0 214	
678	– 0 241	

PS No	a 10^{-4} m	t s
679	– 0 294	
680	– 0 343	
681	– 0 375	
682	– 0 379	
683	– 0 349	
684	– 0 276	
685	– 0 202	
686	– 0 136	
687	– 0 099	
688	– 0 101	
689	– 0 139	
690	– 0 196	
691	– 0 246	

PS No	a 10^{-4} m	t s
692	– 0 256	
693	– 0 234	
694	– 0 156	
695	– 0 078	
696	0 015	
697	0 083	
698	0 118	
699	0 080	
700	0 000	31·0

▼B

Appendix 4b

Set-value signals for the test-stand testing of drivers' seats for category A tractors in class III (point 3.5.3.1.1)

PS = set point

a = amplitude of the set value signal in mm

t = measurement time in seconds

If the signal sequence is repeated for 701 points in the table, point 700 and 0 merge in time, with amplitude a = 0.

PS No	a mm	t s	PS No	a mm	t s	PS No	a mm	t s	PS No	a mm	t s	PS No	a mm	t s
1	0	0,000	27	– 4	0,712	55	– 4	1,478	83	19	2,244	111	10	3,011
2	– 3	0,027	28	– 4	0,739	56	– 8	1,505	84	15	2,272	112	16	3,038
3	– 0	0,055	29	– 4	0,766	57	– 11	1,533	85	8	2,299	113	20	3,055
4	2	0,082	30	– 2	0,794	58	– 13	1,560	86	0	2,326	114	20	3,093
5	4	0,109	31	– 0	0,821	59	– 12	1,587	87	– 7	2,354	115	17	3,120
6	6	0,137	32	2	0,848	60	– 9	1,613	88	– 15	2,361	116	12	3,148
7	6	0,164	33	4	0,876	61	– 4	1,642	89	– 19	2,409	117	5	3,175
8	5	0,192	34	6	0,903	62	6	1,670	90	– 21	2,436	118	– 3	3,202
9	3	0,219	35	6	0,931	63	6	1,697	91	– 20	2,463	119	– 10	3,230
10	1	0,246	36	6	0,958	64	11	1,724	92	– 15	2,491	120	– 17	3,257
11	– 0	0,274	37	4	0,985	65	15	1,752	93	– 8	2,518	121	– 20	3,284
12	– 2	0,301	38	1	1,013	66	16	1,779	94	– 0	2,545	122	– 21	3,312
13	– 4	0,328	39	– 1	1,040	67	14	1,806	95	7	2,573	123	– 18	3,339
14	– 4	0,356	40	– 4	1,067	68	11	1,834	96	14	2,600	124	– 13	3,367
15	– 4	0,383	41	– 6	1,093	69	5	1,861	97	19	2,628	125	– 6	3,396
16	– 2	0,411	42	– 8	1,122	70	– 1	1,869	98	21	2,655	126	2	3,421
17	– 1	0,439	43	– 8	1,150	71	– 8	1,916	99	19	2,662	127	10	3,449
18	0	0,465	44	– 7	1,177	72	– 14	1,943	100	14	2,710	128	16	3,476
19	2	0,493	45	– 4	1,204	73	– 18	1,971	101	7	2,737	129	21	3,503
20	3	0,520	46	– 1	1,232	74	– 19	1,998	102	– 0	2,764	130	22	3,531
21	4	0,547	47	2	1,259	75	– 17	2,025	103	– 8	2,792	131	20	3,558
22	3	0,575	48	6	1,286	76	– 13	2,053	104	– 15	2,819	132	15	3,586
23	1	0,602	49	8	1,314	77	– 6	2,080	105	– 19	2,847	133	8	3,613
24	0	0,630	50	10	1,341	78	0	2,108	106	– 20	2,874	134	0	3,640
25	– 1	0,657	51	10	1,369	79	8	2,135	107	– 18	2,901	135	– 8	3,668
26	– 3	0,684	52	8	1,396	80	15	2,162	108	– 13	2,929	136	– 15	3,695
			53	4	1,423	81	19	2,190	109	– 5	2,956	137	– 20	3,722
			54	0	1,451	82	21	2,217	110	2	2,983	138	– 23	3,750

▼B

PS No	a mm	t s	PS No	a mm	t s	PS No	a mm	t s	PS No	a mm	t s	PS No	a mm	t s
139	– 22	3,777	175	– 1	4,762	211	0	5,748	247	16	6,733	283	26	7,718
140	– 18	3,804	176	4	4,790	212	5	5,775	248	21	6,761	284	21	7,746
141	– 11	3,832	177	8	4,817	213	9	5,803	249	22	6,783	285	13	7,773
142	– 3	3,859	178	12	4,845	214	13	5,830	250	21	6,815	286	4	7,801
143	5	3,887	179	13	4,872	215	15	5,857	251	16	6,843	287	– 5	7,828
144	13	3,914	180	13	4,899	216	15	5,885	252	9	6,870	288	– 13	7,855
145	19	3,941	181	11	4,927	217	13	5,912	253	0	6,897	289	– 20	7,883
146	23	3,969	182	7	4,954	218	9	5,939	254	– 8	6,925	290	– 24	7,910
147	23	3,996	183	3	4,981	219	4	5,967	255	– 16	6,952	291	– 25	7,937
148	20	4,023	184	– 1	5,009	220	– 1	5,994	256	– 22	6,979	292	– 22	7,965
149	14	4,051	185	– 5	5,036	221	– 7	6,022	257	– 25	7,007	293	– 17	7,992
150	6	4,078	186	– 9	5,064	222	– 11	6,049	258	– 24	7,034	294	– 9	8,020
151	– 2	4,106	187	– 11	5,091	223	– 15	6,076	259	– 20	7,062	295	– 1	8,047
152	– 11	4,133	188	– 12	5,118	224	– 16	6,104	260	– 13	7,089	296	7	8,074
153	– 17	4,160	189	– 12	5,146	225	– 16	6,131	261	– 4	7,116	297	14	8,102
154	– 21	4,188	190	– 10	5,173	226	– 12	6,158	262	5	7,144	298	20	8,129
155	– 22	4,215	191	– 6	5,200	227	– 7	6,186	263	14	7,171	299	22	8,156
156	– 20	4,242	192	– 2	5,228	228	– 1	6,213	264	24	7,198	300	22	8,184
157	– 14	4,270	193	1	5,255	229	4	6,240	265	25	7,226	301	19	8,211
158	– 7	4,297	194	5	5,283	230	10	6,268	266	26	7,253	302	13	8,239
159	0	4,325	195	9	5,310	231	16	6,295	267	23	7,281	303	6	8,266
160	8	4,352	196	11	5,337	232	17	6,323	268	17	7,308	304	– 1	8,293
161	14	4,379	197	13	5,365	233	17	6,350	269	8	7,335	305	– 9	8,321
162	18	4,407	198	12	5,392	234	14	6,377	270	– 1	7,363	306	– 15	8,348
163	19	4,434	199	11	5,419	235	9	6,405	271	– 11	7,390	307	– 19	8,375
164	17	4,461	200	7	5,447	236	3	6,432	272	– 20	7,417	308	– 20	8,403
165	13	4,489	201	3	5,474	237	– 3	6,459	273	– 26	7,445	309	– 19	8,430
166	7	4,516	202	– 0	5,501	238	– 10	6,487	274	– 27	7,472	310	– 14	8,457
167	0	4,543	203	– 5	5,529	239	– 15	6,514	275	– 25	7,500	311	– 8	8,485
168	– 6	4,571	204	– 9	5,556	240	– 19	6,542	276	– 19	7,527	312	– 0	8,512
169	– 11	4,598	205	– 12	5,584	241	– 19	6,569	277	– 11	7,554	313	6	8,540
170	– 14	4,626	206	– 14	5,611	242	– 17	6,596	278	– 1	7,582	314	12	8,567
171	– 16	4,653	207	– 14	5,638	243	– 12	6,624	279	9	7,609	315	16	8,594
172	– 14	4,680	208	– 12	5,666	244	– 6	6,651	280	18	7,636	316	18	8,622
173	– 11	4,708	209	– 9	5,693	245	1	6,678	281	24	7,664	317	16	8,649
174	– 6	4,735	210	– 4	5,720	246	9	6,706	282	27	7,691	318	12	8,676

▼B

PS No	a mm	t s	PS No	a mm	t s	PS No	a mm	t s	PS No	a mm	t s	PS No	a mm	t s
319	6	8,704	355	– 18	9,689	391	– 5	10,674	427	8	11,660	463	13	12,645
320	0	8,731	356	– 16	9,717	392	– 0	10,702	428	7	11,687	464	12	12,673
321	– 7	8,759	357	– 12	9,744	393	3	10,729	429	5	11,715	465	10	12,700
322	– 12	8,786	358	– 7	9,771	394	7	10,757	430	2	11,742	466	7	12,727
323	– 15	8,813	359	– 1	9,799	395	9	10,784	431	– 0	11,769	467	2	12,755
324	– 16	8,841	360	4	9,826	396	9	10,811	432	– 2	11,797	468	– 2	12,782
325	– 13	8,868	361	9	9,853	397	8	10,839	433	– 4	11,824	469	– 6	12,809
326	– 8	8,895	362	13	9,881	398	5	10,866	434	– 6	11,851	470	– 9	12,837
327	– 1	8,923	363	16	9,908	399	1	10,893	435	– 7	11,879	471	– 10	12,864
328	5	8,950	364	15	9,935	400	– 2	10,921	436	– 6	11,906	472	– 10	12,891
329	11	8,978	365	14	9,963	401	– 6	10,949	437	– 6	11,934	473	– 8	12,915
330	15	9,005	366	10	9,990	402	– 7	10,975	438	– 4	11,961	474	– 5	12,946
331	17	9,032	367	5	10,018	403	– 8	11,003	439	– 3	11,988	475	– 2	12,974
332	15	9,060	368	– 0	10,045	404	– 7	11,030	440	– 1	12,016	476	1	13,001
333	11	9,087	369	– 5	10,072	405	– 5	11,058	441	0	12,043	477	3	13,028
334	5	9,114	370	– 10	10,100	406	– 2	11,085	442	2	12,070	478	6	13,056
335	– 2	9,142	371	– 13	10,127	407	0	11,112	443	4	12,098	479	6	13,083
336	– 9	9,169	372	– 15	10,154	408	4	11,140	444	6	12,125	480	5	13,110
337	– 15	9,196	372	– 14	10,182	409	6	11,167	445	7	12,152	481	4	13,138
338	– 18	9,224	374	– 12	10,209	410	7	11,195	446	7	12,180	482	2	13,165
339	– 19	9,261	375	– 7	10,237	411	7	11,222	447	7	12,207	483	0	13,193
340	– 16	9,279	376	– 2	10,264	412	6	11,249	448	6	12,235	484	– 0	13,220
341	– 11	9,306	377	2	10,291	413	4	11,277	449	4	12,262	485	– 1	13,247
342	– 3	9,333	378	8	10,319	414	1	11,304	450	1	12,289	486	– 2	13,275
343	4	9,361	379	11	10,346	415	– 1	11,331	451	– 1	12,317	487	– 2	13,302
344	11	9,388	380	13	10,373	416	– 4	11,359	452	– 5	12,344	488	– 1	13,329
345	16	9,415	381	13	10,401	417	– 7	11,386	453	– 8	12,371	489	– 1	13,357
346	19	9,443	382	11	10,428	418	– 8	11,413	454	– 10	12,399	490	– 0	13,384
347	19	9,470	383	7	10,456	419	– 8	11,441	455	– 11	12,426	491	0	13,412
348	16	9,498	384	2	10,483	420	– 6	11,468	456	– 11	12,454	492	1	13,439
349	11	9,525	385	– 2	10,510	421	– 4	11,496	457	– 9	12,481	493	1	13,466
350	4	9,552	386	– 7	10,538	422	– 1	11,523	458	– 5	12,509	494	1	13,494
351	– 2	9,580	387	– 10	10,565	423	1	11,550	459	– 1	12,536	495	0	13,521
352	– 9	9,607	388	– 11	10,592	424	4	11,578	460	3	12,563	496	0	13,548
353	– 14	9,634	389	– 11	10,620	425	7	11,605	461	8	12,590	497	– 0	13,576
354	– 17	9,662	390	– 8	10,647	426	8	11,632	462	11	12,618	498	– 1	13,603

▼B

PS No	a mm	t s	PS No	a mm	t s	PS No	a mm	t s	PS No	a mm	t s	PS No	a mm	t s
499	– 1	13,630	535	4	14,616	571	8	15,601	607	– 12	16,587	643	– 5	17,572
500	– 1	13,659	536	3	14,643	572	1	15,629	608	– 15	16,614	644	– 6	17,599
501	– 1	13,685	537	2	14,671	573	– 6	15,656	609	– 16	16,641	645	– 6	17,627
502	– 1	13,713	538	1	14,698	574	– 12	15,683	610	– 16	16,669	646	– 6	17,654
503	– 1	13,740	539	– 0	14,725	575	– 17	15,711	611	– 13	16,696	647	– 4	17,681
504	– 0	13,767	540	– 2	14,753	576	– 19	15,738	612	– 8	16,728	648	– 3	17,709
505	– 0	13,795	541	– 5	14,780	577	– 19	15,766	613	– 3	16,741	649	– 1	17,736
506	0	13,822	542	– 7	14,807	578	– 15	15,793	614	2	16,776	650	– 0	17,763
507	1	13,849	543	– 8	14,835	579	– 10	15,820	615	8	16,803	651	0	17,791
508	1	13,877	544	– 8	14,862	580	– 8	15,848	616	12	16,833	652	1	17,818
509	2	13,904	545	– 7	14,890	581	4	15,875	617	15	16,860	653	0	17,845
510	2	13,932	546	– 5	14,917	582	11	15,902	618	16	16,888	654	0	17,873
511	2	13,959	547	– 1	14,944	583	16	15,930	619	15	16,915	655	0	17,900
512	2	13,986	548	1	14,972	584	18	15,957	620	12	16,942	656	– 0	17,928
513	1	14,014	549	6	14,999	585	18	15,984	621	8	16,970	657	– 0	17,955
514	1	14,041	550	9	15,026	586	15	16,012	622	2	16,997	658	– 0	17,982
515	0	14,068	551	12	15,054	587	10	16,039	623	– 2	17,024	659	0	18,010
516	– 0	14,096	552	13	15,081	588	3	16,066	624	– 8	17,052	660	1	18,037
517	– 1	14,123	553	11	15,109	589	– 3	16,094	625	– 12	17,079	661	3	18,065
518	– 1	14,151	554	9	15,136	590	– 10	16,121	626	– 14	17,107	662	4	18,092
519	– 2	14,178	555	4	15,163	591	– 15	16,149	627	– 15	17,134	663	5	18,119
520	– 2	14,205	556	– 0	15,191	592	– 17	16,176	628	– 14	17,161	664	5	18,147
521	– 2	14,233	557	– 6	15,218	593	– 17	16,203	629	– 11	17,189	665	5	18,174
522	– 2	14,260	558	– 11	15,245	594	– 15	15,231	630	– 7	17,216	666	4	18,201
523	– 1	14,287	559	– 15	15,273	595	– 10	16,258	631	– 2	17,243	667	2	18,229
524	– 1	14,316	560	– 16	15,300	596	– 3	16,285	632	1	17,271	668	– 0	18,256
525	– 1	14,342	561	– 15	15,327	597	2	16,313	633	6	17,298	669	– 3	18,283
526	– 0	14,370	562	– 12	15,356	598	9	16,340	634	9	17,326	670	– 6	18,311
527	– 0	14,397	563	– 6	15,382	599	14	16,368	635	11	17,353	671	– 9	18,339
528	0	14,424	564	– 0	15,410	600	16	16,395	636	12	17,380	672	– 10	18,366
529	0	14,452	565	6	15,437	601	17	16,422	637	11	17,408	673	– 10	18,393
530	1	14,479	566	12	15,464	602	14	16,450	638	9	17,435	674	– 9	18,420
531	2	14,506	567	17	15,492	603	10	16,477	639	6	17,462	675	– 6	18,448
532	2	14,534	568	19	15,519	604	5	16,504	640	2	17,490	676	– 3	18,475
533	3	14,561	569	18	15,546	605	– 1	16,532	641	– 0	17,517	677	1	18,502
534	4	14,598	570	14	15,574	606	– 7	16,559	642	– 3	17,544	678	6	18,530

