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Safety of forestry machinery

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Contents

About this report

KAN has the task of safeguarding German occupational safety and health interests during the harmonization of standards within the European Single Market and of assuring the participation of the social partners in standardization processes. It therefore pursues the objective of ensuring that not only German and European but also international standardization gives the best possible consideration to OSH issues. KAN comprises five representatives each from employers' organizations, employees' organizations and the state and one representative each from the German Social Accident Insurance (DGUV) and DIN Deutsches Institut für Normung e.V.
KAN analyses OSH-related issues and identifies scope for improvement in standardization activity. One measure for this purpose is the commissioning of studies and reports.

Background

Prompted by KAN Report 41, "Safety of agricultural machinery", the "Forestry" Expert Committee of the German Social Accident Insurance (DGUV) requested a similar study from the KAN Secretariat on the safety of forestry machinery.
In the view of the OSH lobby, areas presenting problems exist in the forestry sector. These include the field of vision on forwarders, ladders for access to high equipment, and work platforms.
The study focused upon the standards governing large forestry equipment. This includes self-propelled harvesting machinery, winches and wood chippers.

- Harvesting machinery includes harvesters, skidders and forwarders. These machines are used to cut down trees and to transport them away.
- Winches used for forestry purposes are primarily skidding winches (fixed or detachable). Winches are however not used solely for cable skidding; yarders for example are also widely used for the recovery of logs harvested on slopes by means of chainsaws. For some years now, (traction) winches have also been used to secure self-propelled forestry machinery on inclines.
- Besides the harvesting of saw timber, the recovery of biomass for use as a source of energy is growing in importance. For this reason, the standard governing wood chippers was included in this study.

Purpose of the study

The purpose of the study was to determine whether, and to what extent, certain health and safety requirements of the 2006/42/EC Machinery Directive are supported in the standards governing large forestry equipment. The catalogue of requirements to be studied was drawn up with the co-operation of the DGUV's "Forestry" Expert Committee and the umbrella association of the agricultural social insurers. The information in brackets refers to sections of the Machinery Directive, Annex I:

- Requirements concerning visibility (e.g. 3.2.1 Driving position; 1.2.2 Control devices)
- Requirements concerning the avoidance of whole-body vibration (e.g. 1.1.8 Seating)
- Requirements concerning the accessibility of components and assemblies for maintenance, cleaning and adjustment purposes and for repairs (e.g. 1.6.2 Access to operating positions and servicing points)
- Requirements concerning the stability of machines and their suitability for use on inclines (e.g. 1.3.1 Risk of loss of stability; 3.4.3 Roll-over and tip-over)

- Requirements concerning the protection offered by drivers' cabs against falling objects or tipping (e.g. 3.4.4 Falling objects; 3.4.3 Roll-over and tip-over)
- Requirements concerning the driver's cab regarding the minimum internal dimensions, the climate, and safe access by ladders (e.g. 1.1.6 Ergonomics; 1.1.7 Operating positions; 1.6.2 Access to operating positions and servicing points)
- Requirements for the machines concerning the facility for storage of personal items and machine accessories (e.g. 1.1.7 Operating positions)
- Requirements concerning actuating forces
- Requirements concerning lighting (e.g. 1.1.4 Lighting)
- Fire prevention and protection measures (collection of brushwood on the machine) (e.g. 1.5.6 Fire)
- Requirements concerning starting and braking (e.g. 1.2.3 Starting; 3.3.3 Travelling function)
- Switching off of drives, emergency stopping (e.g. 1.2.4.1 Normal stop; 1.2.4.3 Emergency stop)

The study was to cover not only the standards governing self-propelled forestry equipment, winches and wood chippers, but also the documents to which reference is made in the standards stated. The estimation of the extent to which the requirements of the Machinery Directive are observed was to be substantiated.

Proposals for improvements were to be formulated which could be submitted to the standardization process. Should this not be possible, the reasons were also to be stated.

KAN wishes to thank the project partner, Dr. Günther Weise, for conducting the project, and the following experts in the supervisory project working group for their supervision and support:

- Martin Hartenbach, umbrella association of the agricultural social insurers (LSV-SpV)
- Torben Hötter, Stuttgart Regional Council
- Dr. Albert Hövel, DIN Deutsches Institut für Normung e.V.
- Günther Koch, German Social Accident Insurance Institution for the public sector in Saxony-Anhalt
- Hans-Jürgen Narjes, Arbeitsgemeinschaft forstwirtschaftlicher Lohnunternehmer Niedersachsen e.V.
- Katharina von Rymon Lipinski, KAN Secretariat
- Marc Schulze, German Federal Ministry of Labour and Social Affairs
- Hans Werner Seidemann, Darmstadt Regional Council
- Werner Sterk, Head of the KAN Secretariat

Summary by KAN

The study reveals the points at which standards satisfy the studied requirements of the Machinery Directive and those at which, from a prevention perspective, amendments are required.

Four standards were studied, together with the documents referred to in them where relevant to the evaluation. The task was limited to the standards governing large forestry equipment:

- Self-propelled forestry machinery (prEN ISO 11850; EN 14861)

- Winches (EN 14492-1 and ISO 19472)
- Wood chippers (EN 13525)

Approximately 100 requirements relevant to the points stated by KAN were identified in the Machinery Directive; for some points, only a small number of requirements are formulated in the directive (such as requirements concerning vibration, actuating forces or prevention of and protection against fire). A large number of requirements are formulated with regard to the areas of visibility, stability, dimensions, climate, access to the driver's workplace, starting/braking and emergency stopping. Other topics of importance from the perspective of prevention, such as facilities for storing tools and/or food for the driver, are not explicitly covered in the directive.

The analysis conducted by the project partner showed that many of the requirements in the Machinery Directive are adequately supported in the standards. Some requirements however were not adequately supported.

Broad areas presenting problems:

- A major problem area is that of visibility of the danger zone. In this area, requirements must be added to the standard – particularly for self-propelled forestry machinery – or a dedicated visibility standard developed for forestry machinery.
- A further issue is that the topics of emergency stopping and remote control are dealt with inadequately, or not at all.
- The standards studied also fail to address ergonomics adequately; reference is made in this context to standards which in some cases are obsolete. Specific requirements in this area should be formulated in the standards themselves, or the references updated.

Problems relating to particular standards among those studied:

- The standards governing winches should be merged and amended; all winch groups (traction winches, yarders, winch units) must be treated separately.
- The standard governing wood chippers should be amended in its scope and with regard to the requirements to include machinery for professional wood-chip production with charging by crane.

KAN's recommendations

KAN requests that **DIN**:

- distribute the report in the agricultural engineering standards group in NAM, and through it, also to the relevant European and international standards committees.

The **KAN Secretariat** is mandated:

- to make the results of the study known in the relevant institutions and committees, such as the "Forestry" Expert Committee of the DGUV;
- to disseminate the results within EUROSHNET;
- to apply to the agricultural engineering standards group for the work item for yarders to receive German support;
- to apply to DIN for requirements concerning slinging equipment for cable skidding to be governed by standards;
- to apply to DIN for the formation of a standing committee on forestry machinery serving as a mirror committee to the European and international standards committee;

- to lobby for this mirror committee, once it has been established, to develop concrete proposals for amendments based upon the results of the study, and to submit them to the standardization process at European and international level.

The **KAN stakeholders** are requested:

- to play an active role in the standardization activity, and
- to adopt, at national level, a co-ordinated OSH position in the committees which, following attainment of a consensus, can be presented as a German position to European and international standardization activity.

1 Standards examined

The following standards were examined within the scope of the study:

- Draft of ISO 11850, "Machinery for forestry – General safety requirements"

Responsibility for the development and updating of ISO 11850 lies with Technical Committee ISO TC 23 (Tractors and machinery for agriculture and forestry), specifically its Subcommittee SC 15 (Machinery for forestry). The secretariat of this subcommittee is maintained by MTT (Finland). A German mirror committee still exists at the Mechanical Engineering standards committee (NAM) of DIN. This is not a permanent mirror committee of ISO TC 23 SC 15; instead, a working group is convened by the responsible secretary on an ad-hoc basis to handle the tasks as they arise.

At the time of commissioning of the study (beginning of 2010), the ISO/DIS 11850:2009 draft was available. This served as the basis for an initial evaluation of the standard. SC 15 of ISO TC 23 met in Edinburgh in May 2010; the project partner attended this meeting. Ahead of this meeting, the German position had been agreed in an ad-hoc working group organized by the Agricultural Engineering standards group at the VDMA, in which KAN and the project partner were also involved. Preliminary results of work had already been considered in this context. The present study is based upon ISO/FDIS 11850:2010, which exhibits significant changes from the previous draft.

- DIN EN 14861:2004, "Forest machinery – Self propelled machinery – Safety requirements"

Responsibility for the European safety standard EN 14861 for forest machinery, currently in force and listed in the Official Journal of the EU, lies with CEN TC 144, "Tractors and machinery for agriculture and forestry". The secretariat of this committee is maintained by AFNOR (France). A German mirror committee formally exists within NAM. This standard was not examined in full during the study, but only referred to for the purposes of comparison. Plans are for ISO 11850 to be adopted at European level following its finalization, and for EN 14861 to be withdrawn.

- DIN EN 14492-1:2006+A1:2009, "Cranes – Power driven winches and hoists – Part 1: Power driven winches"

This standard was developed by CEN TC 147, "Cranes – Safety" (secretariat: BSI, United Kingdom) of the European Committee for Standardization (CEN). The latter's German mirror committee is also maintained at NAM. The standard has a particular status in the context of this study, since it was developed by a committee that principally addresses issues concerning cranes and hoists. The resulting standard therefore primarily addresses hoist operations; although it explicitly considers rope winches for forestry use, it generally regards them only as a subordinate category of winches.

At the time of commissioning of the study, the preceding, only the 2006 version was still available. Whilst the study was in progress, a revised version of the standard was presented which has adopted requirements of the new 2006/42/EC Machinery Directive. The latest version (see title) of the standard was used for the study.

- ISO 19472: 2006, "Machinery for forestry — Winches — Dimensions", performance and safety

This standard was developed by ISO TC 23 SC 15, "Tractors and machinery for agriculture and forestry/Machinery for forestry", the secretariat of which is maintained by MTT in Finland.

- DIN EN 13525:2005+A1:2007, "Forestry machinery – Wood chippers – Safety"

This standard was developed by CEN TC 144, "Tractors and machinery for agriculture and forestry". The secretariat of this committee is maintained by AFNOR (France). A German mirror committee exists within NAM.

2 Subjects considered

In commissioning this study, KAN specified a number of subjects and safety objectives of Annex I of the EU Machinery Directive that were to be considered in the study. The list was drawn up in conjunction with the "Forestry" Expert Committee of the DGUV. The experience of experts also resulted in further important subjects being included.

- Requirements concerning visibility (e.g. 3.2.1 Driving position; 1.2.2 Control devices)
- Requirements concerning the avoidance of whole-body vibration (e.g. 1.1.8 Seating)
- Requirements concerning the accessibility of components and assemblies for maintenance, cleaning and adjustment purposes and for repairs (e.g. 1.6.2 Access to operating positions and servicing points)
- Requirements concerning the stability of machines and their suitability for use on inclines (e.g. 1.3.1 Risk of loss of stability; 3.4.3 Roll-over and tip-over)
- Requirements concerning the protection offered by drivers' cabs against falling objects or tipping (e.g. 3.4.4 Falling objects; 3.4.3 Roll-over and tip-over)
- Requirements concerning the driver's cab regarding the minimum internal dimensions, the climate, and safe access by ladders (e.g. 1.1.6 Ergonomics; 1.1.7 Operating positions; 1.6.2 Access to operating positions and servicing points)
- Requirements for the machines concerning the facility for stowage of personal items and machine accessories (e.g. 1.1.7 Operating positions)
- Requirements concerning actuating forces (e.g. 1.1.2. Principles of safety integration)
- Requirements concerning lighting (e.g. 1.1.4 Lighting)
- Fire prevention and protection measures (collection of brushwood on the machine) (e.g. 1.5.6 Fire)
- Requirements concerning starting and braking (e.g. 1.2.3 Starting; 3.3.3 Travelling function)
- Switching off of drives, emergency stopping (e.g. 1.2.4.1 Normal stop; 1.2.4.3 Emergency stop)

For these subjects, the safety objectives of the Machinery Directive and the health and safety requirements were to be identified, to be examined regarding their relevance to the forestry machinery groups stated, and their implementation in the body of standards to be assessed.

3 Performance of the study

3.1 Steps

Performance of the study was divided into the following steps:
1) The health and safety requirements stated were broken down according to their content and assigned to subjects. For this purpose, the relevant requirements of the EU Machinery Directive, 2006/42/EC, were first examined and listed. These requirements were evaluated with regard to their relevance to the forestry machinery groups stated.

2) For further performance of the study, a suitable relational database was created in which references, evaluations and links could be saved and interpreted. Requirements and references were compared with each other and evaluated. Where deficits were identified, they were compiled and referenced to the individual standards in a table. The results can be found in Annexes II to V.

3) The next step involved differentiated searches regarding the individual health and safety requirements: in the machine-specific standards, and where appropriate, in documents to which these standards refer. In this step, the extent was examined and evaluated to which the standards for forestry machinery reflect the requirements of the Machinery Directive. For each discrete requirement identified, the relevance to the machinery group was first estimated. Where relevance was identified, the standard under consideration was examined with regard to whether it implemented the requirements of the Machinery Directive. Implementation was assessed and expressed in this case in the form of academic grades. Where appropriate, proposals for improvements were drawn up and substantiated based upon the evaluation for discrete requirements.

4) Interim results of the searches in standards were presented to a KAN project support group at two meetings on 1 June 2010 and 22 September 2010, and a draft of the final report on 19 January 2011. The results of the discussion in the project support group were incorporated into the study.

3.2 Methods

A relational database was used for completion of the study. This enables the requirements identified in Annex I of the Machinery Directive to be cross-referenced, separately for each standard, to the references in the standards under consideration. Each subject (see Chapter 2) was first assigned a number (requirement code; see Table 1). The requirements of the Machinery Directive identified within this subject were also assigned a number (the requirement number). The requirements were compared individually for each of the four standards.

An assessment was first conducted of the requirement's relevance to the machinery group. Where relevance was established, searches were performed in the standard for associated references. A single requirement could be assigned to several references in a standard under consideration. The quality of implementation of the requirements was assessed in the comparison. For this purpose, academic grades were awarded for the combination of requirement and references in the standard. All combinations of requirement and reference in the standard to which grades of 1 (the highest grade) to 3 were awarded implement the requirements of the Machinery Directive sufficiently well for no need for amendment to be deemed necessary. Where a grade of 4 was assigned, the implementation was considered to warrant improvement. Relationships

to which a grade of 5 or 6 was assigned fail to satisfy the requirements of the Machinery Directive.

4 Results

4.1 Requirements of the Machinery Directive concerning the subjects of the study

The number of requirements identified for each subject is shown below. Even though the information provides no indication of the importance of the individual requirements and safety objectives, it nevertheless shows the scope and need for regulation in the individual subjects for which the Machinery Directive makes provision.

Table 1 Number of identified requirements in the subjects to be studied, together with the corresponding requirement code

Requirement code	Subjects for which requirements in Annex I of the Machinery Directive must be identified	Number of identified requirements (requirement numbers)
1	Visibility	15
2	Avoidance of whole-body vibration	8
3	Accessibility of components and assemblies for maintenance, cleaning and adjustment purposes and for repairs	17
4	Stability of machines and their suitability for use on inclines	13
5	Protection offered by drivers' cabs against falling objects or tipping	8
6	Minimum internal dimensions and climate of the driver's cab, and safe access to it by ladders	11
7	Facility for stowage of personal items and machine accessories	3
8	Actuating forces	3
9	Lighting	3
10	Fire prevention and protection measures	4
11	Starting and braking	20
12	Switching off of drives, emergency stop	14

For the areas in particular of visibility, access, stability, dimensions, climate, access to the driver's position, starting/braking and emergency stop, the Machinery Directive formulates a large number of requirements and safety objectives. Substantially fewer references are found for the subjects of stowage, actuating forces, lighting and fire prevention and protection. A moderate number of requirements were identified concerning protection against whole-body vibration and the protection afforded by the driver's cab.

The authors of the Machinery Directive therefore saw a particularly high need for regulation in traditional safety functions, such as protection against possible hazards presented by moving parts of machinery, visibility of persons in danger, the stability of the machine, and safe access to it. The complete list of references is appended to the present report in the form of Annex I.