▼B

PS No	a mm	t s	PS No	a mm	t s	PS No	a mm	t s	PS No	a mm	t s	PS No	a mm	t s
679	10	18,557	715	– 6	19,543	751	– 9	20,526	787	1	21,513	824	6	22,526
680	12	18,585	716	– 7	19,570	752	– 7	20,556	788	4	21,541	825	5	22,553
681	14	18,612	717	– 7	19,597	753	– 4	20,583	789	6	21,568	826	3	22,581
682	13	18,639	718	– 5	19,625	754	– 1	20,610	790	7	21,595	827	0	22,608
683	10	18,667	719	– 3	19,652	755	2	20,637	791	7	21,623	828	– 2	22,635
684	6	18,694	720	0	19,679	756	5	20,665	792	7	21,650	829	– 4	22,663
685	1	18,721	721	3	19,707	757	7	20,692	793	5	21,677	830	– 7	22,690
686	– 3	18,749	722	7	19,734	758	8	20,719	794	3	21,705	831	– 8	22,717
687	– 6	18,776	723	9	19,761	759	7	20,747	795	0	21,732	832	– 9	22,745
688	– 11	18,804	724	11	19,789	760	5	20,774	796	– 1	21,760	833	– 8	22,772
689	– 13	18,831	725	11	19,816	761	2	20,802	797	– 4	21,787	834	– 7	22,800
690	– 13	18,858	726	10	19,844	762	– 1	20,829	798	– 5	21,814	835	– 4	22,827
691	– 10	18,886	727	7	19,871	763	– 4	20,856	799	– 6	21,842	836	– 1	22,854
692	– 7	18,913	728	3	19,898	764	– 7	20,884	800	– 5	21,869	837	2	22,882
693	– 3	18,940	729	– 0	19,926	765	– 9	20,911	801	– 4	21,896	838	6	22,909
694	1	18,968	730	– 4	19,953	766	– 9	20,938	802	– 2	21,924	839	9	22,936
695	4	18,996	731	– 8	19,980	767	– 7	20,966	803	– 0	21,951	840	11	22,964
696	7	19,022	732	– 11	20,008	768	– 5	20,993	804	2	21,978	841	12	22,991
697	8	19,050	733	– 12	20,035	769	– 1	21,021	805	4	22,006	842	11	23,019
698	8	19,077	734	– 12	20,063	770	2	21,048	806	5	22,033	843	9	23,046
699	6	19,105	735	– 10	20,090	771	5	21,075	807	5	22,061	844	5	23,073
700	4	19,132	736	– 7	20,117	772	8	21,103	808	4	22,088	845	0	23,101
701	1	19,159	737	– 3	20,145	773	10	21,130	809	3	22,115	846	– 5	23,128
702	– 0	19,187	738	0	20,172	774	10	21,157	810	0	22,143	847	– 9	23,155
703	– 2	19,214	739	5	20,199	775	8	21,185	811	– 1	22,170	848	– 13	23,183
704	– 2	19,241	740	8	20,227	776	6	21,212	812	– 3	22,197	849	– 15	23,210
705	– 2	19,269	741	11	20,254	777	2	21,239	813	– 5	22,225	850	– 15	23,238
706	– 1	19,296	742	12	20,282	778	– 1	21,267	814	– 6	22,252	851	– 13	23,265
707	0	19,324	743	11	20,309	779	– 4	21,294	815	– 5	22,280	852	– 9	23,292
708	1	19,351	744	9	20,336	780	– 7	21,322	816	– 4	22,307	853	– 3	23,320
709	2	19,978	745	6	20,354	781	– 9	21,349	817	– 3	22,334	854	3	23,347
710	2	19,406	746	1	20,391	782	– 9	21,376	818	– 0	22,362	855	9	23,374
711	1	19,433	747	– 2	20,418	783	– 8	21,404	819	1	22,389	856	14	23,402
712	– 0	19,460	748	– 6	20,446	784	– 7	21,431	820	4	22,416	857	18	23,429
713	– 2	19,488	749	– 9	20,473	785	– 4	21,458	821	5	22,444	858	18	23,457
714	– 5	19,515	750	– 10	20,500	786	– 1	21,486	822	6	22,471	859	16	23,484

▼B

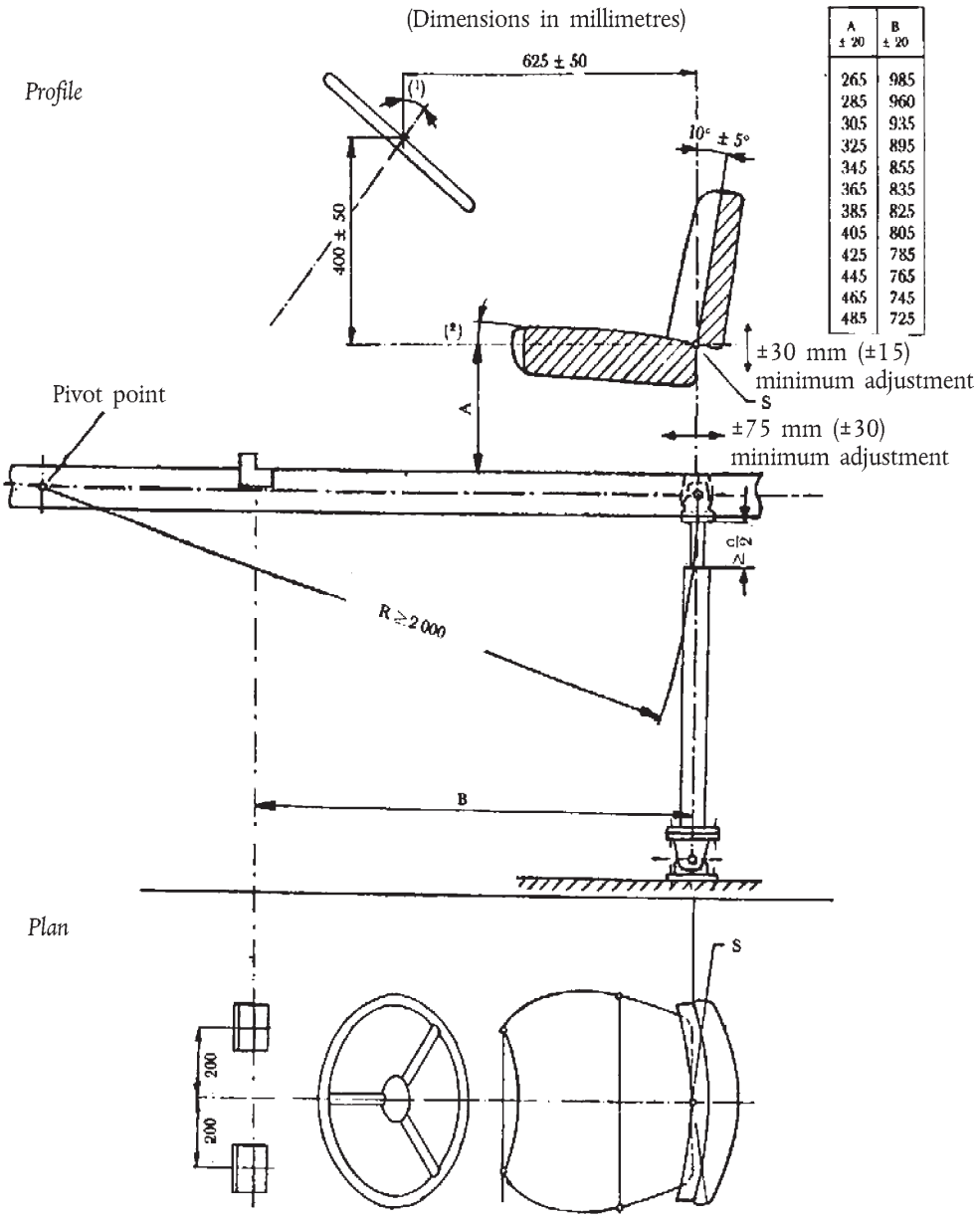
PS No	a mm	t s	PS No	a mm	t s	PS No	a mm	t s	PS No	a mm	t s	PS No	a mm	t s
860	12	23,511	893	6	24,414	926	– 0	25,318	959	6	26,221	992	2	27,124
861	5	23,539	894	3	24,442	927	– 5	25,345	960	4	26,248	993	6	27,152
862	– 1	23,566	895	– 0	24,469	928	– 9	25,372	961	2	26,276	994	10	27,179
863	– 7	23,593	896	– 3	24,497	929	– 12	25,400	962	0	26,303	995	12	27,206
864	– 13	23,621	897	– 6	24,524	930	– 13	25,427	963	– 2	26,330	996	14	27,234
865	– 16	23,648	898	– 8	24,551	931	– 12	25,455	964	– 4	26,358	997	13	27,261
866	– 17	23,675	899	– 9	24,579	932	– 9	25,482	965	– 5	26,385	998	11	27,288
867	– 16	23,703	900	– 8	24,606	933	– 5	25,509	966	– 6	26,413	999	8	27,316
868	– 12	23,730	901	– 6	24,633	934	– 0	25,537	967	– 7	26,440	1000	3	27,343
869	– 7	23,758	902	– 2	24,661	935	4	25,564	968	– 7	26,467	1001	– 0	27,370
870	– 1	23,785	903	0	24,688	936	8	25,591	969	– 7	26,495	1002	– 5	27,399
871	4	23,812	904	4	24,716	937	11	25,619	970	– 6	26,522	1003	– 9	27,426
872	9	23,840	905	7	24,743	938	13	25,645	971	– 4	26,549	1004	– 12	27,453
873	12	23,867	906	8	24,770	939	13	25,674	972	– 2	26,577	1005	– 13	27,480
874	14	23,894	907	9	24,798	940	11	25,701	973	0	26,604	1006	– 13	27,507
875	13	23,922	908	7	24,825	941	7	25,728	974	3	26,631	1007	– 11	27,535
876	11	23,949	909	5	24,852	942	3	25,756	975	6	26,659	1008	– 7	27,562
877	7	23,977	910	1	24,880	943	– 1	25,783	976	9	26,686	1009	– 2	27,589
878	2	24,004	911	– 2	24,907	944	– 5	25,810	977	10	26,714	1010	1	27,617
879	– 1	24,031	912	– 6	24,935	945	– 8	25,839	978	11	26,741	1011	6	27,644
880	– 6	24,059	913	– 8	24,962	946	– 10	25,855	979	10	26,768	1012	9	27,672
881	– 9	24,086	914	– 10	24,989	947	– 11	25,892	980	8	26,796	1013	11	27,699
882	– 11	24,113	915	– 9	25,017	948	– 10	25,920	981	5	26,823	1014	12	27,726
883	– 11	24,141	916	– 7	25,044	949	– 8	25,947	982	1	26,850	1015	10	27,754
884	– 9	24,168	917	– 3	25,071	950	– 6	25,975	983	– 3	26,878	1016	8	27,781
885	– 6	24,196	918	0	25,099	951	– 2	26,002	984	– 7	26,905	1017	4	27,808
886	– 3	24,223	919	4	25,126	952	0	26,029	985	– 10	26,933	1018	0	27,836
887	0	24,250	920	8	25,153	953	3	26,057	986	– 12	26,960	1019	– 3	27,863
888	4	24,278	921	11	25,181	954	5	26,084	987	– 13	26,987	1020	– 6	27,891
889	7	24,305	922	12	25,208	955	7	26,111	988	– 12	27,015	1021	– 8	27,918
890	9	24,332	923	11	25,236	956	8	26,139	989	– 10	27,042	1022	– 9	27,945
891	9	24,360	924	9	25,263	957	8	26,166	990	– 6	27,069	1023	– 8	27,973
892	8	24,387	925	4	25,290	958	7	26,194	991	– 2	27,097	1024	0	28,000

▼B

Appendix 5

Test stand (point 3.5.3.1); example of construction

(dimensions in mm)



A ± 20	B ± 20
265	985
285	960
305	935
325	895
345	855
365	835
385	825
405	805
425	785
445	765
465	745
485	725

(1) The angle of the steering column in relation to the vertical depends on the position of the seat, the diameter of the steering wheel.

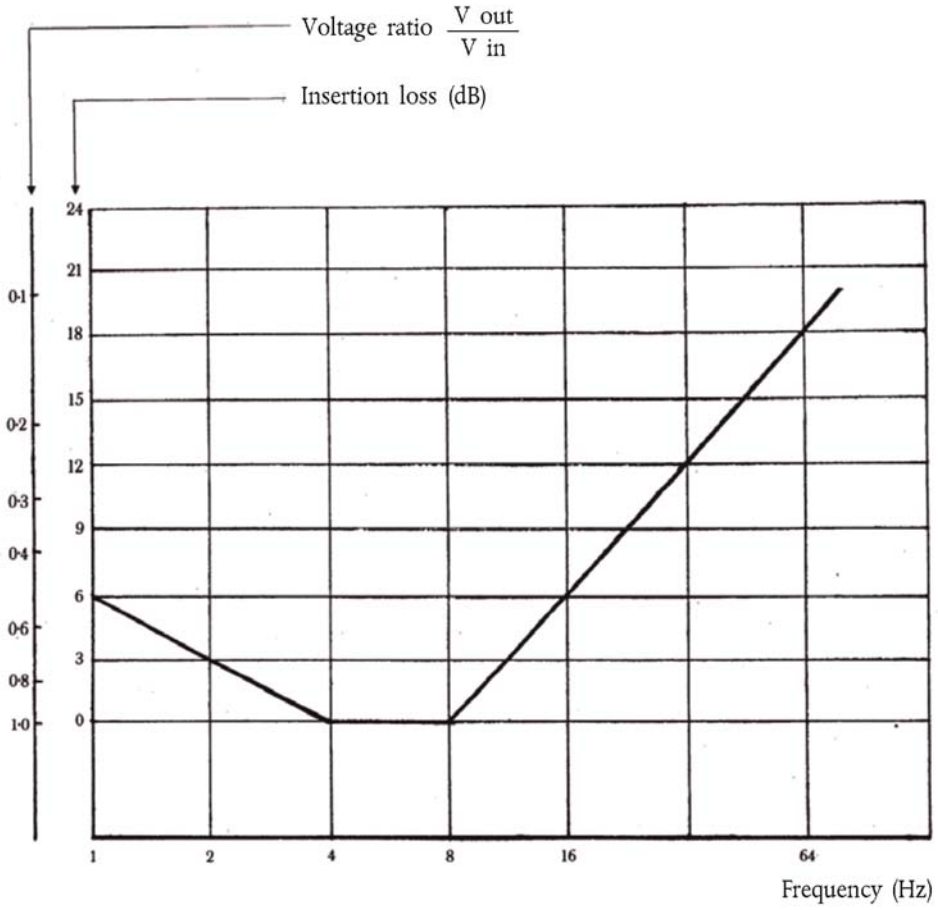
►(1) (2) The rearward inclination of the surface of the fitted seat cushion must be 3° to 12° in relation to the horizontal when measured with the loading device in accordance with Appendix 8. The choice of the angle of inclination within this class depends on the position when seated. ◄

►(1) M1

▼B

Appendix 6

Characteristic of the filter of the vibration measuring instrument (point 3.5.3.3.5)



▼B

Appendix 7

Driver's seat installation requirements for EU type-approval of a tractor

1. Every driver's seat with suspension system must bear the EU component type-approval mark and comply with the following installation requirements:

1.1. the driver's seat must be installed in such a way that:

1.1.1. the driver is assured of a comfortable position for driving and manoeuvring the tractor;

1.1.2. the seat is easily accessible;

1.1.3. the driver, when seated in the normal driving position, can easily reach the various control devices of the tractor that are likely to be actuated during operation;

1.1.4. no part of any of the seat or tractor components is likely to cause the driver to suffer cuts or bruises;

1.1.5. where the position of the seat is adjustable only lengthwise and vertically, the longitudinal axis passing through the Seat Reference Point (S) shall be parallel with the vertical longitudinal plane of the tractor passing through the centre of the steering wheel and not more than 100 mm from that plane.

1.1.6. where the seat is designed to revolve round a vertical axis it must be capable of being locked in all or certain positions and in any case in the position mentioned in point 1.1.5.

2. The holder of the EU type-approval may request that it be extended to other types of seat. The competent authorities must grant this extension on the following conditions:

2.1. the new type of seat has received EU component type-approval;

2.2. it has been designed to be installed on the type of tractor for which the extension of the EU type-approval has been requested;

2.3. it is installed in such a manner as to comply with the installation requirements in this Annex.

3. Seats intended for tractors with a minimum rear-wheel track of not more than 1 150 mm may have the following minimum dimensions in respect of the depth and width of the seat surface:

— depth of seat surface: 300 mm;

— width of seat surface: 400 mm.

This provision is applicable only if the values specified for the depth and the width of the seat surface (i.e. 400 ± 50 mm and at least 450 mm respectively) cannot be adhered to on grounds relating to the tractor.

▼B

Appendix 8

Method for determining the seat reference point (S)

1. **Device for determining the seat reference point (S)**

The device illustrated in Figure 1 consists of a seat pan board and backrest boards. The lower backrest boards must be hinged in the region of the ischium humps (A) and the loin (B), the hinge (B) being adjustable in height.

2. **Method of determining the seat reference point (S)**

The seat reference point (S) must be obtained by using the device illustrated in Figures 1 and 2, which simulates loading by a human occupant. The device must be positioned on the seat. It must then be loaded with a force of 550 N at a point 50 mm in front of hinge (A) and two parts of the backrest lightly pressed tangentially against the padded backrest.

If it is not possible to determine definite tangents to each area of the padded backrest (below and above the lumbar region) the following procedure must be adopted:

(a) where there is no possibility of defining the tangent to the lowest possible area, the lower part of the backrest board in a vertical position must be lightly pressed against the padded backrest;

(b) where there is no possibility of defining the tangent to the highest possible area, if the lower part of the backrest board is vertical, the hinge must be fixed at a height of 230 mm above the seat reference point (S). The two parts of the backrest board in a vertical position must then be lightly pressed tangentially against the padded backrest.

▼M1

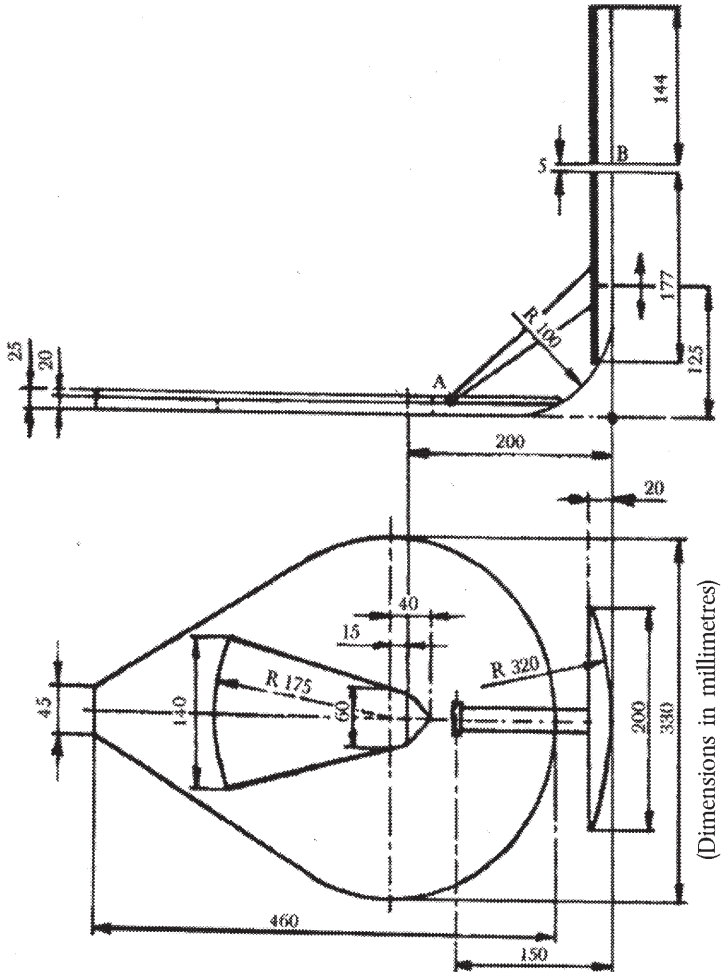
2.1. Positioning of the seat

For the purposes of Annex XV, the seat reference point (S) shall be obtained with the seat set in the rearmost longitudinal position and at the mid-point of the height adjustment range. Seats having a suspension system, whether or not adjustable according to the driver's weight, must be set at the mid-point of the suspension travel.

▼B

Figure 1

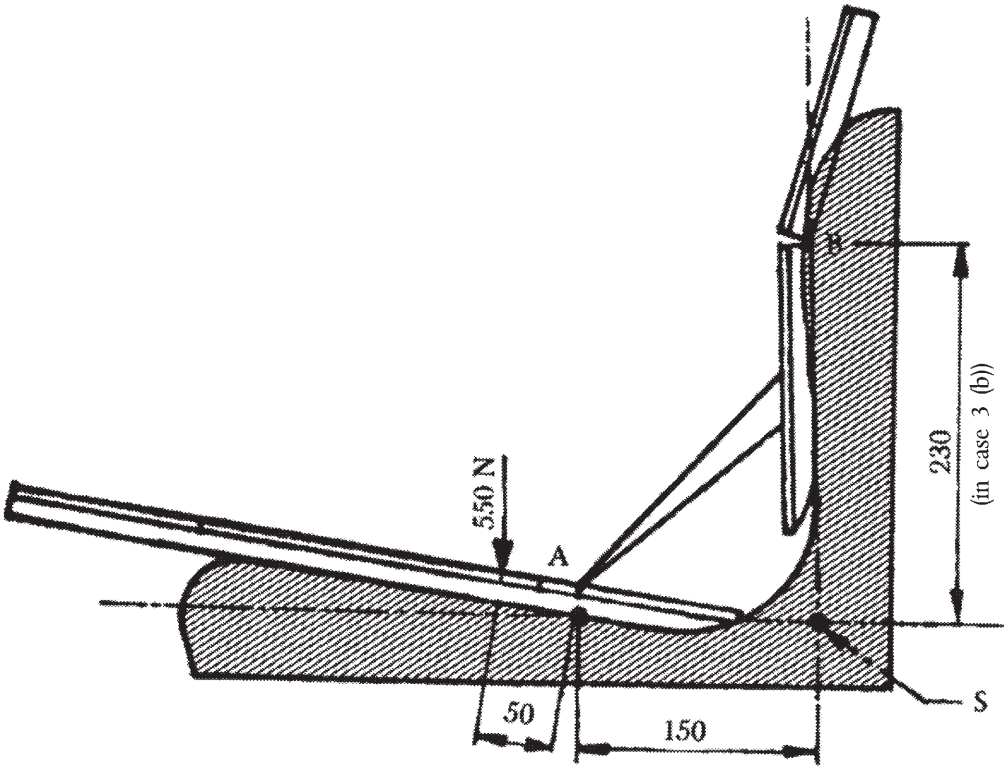
Device for determining the seat reference point (S)



▼B

Figure 2

Device in position



▼B

ANNEX XV

Requirements applying to operating space and to access to the driving position

1. **Definition**

For the purposes of this Annex 'reference plane' means the plane parallel to the median longitudinal plane of the tractor passing through the Seat Reference Point (S).

2. **Operating space**

2.1. For all tractors, with the exception of those that fall within categories T2/C2, T4.1/C4.1 and T4.3/C4.3 and those where the driver's Seat Reference Point (S) is more than 300 mm from the median longitudinal plane of the tractor, the width of the operating space must be at least 900 mm, from 400 to 900 mm above the seat reference point (S) and over a length of 450 mm forward of that point (see Figures 1 and 3).

For tractors of categories T2/C2 and T4.1/C4.1, the operating space must comply with the minimum dimensions of Figure 7.

For tractors of category T4.3/C4.3 and those where the driver's Seat Reference Point (S) is more than 300 mm from the median longitudinal plane of the tractor, the operating space must, over the zone extending to 450 mm in front of the seat reference point (S), have at a height of 400 mm above the seat reference point (S), a total width of at least 700 mm, and at a height of 900 mm above the seat reference point (S), a total width of at least 600 mm.

2.2. Vehicle parts and accessories must not hamper the driver when driving the tractor.

2.3. For all positions of the steering column and the steering wheel, with the exception of those intended solely for entry and exit, the clearance between the base of the steering wheel and the fixed parts of the tractor must be at least 50 mm, except for tractors of categories T2/C2 and T4.1/C4.1 for which must be at least 30 mm; in all other directions this clearance must be at least 80 mm from the rim of the steering wheel, as measured from outside the area occupied by the steering wheel (see Figure 2), except for tractors of categories T2/C2 and T4.1/C4.1 for which must be at least 50 mm,.

2.4. For all tractors, except those of categories T2/C2 and T4.1/C4.1, the rear wall of the cab from 300 to 900 mm above the Seat Reference Point (S) must be a minimum of 150 mm behind a vertical plane which is perpendicular to the reference plane and passes through the reference point (see Figures 2 and 3).

2.4.1. This wall must have a width of at least 300 mm on either side of the seat reference plane (see Figure 3).

2.5. The manual control devices must be located in relation to one another and to the other parts of the tractor so that no danger of injury to the operator's hands arises from their operation.

2.5.1. Hand-operated control devices shall have minimum clearances in accordance with paragraph 4.5.3 of ISO 4254-1:2013. This requirement does not apply to fingertip operation control devices, such as push-buttons or electric switches.

▼B

2.5.2. Alternative locations for the control devices which achieve equally satisfactory safety standards are acceptable.

2.6. For all tractors, except those of categories T2/C2 and T4.1/C4.1, no rigid point on the roof must be less than 1 050 mm from the seat reference point (S) in a section situated forward of a vertical plane passing through the reference point and perpendicular to the reference plane (see Figure 2). The padding may extend downwards to 1 000 mm above the Seat Reference Point (S).

2.6.1. The radius of curvature of the surface between the rear panel of the cab and the roof of the cab may extend up to a maximum of 150 mm.

3. **Access to the driving position (means of entry and exit)**

3.1. It must be possible to use the means of entry and exit without danger. Wheel hubs, hub caps or wheel rims are not acceptable as steps or rungs.

3.2. The points of access to the driving position and to the passenger seat must be free of any parts liable to cause injury. Where an obstruction such as a clutch pedal is present, a step or footrest must be provided to ensure safe access to the driving position.

3.3. Steps, integral foot recesses and rungs.

3.3.1. Steps, integral foot recesses and rungs must have the following dimensions:

depth clearance:	150 mm minimum, (except for tractors of categories T2/C2 and T4.1/C4.1)
width clearance:	250 mm minimum, (Values lower than this minimum width are authorised only where justified as being necessary on technical grounds. Where this is the case, the aim must be to achieve the greatest possible width clearance. It must not, however, be less than 150 mm.)
height clearance:	120 mm minimum,
distance between surface of two steps:	300 mm maximum (see Figure 4).

3.3.2. The upper step or rung must be easily identifiable and accessible for a person leaving the vehicle. The vertical distance between successive steps or rungs must as far as possible be equal.

3.3.3. The lowest foothold must not be more than 550 mm above the ground when the tractor is fitted with the largest tyre size recommended by the manufacturer (see Figure 4).

3.3.4. Steps or rungs must be designed and constructed in such a way that feet will not slip on them (e.g. steel or mesh grilles).

▼B

3.3.5. Alternative requirements for vehicles of category C

3.3.5.1. In the case of step(s) integrated in the track frame (see Figure 5), it can be retracted under an angle of ≤ 15°, if at least the basic dimension of riser height dimension B, and the tread depth F1 according to the Table 1 of EN ISO 2867:2006 is met, measured from the outer edges of the track shoes.

3.3.5.2. In addition, taken into account the limited view during egress, the step width shall be at least as wide as the minimum set out in Table 1 of EN ISO 2867:2006.

3.3.5.3. For vehicles of category C with steel tracks with the access step installed on the frame of the track-rollers, the outer edge of the step does not need to extend beyond the vertical plane formed by the external edge of the track shoes, but shall be as close as practically possible.

3.4. Handrails/handholds

3.4.1. Handrails or handholds shall be provided and designed so that the operator can maintain three-point contact support while accessing or exiting the operator's station. The lower end of the handrail/handhold shall be located no higher than 1 500 mm from the ground surface. A minimum clearance of 30 mm shall be provided for hand clearance between the handrail/handhold and the adjacent parts (except at attaching points).

3.4.2. A handrail or handhold shall be provided above the uppermost step/rung of the boarding means at a height between 850 mm and 1 100 mm. The handhold on tractors shall be at least 110 mm long.

4. **Access to other positions than the driving position**

4.1. It must be possible to use the accesses to other positions (e.g. for adjusting the right mirror or cleaning actions) without danger. Wheel hubs, hub caps or wheel rims are not acceptable as steps or rungs. Handrails or handholds shall be provided and designed so that the operator can maintain three-point contact support at all times.

4.2. Steps, integral foot recesses and rungs must have the following dimensions:

depth clearance:	150 mm minimum,
width clearance:	250 mm minimum, (Values lower than this minimum width are authorised only where justified as being necessary on technical grounds. Where this is the case, the aim must be to achieve the greatest possible width clearance. It must not, however, be less than 150 mm.)

▼M1

height clearance:	125 mm minimum,

▼B

distance between surface of two steps:	300 mm maximum (see Figure 6).

▼B

4.2.1. Such boarding means shall comprise a series of successive steps as shown in Figure 6: each step shall have an anti-slip surface, a lateral boundary on each side and have to be designed so that dirt and snow accumulation in normal working conditions can be largely prevented. ►M1 The vertical and horizontal distance between consecutive steps shall not be less than 150 mm; however, a tolerance of 20 mm between stages is allowed. ◄

5. **Doors and windows**

5.1. The devices operating the doors and windows must be designed and installed in such a way that they neither constitute a danger to the driver nor impede him while driving.

5.2. The opening angle of the door must permit entry and exit without danger.

5.3. The access doors to the cabin must have a minimum width of 250 mm at floor height.

5.4. Ventilation windows, if any, must be easily adjustable.

6. **Emergency exits**

6.1. Number of emergency exits

6.1.1. Single-door cabs must have two extra exits constituting emergency exits.

6.1.2. Two-door cabs must have one extra exit constituting an emergency exit, except for tractors of categories T2/C2 and T4.1/C4.1.

6.2. Each of the exits must be on a different cab wall (the term ‘wall’ may include the roof). Windscreens and side, rear and roof windows may be regarded as emergency exits if provision is made to open them or to move them quickly from inside the cab.

6.3. For all tractors, except those of categories T2/C2 and T4.1/C4.1, emergency exits must have the minimum dimensions required to circumscribe an ellipse with a minor axis of 440 mm and a major axis of 640 mm.

Tractors of categories T2/C2 and T4.1/C4.1 fitted with a cab that do not respect the minimum dimensions of the emergency exits indicated in the previous paragraph shall be provided with at least two doors.

6.4. Any window of sufficient size may be designated as an emergency exit if they are made of breakable glass and can be broken with a tool provided in the cab for that purpose. Glass referred to in Appendices 3, 4, 5, 6, 7, 8 and 9 of Annex I to UNECE Regulation No 43 is considered to be not breakable glass for the purpose of this Annex.

6.5. The surrounds of emergency exits shall not present any danger. When to evacuate the cabin is required to overcome differences in height exceeding 1 000 mm means to facilitate the evacuation shall be provided. For this purpose, when the exit is from the rear side, the supporting points offered by the arms of the three point lifting mechanism or by the PTO guard shall be considered sufficient if they have a resistance to vertical loads of at least 1 200 N.

6.6. Emergency exits must be marked with pictograms containing instructions for the operator in accordance with Annex XXVI.

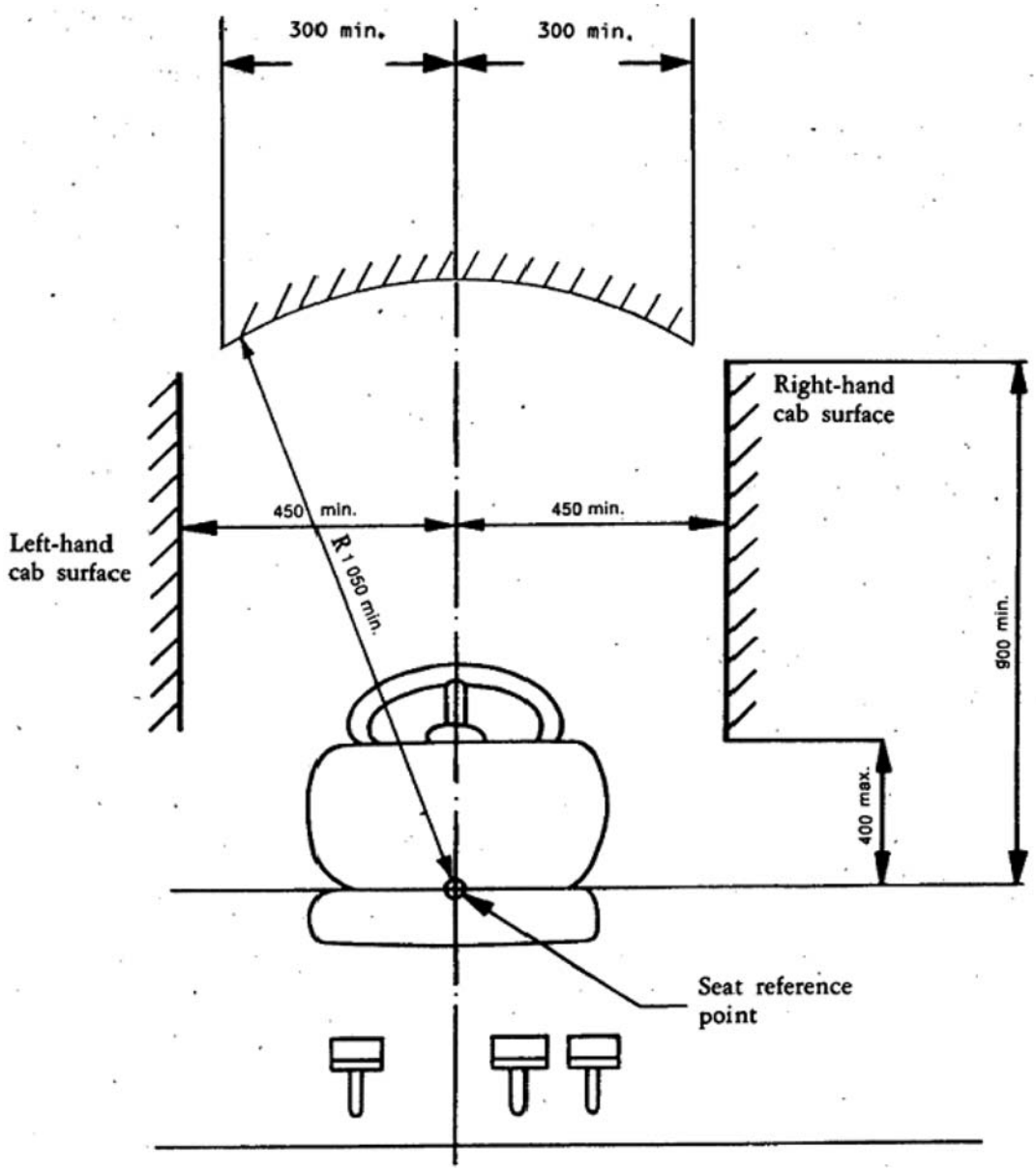
▼B

Appendix 1

Figures

Figure 1

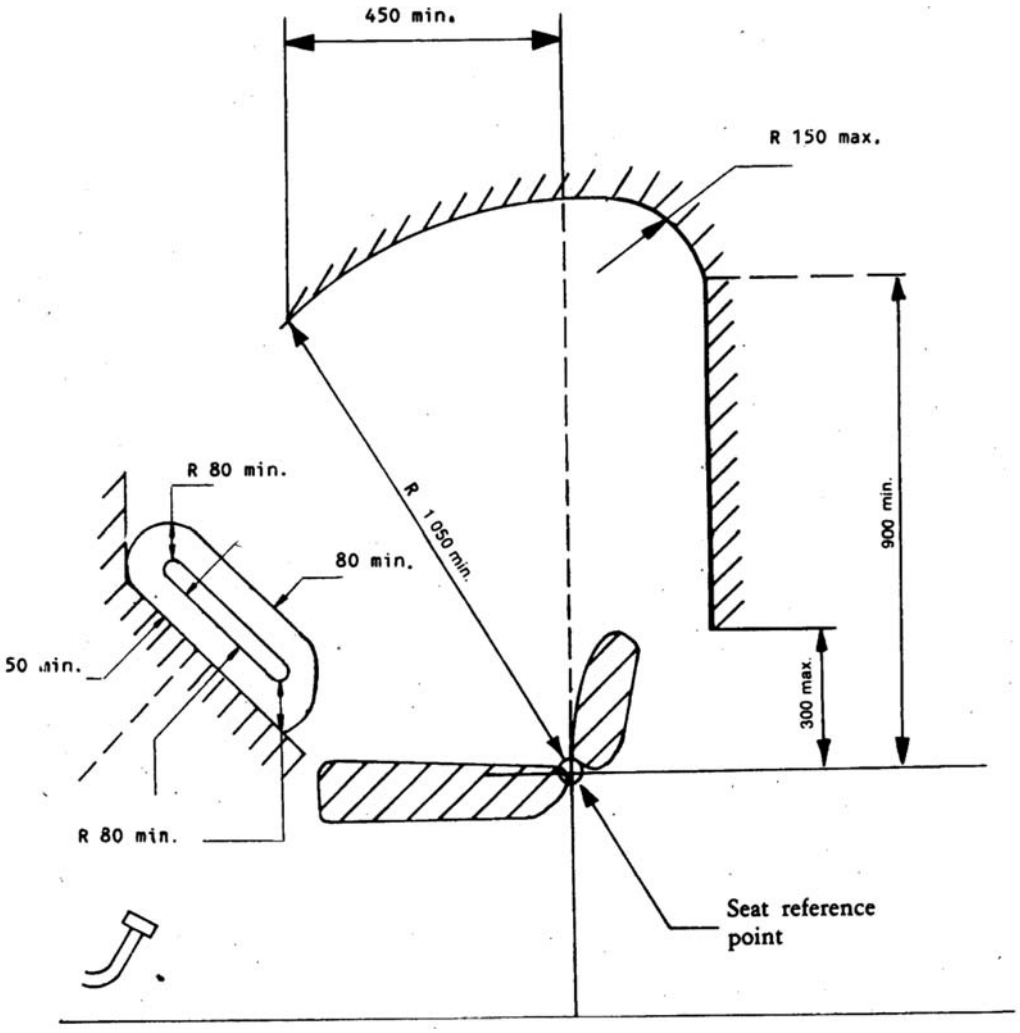
(Dimensions in millimetres)