4.2 Implementation of the requirements for the standards under consideration

4.2.1 Draft of ISO 11850, "Machinery for forestry – General safety requirements"

The scope of the draft of ISO 11850 covers fellers, bunchers, delimbers, forwarders, log loaders, skidders, processors, harvesters and mulchers to ISO 6814, and multi-function versions of these machine types. Certain essential hazards are not covered by this standard. Specific hazards presented by certain individual machines (caused for example by harvesters, fellers or bunchers, or by bunching structures) are not addressed. Chain shot, caused by chain breakage on the upper side of the bar (for example on harvesters), lifting operations, remote control operation, the need for work lights and road safety are likewise excluded from the scope of the standard. Hazards associated with maintenance by professional service personnel are also excluded from the addressed risks. In these cases, manufacturers of machinery rely upon generic Type A and B standards, their own risk assessments conducted on the basis of the Machinery Directive, or other sources of information on the state of the art.

The test methods for vibration and noise exposure are not addressed conclusively. With regard to ISO 11837 (chain shot guarding systems) and ISO 15818 (lifting and tying-down attachment points), to which reference is made in the draft of ISO 11850, the reference refers to drafts of the standards; this is a cause for some concern, particularly with regard to ISO 11837, since this standard is still at the DIS stage, and the hazard presented by chain shot must be considered substantial. In addition, essential hazards relevant to forestry have been excluded from the scope of the standard. Annex ZA of the draft makes reference to the mandate to CEN for the development of this standard, which is intended to facilitate satisfaction by the machinery compliant with it of the essential requirements of the EU Machinery Directive. Owing to the exclusion of essential risks and the as-yet inconclusive treatment of essential reference standards, the coherence between the scope of the standard and the assertion of Annex ZA appears to be at least in doubt.

4.2.1.1 Requirements of the Machinery Directive which are not met

Annex II contains a comparison of the requirements of the directive in Annex I which have not been implemented in ISO 11850, and the corresponding references of the draft standard. Subjects, safety objectives and associated risks that are deemed not relevant in the standard are not listed. In cross-references to the annex, the requirement number and requirement code are stated, separated by a dot.

A point of criticism is that the draft standard fails to address the requirement of the Machinery Directive for emergency-stop devices (refer in this context to Annex II 1.3, 1.4, 12.1, 12.2, 12.5). The standard also fails to adopt certain requirements concerning the vibration exposure, namely that for a seat which reduces exposure to vibration (see Annex II 2.1). Certain specific requirements of the directive concerning the instructions are not addressed (see Annex II 3.9); instead, reference is made to two standards (ISO 3600 and ISO 6750) for the production of instructions, preference generally to be given to ISO 6750 over ISO 3600. Removable mechanical transmission devices (see Annex II 3.12) are also not addressed, despite the importance of this aspect for mounted machines. Control devices are the subject of requirements regarding their location but not, as also required by the directive, their identifiability (see Annex II 1.2). Requirements concerning warning prior to starting are also

addressed either not at all or only for reverse travel, and not in the sense of the delayed starting required in the directive (see Annex II 1.2). A deficit in the standard is observed with regard to the requirements governing protective devices (see Annex II 11.11); many machines are fitted with seat contact switches which prevent machinery from being operated unless the driver is on the seat. As yet however this has not been addressed by the standard. Instead, the requirements of the standard concentrate upon protecting the operator against bursting hydraulic hoses.

Specifically on multi-function machinery or where traction winches are used, operating mode selectors are increasingly found; to date, these have not been addressed by the standard. The Machinery Directive contains certain provisions regarding these machine types which should be implemented in consideration of the risks present (see Annex II 1.4 and 12.7).

4.2.1.2 Unsatisfactory implementation of the requirements of the Machinery Directive

Certain requirements of the Machinery Directive have not been implemented at all; others have been implemented in a manner that is formally correct, but with unsatisfactory formulations. In certain points, reference is made to the safety objectives of the Machinery Directive without the designer being given much in the way of concrete assistance in designing the machine such as to be safe. A grade of 4 was awarded following evaluation of the requirement and its implementation in the standard.

Passages where this was the case were particularly those concerning the areas of visibility and stability. For these aspects in particular, the existing standard must be supplemented by the formulation of specific requirements which permit testing on the machine. In this context, consideration must be given to the requirement in the Machinery Directive (Annex I 3.3.2) for checking to be possible of whether devices exceed the normal clearance zone and thereby present hazards when the machinery is moved. The most urgent aspect is the formulation of specific requirements concerning visibility; virtually no consideration is given to the requirement of the Machinery Directive that guards and protective devices, where fitted, must not obstruct visibility (Annex I 1.4.1). The requirements concerning the isolation of energy sources (1.6.3) are formulated in a manner not entirely consistent with the wording of the Machinery Directive. The requirement of the Machinery Directive (1.2.4.1) for it to be possible to bring the machinery to a stop from any workstation must be implemented.

Maintenance work is a further area presenting problems. An essential requirement is for the performance of routine lubrication and maintenance to be possible with the engine stopped (FDIS ISO 11850: 4.18); at the same time however, the operator's manual is to state the procedures to be followed when work is to be performed with the machine running (FDIS ISO 11850: 5.1 t). In this context, it should be examined how not only organizational, but also engineered measures can be used to ensure more effectively that work performed with the engine running is carried out not by the normal operating personnel, but by specialist service personnel. The standard fails to cover any risks associated with such work. An appropriate distinction between forms of maintenance work should be drawn in the philosophy of the standard, and applied consistently.

A further essential point is the design of access systems. These are governed comprehensively and in detail by the reference to ISO 2867; in practice, however, problems continue to arise during implementation on machinery, particularly with regard to maintenance points and steps providing access to them. It should therefore

be examined to what extent requirements in this area must be substantiated. Provisions could for example govern possible improvements to the concept for daily maintenance (for example by the provision of central lubrication, or constraints upon daily maintenance operations).

Finally, the standard currently contains provisions only concerning the location of the controls within the zones of comfort and reach. The specific requirements of the Machinery Directive governing identifiability, which are addressed by more recent standards such as DIN EN 894, should be implemented.

4.2.1.3 Recommendations

Owing to the diversity of the types of forestry machinery and the wide range of risks covered, the existing draft does not have the character of a Type C standard. It should therefore be reformulated as a generic standard governing this group of products, and supplemented by specific product standards, for example governing harvesters, forwarders or skidders. In addition, the author of the study recommends that the large number of excluded risks, which substantially impair the presumption of conformity to which the standard gives rise, be replaced by suitable normative provisions. Where provisions are missing, particularly regarding emergency stop devices, they should be added. Passages in the standard in which deviations have been identified from the requirements of the Machinery Directive should be reviewed and if appropriate brought into line with the latter. A consistent distinction should be drawn in the operator's manual between operating and service personnel, and a corresponding provision added to the standard. Where beneficial and necessary, test standards should be created for substantiation of the safety objectives formulated in the requirements of the Machinery Directive, some of which are merely referred to (visibility, stability, lighting, chain shot). During work on test standards which have not yet been completed or the revision of which is pending (ISO 11837 and ISO 11839, ISO 8082 -1/-2) to which reference is made in ISO 11850, continued German involvement should be ensured.

With regard to the stowage of personal items, the standard surpasses the requirements of the Machinery Directive; the Machinery Directive requires a stowage facility only for the instructions. Where working shifts are long and the nearest human settlement some distance away, the requirement for a stowage facility for a lunch box is advantageous, as is that for the provision of a first-aid kit. Further ergonomic and occupational medical studies appear warranted in order for this aspect to be addressed conclusively.

4.2.2 "Cranes – Power driven winches and hoists – Part 1: Power driven winches"; German version EN 14492-1:2006+A1:2009/EN 14492-1:2010

The scope of the standard covers design, user information, maintenance and testing of power driven winches the main drive of which is an electric motor, hydraulic motor, internal combustion motor or pneumatic motor. The winches addressed by the standard are designed for:
The lifting and lowering of loads suspended on hooks or other load handling devices
The lifting and lowering of loads on inclines
The exclusive pulling of loads on planes which are normally horizontal

As a rule, winches are used without additional transport movement. Winches used in forestry fall within the scope of the standard. The German national foreword indicates in addition that the concept of a crane extends to include all machines employed for cyclical lifting or cyclical lifting and transport of loads suspended on hooks or other

load handling devices, i.e. that it also extends to winches where they satisfy this definition. It may therefore be assumed that skyline cranes also fall within the scope of the standard. EN 14492-1 defines forestry winches as follows: "Rope winches fitted to forestry machines such as pushing tractors and row crop tractors according to ISO 6814 and used on agricultural tractors, e.g. for fitting in a three-point rod assembly, used for pushing works in the forest." ISO 6814 in turn includes skyline cranes. Finally, EN 14492-1 makes reference in 5.16 to pulling on the ground, but only by specifying rope-end terminations for this application. Conversely, EN 14492-1 contains no definition of "pushing works". For this reason, too, it may be assumed that EN 14492-1 also covers skyline cranes and the lifting processes performed by them in the sense of the Machinery Directive. It may however be assumed that the authors of EN 14492-1 did not primarily have forestry machines of this type in mind, with the result that certain aspects were not addressed in consideration of the actual working procedures and risks associated with the use of skyline cranes for skidding, and that the necessary attention was not paid in the standard to certain significant risks arising specifically with this group of machines.

The classification of traction winches, the significance of which has increased in recent years, is also unclear. The definition of vehicle recovery winches, the requirements of which are occasionally referred to as an alternative, refers according to Section 3.30 of the standard to inoperative vehicles. By contrast, traction winches are employed on fully operative vehicles.

No risks are excluded in principle with regard to certain safety objectives of the Machinery Directive. However, EN 14492-1:2010 contains no provisions for a considerable number of hazards, as indicated by the list of significant hazards which it contains. The standard classifies the following hazards as not being applicable to winches:

Mechanical hazards
- Caused by machine parts or workpieces, for example due to their relative location

Thermal hazards, resulting in
- Damage to health by hot or cold working environment

Hazards generated by vibration
- Use of hand-held machines resulting in a variety of neurological and vascular disorders
- Whole-body vibration, particularly when combined with poor postures

Hazards generated by radiation
- Low-frequency, radio-frequency, microwave radiation
- Infrared, visible and ultraviolet light
- X-ray and gamma radiation
- Alpha, beta rays, electron or ion beams, neutrons
- Lasers

Hazards generated by materials and substances processed or used by machinery and parts of it
- Biological or microbiological hazards (viral or bacterial)

Hazards generated by neglecting ergonomic principles in machinery design as, e.g. hazards from:
- Inadequate consideration of hand-arm or foot-leg anatomy
- Neglected use of personal protective equipment
- Mental overload and underload, stress

Combinations of hazards

Unexpected start-up, unexpected overrun/overspeed (or any similar malfunction) caused by

- Operator error (attributable to mismatch of machinery with human characteristics and abilities)

Variations in the rotational speed of tools
Loss of stability/overturning of machinery
Slipping, tripping or falling of persons (related to machinery)
Relating to the travelling function of the machine:
- Travel during start-up of the machinery
- Travel without the driver being on the driver's seat
- Travel without all parts being in a safe position
- Excessive speed of a pedestrian-controlled machine
- Excessive oscillations during travel
- Inadequate facility for the machine to be slowed down, stopped and immobilized

In relation to the work position (including driving station) on the machine
- Falls by persons whilst accessing or exiting the work position
- Exhaust fumes/insufficient oxygen at the work position
- Fire (flammability of the cab, lack of extinguishing means)
- Mechanical hazards at the work position

a) Contact with the wheels
b) Rollover
c) Falling of objects, penetration by objects
d) Break-up of parts rotating at high speed
e) Contact of persons with machine parts or tools (on pedestrian-controlled machines)
- Inadequate visibility from the work position
- Inadequate lighting
- Inadequate seating
- Vibration at the work position
- Inadequate facilities for evacuation/emergency exit

Due to the power source and transmission of the power
- Hazards presented by the engine and batteries
- Hazards presented by the transmission of power between machines
- Hazards presented by couplings and towing

Caused by/presented to third parties
- Lack or inadequacy of visual or acoustic warning means

Additional hazards and hazardous events presented by lifting operations
- Collision of more than one machine
- Due to access by persons to load supports
- Due to derailment

Hazards caused by neglect of ergonomic principles (with the exception of inadequate visibility from the driving position)
Additional hazards, hazard situations and hazard events due to underground work
Additional hazards, hazard situations and hazard events due to the lifting and moving of persons

In consideration of forestry operations and the manner in which forestry machinery is used, the following must be regarded as issues:

Failure to observe the ergonomic requirements
Failure to consider the issue of stability
Failure to observe the inherent mobility of machinery
Exclusion of risks associated with the transmission of power between machines
Failure to address hazards presented by couplings and towing

Specifically detachable rope winches (as in the example machines in Annex A.5 of EN 14492-1) are generally driven by the tractor power take-off shaft; consideration must

therefore be given to the transmission of power between machines. A further point of criticism concerns the failure of the standard to address risks associated with the falling of objects. Such hazards particularly exist on skyline cranes used for forestry work, treatment of which has been excluded in the standard under consideration. The same applies to the exclusion of the risk presented by fire hazards. More complex machines used in forestry, with its associated fire risk, such as the skyline cranes already referred to, require provisions governing this aspect. Finally, risks caused by inadequate visibility from the work position are also not addressed. Specifically on forestry winches, which are often operated by remote control by a person located some distance from the winch, or on skyline cranes, which often involve the use of several remote controls along the ropeway, visibility requirements must be formulated and the means described for compensating for any obstructions to visibility.

4.2.2.1 Requirements of the Machinery Directive which are not met

Annex III compares the requirements of the Machinery Directive which have been identified and deemed relevant with the associated passages in EN 14492-1 in which safety objectives are implemented inadequately or not at all. Points for which risk exclusions exist have not been listed. The very high number of risks which exist in forestry but are not addressed places the reliability of the standard's Annex ZA at least in doubt. Some of the essential requirements of Annex I of the Machinery Directive require the use of other tools for their observance.

The first point of criticism is the omission of provisions governing the use of mechanical transmission devices, which are present on many detachable winches (see Annex III 3.12). A stowing facility for the mechanical transmission device when not in use must be a minimum requirement. Provisions are also lacking in this context governing the stable stowage of such detachable winches (see Annex III 4.1). Transport, fitting, removal and stowage could on the whole be governed more comprehensively. In some cases, recourse must be made to the generic safety standard (EN ISO 12100-1 and -2). As was the case for the draft of ISO 11850, EN 14492-1 contains no provisions governing the use of remote controls, despite these now being standard on winches and work regularly being performed on skyline cranes at multiple and changing work positions with the use of remote controls (see Annex III 1.9 and 1.12). A relatively large number of points were identified in which the requirements of the Machinery Directive concerning maintenance of the machine are not adequately implemented (see Annex III 3.1, 3.6, 3.7, 3.17). This again concerns skyline cranes and certain less common types of winch such as standalone sled yarders or self-propelled winches with integral drive. Besides the usual winch maintenance points of rope winches (rope drum), these devices have additional maintenance points on the motor and drive, and in some cases even internally, which must be addressed by the standard. It may then be appropriate to consider regulating the access and lighting for maintenance purposes. The standard also fails to describe any adequate protective measures for access to the maintenance points on many detachable winches. The requirements of the Machinery Directive are not fully implemented with regard to control devices. It should be considered in this context whether further substantiation of the requirements is necessary for forestry operations (see Annex III 3.6, 3.7, 6.9, 8.3, 11.2, 12.2).

Risks arise during the operation of traction winches when operation is not performed in the correct sequence during attachment and release. The specified facility for ensuring that this sequence is observed is however not addressed by the winch standard. Operating mode selectors required for this purpose are state of the art on skyline cranes, traction winches, and rope winches with remote control (see Annex III 1.4, 1.9, 1.12, 3.3, 3.15).

In this context, information concerning formulation of the operating instructions should also be included in the standard to the effect that the winches should as a rule be operated by persons wearing personal protective equipment. The wearing of PPE should also be considered in the requirements governing design of the controls (e.g. the remote control device) (see Annex III 8.1, 8.2, 8.3). At the same time, the hazard presented by hot or cold surfaces or by spray should be addressed more comprehensively (see Annex III 6.5).

The following points are also governed inadequately:
The requirements concerning the provision of mechanical protection against the risk of break-up during operation fall short of those of the Machinery Directive (see Annex III 5.2).
No requirements are formulated governing selection of the operating mode of rope winches, which is usual on traction winches and also on winches of other types. This also applies to possible differences in application (see Annex III 1.4, 3.3, 3.15).
No consideration is given to the requirements of the Machinery Directive concerning visibility of the danger zone prior to starting. The standard has also failed to address hazards arising from operation from multiple work positions (as is the case with skyline cranes). The Machinery Directive contains requirements concerning the subject of visibility which EN 14492-1 fails to address, since the standard did not consider poor visibility a significant hazard for the operator (see Annex III 11.2, 12.2).
The machine group of skyline cranes exhibits further risks which are not governed, such as falling loads (see Annex III 4.12). Requirements concerning machines as a whole (such as yarder and carriage) are also not addressed for this group of machines (see Annex III 11.6).
The extensive provisions of the Machinery Directive governing the isolation of energy sources are implemented in EN 14492-1 essentially by the requirement for hold-to-run control elements. On more complex winch systems however (winches with integral drive, skyline cranes), more far-reaching requirements may have to be observed. Where energy-storage devices (such as pressure accumulators) are present, provisions must be included concerning dissipation of the residual energy (see Annex III 11.13, 12.12).

Guards are significant for winches (see Annex III 3.5, 12.10). These are specified; not all specific provisions of the Machinery Directive are fully implemented, however (e.g. prevention of movement in the case of moveable guards, or for maintenance to be performed without removal of the guard if at all possible). The requirements for appropriate assembly instructions for the avoidance of noise and vibration are also not observed (see Annex III 2.7). Specifically on mechanically driven winches with permanently running input shaft, it is essential for the requirement formulated in the Machinery Directive to be included for monitoring of the stop condition (see Annex III 12.4). Finally, requirements governing actuating forces are also not specified: this may be an issue, at least on mechanically powered winches, on which actuating forces may be high (see Annex III 8.2).

4.2.2.2 Unsatisfactory implementation of the requirements of the Machinery Directive

For EN 14492-1, too, certain points are identified at which the requirements of the Machinery Directive warrant better substantiation. The requirements governing the operating instructions should for example be formulated more precisely, since some passages of Sections 7.1 and 7.2 address the requirements of the directive, some of which are more specific, in only very general terms. Requirements governing the equipment are formulated only for winches in potentially explosive atmospheres;

requirements for fire prevention and protection against fire are formulated only for the hydraulic system; mention should be made of hazards typical of forestry (accumulation of flammable material). Whereas the requirements concerning starting are well implemented, those for stopping are limited almost entirely to the hold-to-run controls. This also applies to implementation of the requirements for accidental restarting not to be possible following failure of the power supply, and for it not to be possible for stopping to be prevented. A direct control for stopping, as provided for in the Machinery Directive, is not a requirement. This wider subject requires review.

With regard to the emergency stop devices specified by the Machinery Directive, EN 14492-1 refers to the withdrawn EN 418 rather than to the more recent EN 13850. In addition, no emergency-stop requirements whatsoever are formulated for mechanically powered winches. The permitting of restarting by resetting of the emergency stop should also be reviewed in consideration of the widespread use of radio remote controls and the conceivable internal faults associated with them. The requirements concerning marking of the machines also leave scope for improvement.

The references to standards in general are seen to be a failing in the standards under consideration, often being outdated or incorrect. EN 14492-1 Section 7.1 for example makes reference to EN ISO 12100-1 Section 6, which does not exist (Part 2 of DIN EN ISO 12100 is probably intended), and Annex ZA refers to the previous Machinery Directive, 98/37/EC.

Whereas 1.6.3 of the Machinery Directive requires dissipation of the residual energy, the standard requires only the isolation of stored-energy systems. Where warning signs are required, they are not specified, but only listed.

For forestry winches, the requirement for protection of the control station is formulated only in general terms; no requirements that can be tested against standards are formulated, despite the availability of a test standard in the form of ISO 8084.

Provision is made for warning information only in the operating instructions, and not for affixing to the machine. The same applies to the prohibition of the transport of persons.

4.2.2.3 Recommendations

DIN EN 14492-1 addresses essential safety aspects for almost all rope winch types, comprehensively and in some cases very precisely and extensively; many essential requirements are well substantiated. Owing to the standard's ambitious claim to cover all winches, however, certain aspects of forestry winch work can be covered only in part, or not at all. Examples are the requirements concerning mechanical transmission devices and ergonomics, and machine groups such as traction winches and skyline cranes, the particular hazards of which have not been governed to date in the standard. The author therefore recommends that greater attention be paid to the risks relevant to forestry. This is particularly important with regard to radio remote controls, which are becoming increasingly relevant in forestry and for the evaluation of which recourse must in some cases be made to BG regulations. In addition, EN 14492-1 should be adapted in this sense for all points for which deviations have been identified in Sections 5.2.2.1 and 5.2.2.2 between it and the requirements of the Machinery Directive.

Extension of the standard is recommended to cover the machine groups of skyline cranes and traction winches. It also appears appropriate to address the group of

standalone winch units and sled yarders more precisely. The creation of dedicated Type C standards may be appropriate. More attention should also be paid to the ergonomic requirements.

The risk assessment, which is reflected in the list of significant hazards, does not give adequate consideration to the risks presented by forestry winch operations. A number of hazards (such as stability in consideration of the risk of pulling over, travel movements of winches mounted on vehicles which are triggered by remote controls) are declared to be not applicable, despite their relevance to forestry. The risk assessment should be extended in consideration of these aspects. Suitable normative provisions should be formulated for the specific hazards identified as a result.

Here again, the author recommends that the normative references be extended and updated.

A final point in this context is that the simultaneous existence of two winch standards (EN 14492-1 and ISO 19472), differing in some cases in their requirements, and both able to give rise to the presumption of conformity either directly or through a reference in a harmonized standard, is not compatible with the principle that the body of standards should be free of contradictions.

4.2.3 ISO 19472, "Machinery for forestry – Winches – Dimensions, performance and safety"

The standard defines dimensions and specifies performance and safety requirements for winches used in forestry. It is applicable to fixed and detachable winches and their components mounted on self-propelled forestry machinery such as skidders and forwarders to ISO 6814 and on agricultural tractors used for skidding in forestry operations. Hoisting operations and all forms of skyline crane are explicitly excluded from the scope. The standard also does not apply to traction winches. The standard does not include a list of significant hazards; excluded risks are not therefore stated.

4.2.3.1 Requirements of the Machinery Directive which are not met

Annex IV lists the requirements of the Machinery Directive, identified and deemed relevant, for which no full corresponding provision could be found in ISO 19472. This standard is generally seen to address the specific requirements of winches in forestry operations very well. The most serious point of criticism of ISO 19472 is that it fails to address the requirement of the Machinery Directive for an emergency stop device (see Annex IV 1.3, 12.2, 12.5). A further essential area not addressed by the standard is that of remote controls (see Annex IV 1.9.1.12, 11.1). A positive observation is that actuating forces are governed by the standard; further ergonomic aspects, such as requirements concerning actuators operated whilst PPE is worn (such as gloves; see IV 8.1) should however also be addressed. Hazards presented by contact with hot and possibly also cold machine parts should be covered (see Annex IV 6.5).
Issues relating to visibility are also not addressed (see Annex IV 1.13). Since the visibility conditions are very complex during winch skidding in forestry operations, owing to the machine operator generally being located at the end of the rope, a provision is however necessary in the instruction handbook; the standard should provide appropriate information for this purpose. Specific requirements concerning the visibility must however be formulated at least for non-remote-control winches, where the operator is located at the winch. This is also relevant because the standard presents requirements governing an operator protective structure (OPS) to protect the operator against the risk of ropes and slings flying back.
A further point of criticism is that no safety requirements are imposed upon the hydraulic equipment (see Annex IV 5.2). This is in contrast to DIN EN 14492-1

(already discussed), which addresses this aspect in considerably greater depth. Consideration for aspects of fire prevention and protection against fire would also appear appropriate (see Annex IV 10.2, 10.4).

Owing to the likelihood and severity of accidents, issues of accessibility for maintenance of the winches are of considerable importance. This aspect has not been governed to the extent required by the Machinery Directive. Here too, a clearer distinction is required between daily maintenance and maintenance by skilled personnel (see Annex IV 3.6, 3.7). The requirement for an interlock arrangement which prevents movements when opened should also be considered in this context. ISO 19472 requires only indication of hazardous movements; this is however more far-reaching than the requirements of EN 14492-1. The standard addresses the more extensive requirements concerning operation with guards open (for example for placing the rope on the drum) by references to the instruction handbook (see Annex IV 12.10).

ISO 19472 failed to implement in concrete form the requirements of the Machinery Directive concerning the isolation of energy sources or the monitoring of the stop condition. In virtually all cases, hold-to-run control is regarded as adequate implementation of the requirement (see Annex IV 10.3, 11.13, 12.3, 12.4). Supplementary requirements concerning automatic application of the brakes can be found in ISO 19472 Section 6.5.1. Owing in particular to the design of winches driven by power take-off shafts, on which the drive generally runs continually, this issue should at least be considered. It may be appropriate to consider possibilities here by which de-energization of the power take-off or of the power source machinery can also be included. The requirement for specific control devices for stopping of the machine and safe dissipation of any residual energy must also be considered in this context (see Annex IV 12.12). Attention is also drawn here to the requirement in the Machinery Directive for instructions relating to installation and assembly for reducing noise and vibration. ISO 19472 fails to address this aspect (see Annex IV 2.7), whereas it is at least mentioned in EN 14492-1.

4.2.3.2 Unsatisfactory implementation of the requirements of the Machinery Directive

ISO 19472 contains points which barely satisfy the examined requirements of the Machinery Directive. For rope winches, ISO 19472 implements the requirements of the Machinery Directive governing markings (Annex I 3.6.1) with a large number of listed markings, but fails to specify warnings, apart from the instruction that winches may not be used for hoisting (7.3). With regard to the risk of impact or crushing (Annex I 3.6.1 of the Machinery Directive), protective measures should be defined over and above the OPS protection specified in the standard (6.1.5). Greater attention should be paid to the subject of different operating modes (Machinery Directive Annex I 1.2.5), for example for rope attachment and adjustment operations. Although failure of the power supply (Machinery Directive Annex I 1.2.6) is governed by automatic application of the brakes, and hold-to-run controls generally prevent accidental restarting (ISO 19472 6.5.1 and 6.6.3), the requirements should nevertheless be formulated more specifically, for example that renewed operation of the switch must be a requirement. Finally, the requirement for automatic application of the brakes (ISO 19472 6.5.1) implements the safety objective of preventing accidental movements (Machinery Directive, Annex I 1.3.9); owing to the considerable importance however, the prevention of backward movement of the load (for example by suitable overlap of the drive of coupling and brake) should be governed explicitly.

4.2.3.3 Recommendations

ISO 19472 constitutes a conventional Type C standard for skidding winches. It satisfies a number of the examined requirements of the Machinery Directive, owing to the performance of a risk assessment specific to forestry machinery. Although no specific risk exclusions are formulated, certain essential relevant requirements for forestry winches (for example governing emergency stopping, remote controls, hydraulics) are not addressed. For this reason, the author recommends that suitable provisions governing these aspects be added to the standard. The subjects of visibility, isolation of energy sources and formulation of the maintenance requirements should also be discussed.

4.2.4 Comparison of the two standards: "Cranes – Power driven winches and hoists – Part 1: Power driven winches"; German version EN 14492-1:2006+A1:2009/EN 14492-1:2010 and "Machinery for forestry – Winches – Dimensions, performance and safety; ISO 19472"

4.2.4.1 Study

Two standards, the scope of which overlaps to some degree, exist for forestry winches. EN 14492-1 is a harmonized European standard and gives rise to the presumption of conformity for winches falling within its scope. ISO 19472 is stated as a reference standard in the safety standard for forestry machinery (EN 14861:2004, "Forest machinery – Self propelled machinery – Safety requirements"), which is still valid. It is also stated as a reference standard in the draft of ISO 11850 discussed in the present study. This means that winches mounted on self-propelled forestry machinery are to be designed in accordance with ISO 19472 when this harmonized standard is intended to give rise to the presumption of conformity for the self-propelled forestry machine. Detachable rope winches fall within the scope of EN 14492-1. The scope of EN 14492-1 however also includes fixed winches fitted to self-propelled forestry machinery. At its last meeting, ISO TC 23/SC therefore issued a resolution in which Germany was invited to produce a comparison between the two standards. Such a comparison could be performed based upon the results of the present study.

EN 14492-1 is generally seen to be much more comprehensive in its intent than ISO 19472. The issue of overload/rated capacity limiters is addressed in considerable depth and detail. Separate provisions are formulated for the electrical, pneumatic and hydraulic equipment. Supplementary requirements are formulated for several special applications (explosive atmospheres, vehicle recovery winches and winches for boat trailers, winches for forestry and winches for the pulling of loads). Conversely, ISO 19472 addresses the specific requirements in forestry operations in much more detail. It defines performance requirements in addition to safety requirements. EN 14492-1 in turn contains a normative annex on noise testing, which is not present in the ISO standard. Classification into groups of mechanism is of great importance for rating and testing; this classification is present in DIN EN 14492-1, but not in the ISO standard.

The tables below list the points in which differences exist between the two standards. The list is based upon a cursory consideration of the two standards, and should in no way be considered exhaustive.

Table 2 Differences observed between ISO 19472 and DIN EN 14492-1

ISO 19472	EN 14492-1
For fixed and detachable forestry winches on self-propelled forestry machinery, excluding hoisting operations	Virtually all winches, including skyline cranes (see German national foreword); hoisting operations are included, travel operations generally not; rope winches for forestry are however defined in practice as for the scope of ISO 19472 (rope winches fitted to forestry machines such as pushing tractors and row crop tractors according to ISO 6814 and used on agricultural tractors, e.g. for fitting in a three-point rod assembly, used for pushing works in the forest)
Calculation of the rope breaking load	No calculation of the rope breaking load
Formulae for calculation of the line pull and line speed No formulae for calculation of the maximum load	No formulae for calculation of the line pull or line speed
Holding capacity of the brake: 1.25 times the maximum pull	Brakes must hold the load
Rope breaking load: 1.4 times the rated line pull with a protected operator; otherwise twice the rated line pull	Working coefficient of the rope in forestry operations: 2 (first rope layer); in terms of the highest load occurring (e.g. at operation of the rated capacity limiter)
Projection of the flanged drum end plates: 2 times the nominal rope diameter; drum housing can be included in the calculation	Projection of the flanged drum end plates: 2 times the rope diameter; drum casing not considered
Ratio of drum diameter to rope diameter: 8	Ratio of drum diameter to rope diameter: 10
No explicit reference to traction winches	Traction winches are covered
Resistance to disengagement of the rope fastening on the drum: with 3 turns of rope around the drum, a traction equal to 1.25 times the maximum rated bare drum pull	Resistance to disengagement of the rope fastening on the drum: with 2 turns of rope around the drum, a traction equal to 2.5 times the maximum rated bare drum pull (rated capacity)
No requirements governing the rope construction	Rotation-resistant ropes mandatory for a load suspended by a single-fall rope drive; reference to the discarding criteria
No exceeding of the maximum permissible winch pull (function of the rated capacity limiter)	Force-limit factor for friction torque limiters (serving as direct-acting rated capacity limiters): 1.6

For the operating position, protection by OPS in accordance with ISO 8084	Location of the operating position for the winch and/or with protection such that injury to persons caused by sling or pulling medium flying back is excluded.
An overload device must prevent the maximum permissible pull of the winch from being exceeded	Formulae for calculation of the maximum load and of the direct and indirect-action force-limiting factors (1.6 times maximum pull in the case of friction torque limiters)
No requirements concerning emergency stop/emergency off	Emergency stop required for pneumatic, electrical and hydraulic equipment in accordance with EN 418 (withdrawn and replaced by EN 13850)
Stowage facility required for mechanical transmission devices	No requirements concerning mechanical transmission devices
No requirements concerning the hydraulics	Hydraulic equipment must satisfy EN 982
No indirect-action overload capacity limiters defined; for direct-action overload capacity limiters, only examples	Definition of indirect-action rated capacity limiter
No safety-related requirements concerning controls	Definition of safety-related requirements concerning controls, specification of Performance Level and Category
No reference to groups of mechanism for rope drives	Rating of rope drives according to groups of mechanism to ISO 4308-1
No reference to groups of mechanism for gearboxes	Rating of gearboxes according to groups of mechanism (e.g. in accordance with ISO 6336-5)
Only general references to protective devices on rope sheaves	Specified dimensions for rope sheaves and unwind protection on rope sheaves (interval between the edge of the sheaves and the protective device, groove radius, opening angle of rope sheaves, groove depth)
No requirements concerning rope end termination	Rope end terminations in forestry operations: wire rope clamp or Flemish eye
No requirements governing chain drives	Requirements governing chain drives (design and standardized chains)
No auxiliary brake required	Auxiliary brake required during freespooling, in order to prevent uncontrolled unwinding

4.2.4.2 Summary and recommendations

Inspection of the two winch standards reveals that they employ similar safety philosophies in their approach to specifying safety requirements for rope winches for forestry operations. At the same time however, a number of points are observed in which the two standards differ to a greater or lesser degree in a characteristic or

required value. In principle, ISO 19472 is seen to be closer to forestry operations, whereas EN 14492-1 addresses the requirements of the Machinery Directive more closely. The standardization of winch units (such as sled yarders), skyline cranes and traction winches, which are increasingly being used in forestry, is unclear.