▼B

Figure 2

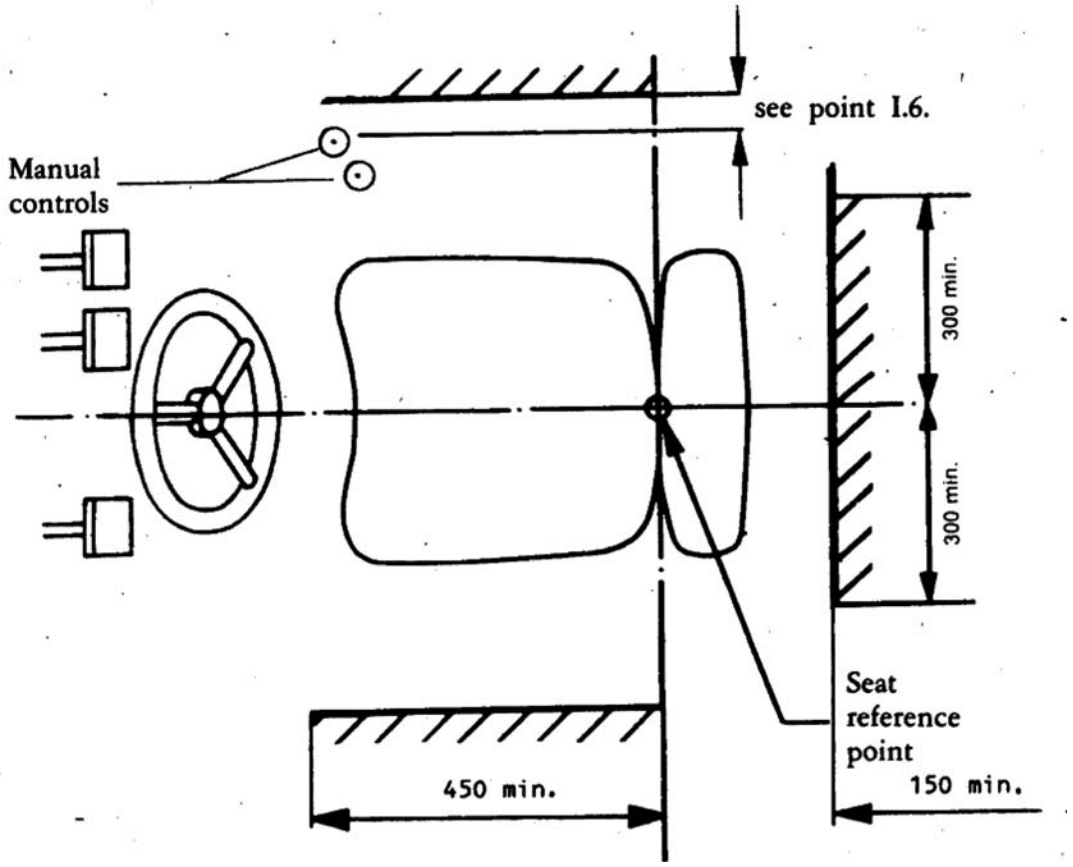
(Dimensions in millimetres)



▼B

Figure 3

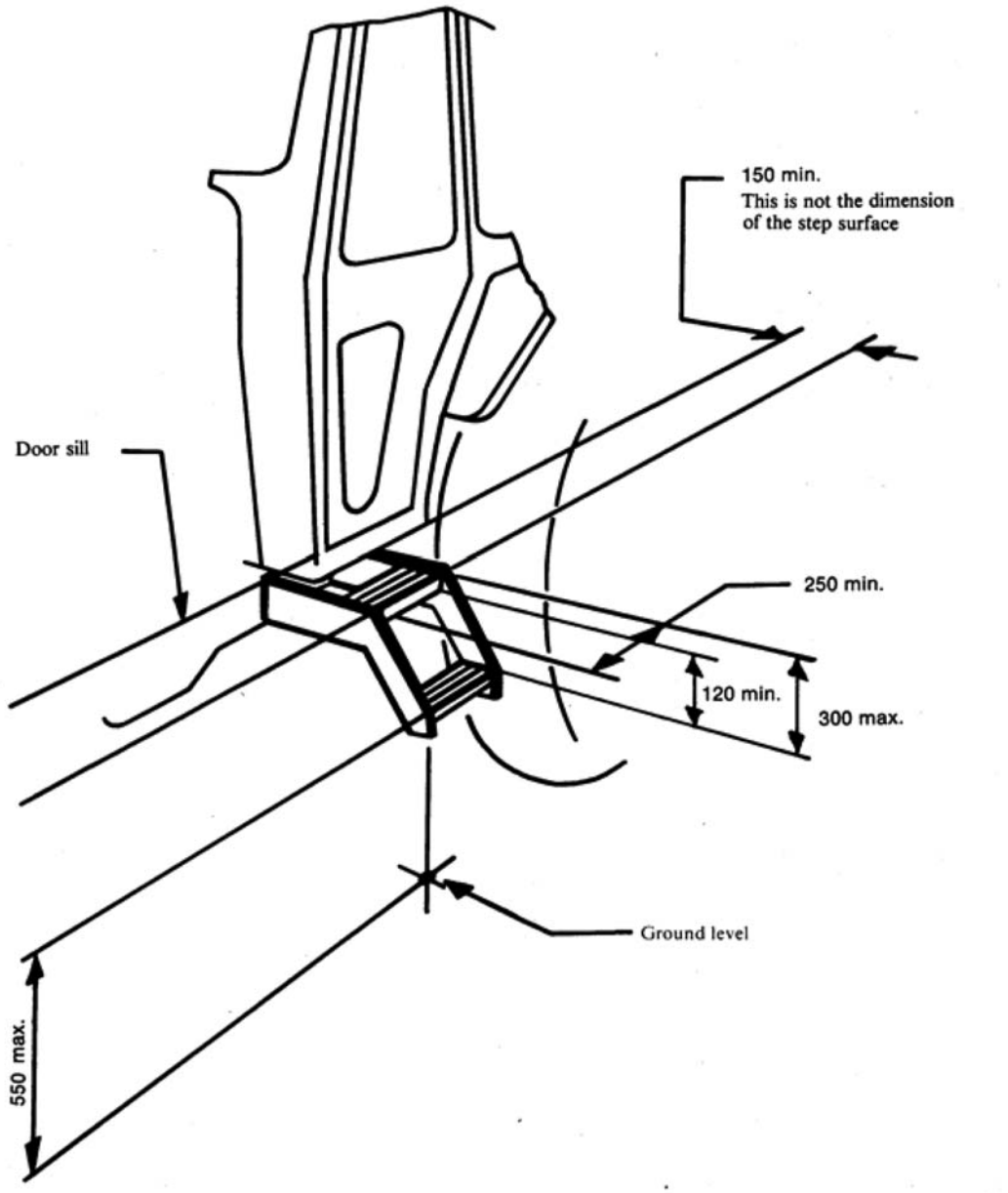
(Dimensions in millimetres)



▼B

Figure 4

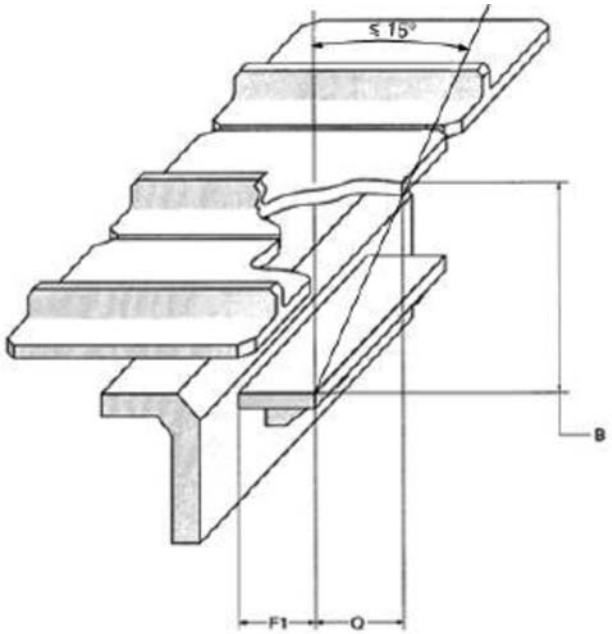
(Dimensions in mm)



▼B

Figure 5

Dimensions of access step integrated in the track frame of track-laid tractors (source: EN ISO 2867:2006)



$B \leq 400$ mm

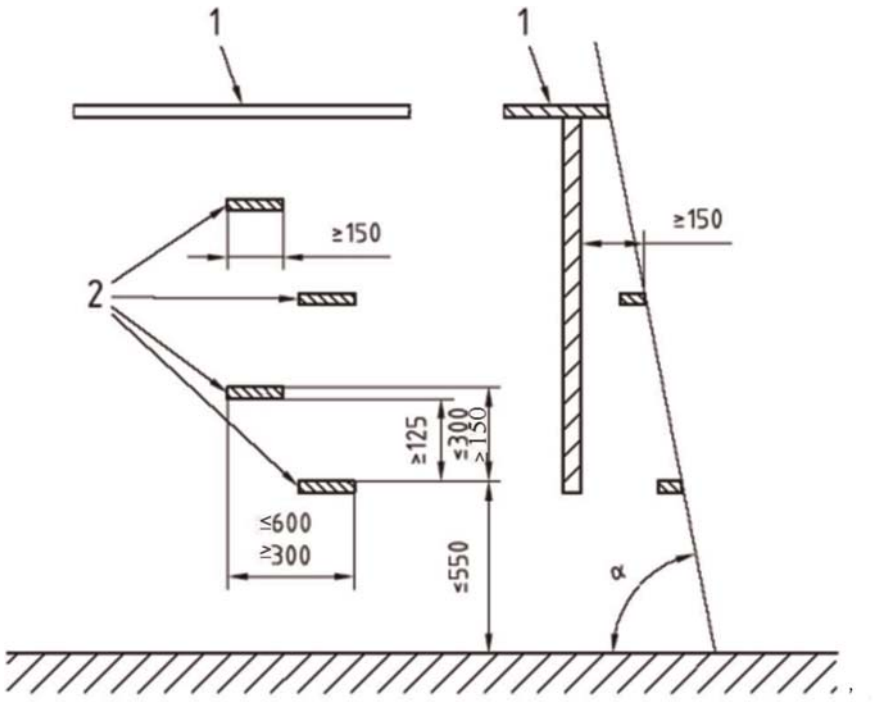
$F1 \geq 130$ mm

Q maximum retraction of a step

▼M1

Figure 6

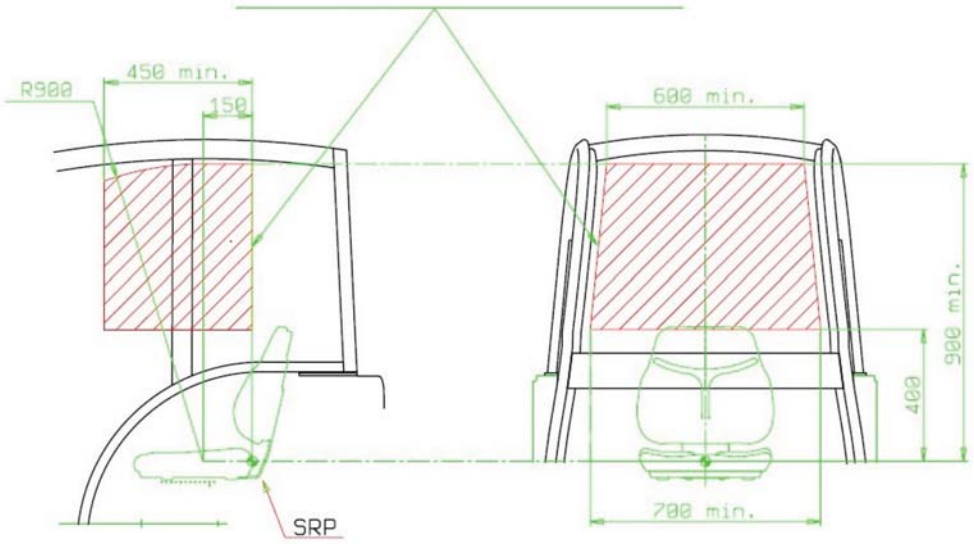
(Source:EN ISO 4254-1 No. 4.7)



▼B

Figure 7

Minimum dimensions of the operating space in tractors of categories T2/C2 and T4.1/C4.1



▼B

ANNEX XVI

Requirements applying to power take-offs

1. **Requirements for rear power take-offs**

The specifications of ISO 500-1:2014 and ISO 500-2:2004 apply to tractors with rear power take-offs according to Table 1.

Table 1

Application of standards for rear power take-offs of the different tractor categories

Standard applicable	T1 C1	T2 C2	T3 C3	T4.1 C4.1	T4.2 C4.2	T4.3 C4.3
▼M1 ISO 500-1:2014 (*)	X	- -	$X_{(1)}$	$X_{(1)}$	$X_{(1)}$	X
▼B ISO 500-2:2004 (**)	- -	X	$X_{(2)}$	$X_{(2)}$	- -	- -

X Standard applicable.
- - Standard not applicable.
$X_{(1)}$ Standard applicable for tractors with a track width of more than 1 150 mm.
$X_{(2)}$ Standard applicable for tractors with a track width of 1 150 mm or less.
(*) In the standard ISO 500-1:2014, the last sentence in section 6.2 is not applicable.
(**) For the purposes of this Annex, this standard also applies to tractors with a power take-off, the power of which exceeds 20 kW, measured in accordance with ISO 789-1:1990

►M1 ——————— ◄

2. **Requirements for front power take-offs**

The specifications of ISO 8759-1:1998, with the exception of its clause 4.2, apply to tractors of all T and C categories which are equipped with front power take-offs as specified in this standard.

▼B

ANNEX XVII

Requirements applying to the protection of drive components

1. **Definitions**

For the purposes of this Annex the following definitions shall apply:

1.1. ‘Dangerous part’ means any point which, owing to the arrangements or design of the fixed or movable part of a tractor, involves a risk of injury. The dangerous parts are, in particular, pinching, shearing, cutting, piercing, penetrating, snatching and attack points.

1.1.1. ‘Pinching point’ means any dangerous point where parts move in relation to each other or to fixed parts in such a way as may cause persons or certain parts of their bodies to be pinched.

1.1.2. ‘Shear point’ means any dangerous point where parts move along each other or along other parts in such a way as may cause persons or certain parts of their bodies to be pinched or shorn.

1.1.3. ‘Cutting, piercing or penetration point’ means any dangerous point where parts, either moving or fixed, sharp-edged, pointed or blunt, may injure persons or certain parts of their bodies.

1.1.4. ‘Snatching point’ means any dangerous point where sharp-edged projections, teeth, pins, screws and bolts, grease nipples, shafts, shaft ends and other parts move in such a way that persons, certain parts of their bodies or clothing may be snatched and pulled along.

1.1.5. ‘Attack point’ means any dangerous point whose parts, by moving, narrow an aperture in which persons, certain parts of their bodies or clothes may be caught.

1.2. ‘Reach’ means the maximum distance which can be reached by persons or certain parts of their bodies upwards, downwards, inwards, above, around or across without the aid of any object (Figure 1).

1.3. ‘Safety distance’ means the distance corresponding to the reach or to the body dimension plus a safety margin (Figure 1).

1.4. ‘Normal operation’ means the use of the tractor for the purpose intended by the manufacturer and by an operator familiar with the tractor characteristics and complying with the information for operation, service and safe practices, as specified by the manufacturer in the operator's manual and by signs on the tractor.

1.5. ‘Clearance zone around the drive wheels’ means the space which must remain clear around the tyres of the drive wheels in relation to the adjacent parts of the vehicle.

1.6. ‘seat Index Point (SIP)’ means the point determined in accordance with ISO 5353:1995.

▼B

2. **General requirements**

2.1. Drive components, projections and wheels on tractors must be designed, fitted and protected in such a way as to prevent accidents to persons under normal conditions of use.

2.2. The requirements of section 2 are regarded as being fulfilled if the requirements set out in section 3 have been complied with. Solutions other than those described in section 3 are authorised if the manufacturer provides proof that they are at least equivalent to the requirements of section 3.