In principle, ISO 19472 could be brought into line with the Machinery Directive with reasonable effort and the existing discrepancies between it and EN 14492-1 resolved. The winches for skidding purposes for fixed mounting on self-propelled forestry machinery could be governed effectively by this standard and therefore excluded from EN 14492-1.

By contrast, with its universal approach, EN 14492-1 appears suitable for covering all other rope systems employed in forestry and already referred to. Besides review of certain aspects of the risk assessment, consideration should be given to extending this standard in this respect and to including the winch groups of skyline cranes, traction winches and winch units, which have not yet been governed satisfactorily. Alternatively, dedicated standards could be created for these winches. For skidding winches used for cable skidding, at least, it would be advantageous to govern the slinging equipment (generally choker ropes and chains). Only slings in lifting operations fall within the scope of the Machinery Directive, whereas slings for cable skidding are not harmonized, and national regulations may be applicable.

4.2.5 Forestry machinery – Wood chippers – Safety; German version EN 13525:2005+A1:2007

The scope of the standard covers mobile (e.g. self-propelled), mounted, semimounted and trailed wood chippers that are used in forestry, agriculture, horticulture and landscaping. The wood chippers are used when stationary and are loaded manually
Through a horizontal or near-horizontal infeed chute
By chipping components also acting as infeed components
By separate feed components such as rollers or chain conveyors integral to the infeed chute

These wood chippers may be powered either by an external power source such as the power take-off of a tractor, hydraulically, or by an integral power source such as an internal-combustion engine or electric motor.

EN 13525 does not cover the following aspects:

Requirements relating to national road regulations arising from transport between work sites
Hazards arising from any self-propelled function
Hazards arising from the transmission of power from an external power source, such as power take-off drive shafts
Any machines on which the infeed chute is fitted with an extension table or the integrated chain conveyor protrudes beyond the outermost lower edge of the infeed chute
Hazards arising from the engine pull-starting facility of an integral power source
Hazards arising from mechanical loading
Vertical infeed chute chippers
Electromagnetic aspects of chippers
Shredders/chippers to EN 13683
Machines equipped with a belt-type conveyor
Mechanical discharge systems

Since the standard only covers manually loaded machines, it does not apply to conventional chippers. Machines for the production of wood chips which also process thicker wood and are intended to deliver a corresponding throughput must be loaded automatically. As with the use of cranes or conveyor belts for loading, hazards arising from mechanical transmission devices are also excluded from the scope of standard.

4.2.5.1 Requirements of the Machinery Directive which are not met

Annex V compares the requirements of the Machinery Directive that were identified and deemed relevant with the associated passages and provisions in EN 13525 in which inconsistencies were observed between the two. Attention is drawn to certain particular points:

The form taken by the control devices and their properties are not addressed, with the exception of the infeed stop control, which is addressed in close detail (see Annex V 1.2).

Emergency stop devices are not specified; instead, an emergency-stop position of the infeed stop control is described (see Annex V 8.3, 12.2, 12.5, 12.6). This safety concept is corresponds to the "necessary protective measures" in accordance with the principles of the Machinery Directive for safety integration, but does not constitute an adequate replacement for the emergency-stop control device. Further studies in this respect would be beneficial. The addition of hold-to-run controls with automatic return to the neutral position could be necessary at least where functions featuring power operation are present on the machine (see Annex V 11.14). In addition, no consideration has been given to date to the requirements concerning the location and identifiability of the control devices. Requirements concerning the durability should also be considered, at least for the infeed stop control, which is of great importance (see Annex V 8.3).

The reference to the use of control devices on a tractor or other external power source is a cause for concern, for reasons of accessibility. It may be appropriate for the manufacturer to specify permissible power source machinery for the individual machines (see Annex V 8.3).

DIN EN 13525 permits switching on of an external power source or integral power source as a means of starting the machine. The Machinery Directive however specifies separate control devices (see Annex V 8.3; possibly with appropriate requirements concerning visibility of the danger zone) for starting. Requirements concerning visibility are also made regarding the guards and protective devices (see Annex V 1.5); of these, the infeed chute is the most important apart from the infeed stop control; the standard however addresses neither this issue, nor the requirement for visibility of the danger zone in relation to the requirements for control devices (see Annex V 1.2, 11.2), nor their ergonomics (e.g. the diameter of the feed control bar for infeed stop control; see Annex V 1.5). Remote controls are also not addressed (see Annex V 11.1).

Fire prevention and fire safety requirements (see Annex V 10.2) are formulated only in relation to the hydraulic equipment. The requirements of the Machinery Directive concerning marking (see V 1.7) have not been incorporated in full into the standard. Although DIN EN 13525 requires a stability test, this point should be addressed in the instruction handbook (see Annex 4.4). The requirement for a battery disconnection switch is also not included (see Section V 3.13).

4.2.5.2 Implementations of the requirements of the Machinery Directive warranting improvement

EN 13525, too, contains aspects which reproduce the requirements of the Machinery Directive in a less than ideal manner.

As already indicated, EN 13525 follows a somewhat different safety concept to that of the Machinery Directive in that the main safety facility is represented by the infeed stop control, which however takes the form of a protective device requiring actuation (emergency-stop function). This approach is not entirely consistent with the safety hierarchy of the Machinery Directive and its principles for the integration of safety (Machinery Directive 2006/42/EC Annex I 1.1.2), since it neither constitutes an emergency-stop device, nor does it satisfy the particular requirements of the Machinery Directive for guards and protective devices (Machinery Directive 2006/42/EC Annex I 1.4.1 and 1.4.2). Since the standard does not specify an emergency-stop device, the existing requirements for marking (for example in accordance with ISO 13850) are not adopted: other colours are permissible for marking in addition to red. In this context, consideration should be given to creation of a solution analogous to the definition of the stop category to ISO 13850 for the infeed stop.

In its reference to use of control devices of the tractor or power source machinery (e.g. 4.2.3.1) for the purpose of starting and stopping, the standard relies fully on the quality of these control devices, without formulating requirements of its own, for example regarding their ergonomics or functional safety, even where the power source is integral.

With the exception of the discharge chute movement, the standard contains virtually no ergonomic provisions. Stresses associated with manual loading are not addressed, as a result of which the operator being obliged under the European Directive governing lifting and carrying (90/269/EEC) to compensate for these design deficiencies by means of organizational measures. No provision is made for adjustment to the needs of the user (such as height adjustment of the infeed). It must be ensured that the machine cannot be used for heavy pieces of wood. More precise addressing of different user groups (e.g. men and women) and consideration of the latest ergonomic findings appear appropriate. Requirements should also be formulated concerning the actuating forces on the controls; the standard contains requirements only for the infeed stop control. Requirements concerning the machine deriving from the wearing of the necessary personal protective equipment are also addressed only in small measure. Comparatively high forces are permitted for actuation of the infeed stop control and for moving of the discharge chute. Notwithstanding the fact that access is not to a driver's cab, the definition of the access arrangements makes no reference to handles. Reference to a standard governing access systems (e.g. ISO 2867) would appear appropriate.

Although EN 13525 formulates requirements concerning the blade-sharpening operating mode (4.5.5), the more comprehensive requirements of the Machinery Directive concerning selection of the operating mode should be addressed in greater detail.

Further scope for improving the standard can be found in the requirements concerning the safety and reliability of the control system. EN 13525 makes reference to EN 954-1, which has since been withdrawn and replaced by EN 13848. At present, a Category is stated for the control system, but not a Performance Level.

The author draws attention to the requirement of the Machinery Directive for tool changes and tool maintenance to be possible ideally without removal or disabling of the guards. By contrast, EN 13525 specifies that opening of the fixed guard must take longer than the time required by the chipping devices to come to a stop.

4.2.5.3 Recommendations

EN 13525 is in principle a standard specifying safety measures for wood chippers which are effective and suitable for implementation. The primary hazard to the user lies in the risk of entrapment in the feed rollers and chipping devices. This hazard is addressed by means of an emergency-stop function in the infeed stop control. According to the safety hierarchy of the Machinery Directive, this constitutes a protective device. The standard should not therefore refer to it as an emergency stop. Consistent adherence to the safety philosophy of the Machinery Directive and to the terminology used in it is advisable.

Requirements relating to the control device (e.g. its strength) should be formulated in greater detail. The use of an emergency stop device is also considered advantageous, at least for the infeed. Besides the emergency-stop functionality, equipping with control devices and issues of access and accessibility also warrant particular attention. The according of greater attention to ergonomics would also be desirable. This would also include closer specification of the control devices. Some of the hazards that are excluded (for example by engine pull starters) are sufficiently relevant to warrant provisions.

No dedicated standard exists at this point in time for the commercial use of chippers in wood-chip production for energy recovery applications. Effective use of chippers with an appropriate throughput requires automated loading, which is possible only by means of a crane and grab. A dedicated safety standard based upon the EN 13525 standard considered here should therefore be created for this type of machine, which has grown considerably in importance in recent years.

5 Summary

The present study examined four standards (two ISO and two EN standards) governing forestry machinery with regard to their compatibility with selected safety objectives of the Machinery Directive. Relatively few discrepancies were identified in the current draft of ISO 11850. This has however been achieved at the cost of a number of excluded risks. These must be considered at least a point of criticism, owing to the presumption of conformity expected of this standard by users. The lack of provisions governing emergency stop devices and also of provisions governing remote controls, which are increasing in importance, is an issue. Visibility of the danger zone is a recurring issue. For self-propelled machinery, at least, the development of a standard governing visibility is an urgent requirement. For the other machines, this issue should be examined, and a partial risk exclusion applied if appropriate.

The existing EN 14492-1 winch standard has the potential to become the comprehensive standard for winches and yarders. It too fails to address remote controls. In addition, it contains a long list of risks that are not addressed. It would be desirable for these to be dealt with conclusively where they are relevant to forestry. This particularly applies to requirements concerning visibility. In some areas, it would be appropriate to address the particular needs of forestry winch applications in greater detail. In this context, machine groups should be addressed that to date have been ignored or have received only marginal attention. These include traction winches, yarders and winch units. A normative arrangement is also lacking for slings; for lifting operations, these are subject to the Machinery Directive.

ISO 19472 proves to be a specialized standard for skidding winches. This standard too, however, lacks particular provisions governing emergency-stop devices, and also for remote controls. Attention must also be paid to maintenance. It should be clear that daily maintenance performed under operational conditions should be subject to appropriately strict requirements, particularly with regard to accessibility, whereas requirements of the same rigour are not necessary for maintenance performed in the workshop. A corresponding distinction should however be set out in the requirements concerning the maintenance instructions.

The situation whereby two winch standards exist in parallel, overlapping in their scope and differing in places in their requirements, is not satisfactory. The author urgently recommends that the discrepancies between the two standards be resolved, since both standards may give rise to a presumption of conformity with the Machinery Directive: the European standard directly, the international standard indirectly through a reference in EN 14861 (the currently valid harmonized standard) and in ISO 11850, once the latter has been adopted as an EN and has replaced EN 14861.

Some safety objectives are seen not to be implemented in EN 13525, the standard governing wood chippers. In particular, the use of an emergency-stop device is not addressed. In addition, certain requirements upon the infeed stop control should be substantiated. Greater importance should also be attached to the ergonomic design of the control devices.
Owing to the unambiguous scope and the comprehensive range of risks that are still excluded, the standard cannot be applied to chippers for the commercial production of wood chips with loading by crane.

Visibility requirements have emerged as a recurring issue. In some cases, the relevant hazards are not addressed in the standards; a generic issue is however the absence of

test standards for visibility requirements. The development of such standards is currently one of the most urgent standardization tasks within the area of forestry. A general observation is that ergonomics still fails to receive the desired attention in the safety standards for the machines. The study found that the practice of normative references was not always satisfactory, since in some cases, references are made to standards that have already been withdrawn. Certain doubts exist as to whether the safety objectives concerning stopping have been implemented in all cases in the sense of the Machinery Directive.

6 Annexes

Annex 1 – requirements of Directive 2006/42/EC

Annex 2 – comparison of ISO 11850 – Directive 2006/42/EC – points not satisfied

Annex 3 – comparison of EN 14492-1 – Directive 2006/42/EC – points not satisfied

Annex 4 – comparison of ISO 19472 – Directive 2006/42/EC – points not satisfied

Annex 5 - comparison of EN 13525 – Directive 2006/42/EC – points not satisfied

Annex 1 – requirements of Directive 2006/42/EC

Requirement code	Requirement number	Text of the directive
1	1	1.1.4. Lighting Machinery must be supplied with integral lighting suitable for the operations concerned where the absence thereof is likely to cause a risk despite ambient lighting of normal intensity. Machinery must be designed and constructed so that there is no area of shadow likely to cause nuisance, that there is no irritating dazzle and that there are no dangerous stroboscopic effects on moving parts due to the lighting. Internal parts requiring frequent inspection and adjustment, and maintenance areas must be provided with appropriate lighting.
1	2	1.2.2. Control devices Control devices must be: - clearly visible and identifiable, using pictograms where appropriate, ... Machinery must be fitted with indicators as required for safe operation. The operator must be able to read them from the control position. From each control position, the operator must be able to ensure that no-one is in the danger zones, or the control system must be designed and constructed in such a way that starting is prevented while someone is in the danger zone. If neither of these possibilities is applicable, before the machinery starts, an acoustic and/or visual warning signal must be given. The exposed persons must have time to leave the danger zone or prevent the machinery starting up.
1	3	1.2.4.3. Emergency stop ... The device must: - have clearly identifiable, clearly visible and quickly accessible control devices,
1	4	1.2.5. Selection of control or operating modes The control or operating mode selected must override all other control or operating modes, with the exception of the emergency stop. If machinery has been designed and constructed to allow its use in several control or operating modes requiring different protective measures and/or work procedures, it must be fitted with a mode selector which can be locked in each position. Each position of the selector must be clearly identifiable and must correspond to a single operating or control mode.
1	5	Guards and protective devices must: ... - cause minimum obstruction to the view of the production process, and...
1	6	Where laser equipment is used, the following should be taken into account: ... - optical equipment for the observation or adjustment of laser

Requirement code	Requirement number	Text of the directive
		equipment on machinery must be such that no health risk is created by laser radiation.
1	7	1.7.3. Marking of machinery All machinery must be marked visibly, legibly and indelibly with the following minimum particulars: - the business name and full address of the manufacturer and, where applicable, his authorised representative, - designation of the machinery, - the CE Marking (see Annex III), - designation of series or type, - serial number, if any, - the year of construction, that is the year in which the manufacturing process is completed. It is prohibited to pre-date or post-date the machinery when affixing the CE marking.
1	8	3.2.1. Driving position Visibility from the driving position must be such that the driver can, in complete safety for himself and the exposed persons, operate the machinery and its tools in their foreseeable conditions of use. Where necessary, appropriate devices must be provided to remedy hazards due to inadequate direct vision.
1	9	3.3. CONTROL SYSTEMS If necessary, steps must be taken to prevent unauthorised use of controls. In the case of remote controls, each control unit must clearly identify the machinery to be controlled from that unit.
1	10	3.3.2. Starting/moving ... Where, for operating purposes, machinery is fitted with devices which exceed its normal clearance zone (e.g. stabilisers, jib, etc.), the driver must be provided with the means of checking easily, before moving the machinery, that such devices are in a particular position which allows safe movement. This also applies to all other parts which, to allow safe movement, have to be in particular positions, locked if necessary.
1	11	3.6.1. Signs, signals and warnings All machinery must have signs and/or instruction plates concerning use, adjustment and maintenance, wherever necessary, so as to ensure the health and safety of persons. They must be chosen, designed and constructed in such a way as to be clearly visible and indelible.
1	12	3.6.1. Signs, signals and warnings ... Remote-controlled machinery which, under normal conditions of use, exposes persons to the risk of impact or crushing must be fitted with appropriate means to signal its movements or with means to protect persons against such risks. The same applies to machinery which involves, when in use, the constant repetition of a forward and backward movement on a single axis where the area to the rear of the machine is not directly visible to the driver.
1	13	4.1.2.7. Movements of loads during handling The operating position of machinery must be located in such a way

Requirement code	Requirement number	Text of the directive
		as to ensure the widest possible view of trajectories of the moving parts, in order to avoid possible collisions with persons, equipment or other machinery which might be manoeuvring at the same time and liable to constitute a hazard.
1	14	4.3.3. Lifting machinery The maximum working load must be prominently marked on the machinery. This marking must be legible, indelible and in an un-coded form. Where the maximum working load depends on the configuration of the machinery, each operating position must be provided with a load plate indicating, preferably in diagrammatic form or by means of tables, the working load permitted for each configuration. Machinery intended for lifting goods only, equipped with a carrier which allows access to persons, must bear a clear and indelible warning prohibiting the lifting of persons. This warning must be visible at each place where access is possible.
1	15	4.4.2. Lifting machinery Lifting machinery must be accompanied by instructions containing information on: (a) the technical characteristics of the machinery, and in particular: - the maximum working load and, where appropriate, a copy of the load plate or load table described in the second paragraph of section 4.3.3, - the reactions at the supports or anchors and, where appropriate, characteristics of the tracks, - where appropriate, the definition and the means of installation of the ballast; (b) the contents of the logbook, if the latter is not supplied with the machinery; (c) advice for use, particularly to offset the lack of direct vision of the load by the operator;
2	1	1.1.8. Seating Where appropriate and where the working conditions so permit, work stations constituting an integral part of the machinery must be designed for the installation of seats. If the operator is intended to sit during operation and the operating position is an integral part of the machinery, the seat must be provided with the machinery. The operator's seat must enable him to maintain a stable position. Furthermore, the seat and its distance from the control devices must be capable of being adapted to the operator. If the machinery is subject to vibrations, the seat must be designed and constructed in such a way as to reduce the vibrations transmitted to the operator to the lowest level that is reasonably possible. The seat mountings must withstand all stresses to which they can be subjected. Where there is no floor beneath the feet of the operator, footrests covered with a slip-resistant material must be provided.
2	2	1.1.6. Ergonomics

Requirement code	Requirement number	Text of the directive
		Under the intended conditions of use, the discomfort, fatigue and physical and psychological stress faced by the operator must be reduced to the minimum possible, taking into account ergonomic principles such as: - allowing for the variability of the operator's physical dimensions, strength and stamina, - providing enough space for movements of the parts of the operator's body, - avoiding a machine-determined work rate, - avoiding monitoring that requires lengthy concentration, - adapting the man/machinery interface to the foreseeable characteristics of the operators.
2	3	1.1.7. Operating positions ... If the machinery is intended to be used in a hazardous environment presenting risks to the health and safety of the operator or if the machinery itself gives rise to a hazardous environment, adequate means must be provided to ensure that the operator has good working conditions and is protected against any foreseeable hazards.
2	4	1.4.1. General requirements In addition, guards must, where possible, protect against the ejection or falling of materials or objects and against emissions generated by the machinery.
2	5	1.5.9. Vibrations Machinery must be designed and constructed in such a way that risks resulting from vibrations produced by the machinery are reduced to the lowest level, taking account of technical progress and the availability of means of reducing vibration, in particular at source. The level of vibration emission may be assessed with reference to comparative emission data for similar machinery.
2	6	1.7.2. Warning of residual risks Where risks remain despite the inherent safe design measures, safeguarding and complementary protective measures adopted, the necessary warnings, including warning devices, must be provided.
2	7	1.7.4.2. Contents of the instructions (j) instructions relating to installation and assembly for reducing noise or vibration;
2	8	3.6.3.1. Vibrations The instructions must give the following information concerning vibrations transmitted by the machinery to the hand-arm system or to the whole body: - the vibration total value to which the hand-arm system is subjected, if it exceeds 2,5 m/s2. Where this value does not exceed 2,5 m/s2, this must be mentioned, - the highest root mean square value of weighted acceleration to which the whole body is subjected, if it exceeds 0,5 m/s2. Where this value does not exceed 0,5 m/s2, this must be mentioned, - the uncertainty of measurement. These values must be either those actually measured for the

Requirement code	Requirement number	Text of the directive
		machinery in question or those established on the basis of measurements taken for technically comparable machinery which is representative of the machinery to be produced. Where harmonised standards are not applied, the vibration must be measured using the most appropriate measurement code for the machinery concerned. The operating conditions during measurement and the measurement codes used must be described.
3	1	1.1.4. Lighting ... Internal parts requiring frequent inspection and adjustment, and maintenance areas must be provided with appropriate lighting.
3	2	1.1.6. Ergonomics Under the intended conditions of use, the discomfort, fatigue and physical and psychological stress faced by the operator must be reduced to the minimum possible, taking into account ergonomic principles such as: - allowing for the variability of the operator's physical dimensions, strength and stamina, - providing enough space for movements of the parts of the operator's body, ...
3	3	1.2.5. Selection of control or operating modes The control or operating mode selected must override all other control or operating modes, with the exception of the emergency stop. If machinery has been designed and constructed to allow its use in several control or operating modes requiring different protective measures and/or work procedures, it must be fitted with a mode selector which can be locked in each position. Each position of the selector must be clearly identifiable and must correspond to a single operating or control mode. The selector may be replaced by another selection method which restricts the use of certain functions of the machinery to certain categories of operator. If, for certain operations, the machinery must be able to operate with a guard displaced or removed and/or a protective device disabled, the control or operating mode selector must simultaneously: - disable all other control or operating modes, - permit operation of hazardous functions only by control devices requiring sustained action, - permit the operation of hazardous functions only in reduced risk conditions while preventing hazards from linked sequences, - prevent any operation of hazardous functions by voluntary or involuntary action on the machine's sensors. If these four conditions cannot be fulfilled simultaneously, the control or operating mode selector must activate other protective measures designed and constructed to ensure a safe intervention zone. In addition, the operator must be able to control operation of the parts he is working on from the adjustment point.
3	4	1.3.2. Risk of break-up during operation ...

Requirement code	Requirement number	Text of the directive
		The instructions must indicate the type and frequency of inspections and maintenance required for safety reasons. They must, where appropriate, indicate the parts subject to wear and the criteria for replacement.
3	5	1.4.1. General requirements Guards and protective devices must: ... - enable essential work to be carried out on the installation and/or replacement of tools and for maintenance purposes by restricting access exclusively to the area where the work has to be done, if possible without the guard having to be removed or the protective device having to be disabled.
3	6	1.6.2. Access to operating positions and servicing points Machinery must be designed and constructed in such a way as to allow access in safety to all areas where intervention is necessary during operation, adjustment and maintenance of the machinery.
3	7	1.6.4. Operator intervention Machinery must be so designed, constructed and equipped that the need for operator intervention is limited. If operator intervention cannot be avoided, it must be possible to carry it out easily and safely.
3	8	1.6.5. Cleaning of internal parts The machinery must be designed and constructed in such a way that it is possible to clean internal parts which have contained dangerous substances or preparations without entering them; any necessary unblocking must also be possible from the outside. If it is impossible to avoid entering the machinery, it must be designed and constructed in such a way as to allow cleaning to take place safely.
3	9	1.7.4.2. Contents of the instructions ... (e) the drawings, diagrams, descriptions and explanations necessary for the use, maintenance and repair of the machinery and for checking its correct functioning; ... (o) the conditions in which the machinery meets the requirement of stability during use, transportation, assembly, dismantling when out of service, testing or foreseeable breakdowns; ... (r) the description of the adjustment and maintenance operations that should be carried out by the user and the preventive maintenance measures that should be observed; (s) instructions designed to enable adjustment and maintenance to be carried out safely, including the protective measures that should be taken during these operations;
3	10	3.4.2. Moving transmission parts By way of exception to section 1.3.8.1, in the case of engines, moveable guards preventing access to the moving parts in the engine compartment need not have interlocking devices if they have to be opened either by the use of a tool or key or by a control located in the driving position, providing the latter is in a fully

Requirement code	Requirement number	Text of the directive
		enclosed cab with a lock to prevent unauthorised access.
3	11	Handholds and steps must be designed, constructed and arranged in such a way that the operators use them instinctively and do not use the control devices to assist access.
3	12	3.4.7. Transmission of power between self-propelled machinery (or tractor) and recipient machinery Removable mechanical transmission devices linking self-propelled machinery (or a tractor) to the first fixed bearing of recipient machinery must be designed and constructed in such a way that any part that moves during operation is protected over its whole length. On the side of the self-propelled machinery (or tractor), the power take-off to which the removable mechanical transmission device is attached must be protected either by a guard fixed and linked to the self-propelled machinery (or tractor) or by any other device offering equivalent protection. It must be possible to open this guard for access to the removable transmission device. Once it is in place, there must be enough room to prevent the drive shaft damaging the guard when the machinery (or the tractor) is moving. On the recipient machinery side, the input shaft must be enclosed in a protective casing fixed to the machinery. All recipient machinery, the operation of which requires a removable mechanical transmission device to connect it to self-propelled machinery (or a tractor), must have a system for attaching the removable mechanical transmission device so that, when the machinery is uncoupled, the removable mechanical transmission device and its guard are not damaged by contact with the ground or part of the machinery.
3	13	3.5.1. Batteries 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 rollover or tipover and to avoid the accumulation of vapours in places occupied by operators. Machinery must be designed and constructed in such a way that the battery can be disconnected with the aid of an easily accessible device provided for that purpose.
3	14	3.6.1. Signs, signals and warnings All machinery must have signs and/or instruction plates concerning use, adjustment and maintenance, wherever necessary, so as to ensure the health and safety of persons. They must be chosen, designed and constructed in such a way as to be clearly visible and indelible.
3	15	3.6.3.2. Multiple uses The instructions for machinery allowing several uses depending on the equipment used and the instructions for the interchangeable equipment must contain the information necessary for safe assembly and use of the basic machinery and the interchangeable equipment that can be fitted.
3	16	4.1.2.8.3. Risks due to contact with the moving carrier Where necessary in order to fulfil the requirement expressed in the

Requirement code	Requirement number	Text of the directive
		second paragraph of section 4.1.2.7, the travel zone must be rendered inaccessible during normal operation. When, during inspection or maintenance, there is a risk that persons situated under or above the carrier may be crushed between the carrier and any fixed parts, sufficient free space must be provided either by means of physical refuges or by means of mechanical devices blocking the movement of the carrier.
3	17	1.6.1. Machinery maintenance Adjustment and maintenance points must be located outside danger zones. It must be possible to carry out adjustment, maintenance, repair, cleaning and servicing operations while machinery is at a standstill. If one or more of the above conditions cannot be satisfied for technical reasons, measures must be taken to ensure that these operations can be carried out safely (see section 1.2.5). In the case of automated machinery and, where necessary, other machinery, a connecting device for mounting diagnostic fault-finding equipment must be provided. Automated machinery components which have to be changed frequently must be capable of being removed and replaced easily and safely. Access to the components must enable these tasks to be carried out with the necessary technical means in accordance with a specified operating method.
4	1	1.1.5. Design of machinery to facilitate its handling Machinery, or each component part thereof, must: - be capable of being handled and transported safely, - be packaged or designed so that it can be stored safely and without damage. During the transportation of the machinery and/or its component parts, there must be no possibility of sudden movements or of hazards due to instability as long as the machinery and/or its component parts are handled in accordance with the instructions.
4	2	1.3.1. Risk of loss of stability Machinery and its components and fittings must be stable enough to avoid overturning, falling or uncontrolled movements during transportation, assembly, dismantling and any other action involving the machinery. If the shape of the machinery itself or its intended installation does not offer sufficient stability, appropriate means of anchorage must be incorporated and indicated in the instructions.
4	3	1.3.6. Risks related to variations in operating conditions Where the machinery performs operations under different conditions of use, it must be designed and constructed in such a way that selection and adjustment of these conditions can be carried out safely and reliably.
4	4	1.7.4.2. Contents of the instructions (o) the conditions in which the machinery meets the requirement of stability during use, transportation, assembly, dismantling when out of service, testing or foreseeable breakdowns;
4	5	3.2.2. Seating Where there is a risk that operators or other persons transported by

Requirement code	Requirement number	Text of the directive
		the machinery may be crushed between parts of the machinery and the ground should the machinery roll or tip over, in particular for machinery equipped with a protective structure referred to in section 3.4.3 or 3.4.4, their seats must be designed or equipped with a restraint system so as to keep the persons in their seats, without restricting movements necessary for operations or movements relative to the structure caused by the suspension of the seats. Such restraint systems should not be fitted if they increase the risk.
4	6	3.3.3. Travelling function Without prejudice to road traffic regulations, self-propelled machinery and its trailers must meet the requirements for slowing down, stopping, braking and immobilisation so as to ensure safety under all the operating, load, speed, ground and gradient conditions allowed for. The driver must be able to slow down and stop self-propelled machinery by means of a main device. Where safety so requires, in the event of a failure of the main device, or in the absence of the energy supply needed to actuate the main device, an emergency device with a fully independent and easily accessible control device must be provided for slowing down and stopping. Where safety so requires, a parking device must be provided to render stationary machinery immobile. This device may be combined with one of the devices referred to in the second paragraph, provided that it is purely mechanical.
4	7	3.4.1. Uncontrolled movements Machinery must be designed, constructed and where appropriate placed on its mobile support in such a way as to ensure that, when moved, uncontrolled oscillations of its centre of gravity do not affect its stability or exert excessive strain on its structure.
4	8	3.4.3. Roll-over and tip-over Where, in the case of self-propelled machinery with a ride-on driver, operator(s) or other person(s), there is a risk of rolling or tipping over, the machinery must be fitted with an appropriate protective structure, unless this increases the risk. This structure must be such that in the event of rolling or tipping over it affords the ride-on person(s) an adequate deflection-limiting volume. In order to verify that the structure complies with the requirement laid down in the second paragraph, the manufacturer or his authorised representative must, for each type of structure concerned, perform appropriate tests or have such tests performed.
4	9	3.5.1. Batteries 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 rollover or tipover and to avoid the accumulation of vapours in places occupied by operators.
4	10	4.1.2.1. Risks due to lack of stability Machinery must be designed and constructed in such a way that the stability required by section 1.3.1 is maintained both in service and out of service, including all stages of transportation, assembly and

Requirement code	Requirement number	Text of the directive
		dismantling, during foreseeable component failures and also during the tests carried out in accordance with the instruction handbook. To that end, the manufacturer or his authorised representative must use the appropriate verification methods.
4	11	4.1.2.6. Control of movements Devices for controlling movements must act in such a way that the machinery on which they are installed is kept safe. ... (c) Machinery must be designed and constructed in such a way that the loads cannot creep dangerously or fall freely and unexpectedly, even in the event of partial or total failure of the power supply or when the operator stops operating the machine.
4	12	4.1.2.8.4. Risk due to the load falling off the carrier Where there is a risk due to the load falling off the carrier, the machinery must be designed and constructed in such a way as to prevent this risk.
4	13	4.2.2. Loading control Machinery with a maximum working load of not less than 1000 kilograms or an overturning moment of not less than 40000 Nm must be fitted with devices to warn the driver and prevent dangerous movements in the event: - of overloading, either as a result of the maximum working load or the maximum working moment due to the load being exceeded, or - of the overturning moment being exceeded.
5	1	1.1.7. Operating positions The operating position must be designed and constructed in such a way as to avoid any risk due to exhaust gases and/or lack of oxygen. If the machinery is intended to be used in a hazardous environment presenting risks to the health and safety of the operator or if the machinery itself gives rise to a hazardous environment, adequate means must be provided to ensure that the operator has good working conditions and is protected against any foreseeable hazards. Where appropriate, the operating position must be fitted with an adequate cabin designed, constructed and/or equipped to fulfil the above requirements. The exit must allow rapid evacuation. Moreover, when applicable, an emergency exit must be provided in a direction which is different from the usual exit.
5	2	1.3.2. Risk of break-up during operation ... Where a risk of rupture or disintegration remains despite the measures taken, the parts concerned must be mounted, positioned and/or guarded in such a way that any fragments will be contained, preventing hazardous situations. Both rigid and flexible pipes carrying fluids, particularly those under high pressure, must be able to withstand the foreseen internal and external stresses and must be firmly attached and/or protected to ensure that no risk is posed by a rupture.
5	3	1.3.3. Risks due to falling or ejected objects Precautions must be taken to prevent risks from falling or ejected objects.