2.3. Protective devices must be firmly attached to the tractor.

2.4. Lids and hoods which could cause injury if they are slammed shut must be made in such a way as to preclude their shutting accidentally (e.g. by means of safety devices or suitable mounting or design).

2.5. A single protective device may protect a number of dangerous points. However, if adjustment, maintenance or interference suppression devices - which can be actuated only when the engine is running - are fitted beneath a single protective device, then further protective devices must be fitted.

▼M1

2.6. The following securing devices shall be firmly attached either to the tractor mounting or to the protective device:

(a) devices to secure quick-release mounting components;

(b) components of protective devices which open without the aid of tools.

▼B

3. **Safety distances for avoiding contact with dangerous parts**

3.1. The safety distance is measured from those points which may be reached to actuate, service and inspect the tractor, and also from ground level in accordance with the operator's manual. In determining the safety distances the basic principle is that the tractor is in the state for which it has been designed and that no means has been used in order to reach the dangerous part.

Safety distances are set out in points 3.2.1 to 3.2.5. In certain specific areas or for certain specific component parts an appropriate safety level is provided if the tractor corresponds to the requirements set out in points 3.2.6 to 3.2.14.

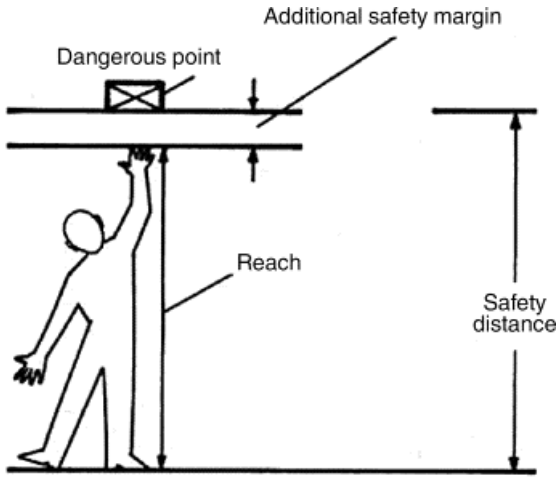
3.2. Protection of dangerous points

3.2.1. Upwards

The upward safety margin is 2 500 mm (see Figure 1) in the case of persons standing upright.

▼B

Figure 1



3.2.2. Downwards, above

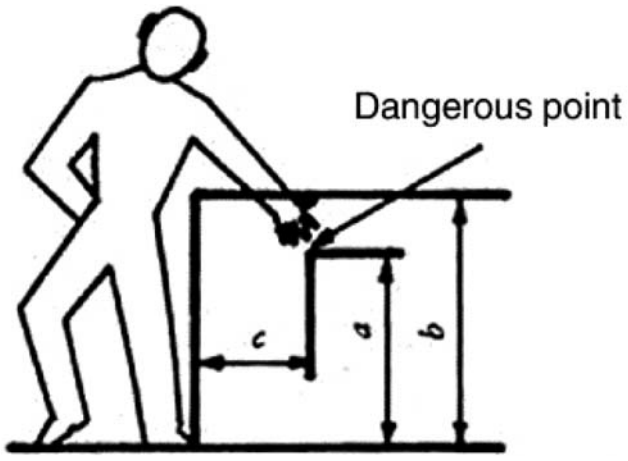
The safety margin for reaching above a barrier is:

a = from ground level up to the dangerous point;

b = height of barrier or protective device;

c = horizontal distance between dangerous point and barrier (see Figure 2).

Figure 2



When reaching both downwards and above the safety distances set out in Table 1 must be maintained.

Table 1

(in mm)

a: Distance from ground of dangerous point	Height between barrier and protective device *b*							
	2 400	2 200	2 000	1 800	1 600	1 400	1 200	1 000
	Horizontal distance *c* from dangerous point							
2 400	—	100	100	100	100	100	100	100
2 200	—	250	350	400	500	500	600	600

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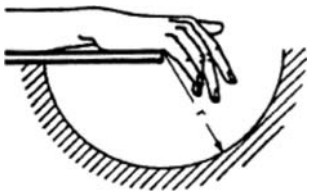
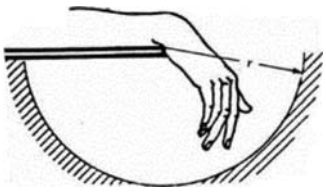
(in mm)

a: Distance from ground of dangerous point	Height between barrier and protective device *b*							
	2 400	2 200	2 000	1 800	1 600	1 400	1 200	1 000
	Horizontal distance *c* from dangerous point							
2 000	—	—	350	500	600	700	900	1 100
1 800	—	—	—	600	900	900	1 000	1 100
1 600	—	—	—	500	900	900	1 000	1 300
1 400	—	—	—	100	800	900	1 000	1 300
1 200	—	—	—	—	500	900	1 000	1 400
1 000	—	—	—	—	300	900	1 000	1 400
800	—	—	—	—	—	600	900	1 300
600	—	—	—	—	—	—	500	1 200
400	—	—	—	—	—	—	300	1 200
200	—	—	—	—	—	—	200	1 100

3.2.3. Reach around

The safety margin shown in Table 2 below must, at the minimum, be maintained if the part of the body concerned is not to reach a dangerous point. In applying the safety margin it is assumed that the main body joint concerned is pushed firmly against the edge of the protective device. The safety margins are not considered to have been maintained until one is satisfied that part of the body may quite definitely not advance or penetrate further.

Table 2

Part of the body	Safety distance	Figure
Hand From the fist knuckle to the fingertips	≥ 120 mm	
Hand From the wrist to the fingertips	≥ 230 mm	

▼B

Limb	Safety distance	Illustration
Arm From the elbow to the fingertips	≥ 550 mm	
Arm From the shoulder to the fingertips	≥ 850 mm	

3.2.4. Penetration and reach across

If penetration is possible into or across openings and up to dangerous parts, the minimum safety distances set out in Tables 3 and 4 must be maintained.

Parts which move in relation to one another or moving parts set alongside fixed parts are not regarded as risk factors provided they are no more than 8 mm apart.

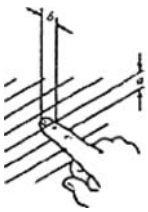
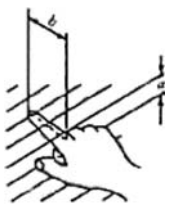
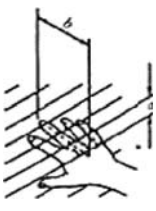
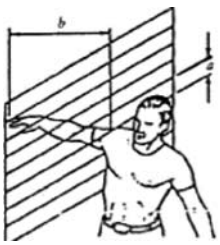
In addition to these requirements, vehicles equipped with a straddled seat and handlebars must comply with the requirements of EN 15997:2011 on moving parts.

Table 3

Safety distances for elongated and parallel openings

a is the smaller dimension of the aperture.

b is the safety distance from danger point.

Fingertip	Finger		Hand to ball of thumb	Arm to armpit	—
					
$4 < a \leq 8$	$8 < a \leq 12$	$12 < a \leq 20$	$20 < a \leq 30$	$30 < a \leq 135$ maximum	> 135
$b \geq 15$	$b \geq 80$	$b \geq 120$	$b \geq 200$	$b \geq 850$	—

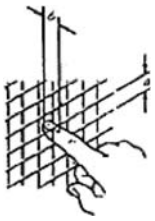
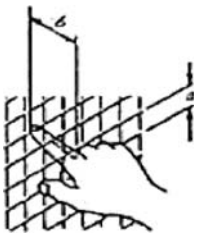
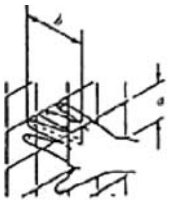
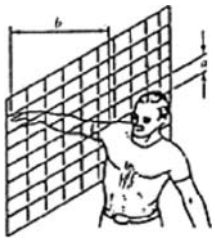
▼B

Table 4

Safety distances for square or circular apertures

a is the aperture/diameter or length of side.

b is the safety distance from danger point.

Fingertip	Finger		Hand to thumb root	Arm to armpit	—
					
$4 < a \leq 8$	$8 < a \leq 12$	$12 < a \leq 25$	$25 < a \leq 40$	$40 < a \leq 250$ maximum	250
$b \geq 15$	$b \geq 80$	$b \geq 120$	$b \geq 200$	$b \geq 850$	—

3.2.5. Safety distances at pinching points

A pinching point is not considered dangerous for the part of the body shown if the safety distances are not less than those set out in Table 5, and if it is ensured that the adjacent, wider part of the body cannot be introduced.

Table 5

Limb	Body	Leg	Foot	Arm	Hand, joint, fist	Finger
Safety distances	500	180	120		100	25
Illustration						

3.2.6. Control devices

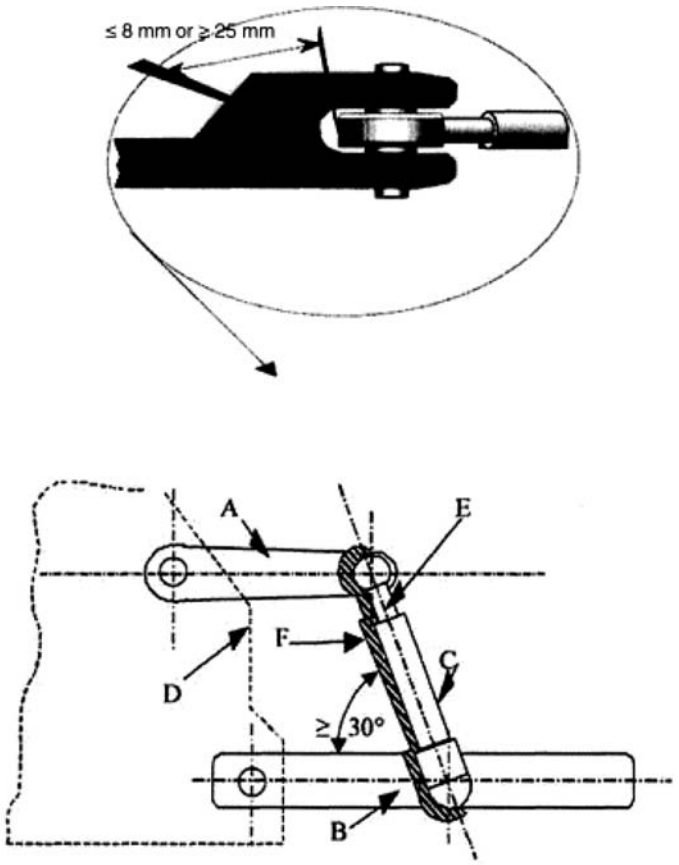
The gap between two pedals and the holes through which control devices pass are not regarded as being pinching or shearing points.

3.2.7. Rear three-point coupling

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3.2.7.1. Behind a plane passing through the median plane of the pivot points of the lifting rods in a three-point coupling system a minimum safety margin of 25 mm must be maintained between the moving parts for each point or of the lifting device's travel — but not for the extreme upper and lower positions 0,1 *n*, together with a distance of 25 mm or a minimum angle of 30° for the parts in shear which cause a change in angularity (see Figure 3). Travel *n′*, reduced by 0,1 *n* at both its upper and lower ends is defined as follows (see Figure 4). Where the lower links are directly activated by the lifting mechanism, the reference plane is determined by the median transverse vertical plane of those links.

Figure 3



Legend:

A = Lift arm

B = Lower link

C = Lift rod

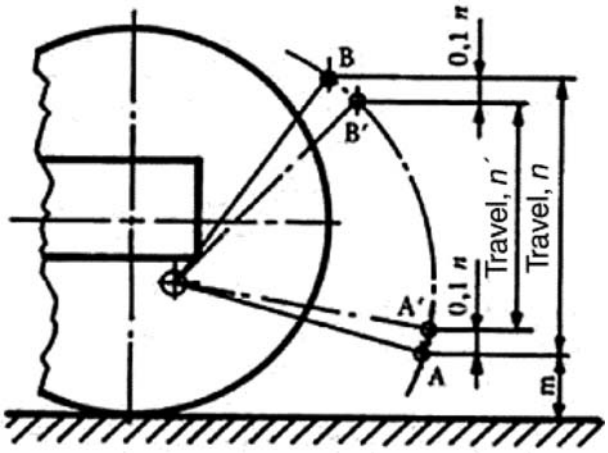
D = Tractor chassis

E = Plane passing through the axes of the lift rod pivot points

F = Clearance envelope

▼B

Figure 4



3.2.7.2. For travel n of the hydraulic lifting unit, lower position A of the coupling point of the lower link is limited by dimension '14' in accordance with the requirements laid down in standard ISO 730:2009, while upper position B is limited by the maximum hydraulic travel. Travel n′ corresponds to travel n reduced upwards and downwards by 0,1 n, and constitutes the vertical distance between A′ and B′.

3.2.7.3. Moreover, within travel *n′* a minimum safety margin of 25 mm in relation to the adjacent parts must be maintained around the profile of the lifting rods.

3.2.7.4. If, in the case of a three-point coupling, coupling devices are used which do not require the presence of an operator between the tractor and the implement carried (for example, in the case of a quick coupling), the provisions of point 3.2.7.3 do not apply.

3.2.7.5. The operating manual should contain specific information on the dangerous points located at the front of the plane defined in the first sentence of point 3.2.7.1.

3.2.8. Front three-point coupling

3.2.8.1. At each point of the lifting unit's travel *n* — but not for the extreme upper and lower reaches 0,1 *n* — a minimum safety margin of 25 mm must be maintained between the moving parts together with a minimum angle of 30° or a safety margin of 25 mm in the case of the change of angularity caused by the parts in shear with each other. Travel *n′* reduced by 0,1 *n* at both its upper and lower ends, is defined as follows (see also Figure 4).

3.2.8.2. For travel *n* of the hydraulic lifting unit, the extreme lower position A of the coupling point of the lower link is limited by dimension '14' in accordance with ISO Standard 8759, Part 2, of March 1998 while extreme upper position B is limited by the maximum hydraulic travel. Travel *n′* is reduced upwards and downwards by 0,1 *n* and the vertical distance between A′ and B′.

3.2.8.3. If, for the lower links of a front three-point coupling, coupling devices (such as a rapid-action coupling) are used which do not require the presence of a person between the tractor and the implement attached during coupling, the requirements under 3.2.8.1 do not apply within the reach of a radius of 250 mm from the points at which the lower links are coupled to the tractor. However, a minimum safety margin of 25 mm from neighbouring parts within the defined travel *n′* must in any case be maintained around the outside of the travel rods/cylinders.

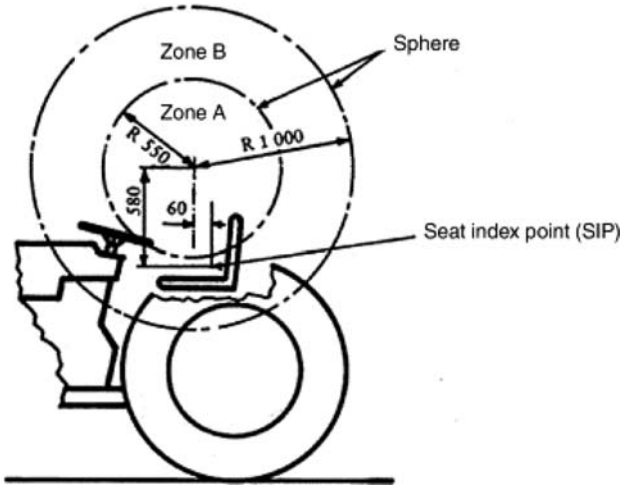
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3.2.9. Driving seat and environment

When he is in a sitting position, all pinching or shearing points must be out of range of the driver's hands or feet. This requirement is considered to have been met if the following conditions are fulfilled:

3.2.9.1. The driver's seat is at the mid-point in its longitudinal and vertical adjustment range. The driver's reach limit is divided into zones A and B. A central spherical point of these zones is 60 mm in front of and 580 mm above the Seat Index Point (SIP) (see Figure 5). Zone A consists of a sphere having a radius of 550 mm while zone B is located between that sphere and a sphere having a radius of 1 000 mm.

Figure 5



3.2.9.2. A safety distance of 120 mm in zone A and 25 mm in zone B is maintained near the pinching and shearing points, whilst a minimum angle of 30° is maintained in the case of shearing parts causing a change in angularity.

3.2.9.3. In zone A, only the pinching and shearing points caused by parts set in motion by an outside energy source must be taken into account.

3.2.9.4. If a dangerous point is due to the presence of structural parts adjacent to the seat, a safety distance of a least 25 mm is maintained between that structural part and the seat. There is no dangerous point between the seat backrest and the adjacent structural parts located behind that backrest if the adjacent structural parts are smooth and the seat backrest itself is rounded in the surrounding area and has no sharp points.

3.2.9.5. Gearboxes and other vehicle parts and accessories generating noise, vibrations and/or heat shall be isolated from the driving seat.

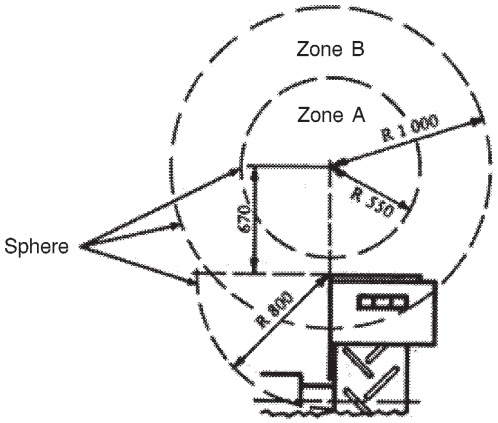
3.2.10. Passenger seat (if any)

3.2.10.1. If parts may constitute a danger for the feet, provision must be made for protective devices within a hemispherical radius of 800 mm starting from the forward edge of the seat cushion and pointing downwards.

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3.2.10.2. As described in point 3.2.9 (see Figure 6) the dangerous points in zones A and B must be protected within a sphere whose centre is 670 mm above the centre of the front edge of the passenger seat.