Requirement code	Requirement number	Text of the directive
5	4	1.4.1. General requirements Guards and protective devices ... In addition, guards must, where possible, protect against the ejection or falling of materials or objects and against emissions generated by the machinery.
5	5	1.5.14. Risk of being trapped in a machine Machinery must be designed, constructed or fitted with a means of preventing a person from being enclosed within it or, if that is impossible, with a means of summoning help.
5	6	3.2.2. Seating Where there is a risk that operators or other persons transported by the machinery may be crushed between parts of the machinery and the ground should the machinery roll or tip over, in particular for machinery equipped with a protective structure referred to in section 3.4.3 or 3.4.4, their seats must be designed or equipped with a restraint system so as to keep the persons in their seats, without restricting movements necessary for operations or movements relative to the structure caused by the suspension of the seats. Such restraint systems should not be fitted if they increase the risk.
5	7	3.4.3. Roll-over and tip-over Where, in the case of self-propelled machinery with a ride-on driver, operator(s) or other person(s), there is a risk of rolling or tipping over, the machinery must be fitted with an appropriate protective structure, unless this increases the risk. This structure must be such that in the event of rolling or tipping over it affords the ride-on person(s) an adequate deflection-limiting volume. In order to verify that the structure complies with the requirement laid down in the second paragraph, the manufacturer or his authorised representative must, for each type of structure concerned, perform appropriate tests or have such tests performed.
5	8	3.4.4. Falling objects Where, in the case of self-propelled machinery with a ride-on driver, operator(s) or other person(s), there is a risk due to falling objects or material, the machinery must be designed and constructed in such a way as to take account of this risk and fitted, if its size allows, with an appropriate protective structure. This structure must be such that, in the event of falling objects or material, it guarantees the ride-on person(s) an adequate deflection-limiting volume. In order to verify that the structure complies with the requirement laid down in the second paragraph, the manufacturer or his authorised representative must, for each type of structure concerned, perform appropriate tests or have such tests performed.
6	1	1.1.6. Ergonomics Under the intended conditions of use, the discomfort, fatigue and physical and psychological stress faced by the operator must be reduced to the minimum possible, taking into account ergonomic principles such as: ... - providing enough space for movements of the parts of the

Requirement code	Requirement number	Text of the directive
		operator's body, ... - adapting the man/machinery interface to the foreseeable characteristics of the operators.
6	2	1.1.7. Operating positions The operating position must be designed and constructed in such a way as to avoid any risk due to exhaust gases and/or lack of oxygen. If the machinery is intended to be used in a hazardous environment presenting risks to the health and safety of the operator or if the machinery itself gives rise to a hazardous environment, adequate means must be provided to ensure that the operator has good working conditions and is protected against any foreseeable hazards. Where appropriate, the operating position must be fitted with an adequate cabin designed, constructed and/or equipped to fulfil the above requirements. The exit must allow rapid evacuation. Moreover, when applicable, an emergency exit must be provided in a direction which is different from the usual exit.
6	3	1.1.8. Seating Where appropriate and where the working conditions so permit, work stations constituting an integral part of the machinery must be designed for the installation of seats. If the operator is intended to sit during operation and the operating position is an integral part of the machinery, the seat must be provided with the machinery. The operator's seat must enable him to maintain a stable position. Furthermore, the seat and its distance from the control devices must be capable of being adapted to the operator. If the machinery is subject to vibrations, the seat must be designed and constructed in such a way as to reduce the vibrations transmitted to the operator to the lowest level that is reasonably possible. The seat mountings must withstand all stresses to which they can be subjected. Where there is no floor beneath the feet of the operator, footrests covered with a slip-resistant material must be provided.
6	4	1.5.3. Energy supply other than electricity Where machinery is powered by source of energy other than electricity, it must be so designed, constructed and equipped as to avoid all potential risks associated with such sources of energy.
6	5	1.5.5. Extreme temperatures Steps must be taken to eliminate any risk of injury arising from contact with or proximity to machinery parts or materials at high or very low temperatures. The necessary steps must also be taken to avoid or protect against the risk of hot or very cold material being ejected.
6	6	1.5.11. External radiation Machinery must be designed and constructed in such a way that external radiation does not interfere with its operation.
6	7	1.5.13. Emissions of hazardous materials and substances Machinery must be designed and constructed in such a way that risks of inhalation, ingestion, contact with the skin, eyes and mucous membranes and penetration through the skin of hazardous materials and substances which it produces can be avoided.

Requirement code	Requirement number	Text of the directive
		Where a hazard cannot be eliminated, the machinery must be so equipped that hazardous materials and substances can be contained, evacuated, precipitated by water spraying, filtered or treated by another equally effective method.
6	8	1.5.15. Risk of slipping, tripping or falling Parts of the machinery where persons are liable to move about or stand must be designed and constructed in such a way as to prevent persons slipping, tripping or falling on or off these parts. Where appropriate, these parts must be fitted with handholds that are fixed relative to the user and that enable them to maintain their stability.
6	9	1.6.2. Access to operating positions and servicing points Machinery must be designed and constructed in such a way as to allow access in safety to all areas where intervention is necessary during operation, adjustment and maintenance of the machinery.
6	10	3.2.1. Driving position ... Machinery on which the driver is transported must be designed and constructed in such a way that, from the driving positions, there is no risk to the driver from inadvertent contact with the wheels and tracks. The driving position of ride-on drivers must be designed and constructed in such a way that a driver's cab may be fitted, provided this does not increase the risk and there is room for it. The cab must incorporate a place for the instructions needed for the driver.
6	11	3.4.5. Means of access Handholds and steps must be designed, constructed and arranged in such a way that the operators use them instinctively and do not use the control devices to assist access.
7	1	1.1.2. Principles of safety integration ... (e) Machinery must be supplied with all the special equipment and accessories essential to enable it to be adjusted, maintained and used safely.
7	2	1.1.7. Operating positions If the machinery is intended to be used in a hazardous environment presenting risks to the health and safety of the operator or if the machinery itself gives rise to a hazardous environment, adequate means must be provided to ensure that the operator has good working conditions and is protected against any foreseeable hazards.
7	3	3.2.1. Driving position ... The driving position of ride-on drivers must be designed and constructed in such a way that a driver's cab may be fitted, provided this does not increase the risk and there is room for it. The cab must incorporate a place for the instructions needed for the driver.
8	1	1.1.2. Principles of safety integration (d) Machinery must be designed and constructed to take account of

Requirement code	Requirement number	Text of the directive
		the constraints to which the operator is subject as a result of the necessary or foreseeable use of personal protective equipment.
8	2	1.1.6. Ergonomics Under the intended conditions of use, the discomfort, fatigue and physical and psychological stress faced by the operator must be reduced to the minimum possible, taking into account ergonomic principles such as: - allowing for the variability of the operator's physical dimensions, strength and stamina, ... - adapting the man/machinery interface to the foreseeable characteristics of the operators.
8	3	1.2.2. Control devices Control devices must be: ... - positioned in such a way as to be safely operated without hesitation or loss of time and without ambiguity, ... - made in such a way as to withstand foreseeable forces; particular attention must be paid to emergency stop devices liable to be subjected to considerable forces. ... Control devices must be so arranged that their layout, travel and resistance to operation are compatible with the action to be performed, taking account of ergonomic principles.
9	1	1.1.2. Principles of safety integration ... (e) Machinery must be supplied with all the special equipment and accessories essential to enable it to be adjusted, maintained and used safely.
9	2	1.1.4. Lighting Machinery must be supplied with integral lighting suitable for the operations concerned where the absence thereof is likely to cause a risk despite ambient lighting of normal intensity. Machinery must be designed and constructed so that there is no area of shadow likely to cause nuisance, that there is no irritating dazzle and that there are no dangerous stroboscopic effects on moving parts due to the lighting. Internal parts requiring frequent inspection and adjustment, and maintenance areas must be provided with appropriate lighting.
9	3	1.6.3. Isolation of energy sources As an exception to the requirement laid down in the previous paragraphs, certain circuits may remain connected to their energy sources in order, for example, to hold parts, to protect information, to light interiors, etc. In this case, special steps must be taken to ensure operator safety.
10	1	1.1.3. Materials and products The materials used to construct machinery or products used or created during its use must not endanger persons' safety or health. In particular, where fluids are used, machinery must be designed and constructed to prevent risks due to filling, use, recovery or

Requirement code	Requirement number	Text of the directive
		draining.
10	2	1.5.6. Fire Machinery must be designed and constructed in such a way as to avoid any risk of fire or overheating posed by the machinery itself or by gases, liquids, dust, vapours or other substances produced or used by the machinery.
10	3	1.6.3. Isolation of energy sources Machinery must be fitted with means to isolate it from all energy sources. Such isolators must be clearly identified. They must be capable of being locked if reconnection could endanger persons. Isolators must also be capable of being locked where an operator is unable, from any of the points to which he has access, to check that the energy is still cut off. ... As an exception to the requirement laid down in the previous paragraphs, certain circuits may remain connected to their energy sources in order, for example, to hold parts, to protect information, to light interiors, etc. In this case, special steps must be taken to ensure operator safety.
10	4	3.5.2. Fire Depending on the hazards anticipated by the manufacturer, machinery must, where its size permits: - either allow easily accessible fire extinguishers to be fitted, or - be provided with built-in extinguisher systems.
11	1	1.2.1. Safety and reliability of control systems Particular attention must be given to the following points: - the machinery must not start unexpectedly, - the machinery must not be prevented from stopping if the stop command has already been given, - automatic or manual stopping of the moving parts, whatever they may be, must be unimpeded, - the protective devices must remain fully effective or give a stop command, For cable-less control, an automatic stop must be activated when correct control signals are not received, including loss of communication.
11	2	1.2.2. Control devices ... From each control position, the operator must be able to ensure that no-one is in the danger zones, or the control system must be designed and constructed in such a way that starting is prevented while someone is in the danger zone. If neither of these possibilities is applicable, before the machinery starts, an acoustic and/or visual warning signal must be given. The exposed persons must have time to leave the danger zone or prevent the machinery starting up. Where there is more than one control position, the control system must be designed in such a way that the use of one of them

Requirement code	Requirement number	Text of the directive
		precludes the use of the others, except for stop controls and emergency stops.
11	3	1.2.3. Starting It must be possible to start machinery only by voluntary actuation of a control device provided for the purpose. The same requirement applies: - when restarting the machinery after a stoppage, whatever the cause, - when effecting a significant change in the operating conditions. However, the restarting of the machinery or a change in operating conditions may be effected by voluntary actuation of a device other than the control device provided for the purpose, on condition that this does not lead to a hazardous situation. For machinery functioning in automatic mode, the starting of the machinery, restarting after a stoppage, or a change in operating conditions may be possible without intervention, provided this does not lead to a hazardous situation. Where machinery has several starting control devices and the operators can therefore put each other in danger, additional devices must be fitted to rule out such risks. If safety requires that starting and/or stopping must be performed in a specific sequence, there must be devices which ensure that these operations are performed in the correct order.
11	4	1.2.4.1. Normal stop Machinery must be fitted with a control device whereby the machinery can be brought safely to a complete stop. Each workstation must be fitted with a control device to stop some or all of the functions of the machinery, depending on the existing hazards, so that the machinery is rendered safe. The machinery's stop control must have priority over the start controls. Once the machinery or its hazardous functions have stopped, the energy supply to the actuators concerned must be cut off.
11	5	1.2.4.2. Operational stop Where, for operational reasons, a stop control that does not cut off the energy supply to the actuators is required, the stop condition must be monitored and maintained.
11	6	1.2.4.4. Assembly of machinery In the case of machinery or parts of machinery designed to work together, the machinery must be designed and constructed in such a way that the stop controls, including the emergency stop devices, can stop not only the machinery itself but also all related equipment, if its continued operation may be dangerous.
11	7	1.2.5. Selection of control or operating modes If, for certain operations, the machinery must be able to operate with a guard displaced or removed and/or a protective device disabled, the control or operating mode selector must simultaneously: - disable all other control or operating modes, - permit operation of hazardous functions only by control devices requiring sustained action,

Requirement code	Requirement number	Text of the directive
		- permit the operation of hazardous functions only in reduced risk conditions while preventing hazards from linked sequences, - prevent any operation of hazardous functions by voluntary or involuntary action on the machine's sensors. If these four conditions cannot be fulfilled simultaneously, the control or operating mode selector must activate other protective measures designed and constructed to ensure a safe intervention zone. In addition, the operator must be able to control operation of the parts he is working on from the adjustment point.
11	8	1.2.6. Failure of the power supply The interruption, the re-establishment after an interruption or the fluctuation in whatever manner of the power supply to the machinery must not lead to dangerous situations. Particular attention must be given to the following points: - the machinery must not start unexpectedly, ... - the machinery must not be prevented from stopping if the command has already been given, ... - automatic or manual stopping of the moving parts, whatever they may be, must be unimpeded, - the protective devices must remain fully effective or give a stop command.
11	9	1.3.5. Risks related to combined machinery Where the machinery is intended to carry out several different operations with manual removal of the piece between each operation (combined machinery), it must be designed and constructed in such a way as to enable each element to be used separately without the other elements constituting a risk for exposed persons. For this purpose, it must be possible to start and stop separately any elements that are not protected.
11	10	1.3.9. Risks of uncontrolled movements When a part of the machinery has been stopped, any drift away from the stopping position, for whatever reason other than action on the control devices, must be prevented or must be such that it does not present a hazard.
11	11	1.4.2.2. Interlocking movable guards Interlocking movable guards must be associated with an interlocking device that: - prevents the start of hazardous machinery functions until they are closed and - gives a stop command whenever they are no longer closed. Where it is possible for an operator to reach the danger zone before the risk due to the hazardous machinery functions has ceased, movable guards must be associated with a guard locking device in addition to an interlocking device that: - prevents the start of hazardous machinery functions until the guard is closed and locked, and - keeps the guard closed and locked until the risk of injury from the

Requirement code	Requirement number	Text of the directive
		hazardous machinery functions has ceased. Interlocking movable guards must be designed in such a way that the absence or failure of one of their components prevents starting or stops the hazardous machinery functions.
11	12	1.4.3. Special requirements for protective devices Protective devices must be designed and incorporated into the control system in such a way that: - moving parts cannot start up while they are within the operator's reach, - persons cannot reach moving parts while the parts are moving, and - the absence or failure of one of their components prevents starting or stops the moving parts. Protective devices must be adjustable only by means of an intentional action.
11	13	1.6.3. Isolation of energy sources Machinery must be fitted with means to isolate it from all energy sources. Such isolators must be clearly identified. They must be capable of being locked if reconnection could endanger persons. Isolators must also be capable of being locked where an operator is unable, from any of the points to which he has access, to check that the energy is still cut off. In the case of machinery capable of being plugged into an electricity supply, removal of the plug is sufficient, provided that the operator can check from any of the points to which he has access that the plug remains removed. After the energy is cut off, it must be possible to dissipate normally any energy remaining or stored in the circuits of the machinery without risk to persons. As an exception to the requirement laid down in the previous paragraphs, certain circuits may remain connected to their energy sources in order, for example, to hold parts, to protect information, to light interiors, etc. In this case, special steps must be taken to ensure operator safety.
11	14	3.3.1. Control devices ... Where their operation can lead to hazards, notably dangerous movements, the control devices, except for those with preset positions, must return to the neutral position as soon as they are released by the operator.
11	15	3.3.2. Starting/moving All travel movements of self-propelled machinery with a ride-on driver must be possible only if the driver is at the controls. Where, for operating purposes, machinery is fitted with devices which exceed its normal clearance zone (e.g. stabilisers, jib, etc.), the driver must be provided with the means of checking easily, before moving the machinery, that such devices are in a particular position which allows safe movement. This also applies to all other parts which, to allow safe movement, have to be in particular positions, locked if necessary. Where it does not give rise to other

Requirement code	Requirement number	Text of the directive
		risks, movement of the machinery must depend on safe positioning of the aforementioned parts. It must not be possible for unintentional movement of the machinery to occur while the engine is being started.
11	16	3.3.3. Travelling function Without prejudice to road traffic regulations, self-propelled machinery and its trailers must meet the requirements for slowing down, stopping, braking and immobilisation so as to ensure safety under all the operating, load, speed, ground and gradient conditions allowed for. The driver must be able to slow down and stop self-propelled machinery by means of a main device. Where safety so requires, in the event of a failure of the main device, or in the absence of the energy supply needed to actuate the main device, an emergency device with a fully independent and easily accessible control device must be provided for slowing down and stopping. Where safety so requires, a parking device must be provided to render stationary machinery immobile. This device may be combined with one of the devices referred to in the second paragraph, provided that it is purely mechanical. Remote-controlled machinery must be equipped with devices for stopping operation automatically and immediately and for preventing potentially dangerous operation in the following situations: - if the driver loses control, - if it receives a stop signal, - if a fault is detected in a safety-related part of the system, - if no validation signal is detected within a specified time. Section 1.2.4 does not apply to the travelling function.
11	17	3.3.4. Movement of pedestrian-controlled machinery Movement of pedestrian-controlled self-propelled machinery must be possible only through sustained action on the relevant control device by the driver. In particular, it must not be possible for movement to occur while the engine is being started. The control systems for pedestrian-controlled machinery must be designed in such a way as to minimise the risks arising from inadvertent movement of the machine towards the driver, in particular: - crushing, - injury from rotating tools. The speed of travel of the machinery must be compatible with the pace of a driver on foot. In the case of machinery on which a rotary tool may be fitted, it must not be possible to actuate the tool when the reverse control is engaged, except where the movement of the machinery results from movement of the tool. In the latter case, the reversing speed must be such that it does not endanger the driver.
11	18	3.3.5. Control circuit failure A failure in the power supply to the power-assisted steering, where fitted, must not prevent machinery from being steered during the time required to stop it.

Requirement code	Requirement number	Text of the directive
11	19	3.4.1. Uncontrolled movements Machinery must be designed, constructed and where appropriate placed on its mobile support in such a way as to ensure that, when moved, uncontrolled oscillations of its centre of gravity do not affect its stability or exert excessive strain on its structure.
11	20	4.2.1. Control of movements Hold-to-run control devices must be used to control the movements of the machinery or its equipment. However, for partial or complete movements in which there is no risk of the load or the machinery colliding, the said devices may be replaced by control devices authorising automatic stops at pre-selected positions without the operator holding a hold-to-run control device.
12	1	1.2.1. Safety and reliability of control systems ... Particular attention must be given to the following points: ... - the machinery must not be prevented from stopping if the stop command has already been given, ... - automatic or manual stopping of the moving parts, whatever they may be, must be unimpeded, - the protective devices must remain fully effective or give a stop command,
12	2	1.2.2. Control devices Control devices must be: - located outside the danger zones, except where necessary for certain control devices such as an emergency stop or a teach pendant, - made in such a way as to withstand foreseeable forces; particular attention must be paid to emergency stop devices liable to be subjected to considerable forces. ... Where there is more than one control position, the control system must be designed in such a way that the use of one of them precludes the use of the others, except for stop controls and emergency stops. ... Where machinery has several starting control devices and the operators can therefore put each other in danger, additional devices must be fitted to rule out such risks. If safety requires that starting and/or stopping must be performed in a specific sequence, there must be devices which ensure that these operations are performed in the correct order.
12	3	1.2.4.1. Normal stop Machinery must be fitted with a control device whereby the machinery can be brought safely to a complete stop. Each workstation must be fitted with a control device to stop some or all of the functions of the machinery, depending on the existing hazards, so that the machinery is rendered safe. The machinery's stop control must have priority over the start controls. Once the machinery or its hazardous functions have stopped, the energy

Requirement code	Requirement number	Text of the directive
		supply to the actuators concerned must be cut off.
12	4	1.2.4.2. Operational stop Where, for operational reasons, a stop control that does not cut off the energy supply to the actuators is required, the stop condition must be monitored and maintained.
12	5	1.2.4.3. Emergency stop Machinery must be fitted with one or more emergency stop devices to enable actual or impending danger to be averted. The following exceptions apply: - machinery in which an emergency stop device would not lessen the risk, either because it would not reduce the stopping time or because it would not enable the special measures required to deal with the risk to be taken, - portable hand-held and/or hand-guided machinery. The device must: - have clearly identifiable, clearly visible and quickly accessible control devices, - stop the hazardous process as quickly as possible, without creating additional risks, - where necessary, trigger or permit the triggering of certain safeguard movements. Once active operation of the emergency stop device has ceased following a stop command, that command must be sustained by engagement of the emergency stop device until that engagement is specifically overridden; it must not be possible to engage the device without triggering a stop command; it must be possible to disengage the device only by an appropriate operation, and disengaging the device must not restart the machinery but only permit restarting. The emergency stop function must be available and operational at all times, regardless of the operating mode. Emergency stop devices must be a back-up to other safeguarding measures and not a substitute for them.
12	6	1.2.4.4. Assembly of machinery In the case of machinery or parts of machinery designed to work together, the machinery must be designed and constructed in such a way that the stop controls, including the emergency stop devices, can stop not only the machinery itself but also all related equipment, if its continued operation may be dangerous.
12	7	1.2.5. Selection of control or operating modes The control or operating mode selected must override all other control or operating modes, with the exception of the emergency stop.
12	8	1.2.6. Failure of the power supply The interruption, the re-establishment after an interruption or the fluctuation in whatever manner of the power supply to the machinery must not lead to dangerous situations. ... - the machinery must not be prevented from stopping if the command has already been given,

Requirement code	Requirement number	Text of the directive
		... - automatic or manual stopping of the moving parts, whatever they may be, must be unimpeded, - the protective devices must remain fully effective or give a stop command.
12	9	1.3.9. Risks of uncontrolled movements When a part of the machinery has been stopped, any drift away from the stopping position, for whatever reason other than action on the control devices, must be prevented or must be such that it does not present a hazard.
12	10	1.4.2.2. Interlocking movable guards Interlocking movable guards must be associated with an interlocking device that: - prevents the start of hazardous machinery functions until they are closed and - gives a stop command whenever they are no longer closed. ... Interlocking movable guards must be designed in such a way that the absence or failure of one of their components prevents starting or stops the hazardous machinery functions.
12	11	1.4.3. Special requirements for protective devices Protective devices must be designed and incorporated into the control system in such a way that: ... - the absence or failure of one of their components prevents starting or stops the moving parts.
12	12	1.6.3. Isolation of energy sources ... After the energy is cut off, it must be possible to dissipate normally any energy remaining or stored in the circuits of the machinery without risk to persons.
12	13	3.3.3. Travelling function Without prejudice to road traffic regulations, self-propelled machinery and its trailers must meet the requirements for slowing down, stopping, braking and immobilisation so as to ensure safety under all the operating, load, speed, ground and gradient conditions allowed for. The driver must be able to slow down and stop self-propelled machinery by means of a main device. Where safety so requires, in the event of a failure of the main device, or in the absence of the energy supply needed to actuate the main device, an emergency device with a fully independent and easily accessible control device must be provided for slowing down and stopping. Where safety so requires, a parking device must be provided to render stationary machinery immobile. This device may be combined with one of the devices referred to in the second paragraph, provided that it is purely mechanical. Remote-controlled machinery must be equipped with devices for stopping operation automatically and immediately and for preventing potentially dangerous operation in the following

Requirement code	Requirement number	Text of the directive
		situations: - if the driver loses control, - if it receives a stop signal, - if a fault is detected in a safety-related part of the system, - if no validation signal is detected within a specified time. Section 1.2.4 does not apply to the travelling function.
12	14	4.2.1. Control of movements Hold-to-run control devices must be used to control the movements of the machinery or its equipment. However, for partial or complete movements in which there is no risk of the load or the machinery colliding, the said devices may be replaced by control devices authorising automatic stops at pre-selected positions without the operator holding a hold-to-run control device.

Annex 2 – comparison of ISO 11850 – Directive 2006/42/EC – points not satisfied

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
1	2	1.2.2. Control devices Control devices must be: - clearly visible and identifiable, using pictograms where appropriate, ... Machinery must be fitted with indicators as required for safe operation. The operator must be able to read them from the control position. From each control position, the operator must be able to ensure that no-one is in the danger zones, or the control system must be designed and constructed in such a way that starting is prevented while someone is in the danger zone. If neither of these possibilities is applicable, before the machinery starts, an acoustic and/or visual warning signal must be given. The exposed persons must have time to leave the danger zone or prevent the machinery starting up.	The operator controls shall be selected, designed, constructed and arranged as follows: a) The primary controls, i.e. controls that are used frequently or continuously by the operator, such as: machine controls, transmission, brakes, steering, engine speed and working tool controls, shall be located within the zones of comfort and secondary controls, i.e. controls that are infrequently used by the operator, such as windscreen wipers, starter, heater, air conditioner etc, within the zones of reach in accordance with ISO 6682. Control arrangement and function shall consider space requirements for arctic clothing in accordance with ISO 2860 and ISO 3411, unless a heated	No requirements concerning identifiability

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
			operator enclosure is provided.	
1	2	1.2.2. Control devices Control devices must be: - clearly visible and identifiable, using pictograms where appropriate, ... Machinery must be fitted with indicators as required for safe operation. The operator must be able to read them from the control position. From each control position, the operator must be able to ensure that no-one is in the danger zones, or the control system must be designed and constructed in such a way that starting is prevented while someone is in the danger zone. If neither of these possibilities is applicable, before the machinery starts, an acoustic and/or visual warning signal must be given. The exposed persons must have time to leave the danger zone or prevent the machinery starting up.	Machines shall be equipped with an operator-controlled alarm horn and back-up alarm in accordance with ISO 9533.	No requirement for an obligatory warning for persons present in the danger zone; ISO 9533 applies to the warning alarm to the rear and the front; the form is not specified; minor improvement by the additional requirement for a back-up alarm; the start-up delay required by the Machinery Directive is not implemented by the alarm; a clearer provision would be necessary
1	3	1.2.4.3. Emergency stop ... The device must: - have clearly identifiable, clearly visible and quickly accessible	No equivalent found	Requirement not found in the standard, nor in the latest version

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		control devices,		
1	4	1.2.5. Selection of control or operating modes The control or operating mode selected must override all other control or operating modes, with the exception of the emergency stop. If machinery has been designed and constructed to allow its use in several control or operating modes requiring different protective measures and/or work procedures, it must be fitted with a mode selector which can be locked in each position. Each position of the selector must be clearly identifiable and must correspond to a single operating or control mode.	No equivalent found	The point is not addressed, although the case may occur, for example with traction winches; a normative provision should therefore be formulated
1	7	1.7.3. Marking of machinery All machinery must be marked visibly, legibly and indelibly with the following minimum particulars: - the business name and full address of the manufacturer and, where applicable, his authorised representative, - designation of the machinery, - the CE Marking (see Annex III), - designation of series or type, - serial number, if any, - the year of construction, that is the year in which the	5.2 Marking The following forestry machinery specific markings shall be provided: ... NOTE 2 Be also aware of national and regional provisions for additional mandatory markings	Statutory marking can be taken only from the directive itself; should be a normative provision; exists at present only as a note

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		manufacturing process is completed. It is prohibited to pre-date or post-date the machinery when affixing the CE marking.		
1	10	3.3.2. Starting/moving Where, for operating purposes, machinery is fitted with devices which exceed its normal clearance zone (e.g. stabilisers, jib, etc.), the driver must be provided with the means of checking easily, before moving the machinery, that such devices are in a particular position which allows safe movement. This also applies to all other parts which, to allow safe movement, have to be in particular positions, locked if necessary.	No equivalent found	No reference to the requirement for examination of the safe clearance zone
2	1	1.1.8. Seating Where appropriate and where the working conditions so permit, work stations constituting an integral part of the machinery must be designed for the installation of seats. If the operator is intended to sit during operation and the operating position is an integral part of the machinery, the seat must be provided with the machinery. The operator's seat must enable him to maintain a	No equivalent found	4.16.1.1 contains a general requirement for the reduction of vibration to be an integral part of the development process; no direct reference to the seat

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		stable position. Furthermore, the seat and its distance from the control devices must be capable of being adapted to the operator. If the machinery is subject to vibrations, the seat must be designed and constructed in such a way as to reduce the vibrations transmitted to the operator to the lowest level that is reasonably possible. The seat mountings must withstand all stresses to which they can be subjected. Where there is no floor beneath the feet of the operator, footrests covered with a slip-resistant material must be provided.		
3	7	1.6.4. Operator intervention Machinery must be so designed, constructed and equipped that the need for operator intervention is limited. If operator intervention cannot be avoided, it must be possible to carry it out easily and safely.	No equivalent found	Concrete requirement not implemented
3	9	1.7.4.2. Contents of the instructions ... (e) the drawings, diagrams, descriptions and explanations necessary for the use, maintenance and repair of the machinery and for	5.1 Operator's manual All machines shall be equipped with an operator's manual in accordance with 6.5 of ISO 12100-2:2003 and respectively with ISO	No concrete requirements concerning diagrams present; ISO 3600 formulates no specific requirements; ISO 4413, to which the draft standard refers for the requirements upon the

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		checking its correct functioning; ... (o) the conditions in which the machinery meets the requirement of stability during use, transportation, assembly, dismantling when out of service, testing or foreseeable breakdowns; ... (r) the description of the adjustment and maintenance operations that should be carried out by the user and the preventive maintenance measures that should be observed; (s) instructions designed to enable adjustment and maintenance to be carried out safely, including the protective measures that should be taken during these operations;	3600 or ISO 6750 providing information for safe use and maintenance of the machine. In particular the following points, where applicable, shall be emphasized: ... o) general requirements for routine lubrication, maintenance and use of special tools;	hydraulic system, specifies circuit diagrams
3	9	1.7.4.2. Contents of the instructions ... (e) the drawings, diagrams, descriptions and explanations necessary for the use, maintenance and repair of the machinery and for checking its correct functioning; ... (o) the conditions in which the machinery meets the requirement of stability during use, transportation, assembly,	5.1 Operator's manual All machines shall be equipped with an operator's manual in accordance with 6.5 of ISO 12100-2:2003 and respectively with ISO 3600 or ISO 6750 providing information for safe use and maintenance of the machine. In particular the following points, where applicable,	ISO 6750 is generally the better standard for instruction handbooks

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		dismantling when out of service, testing or foreseeable breakdowns; ... (r) the description of the adjustment and maintenance operations that should be carried out by the user and the preventive maintenance measures that should be observed; (s) instructions designed to enable adjustment and maintenance to be carried out safely, including the protective measures that should be taken during these operations;	shall be emphasized: ... o) general requirements for routine lubrication, maintenance and use of special tools;	
3	9	1.7.4.2. Contents of the instructions ... (e) the drawings, diagrams, descriptions and explanations necessary for the use, maintenance and repair of the machinery and for checking its correct functioning; ... (o) the conditions in which the machinery meets the requirement of stability during use, transportation, assembly, dismantling when out of service, testing or foreseeable breakdowns; ... (r) the description of the adjustment and maintenance operations that should be carried	4.20 Hydraulic systems shall comply with the safety requirements of ISO 4413	Reference to ISO 4413 makes circuit diagrams mandatory only for stationary industrial machinery

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		out by the user and the preventive maintenance measures that should be observed; (s) instructions designed to enable adjustment and maintenance to be carried out safely, including the protective measures that should be taken during these operations;		
3	10	3.4.2. Moving transmission parts By way of exception to section 1.3.8.1, in the case of engines, moveable guards preventing access to the moving parts in the engine compartment need not have interlocking devices if they have to be opened either by the use of a tool or key or by a control located in the driving position, providing the latter is in a fully enclosed cab with a lock to prevent unauthorised access.	no equivalent found	Adoption of the requirement would be advantageous; since the provision represents an alleviation, its omission does not constitute a fundamental problem
3	12	3.4.7. Transmission of power between self-propelled machinery (or tractor) and recipient machinery Removable mechanical transmission devices linking self-propelled machinery (or a tractor) to the first fixed bearing of recipient machinery must be designed and constructed in such a way that any part that moves	no equivalent found	Occurs only rarely; of relevance to converted tractors: these are subject to standards governing agricultural machinery; the addition of a normative provision is recommended

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		during operation is protected over its whole length. On the side of the self-propelled machinery (or tractor), the power take-off to which the removable mechanical transmission device is attached must be protected either by a guard fixed and linked to the self-propelled machinery (or tractor) or by any other device offering equivalent protection. It must be possible to open this guard for access to the removable transmission device. Once it is in place, there must be enough room to prevent the drive shaft damaging the guard when the machinery (or the tractor) is moving. On the recipient machinery side, the input shaft must be enclosed in a protective casing fixed to the machinery. All recipient machinery, the operation of which requires a removable mechanical transmission device to connect it to self-propelled machinery (or a tractor), must have a system for attaching the removable mechanical transmission device so that, when the machinery is uncoupled, the removable mechanical transmission device and its guard are not		