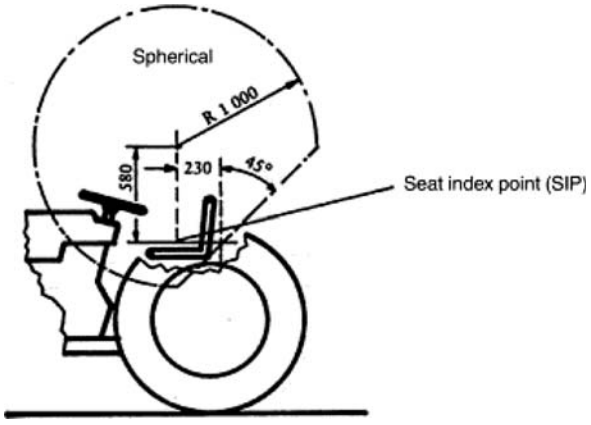
Figure 6



3.2.11. Tractors of categories T2/C2, T4.1/C4.1 and T4.3/C4.3

3.2.11.1. In the case of tractors of categories T2/C2, T4.1/C4.1 and T4.3/C4.3, the requirements of point 3.2.9 shall not apply to the zone situated below a plane inclined at 45° to the rear and transverse to the direction of travel and passing through a point located 230 mm behind the Seat Index Point (SIP) (see Figure 7). If there are any dangerous points in this zone, corresponding warnings must be affixed to the tractor.

Figure 7



3.2.12. Steering and swing axle

Parts moving in relation to each other or to fixed parts must be protected if they lie within the zone defined in points 3.2.9 and 3.2.10.

When articulated steering is fitted, there must be indelible and clear markings within the articulation range on both sides of the tractor, indicating by means of an illustrative sign or in words that remaining within the unprotected range of articulation is not permitted. The corresponding indications must be included in the operating manual.

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3.2.13. Transmission shafts fixed on the tractor

Transmission shafts (for example, for four-wheel drive) which can only rotate while the tractor is in motion must be protected if they are located within the zone defined in points 3.2.9 and 3.2.10.

3.2.14. Clearance zone around the drive wheels

3.2.14.1. The clearance zone around the drive wheels on tractors without an enclosed cab, when fitted with largest-size tyres, must correspond to the dimensions set out in the following Figure 8 and Table 6.

Figure 8

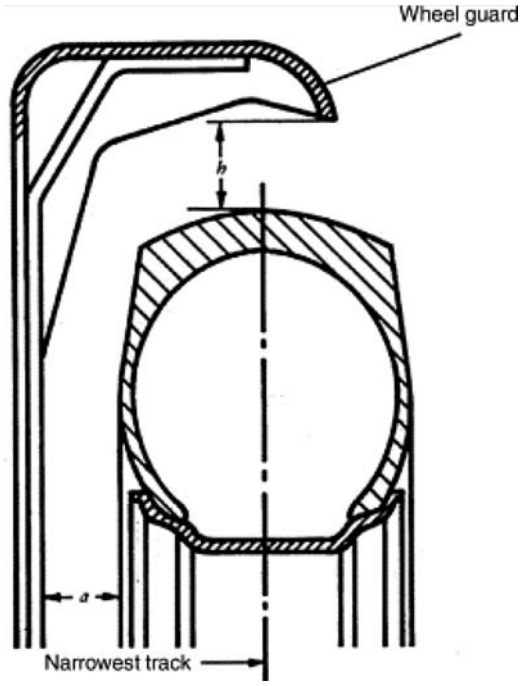


Table 6

Categories T1/C1, T3/C3 and T4.2/C4.2		Categories T2/C2, T4.1/C4.1 and T4.3/C4.3	
a	*h*	*a*	*h*
mm	mm	mm	mm
40	60	15	30

3.2.14.2. A clearance zone around the drive wheels smaller than that illustrated in Figure 8 and Table 6 is permissible in addition to the zones referred to in points 3.2.9 and 3.2.10 in the case of tractors of categories T2/C2, T4.1/C4.1 and T4.3/C4.3, where wheel guards are also used to scrape off earth stuck to the wheels.

4. **Strength requirements for protective devices**

4.1. Protective devices, and in particular those with a vertical height from the ground of up to 550 mm, whose use as access steps during normal use cannot be prevented, shall be designed so that they can withstand a

▼B

vertical load of 1 200 N. Conformance with this requirement shall be checked using the test given in Annex C of ISO 4254-1:2013 or an equivalent method which fulfils the same test acceptance criteria.

5. **Engine hood**

5.1. The engine hinged hood shall be opened only with a tool (release mechanism located in the cabin is acceptable) and with a self-locking mechanism when closed.

5.2. Side hoods shall be mounted as:

5.2.1. Fixed guards held in place by welding or screws and bolts and which are openable only by means of a tool. The fixed guards must not remain in place if the fixing elements are missing;

or

5.2.2. Hinged guards that can be opened only through the use of a tool and self-locked when closed;

or

5.2.3. Guards with its opening linked to the opening of the hood, and that can be opened only through the use of a tool.

5.3. Additional means of protection must be installed if beneath the engine hood there are adjustment, maintenance or interference suppression systems that can be handled only while the engine is running.

5.4. Mechanical supports or hydraulic locking devices (e.g. struts or gas springs) shall be provided to prevent the engine hoods from falling when opened.

5.5. Devices that facilitate the safe handling of the hood (e.g. handles, ropes or parts of the hood itself appropriately shaped to grip it better) without risk of crushing, impact or excessive effort shall be provided.

5.6. The engine hood openings shall be identified with pictograms in accordance with Annex XXVI, and instructions shall be provided in the operator's manual.

6. **Hot surfaces**

6.1. Hot surfaces which can be reached by the operator during normal operation of the tractor shall be covered or insulated. This applies to hot surfaces which are near to steps, handrails, handholds, integral tractor parts used as boarding means and which may be inadvertently touched and parts directly accessible from the driver's seat (e.g. gearbox-transmission in tractors not equipped with platform).

6.2. This requirement shall be satisfied by properly positioning fixed guards or by safety distances to segregate or thermally isolate the hot surfaces of the vehicle.

6.3. Contact with other not particularly dangerous hot surfaces or those that may be dangerous only in particular situations of use which go beyond the ordinary shall be identified with pictograms in accordance with Annex XXVI and identified in the operator's manual.

6.4. In addition, vehicles equipped with a straddled seat and handlebars must comply with the requirements of EN 15997:2011 concerning hot surfaces.

▼B

ANNEX XVIII

Requirements applying to seat-belt anchorages

A. GENERAL REQUIREMENTS

1.1. When a vehicle of category T or C is fitted with ROPS, it shall be fitted with seat-belt anchorages complying with the standard ISO 3776-1:2006.

1.2. In addition, the seat-belt anchorages shall comply with the requirements laid down in one of the points B, C or D.

B. ADDITIONAL REQUIREMENTS APPLYING TO SEAT-BELT ANCHORAGES (ALTERNATIVE TO THOSE SET OUT IN POINTS C AND D)[1]

1. **Scope**

1.1. Seat belts are one of the operator restraint systems used for securing the driver in motor vehicles.

This recommended procedure provides minimum performance and tests requirements for anchorage for agricultural and forestry tractors.

It applies to the anchorage of pelvic restraint systems.

2. **Explanation of terms used in the performance testing**

2.1. The *seat belt assembly* is any strap or belt device fastened across the lap or pelvic girdle area designed to secure a person in a machine.

2.2. The *extension belt* is intended as any strap, belt, or similar device that aids in the transfer of seat belt loads.

2.3. The *anchorage* is intended as the point where the seat belt assembly is mechanically attached to the seat system or tractor.

2.4. The *seat mounting* is intended as all intermediary fittings (such as slides, etc.) used to secure the seat to the appropriate part of the tractor.

2.5. The *Operator Restraint System* is intended as the total system composed of seat belt assembly, seat system, anchorages and extension which transfers the seat belt load to the tractor.

2.6. *Applicable Seat Components* comprise all components of the seat whose mass could contribute to loading of the seat mounting (to the vehicle structure) during a roll-over event.

3. **Test procedure**

The procedure is applicable to a seat belt anchorage system provided for a driver or a person in addition to the driver carried by the tractor.

Only static tests for anchorages are given in this procedure

If, for a given protective structure, a manufacturer provides more than one seat with identical components which transfer the load from the seatbelt anchorage, to the seat mounting on the ROPS floor or tractor chassis, the Testing Station is authorised to test only one configuration, corresponding to the heaviest seat (see also below).

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The seat shall be in position during the tests and fixed to the mounting point on the tractor using all intermediary fittings (such as suspension, slides, etc.) specified for the complete tractor. No additional non-standard fittings contributing to the strength of the construction may be used.

The worst case loading scenario for seat belt anchorage performance testing should be identified with consideration to the following points:

— If the masses of alternative seats are comparable, those featuring seat belt anchorages which transfer loading through the seat structure (e.g. via the suspension system and/or adjustment slides), will be required to withstand much higher test loading. They are therefore likely to represent the worst case;

— If the applied loading will pass through the seat mountings to the vehicle chassis, the seat should be adjusted longitudinally to achieve the minimum amount of overlap of the mounting slides / rails. This will usually be when the seat is in the fully-rearward position but, if certain vehicle installations limit seat rearward travel, the fully-forward seat position may provide the worst case loading position. Observation of the amount of seat movement and mounting slide / rail overlap is required.

The anchorages shall be capable of withstanding the loads applied to the seat belt system using a device as shown in Figure 1. The seat belt anchorages shall be capable of withstanding these test loads applied with the seat adjusted in the worst position of the longitudinal adjustment to ensure that the test condition is met. The test loads shall be applied with the seat in the mid-position of the longitudinal adjustment if a worst position among the possible seat adjustments is not recognised by the testing station. For a suspended seat, the seat shall be set to the midpoint of the suspension travel, unless this is contradictory to a clearly stated instruction by the seat manufacturer. Where special instructions exist for the seat setting, these shall be observed and specified in the report.

After the load is applied to the seat system, the load application device shall not be repositioned to compensate for any changes that may occur to the load application angle.

3.1. Forward loading

A tensile force shall be applied in a forward and upward direction at an angle of 45° ± 2° to the horizontal, as shown in Figure 2. The anchorages shall be capable of withstanding a force of 4 450 N. In the event that the force applied to the seat belt assembly is transferred to the vehicle chassis by means of the seat, the seat mounting shall be capable of withstanding this force plus an additional force equal to four times the force of gravity on the mass of all applicable seat components, applied 45° ± 2° to the horizontal in a forward and upward direction, as shown in Figure 2.

3.2. Rearward loading

A tensile force shall be applied in a rearward and upward direction at an angle of 45° ± 2° to the horizontal, as shown in Figure 3. The anchorages shall be capable of withstanding a force of 2 225 N. In the event that the force applied to the seat belt assembly is transferred to the vehicle chassis by means of the seat, the seat mounting shall be capable of withstanding this force plus an additional force equal to two times the force of gravity on the mass of all applicable seat components, applied 45° ± 2° to the horizontal in a rearward and upward direction, as shown in Figure 3.

▼B

Both tensile forces shall be equally divided between the anchorages.

3.3. Seatbelt buckle release force (if required by the manufacturer)

The seat belt buckle shall open with a maximum force of 140 N following the load applications. This requirement is fulfilled for seat belt assemblies that satisfy the requirements of UNECE Regulation No 16 or Council Directive 77/541/EEC ([1]).

▼M1

3.4. Test result

Condition of acceptance

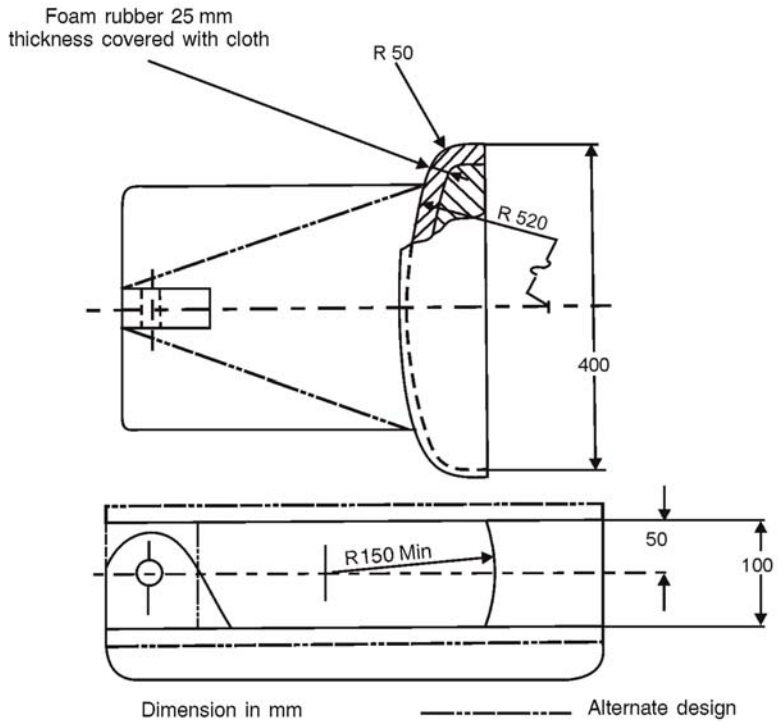
Permanent deformation of any system component and anchorage area is acceptable under the action of the forces specified in points 3.1 and 3.2. However, there shall be no failure allowing release of the seat belt system, seat assembly, or the seat adjustment locking mechanism.

The seat adjuster or locking device need not be operable after application of the test load.

▼B

Figure 1

The load application device



Note: The dimensions not shown are optional to satisfy the test facility and do not influence the test results.

([1]) Council Directive of 28 June 1977 on the approximation of the laws of the Member States relating to safety belts and restraint systems of motor vehicles (OJ L 220, 29.8.1977, p. 95).

▼B

Figure 2

Load application in the upward and forward direction

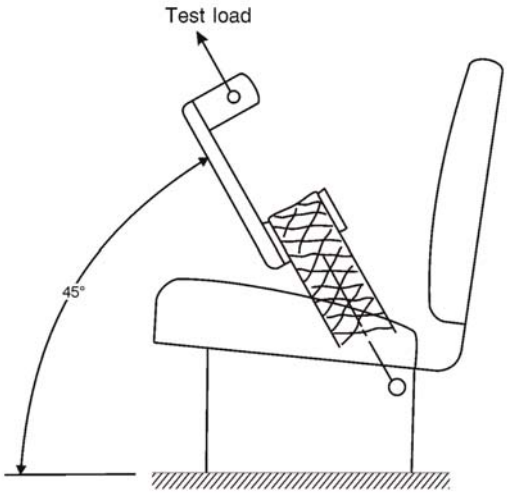
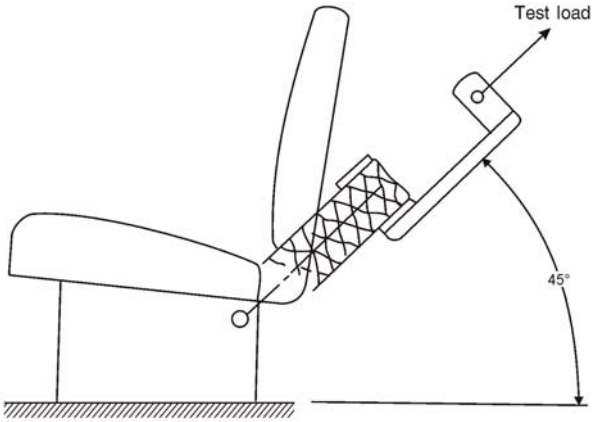


Figure 3

Load application in the upward and rearward direction



C. ADDITIONAL REQUIREMENTS APPLYING TO SEAT-BELT ANCHORAGES (ALTERNATIVE TO THOSE SET OUT IN POINTS B AND D)

Vehicles of categories T and C fitted with seat belt anchorages complying with the requirements laid down in standard ISO 3776-2:2013 shall be deemed to be complying with this Annex.

D. ADDITIONAL REQUIREMENTS APPLYING TO SEAT-BELT ANCHORAGES (ALTERNATIVE TO THOSE SET OUT IN POINTS B AND C)

Vehicles of categories T and C, fitted with seat belt anchorages tested and granted a test report on the basis of UNECE Regulation No 14, shall be deemed to be complying with this Annex.

Explanatory notes to Annex XVIII

(1) Unless the numbering, the requirements set out in point B are identical with the text of the OECD standard code for the official testing of for the official testing of protective structures on agricultural and forestry tractors (static test), OECD Code 4, Edition 2015 of July 2014.

▼B

ANNEX XIX

Requirements applying to safety belts

1. When a vehicle of category T or C is fitted with roll-over protection structures, the vehicles shall be fitted with safety belts and shall comply with the requirements laid down in ISO 3776-3:2009.

2. As an alternative to the requirements set out in point 1, vehicles of category T or C fitted with roll-over protection structures, which have been tested and granted a test report on the basis of the UNECE Regulation No 16, as amended, shall be deemed to be complying with this Annex.

▼B

ANNEX XX

Requirements applying to the protection against penetrating objects

1. Vehicles of categories T and C equipped for forestry applications shall comply with the requirements for protection against penetrating objects laid down in ISO 8084:2003.

2. All other vehicles of categories T and C, if equipped with protection against penetrating objects, shall comply with the requirements of point 1 of UNECE Regulation No 43 ([1]), Annex 14 on safety glazing.

([1]) OJ L 230, 31.8.2010, p. 119.

▼B

ANNEX XXI

Requirements applying to exhaust systems

1. **Definitions**

For the purpose of this Annex, 'exhaust system' means the combination of the exhaust pipe, the expansion box and the exhaust silencer and pollution control device.

2. **General requirements**

2.1. The exhaust tailpipe must be positioned in such a way that the exhaust gases cannot penetrate inside the cab.

▼M1

2.2. The parts of the exhaust pipe which can be reached by the operator during normal operation of the tractor, as described in point 6.1 of Annex XVII, must be protected by means of segregation, guards or grids, so as to avoid the possibility of accidental contact with hot surfaces.

▼B

3. **Tractors of categories T2/C2 and T4.1/C4.1**

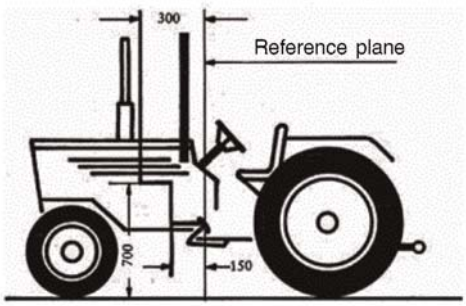
For tractors of categories T2/C2 and T4.1/C4.1, the following requirements shall apply:

3.1. In front of a reference plane which passes at right angles to the longitudinal axis of the vehicle and through the centre of the load-free pedal (clutch and/or service brake), very hot exhaust components must be protected if located within 300 mm in the upper zone (700 mm above ground level) and within 150 mm in the lower zone (see Figure 1). Laterally, the area to be protected is limited by the external outline of the tractor and the external outline of the exhaust system.

3.2. Very hot exhaust system components passing beneath the entry step must be covered in their vertical projection or otherwise thermally protected.

Figure 1

(dimensions in mm)



▼B

ANNEX XXII

Requirements applying to the operator's manual

1. The operator's manual shall comply with the requirements set out in standard ISO 3600:1996, with the exception of section 4.3 (Machine identification).

2. In addition, the operator's manual shall contain relevant information with regard to the following topics:

   (a) adjustment of the seat and suspension related to the ergonomic position of the operator with respect to the control devices and in order to minimise the risks from whole body vibration;

   (b) use and adjustment of the system for heating, ventilation and air-conditioning, if provided;

   (c) starting and stopping of the engine, including the principles of safe starting/stopping, involving use of handbrake, placing control devices in neutral and removing the key;

   (d) location and method of opening of emergency exits;

   (e) instructions for boarding and leaving the tractor;

   (f) the hazard area near to the pivot axis of articulated tractors;

   (g) use of special tools, if any are provided;

   (h) safe methods used for service and maintenance, including cleaning and working at height;

   (i) information about the interval of inspection of hydraulic hoses;

   (j) instructions about how to tow the tractor;

   (k) Instructions about the procedures for safe use of jacks and recommended jacking points;

   (l) hazards related to batteries and fuel tank;

   (m) prohibited use of the tractor, where overturning hazards exist with mention that the list is not exhaustive;

   (n) risks related to contact with hot surfaces, including residual risks such as filling of oil or coolant in hot engines or transmissions;

   (o) the level of protection of the falling objects protective structure, if applicable;

   (p) the level of protection of the operator's protection structure against penetrating objects, if applicable.

   (q) warning of the hazard of contact with overhead power lines

   (r) lightning strikes

   (s) regular cleaning of spray suppression valances

   (t) Tyre risks, including those associated with handling, repair, over inflation and installation of tyres.

▼B

(u) stability degradation when using heavy attached implements at height

(v) risks of overturning when travelling over sloping ground or rough ground

(w) carrying of passengers only in approved passenger seats

(x) use of the vehicle by appropriately trained operators only

(y) information about safe loading of the vehicle.

(z) information about towing: location and conditions for a safe process.

(aa) information about the location and conditions of use of battery isolators (mechanical devices, electrical switches or electronic systems);

(ab) use of safety belts and other types of operator seat restraints;

(ac) for tractor with auto-guidance system, relevant instructions and safety information;

(ad) for vehicles with foldable ROPS, information about save use of foldable ROPS, including: erecting/lowering operations and locking in the erected position.

(ae) for vehicles with foldable ROPS, warning of consequences in the event of roll over with the ROPS folded;

(af) for vehicles with foldable ROPS, description of the situations where might need to be folded (e.g. work within a building, orchard, hop or vineyard) and a reminder that the ROPS should be re-deployed on completion of the aforementioned tasks.

▼M1

(ag) information about the location of the greasing points, the safe greasing process and greasing intervals (daily/monthly/yearly);

▼B

(ah) information about the minimum requirements of the seats and their compatibility with the vehicle, in order to meet the vibration declaration set out in point 5.

3. Additional information concerning attaching, detaching and working with mounted machinery, trailers and interchangeable towed machinery

The operator's manual shall include the following:

(a) a warning to strictly follow the instructions outlined in the operator's manual of the mounted or trailed machinery or trailer, and not to operate the combination tractor — machine or tractor — trailer unless all instructions have been followed;

(b) a warning to stay clear from the area of the three-point linkage and of the pick-up hitch (where fitted) when controlling them;

▼B

(c) a warning that mounted machinery must be lowered to the ground before leaving the tractor;

(d) speed of the power take-off drive shafts in function of the mounted machinery or trailed vehicle;

(e) a requirement to use only power take-off drive shafts with adequate guards and shields, and to fit a cap or cover if the shield is removed from the tractor;

(f) information about hydraulic coupling devices and their function;

▼M1

(g) information about the maximum lift capacity of the three-point lifting mechanism and information on how to fix the three-point lifting mechanism laterally and vertically for road travel;

▼B

(h) information about the determination of the total mass, the axle loads, the tyre load carrying capacity and the necessary minimum ballasting;

(i) information on intended use, installation, removal and maintenance of ballast weights

(j) information about the available trailer braking systems and their compatibility with the trailed vehicles;

(k) the maximum vertical load on the rear hitch, related to the rear tyre size and type of hitch;

▼M1

(l) information about using implements with power take-off drive shafts and that the technically possible inclination of the shafts depend on the shape and size of the master shield and clearance zone, including instructions and specific warnings relating to:

(i) coupling and releasing the power take-offs,

(ii) use of tools or machines coupled to the rear power take-off,

(iii) if applicable, use of PTO type 3 with reduced dimensions and the consequences and risks caused by the reduced dimension of the protective guard;

▼B

(m) a repeat of the data on the statutory plate about maximum allowed trailed masses;

(n) a warning to stay clear from the area between tractor and trailed vehicle.

(o) For tractors with machinery mounted on them, the information required in the operator's manual of the machinery mounted in accordance with Directive 2006/42/EC.

4. Noise declaration

The operator’s manual shall give the value of the noise at the operator’s ear, measured according to Annex XIII.

▼B

5. Vibration declaration

The operator's manual shall give the value of the vibration level measured according to Annex XIV.

6. Operating modes

The operator's manual shall include relevant information to enable the safe use of the tractor when it is used in the following operational situations:

(a) work with front-end loader (risk of falling objects);

(b) forestry application (risk of falling and/or penetrating objects);

(c) work with crop sprayers mounted or trailed (risk of hazardous substances).

Particular attention shall be given in the operator's manual to the use of the tractor in combination with the above equipment.

6.1. Front–end loader

6.1.1. The operator's manual shall outline the hazards associated with front-end loader work, and explain how to avoid those hazards.

6.1.2. The operator's manual shall indicate the fixation points on the body of the tractor where the front–end loader must be installed, together with the size and quality of the hardware to be used. If no such attachment points are foreseen, the operator's manual shall prohibit the installation of a front–end loader.

6.1.3. Tractors fitted with programmable hydraulic sequencing functions shall provide information on how to connect the loader hydraulics so that this function is inoperable.

6.2. Forestry application

6.2.1. In case of use of an agricultural tractor in a forestry application, the identified hazards include the following:

(a) toppling trees, for example in case a rear-mounted tree grab-crane is mounted at the rear of the tractor;

(b) penetrating objects in the operator's enclosure, especially in case a winch is mounted at the rear of the tractor;

(c) falling objects, such as branches, logs or tree limbs;

(d) steep slope or rough terrain working conditions.

6.2.2. The operator's manual shall provide information about the following:

(a) the existence of the hazards described in point 6.2.1;

(b) any optional equipment that might be available to deal with those hazards;

(c) fixation points on the tractor where protective structures can be fixed, together with the size and quality of the hardware to be used; when no means are foreseen to fit adequate protective structures, this shall be mentioned;

▼B

(d) protective structures provided, which may consist of a frame protecting the operating station against toppling trees or (mesh) grids in front of the cab doors, roof and windows, etc.;

(e) the FOPS level, if provided.

6.3. Crop sprayers (protection against hazardous substances):

6.3.1. In case of use of an agricultural tractor with crop sprayers, the identified risks include the following:

(a) risks encountered when spraying hazardous substances with a tractor fitted with a cabin or not;

(b) risks related with entering or exiting the cabin when spraying hazardous substances;

(c) risks related with the possible contamination of the operating space;

(d) risks related with the cleaning of the cabin and the maintenance of the air filters,

6.3.2. The operator's manual shall provide information about the following:

(a) the existence of at least the risks described in point 6.3.1;

(b) the protection level against hazardous substances provided by the cabin and the filter. In particular, the information required by standards EN 15695-1:2009 and EN 15695-2:2009/AC 2011 shall be indicated.

(c) the selection and cleaning of the cabin air filter, as well as the replacement intervals required in order to provide a continuous protection. Including how to carry out such tasks safely and without risks to health;

(d) maintaining the operating space uncontaminated, in particular when the tractor is used with personal protective equipment;

(e) a reminder that a safe spraying operation requires compliance with the label of the hazardous substance and the instructions of the mounted or towed sprayer.

▼B

ANNEX XXIII

Requirements applying to control devices, including safety and reliability of control systems and emergency and automatic stop devices

LIST OF APPENDICES

Appendix Number	Appendix title
1	Figures
2	Complex electronic vehicle control systems that must comply with the provisions of Annex 6 of UNECE Regulation 79

1. **General requirements**

1.1. Control devices must be easily accessible and must not constitute a danger to the operator, who must be able to actuate them without difficulty or risk; they must be so designed and laid out, or protected, as to preclude any inadvertent switching operation or any unintentional triggering of a movement or any other operation which might be dangerous.

1.2. ►**M1** Control devices must satisfy the corresponding applicable requirements set out in points 1.2.1 to 1.2.4 as regards the installation, location, operation and identification of control devices. ◄ Other arrangements are permitted, should a manufacturer provide evidence that they have an effect at least equivalent to the requirements specified in this Annex.

1.2.1. Control devices such as steering wheels or steering levers, gear levers, control levers, cranks, pedals and switches shall be chosen, designed, constructed and arranged so that their actuating forces, displacement, locations, methods of operation and colour coding are in accordance with ISO 15077:2008, and shall comply with the provisions set out in Annexes A and C of that standard.

1.2.2. Hand-operated control devices shall have minimum clearances in accordance with paragraph 4.5.3 of ISO 4254-1:2013. This requirement does not apply to fingertip operation control devices, such as push-buttons or electric switches.

1.2.3. Pedals shall have an appropriate size and space and be adequately spaced. Pedals shall have a slip-resistant surface and shall be easy to clean.

▼M1

In order to avoid confusing the driver, the clutch, brake and accelerator pedals shall have the same function and arrangement as those of a motor vehicle, except for:

(a) vehicles equipped with a straddle seat and handlebars, which are deemed to comply with the requirements of EN 15997:2011 for throttle control and manual clutch control,

(b) vehicles of category T or C requiring a sustained activation of the right pedal to keep them in motion (e.g. vehicles fitted with a throttle pedal and a continuous variable transmission, or vehicles fitted with two pedals for forward and reverse direction and a hydro-static transmission),

▼M1

(c) vehicles of category C with a maximum design speed of less than 15 km/h and fitted with hand-operated levers for controlling differential steering.

▼B

1.2.4. For tractors without enclosed cab, the accessibility to internal control devices from the ground shall be limited; in particular, it shall be avoided the possibility of reaching the internal rear PTO control device, the rear three point lifting control device and any propulsion control device from inside the area determined by the vertical planes passing on the inner edge of the mud-guards (see Figure 3).

2. **Identification of control devices**

▼M1

2.1. The symbols used for identification of control devices shall comply with the requirements set out in section 1 of Annex XXVI.

▼B

2.2. Symbols other than those set out in Annex XXVI may be used for other purposes, provided that there is no danger of confusion with those shown in that Annex.

2.3. The symbols shall appear on or in the immediate proximity of the control devices.

2.4. The symbols shall stand out clearly against the background.

2.6. Control devices may be identified with pictograms in accordance with Annex XXVI and instructions of use shall be provided in the operator's manual.

3. **Safe start of the engine**

It must not be possible to start the engine if there is a risk that this might cause an uncontrolled movement of the tractor or of any implement or equipment connected to it.

3.1. The requirement set out in point 3 is deemed to be fulfilled if the engine cannot be started unless:

the clutch mechanism is disengaged and at least one of the following control devices of the vehicle transmission is in neutral position:

— the reverse shuttle control lever, or

— the gear change control lever, or

— the range selection control lever.

▼M1

3.1.1. In the case of a vehicle fitted with hydrostatic transmission or a transmission with a hydrostatic component, the requirement laid down in point 3.1 that the engine cannot be started unless the clutch mechanism is disengaged shall be construed as that the engine cannot be started unless the transmission control is in neutral position or depressurized.

3.2. In case that an operator standing on the ground (e.g. tractor's side), can start the engine and fulfil simultaneously the requirements guaranteeing the safe start of the engine in accordance with point 3.1, one additional control device shall be activated to start the engine.

▼M1

3.3. The terminals of the starter motor shall be protected in order to prevent shunting its solenoid by means of simple tools (e.g. a screwdriver).

▼B

4. **Engine shut-off control device**

Actuating this device must stop the engine without sustained manual effort; it must not be possible for the engine to start again automatically.

When the engine shut-off control device is not combined with the starter control device, it must be of a colour contrasting clearly with the background and the other control devices. If the shut-off control device is a button, it must be coloured red.

5. **Differential lock control device**

Identification of this control device, where fitted, is mandatory. The functioning of the differential lock must be clearly indicated, if this is not apparent from the position of the control device.

6. **Three-point lifting mechanism control device(s)**

6.1. Either the three-point lifting mechanism control device(s) shall be fitted in such a way as to ensure that lifting and lowering manoeuvres can be carried out safely, and/or automatic coupling parts shall be fitted on the attachment devices of the lifting equipment so that the presence of an operator between the tractor and the equipment is not required. The presence of such a control device(s), where fitted, must be indicated.

6.2. The safety requirements for the lifting and lowering of the tools being carried are deemed to be fulfilled where the following conditions are met:

6.2.1. Main control device(s)

The main control device(s) and any linkage are arranged or protected in such a way that the operator is unable to reach them if he is standing on the ground between the tractor and the mounted implement, or external control device(s) shall be fitted;

6.2.2. External control device(s)

6.2.2.1. The rear external control device(s) of the three-point hydraulic lifting mechanism, when fitted, shall be laid out in such a way that the operator can actuate them from outside of the rear hazard zone (Figure 1). This requirement is deemed to be fulfilled if are located outside the area identified by the vertical planes passing on the inner edge of the mudguards and at:

(a) a horizontal distance of minimum 550 mm from the PTO axis or, when this is not technically possible, on the outer side of the mudguard/fender.

(b) a maximum height of 1 800 mm from the ground or, when this is not technically possible, 2 000 mm.

6.2.2.2. The front three-point lift external control device(s) shall be located outside the front hazard zone (Figure 2) and at a maximum height above the ground of 1 800 mm or, when this is not technically possible, 2 000 mm.

And

▼B

6.2.2.3. The three-point hydraulic lifting mechanism is actuated by means of control device(s) which restrict the amount of movement to a maximum of 100 millimetres each time the control device is actuated. The measurement points in this case are formed by the coupling points on the lower arms of the three-point coupling,

Or

6.2.2.4. The three-point hydraulic lifting mechanism is actuated by means of control device(s) which operate on the 'hold-to-run principle'.

6.2.3. Tractors of categories T2/C2 and T4.1/C4.1

In the case of tractors of categories T2/C2 and T4.1/C4.1, the main control device(s) shall be located in front of the vertical plane passing through the seat reference point (S), the seat being in a central position.

6.2.4. Other arrangements are permitted if the manufacturer provides evidence that they have an effect at least equivalent to the requirements set out in points 6.2.1 to 6.2.3.

7. **Power Take-Off (PTO) control device(s)**

7.1. PTO control device(s) shall be designed in a way which avoids unintentional actuation.

7.1.1. The PTO control device(s) shall be clearly identified by yellow colour and shall not be subject to confusion with other control device(s) if provided (e.g. three-point linkage control device, hydraulic control devices).

7.2. It shall not be possible to start the engine with the PTO engaged.

▼M1

7.3. It shall always be possible to shut off the PTO from the driving position. This requirement shall also apply to the associated PTO external control device(s), if fitted. The shut off shall be always an override control device.

7.4. Additional requirements for the PTO external control device(s), if fitted

▼B

7.4.1. The start control device shall operate according to the 'hold-to-run principle' for at least the first three seconds of actuation.

7.4.2. After actuating the control device(s) the time delay to the intended operation shall not be more than the time for the power take-off technical engage/disengage system to operate. If this delay time is exceeded, an automatic deactivation of the PTO drive shall occur.

7.4.3. Interaction between external PTO control device(s) and operator's seat position PTO control device(s) shall not be permitted.

7.4.4. The rear PTO external control device(s), when fitted, shall be laid out in such a way that the operator can actuate them from outside of the rear hazard zone (Figure 1). This requirement is deemed fulfilled if the external control device(s) are located outside the area identified by the vertical planes passing on the inner edge of the mud-guards and at:

▼B

(a) a horizontal distance of minimum 550 mm from the PTO axis or, when this is not technically possible, on the outer side of the mud-guard/fender;

(b) a maximum height of 1 800 mm from the ground or, when this is not technically possible, 2 000 mm.

7.4.5. The front PTO external control device(s), when fitted, shall be located outside the front hazard zone (see Figure 2) and at a maximum height above the ground of 1 800 mm, or, when this is not technically possible, 2 000 mm.

7.4.6. An external PTO stop red or yellow single button shall be located outside the hazard zones identified in Figures 1 and 2.

7.4.6.1. The external PTO stop red or yellow single button shall stop simultaneously the three-point lifting mechanism if the requirements set out in point 6.2.2.4 are not fulfilled in accordance with point 6.2.4.

8. **Remote valve control device(s)**

8.1. The rear remote valve control device(s), when fitted, shall be laid out in such a way that the operator can actuate them from outside of the rear hazard zone (Figure 1). This requirement is deemed fulfilled if the external control device(s) are located outside the area identified by the vertical planes passing on the inner edge of the mud-guards and at:

(a) a horizontal distance of minimum 550 mm from the PTO axis or, when this is not technically possible, on the outer side of the mud-guard/fender.

(b) a maximum height of 1 800 mm from the ground or, when this is not technically possible, 2 000 mm.

8.2. The front remote valve control device(s), when fitted, shall be located outside the front hazard zone (see Figure 2) and at a maximum height above the ground of 1 800 mm, or, when this is not technically possible, 2 000 mm.

9. **Operator Presence Control (OPC)**

9.1. Park brake OPC

Vehicles of categories T and C, with the exception of those equipped with a straddled seat and handlebars which require an active driving position shall have an audible and visible alarm that alerts the operator when he leaves the driving position with the park brake not applied. This audible and visible alarm shall be activated after the operator has been detected out of the driving position and the park brake is not applied. The time-out of the alarm shall be not less than 10 seconds. The alarm shall be de-activated when the operator is detected to be present again in the driving position within this time period or when the park brake is applied within this time period.

9.1.1. Vehicles which require an active driving position, shall have an audible and visible alarm that alerts the operator when he leaves the driving position with vehicle is stationary and the park brake or park lock not applied. This audible and visible alarm shall be activated after the operator has been detected out of the driving position, the park brake

▼B

or park lock is not applied. The time-out of the alarm shall be not less than 10 seconds. The alarm shall be de-activated when the operator is detected to be present again in the driving position within this time period or when the park brake or park lock is applied within this time period.

9.2. Power take-off OPC

For vehicles of categories T and C the stationary power take-off operation shall be enabled by an intentional command from an operator when the tractor is not in motion.

When the operator leaves the driving position with the PTO engaged and the vehicle is not in motion, the drive of the power take-off shaft shall shut off automatically within 7 seconds. The automatic PTO shut off action shall not have negative effects on safety related functions (e.g. breaking). A restart of the Power take-off shall only be possible by an intentional actuation of the operator.

10. **Auto-guidance systems**

Auto-guidance systems for tractors (categories T and C) shall be in accordance with the requirements of, ISO 10975:2009.

11. **Complex electronic vehicle control systems**

Complex electronic control systems, as listed in appendix 2 of and as defined by (UNECE) Regulation No 79 shall comply with the provisions of Annex 6 to that Regulation.

▼M1

12. **Virtual terminals**

Control devices related to virtual terminals shall meet the requirements set out in Annex B of ISO 15077:2008.

▼B

Appendix 1

Figures

Figure 1

Rear hazard zone for location of hydraulic three point lift, PTO and remote valve external control device(s) (three possible locations: A, B or C)

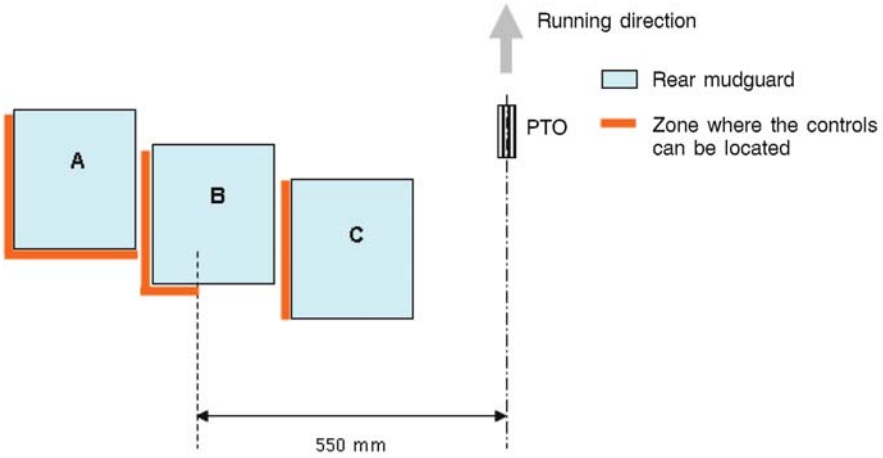
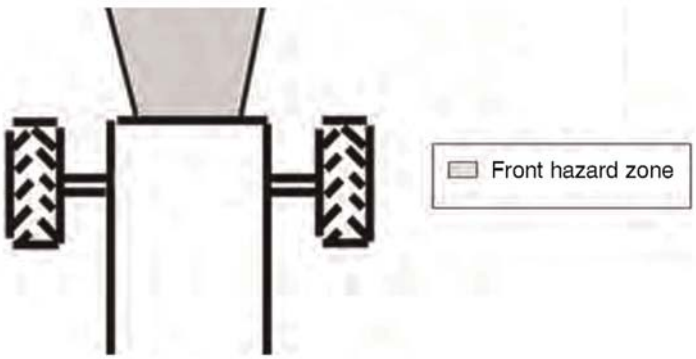


Figure 2

Front hazard zone for location of hydraulic three point lift, PTO and remote valve external control device(s). In the plan view, the front hazard zone is the isosceles trapezoid area, the oblique sides of which are the three-point lift arms: the smaller base of which is the projection of the front part of the tractor's body and the larger base of which is the line passing through the ends of the three-point lift arms.



▼B

Figure 3

Area without access to rear PTO and rear three point lifting internal control device(s) for tractors without cab, determined by the vertical planes passing on the inner edge of the mud-guards

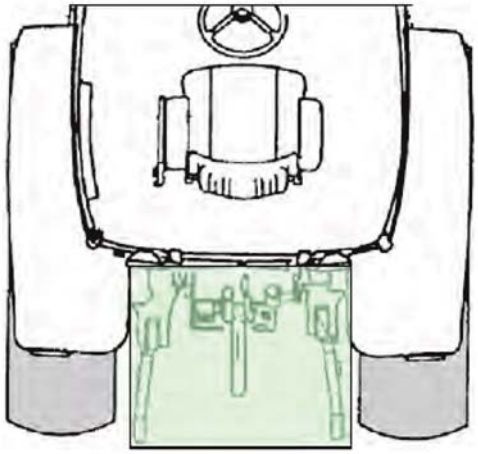
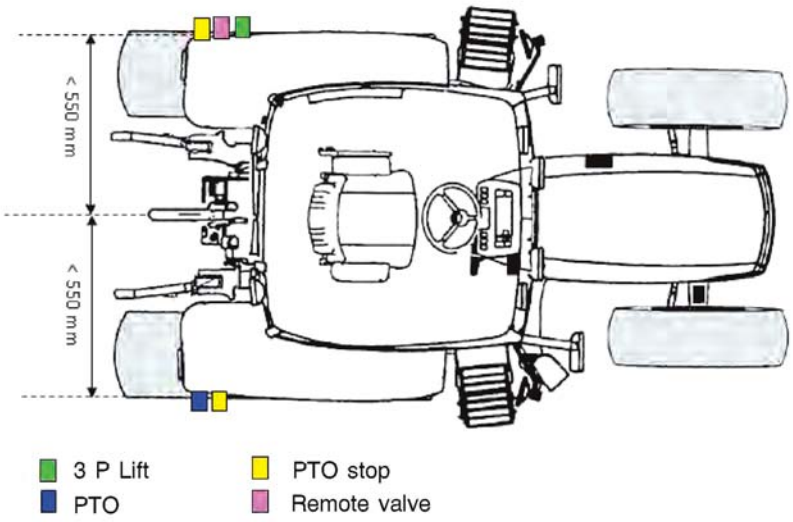


Figure 4

Example of external control device(s) arrangement without presumption of comprehensiveness



▼B

Appendix 2

Complex electronic vehicle control systems that must comply with the provisions of Annex 6 of UNECE Regulation 79

1. Systems that affect the steering function

2. …

▼B

ANNEX XXIV

Requirements applying to the protection against other mechanical hazards

1. **Layout and marking of flexible hydraulic hoses**

1.1. Flexible hydraulic hoses must be arranged in such a way as to prevent mechanical and thermal damage.

1.2. Flexible hydraulic hoses in the vicinity of the driver's or the passenger's seat must be arranged or protected in such a way that in the event of their failure there can be no danger to any person.

▼M1

1.3. Flexible hydraulic hoses must be clearly identifiable and indelibly marked in accordance with the requirements set out in paragraph 13 of ISO 17165-1:2007.

▼B

2. **R-category trailers with tipping capability (supports for service and maintenance)**

2.1. When it is necessary for the operator to work under raised parts of the machine in order to carry out maintenance or service, mechanical supports or hydraulic locking devices shall be provided to prevent inadvertent lowering.

2.1.1. Means other than mechanical or hydraulic devices are acceptable, provided an equal or greater level of safety is ensured.

2.2. It shall be possible to control hydraulic locking devices and mechanical supports from outside the hazard zones.

2.3. Mechanical supports and hydraulic locking devices shall be identified by use of a colour that contrasts with the overall machine colour or by a safety sign located either on, or in close proximity to, the device.

2.4. Supports or hydraulic devices manually controlled shall be identified with pictograms in accordance with Annex XXVI and instructions of use shall be provided in the operator's manual.

2.5. Mechanical supports

2.5.1. Mechanical supporting devices shall withstand a load of 1,5 times the maximum static load to be supported.

2.5.2. Detachable mechanical supports shall have a dedicated and clearly visible and identifiable storage position on the machine.

2.6. Hydraulic locking devices

2.6.1. Hydraulic locking devices shall be located on the hydraulic cylinder or connected to the hydraulic cylinder by rigid or flexible lines. In the latter case, the lines connecting the locking device to the hydraulic cylinder shall be designed to withstand a pressure at least four times the rated maximum hydraulic pressure.

▼B

2.6.2. The rated maximum hydraulic pressure shall be specified in the operator's manual. The conditions for the replacement of such flexible lines shall also be given in the operator's manual.

3. **Rough surfaces and sharp edges**

Parts that are likely to be contacted by the driver or passengers, while driving, shall have no sharp edges or rough surfaces hazardous to the occupants.

4. **Greasing points**

4.1. Greasing points shall be directly accessible by the operator or provided of rigid pipes or flexible high pressure lines to allow the greasing process from an accessible location.

▼M1

4.2. Greasing points shall be clearly identified on the vehicle with symbols, pictorials, pictograms or colour coding and its location and instructions of use shall be indicated in the operator's manual.

▼B

ANNEX XXV

Requirements applying to guards and protective devices

1. **Vehicles of categories T and C**

   For vehicles of categories T and C, the definitions and requirements are identical to those laid down in Annex XVII for the protection of drive components.

2. **Vehicles of categories R and S**

   For vehicles of categories R and S, the following requirements of Annex XVII for the protection of drive components shall apply:

   — section 2. General requirements,

   — section 3. Safety distances for avoiding contact with dangerous parts: points 3.1 to 3.2.6, and

   — section 4. Strength requirements for guards and barriers.

▼B

ANNEX XXVI

Requirements applying to information, warnings and markings

1. **Symbols**

1.1. Symbols used for the control devices indicated in Annex XXIII and other displays should comply with the requirements laid down in ISO 3767 Parts 1 (1998+A2:2012) and, if applicable, Part 2 (:2008).

1.2. Alternatively to the requirements set out in point 1.1, vehicles with symbols complying with the requirements laid down in UNECE Regulation No 60 shall be deemed to be complying with this Annex.

2. **Pictorials**

2.1. Hazard pictorials should comply with the requirements laid down in ISO 11684:1995.

2.2. Pictorials for personal protective equipment should comply with the requirements laid down in ISO 7010:2011.

▼M1

3. **Hydraulic couplings**

Hydraulic valves and the couplers on the hydraulic valves at the rear, front or sides of tractors, as well as the flow direction and the mode of operation, shall be identified by colour coding and/or numerals to be stated on durable labels resistant to oil, fuel, wear and chemical agents, such as fertilizers; its location, identification and instructions of use shall be indicated in the operator's manual.

▼B

4. **Jacking points**

Safe jacking points shall be identified by the manufacturer and clearly marked on the vehicle (e.g. with pictorials).

▼M1

5. **Additional warning signals with regard to braking**

Tractors shall be equipped with optical brake failure and defect warning signals, in accordance with points 2.2.1.29.1.1 to 2.2.1.29.2.1 of Annex I to Commission Delegated Regulation (EU) 2015/68 ([1])

([1]) Commission Delegated Regulation (EU) 2015/68 of 15 October 2014 supplementing Regulation (EU) No 167/2013 of the European Parliament and of the Council with regard to vehicle braking requirements for the approval of agricultural and forestry vehicles (OJ L 17, 23.1.2015, p. 1).

▼B

ANNEX XXVII

Requirements applying to materials and products

1. **Oil reservoirs and coolant systems**

   Oil reservoirs and coolant systems shall be located, constructed, coated and/or sealed to minimise the risk of spillage that might be injurious to the operator in the event of an overturn.

2. **Burning rate of cab material**

   The burning rate of cab interior material such as the seat covering, wall, floor and headliner coverings when provided shall not exceed the maximum rate of 150 mm/min when tested in accordance with ISO 3795:1989.

▼B

ANNEX XXVIII

Requirements applying to batteries

1. Batteries shall be located so they can be properly maintained and exchanged, from the ground or a platform, and shall be secured to remain in position and located or constructed and sealed so as to reduce the possibility of spillage in the event of an overturn.

2. The battery housing must be designed and constructed in such a way as to prevent the electrolyte being ejected on to the operator in the event of roll-over or tip-over and to avoid the accumulation of vapours in places occupied by operators.

3. The electrical, non-earth terminals of batteries shall be protected to prevent unintentional contact and shorting to earth.

4. Battery isolator

4.1. A vehicle must be designed and constructed in such a way that the battery electrical circuit can be easily disconnected with the aid of an electronic system or an accessible device provided for that purpose (e.g. the tractor's ignition key, common tools or a switch).

4.2. The position of the battery isolator must be easily accessible and not near dangerous areas.

4.3. When the battery isolator has neither a specific pictogram for its identification nor the indication of its operation (on-off), the specific graphical symbol indicated in the Figure 1 shall be affixed.

Figure 1

Graphical symbols for the identification of the battery isolator according to ISO 7000:2014 codes.

2063



code 2063 battery disconnected

0247



code 0247 battery connected

▼B

ANNEX XXIX

Requirements applying to protection against hazardous substances

1. **Definitions**

For the purposes of this Annex the following definitions shall apply:

1.1. ‘hazardous substances’ means any substance, such as dust, vapour and aerosol except fumigant which can occur when applying plant protection products and fertiliser and which can expose an operator to a risk of harm.

1.2. ‘plant protection product’ means any product falling within the scope of Regulation (EC) No 1107/2009.

▼M1

2. **Requirements for the cabin**

2.1. Vehicles of categories T and C fitted with a cab shall comply with the standard EN 15695-1:2009.

2.2. Vehicles of categories T and C, declared by the manufacturer to provide protection against hazardous substances shall be fitted with a cab of level 2, 3 or 4 according to the definition and complying with the requirements set out in the standard EN 15695-1:2009 (e.g. for a vehicle providing protection against plant protection products that produce vapours which can expose the operator to a risk or harm, the cabin shall be of level 4).

▼B

3. **Requirements for the filters**

3.1. Filters housing must have adequate sizes to allow convenient filter maintenance operations with no risks for the operator.

3.2. Vehicles of categories T and C providing protection against hazardous substances shall be fitted with a filter meeting the requirements of EN 15695-2:2009/AC 2011.

▼B

ANNEX XXX

Performance standards and assessment of technical services

1. **General Requirements**

Technical services shall demonstrate appropriate skills, specific technical knowledge and proven experience in the specific fields of competence covered by Regulation (EU) No 167/2013 and its delegated and implementing acts adopted pursuant to that Regulation.

2. **Standards with which the technical services have to comply**

2.1. Technical services of the different categories set out in Article 59 of Regulation (EU) No 167/2013 shall comply with the standards listed in Appendix 1 to Annex V to Directive 2007/46/EC of the European Parliament and of the Council ([1]) which are relevant for the activities they carry out.

2.2.1. Reference to Article 41 of Directive 2007/46/EC in that Appendix shall be construed as a reference to Article 59 of Regulation (EU) No 167/2013.

2.2.2. Reference to Annex IV of Directive 2007/46/EC in that Appendix shall be construed as a reference to Annex I to Regulation (EU) No 167/2013.

3. **Procedure for the assessment of the technical services**

3.1. The compliance of the Technical services with the requirements of Regulation (EU) No 167/2013 and the delegated acts adopted pursuant to that Regulation shall be assessed in accordance with the procedure set out in Appendix 2 to Annex V to Directive 2007/46/EC.

3.2. References to Article 42 of Directive 2007/46/EC in Appendix 2 to Annex V to Directive 2007/46/EC shall be construed as references to Article 62 of Regulation (EU) No 167/2013.

4. **Accredited in-house technical services of the manufacturer**

4.1. When a manufacturer or a subcontracting party acting on his behalf satisfies the standards set out in section 2. and the assessment procedure set out in section 2. may be allowed to be designated as a technical service by the approval authority within the meaning Article 60 of Regulation (EU) No 167/2013.

4.2. However, in order to prevent potential conflicts of interest, the responsibilities of the manufacturer should be specified and the conditions under which a manufacturer may subcontract tests shall be also indicated.

([1]) Directive 2007/46/EC of the European Parliament and of the Council of 5 September 2007 establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles (OJ L 263, 9.10.2007, p. 1).