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		damaged by contact with the ground or part of the machinery.		
11	11	1.4.2.2. Interlocking movable guards Interlocking movable guards must be associated with an interlocking device that: - prevents the start of hazardous machinery functions until they are closed and - gives a stop command whenever they are no longer closed. Where it is possible for an operator to reach the danger zone before the risk due to the hazardous machinery functions has ceased, movable guards must be associated with a guard locking device in addition to an interlocking device that: - prevents the start of hazardous machinery functions until the guard is closed and locked, and - keeps the guard closed and locked until the risk of injury from the hazardous machinery functions has ceased. Interlocking movable guards must be designed in such a way that the absence or failure of one of their components prevents starting or stops the hazardous machinery functions.	4.3.2.5 Fumes, spillage, hose guards and sharp edges A person in the operator station shall be protected as follows: ... d) Pressurized hoses, pipes and components shall be located or shielded so that in the event of rupture, the fluid can not be discharged directly onto the operator when in the operating position. This is also applicable to in all operating positions for movable shields (e.g. doors or windows) designed to be open during machine operations.	Is not governed to this effect; some machines feature door contact switches or seat switches: these protective devices are not addressed in the standard, which assumes that guards are opened only when the engine/motor is not running, and that protection need be assured only against the sprayed discharge of fluids

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
12	1	1.2.1. Safety and reliability of control systems ... Particular attention must be given to the following points: ... - the machinery must not be prevented from stopping if the stop command has already been given, ... - automatic or manual stopping of the moving parts, whatever they may be, must be unimpeded, - the protective devices must remain fully effective or give a stop command	no equivalent found	ISO 11850 does not address stopping in an emergency; a normative provision is recommended
12	2	1.2.2. Control devices Control devices must be: - located outside the danger zones, except where necessary for certain control devices such as an emergency stop or a teach pendant, - made in such a way as to withstand foreseeable forces; particular attention must be paid to emergency stop devices liable to be subjected to considerable forces. ... Where there is more than one control position, the control system	4.5 Controls 4.5.1 Starting 4.5.1.1 Unauthorized starting or movement of machines Means shall be provided to render the starting control and parking release systems inoperative in order to deter unauthorized machine or working tool movement following machine shutdown. Locking devices such as key-type ignition switches, lockable master	The standard fails to address a number of specific requirements; stopping in an emergency covered only by stopping of the engine/motor; the most recent version even fails to require marking; requirements governing the sequence of operation should be formulated, for example for traction winches; the addition of a normative provision is recommended

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		must be designed in such a way that the use of one of them precludes the use of the others, except for stop controls and emergency stops. ... Where machinery has several starting control devices and the operators can therefore put each other in danger, additional devices must be fitted to rule out such risks. If safety requires that starting and/or stopping must be performed in a specific sequence, there must be devices which ensure that these operations are performed in the correct order.	energy disconnect switches or provisions for padlocks satisfy this requirement. Lockable cabs can be used as protection for controls or systems located within the cab. Verification of conformity shall be checked by inspection. 4.5.1.2 Transmission neutral start In order to prevent unexpected machine movement during engine start-up, an interlock shall be provided which shall prevent the engine from being started unless: ☐ the transmission is in neutral; or ☐ the transmission clutch is disengaged; or ☐ the combination direction and speed control is in neutral; or ☐ an equivalent system is provided. No interlock is required if the transmission control returns to neutral when released.	

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
			Verification of conformity shall be checked by inspection and functional test. ISO/FDIS 11850:2010(E) 8 © ISO 2010 – All rights reserved 4.5.1.3 Bypass start protection Starter-motor solenoid and relay electrical connections shall be shielded or blocked by obstacles to prevent accidental connection and to discourage deliberate connection that circumvents neutral start interlock features without using tools. Verification of conformity shall be checked by inspection. 4.5.2 Engine stop control The engine stop control shall be clearly identified and, if separate from the ignition key, shall be with a colour contrasting to the background. Verification of conformity shall be checked by inspection.	

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
			4.5.3 Other controls The operator controls shall be selected, designed, constructed and arranged as follows: a) The primary controls, i.e. controls that are used frequently or continuously by the operator, such as: machine controls, transmission, brakes, steering, engine speed and working tool controls, shall be located within the zones of comfort and secondary controls, i.e. controls that are infrequently used by the operator, such as windscreen wipers, starter, heater, air conditioner etc, within the zones of reach in accordance with ISO 6682. Control arrangement and function shall consider space requirements for arctic clothing in accordance with ISO 2860 and ISO 3411, unless a heated operator enclosure is provided.	

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
			b) The required travel and actuation force of controls shall be consistent with the frequency of use and practical ergonomics needed to minimize operator fatigue or stress. NOTE See ISO 10968 and ISO 15077 for guidance. c) Foot pedals shall be of appropriate size, shape, spacing and have a slip-resistant surface. In designs where there is an analogy between driving a forestry machine and a motor vehicle (i.e. with the clutch on the left, the brake in the centre and the accelerator on the right), pedals shall be similarly located to avoid the risk of confusion. d) Equipment controls shall automatically return to their neutral position when the operator releases the control. This does not apply to travel or other controls where a detent is necessary for a specific operational requirement.	

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
			e) Controls, which cause movement of the machine or equipment shall be arranged, protected or provided with neutral-position locks to minimize accidental activation when the operator enters or leaves the machine. f) For machines with more than one working position, the operator shall be able to move from one position to the other without hazard from accidental contact with a control.	
12	5	1.2.4.3. Emergency stop Machinery must be fitted with one or more emergency stop devices to enable actual or impending danger to be averted. The following exceptions apply: - machinery in which an emergency stop device would not lessen the risk, either because it would not reduce the stopping time or because it would not enable the special measures required to deal with the risk to be taken, - portable hand-held and/or hand-guided machinery. The device must: - have clearly identifiable, clearly	no equivalent found	Emergency stop devices are state of the art for self-propelled forestry machinery; they must therefore also be included in this standard

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		visible and quickly accessible control devices, - stop the hazardous process as quickly as possible, without creating additional risks, - where necessary, trigger or permit the triggering of certain safeguard movements. Once active operation of the emergency stop device has ceased following a stop command, that command must be sustained by engagement of the emergency stop device until that engagement is specifically overridden; it must not be possible to engage the device without triggering a stop command; it must be possible to disengage the device only by an appropriate operation, and disengaging the device must not restart the machinery but only permit restarting. The emergency stop function must be available and operational at all times, regardless of the operating mode. Emergency stop devices must be a back-up to other safeguarding measures and not a substitute for them.		
12	7	1.2.5. Selection of control or operating modes The control or operating mode selected must override all other	no equivalent found	A rare case, possibly for multi-function machinery with changing equipment (Buffalo dual, combination of forwarder

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		control or operating modes, with the exception of the emergency stop.		and skidder); the emergency-stop aspect is missing from ISO 11850; the point is relevant for example for traction winches

Annex 3 – comparison of EN 14492-1 – Directive 2006/42/EC – points not satisfied

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
1	4	1.2.5. Selection of control or operating modes The control or operating mode selected must override all other control or operating modes, with the exception of the emergency stop. If machinery has been designed and constructed to allow its use in several control or operating modes requiring different protective measures and/or work procedures, it must be fitted with a mode selector which can be locked in each position. Each position of the selector must be clearly identifiable and must correspond to a single operating or control mode.	5.2.1 Control devices Devices for starting and stopping manually controlled winches shall be fitted with hold-to-run control elements so that the drive energy supply is interrupted when the actuating elements are released. Actuating elements of control devices shall incorporate features that prevent unintentional operation or not wanted movements of the load. (See EN 13557:2003, 5.2.3.1.2.) Actuating elements of control devices shall incorporate features and be arranged and marked in such a way that their assignments, direction of operation and switching state are unmistakably recognisable.	Operating mode selectors are fitted to winches used in forestry (such as traction winches); owing to the presence of risks (in particular, a high risk of incorrect operation), the requirements of the Machinery Directive must be implemented in standards
1	9	3.3. CONTROL SYSTEMS If necessary, steps must be taken to prevent unauthorised use of controls. In the case of remote controls, each control unit must clearly identify the machinery to be controlled from that unit.	no equivalent found	Remote controls are not addressed; protection against unauthorized use is assured at most for self-propelled machines; owing to the presence of hazards, a normative provision should be formulated

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
1	12	3.6.1. Signs, signals and warnings ... Remote-controlled machinery which, under normal conditions of use, exposes persons to the risk of impact or crushing must be fitted with appropriate means to signal its movements or with means to protect persons against such risks. The same applies to machinery which involves, when in use, the constant repetition of a forward and backward movement on a single axis where the area to the rear of the machine is not directly visible to the driver.	no equivalent found	Remote controls are not addressed; the author recommends examination of whether the safety objectives are adequately implemented; owing to the presence of hazards, a normative provision should be formulated
2	7	1.7.4.2. Contents of the instructions (j) instructions relating to installation and assembly for reducing noise or vibration;	no equivalent found	The requirement is not implemented but is relevant where winches are mounted on vehicles in fixed form; it may also be relevant to detachable winches; owing to the presence of relevant hazards, a normative provision should be formulated
3	1	1.1.4. Lighting ... Internal parts requiring frequent inspection and adjustment, and maintenance areas must be provided with appropriate lighting.	no equivalent found	The need should be examined for a provision governing winch units

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
3	3	1.2.5. Selection of control or operating modes The control or operating mode selected must override all other control or operating modes, with the exception of the emergency stop. If machinery has been designed and constructed to allow its use in several control or operating modes requiring different protective measures and/or work procedures, it must be fitted with a mode selector which can be locked in each position. Each position of the selector must be clearly identifiable and must correspond to a single operating or control mode. The selector may be replaced by another selection method which restricts the use of certain functions of the machinery to certain categories of operator. If, for certain operations, the machinery must be able to operate with a guard displaced or removed and/or a protective device disabled, the control or operating mode selector must simultaneously: - disable all other control or operating modes, - permit operation of hazardous functions only by control devices requiring sustained action, - permit the operation of hazardous functions only in reduced risk conditions while preventing hazards	no equivalent found	The need should be examined for operating mode selectors for certain winch types (e.g. traction winches) to be governed; owing to the presence of relevant hazards, a normative provision should be formulated

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		from linked sequences, - prevent any operation of hazardous functions by voluntary or involuntary action on the machine's sensors. If these four conditions cannot be fulfilled simultaneously, the control or operating mode selector must activate other protective measures designed and constructed to ensure a safe intervention zone. In addition, the operator must be able to control operation of the parts he is working on from the adjustment point.		
3	5	1.4.1. General requirements Guards and protective devices must: ... - enable essential work to be carried out on the installation and/or replacement of tools and for maintenance purposes by restricting access exclusively to the area where the work has to be done, if possible without the guard having to be removed or the protective device having to be disabled.	no equivalent found	The need for a provision should be examined
3	6	1.6.2. Access to operating positions and servicing points Machinery must be designed and constructed in such a way as to allow access in safety to all areas where intervention is necessary during	no equivalent found	No provisions governing safety during maintenance; owing to the presence of hazards, a normative provision should be formulated

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		operation, adjustment and maintenance of the machinery.		
3	7	1.6.4. Operator intervention Machinery must be so designed, constructed and equipped that the need for operator intervention is limited. If operator intervention cannot be avoided, it must be possible to carry it out easily and safely.	5.7.2 Rope drum ... The fixing point of the rope shall be easily accessible for maintenance and replacement of the rope.	Provision present only for one point; the author recommends that the need for further provisions be examined
3	12	3.4.7. Transmission of power between self-propelled machinery (or tractor) and recipient machinery Removable mechanical transmission devices linking self-propelled machinery (or a tractor) to the first fixed bearing of recipient machinery must be designed and constructed in such a way that any part that moves during operation is protected over its whole length. On the side of the self-propelled machinery (or tractor), the power take-off to which the removable mechanical transmission device is attached must be protected either by a guard fixed and linked to the self-propelled machinery (or tractor) or by any other device offering equivalent	no equivalent found	Mechanical transmission devices are not addressed, despite Figure A 5 of the standard showing a detachable forestry winch with mechanical transmission device; at least a normative reference is required

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		protection. It must be possible to open this guard for access to the removable transmission device. Once it is in place, there must be enough room to prevent the drive shaft damaging the guard when the machinery (or the tractor) is moving. On the recipient machinery side, the input shaft must be enclosed in a protective casing fixed to the machinery. All recipient machinery, the operation of which requires a removable mechanical transmission device to connect it to self-propelled machinery (or a tractor), must have a system for attaching the removable mechanical transmission device so that, when the machinery is uncoupled, the removable mechanical transmission device and its guard are not damaged by contact with the ground or part of the machinery.		
3	15	3.6.3.2. Multiple uses The instructions for machinery allowing several uses depending on the equipment used and the instructions for the interchangeable equipment must contain the information necessary for safe assembly and use of the basic machinery and the interchangeable equipment that can be fitted.	no equivalent found	Not generally the case with winches; consideration may be necessary for detachable traction winches; a reference or risk exclusion is therefore deemed necessary

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
3	17	1.6.1. Machinery maintenance Adjustment and maintenance points must be located outside danger zones. It must be possible to carry out adjustment, maintenance, repair, cleaning and servicing operations while machinery is at a standstill. If one or more of the above conditions cannot be satisfied for technical reasons, measures must be taken to ensure that these operations can be carried out safely (see section 1.2.5). In the case of automated machinery and, where necessary, other machinery, a connecting device for mounting diagnostic fault-finding equipment must be provided. Automated machinery components which have to be changed frequently must be capable of being removed and replaced easily and safely. Access to the components must enable these tasks to be carried out with the necessary technical means in accordance with a specified operating method.	no equivalent found	Relevant to sled yarders and possibly also to detachable winches; no reference to maintenance with the machine stopped; this point is however covered for some winches by the base vehicle
4	1	1.1.5. Design of machinery to facilitate its handling Machinery, or each component part thereof, must: - be capable of being handled and transported safely, - be packaged or designed so that it	5.1 General Winches shall comply with the safety requirements and or protective measures of this clause. In addition, the winches shall be designed in accordance with the principles of EN ISO	Implementation should be examined with reference to the safety objectives

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		can be stored safely and without damage. During the transportation of the machinery and/or its component parts, there must be no possibility of sudden movements or of hazards due to instability as long as the machinery and/or its component parts are handled in accordance with the instructions.	12100-1 and EN ISO 12100-2 for hazards relevant but not significant, which are not dealt with by this document. Winches shall be classified in groups of mechanism in accordance with ISO 4301-1 in accordance with the operational requirements and conditions of application. Winches shall be designed in accordance with FEM 1.001, booklets 1, 2, 3, 4, 8 and 9 and FEM 9.901. NOTE For the calculation, EN 13001-1, EN 13001-2, and CEN/TS 13001-3-1 are available. After publication of these documents as harmonized European Standards, CEN/TC 147/WGP 7 will check to see how to update this European Standard and to make reference to these documents. Winches shall be designed taking into account the static and dynamic forces which may occur at intended use. Forces which occur due to the activation of the rated capacity limiter and the emergency stop device shall be taken into account. Accessible parts shall not have sharp edges, sharp angles or	

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
			protruding parts that can cause injury. This can be achieved by e.g. de-burring, flanging, trimming, sand blasting.	
4	1	1.1.5. Design of machinery to facilitate its handling Machinery, or each component part thereof, must: - be capable of being handled and transported safely, - be packaged or designed so that it can be stored safely and without damage. During the transportation of the machinery and/or its component parts, there must be no possibility of sudden movements or of hazards due to instability as long as the machinery and/or its component parts are handled in accordance with the instructions.	No equivalent found for the requirement concerning storage and transport.	Stowage of detachable winches is not addressed; owing to the presence of hazards, a normative provision should be formulated
4	12	4.1.2.8.4. Risk due to the load falling off the carrier Where there is a risk due to the load falling off the carrier, the machinery must be designed and constructed in such a way as to prevent this risk.	5.16.7 Rope fastening onto the rope drum Where the drum is equipped with a detachable rope fastening, this shall be designed in such a way that it detaches in case of a smaller pulling force resulting from 30% of the rated capacity, when the rope is wound completely off the drum.	Provides no protection against falling; a mandatory limiter appears more appropriate in this context

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
5	2	1.3.2. Risk of break-up during operation ... Where a risk of rupture or disintegration remains despite the measures taken, the parts concerned must be mounted, positioned and/or guarded in such a way that any fragments will be contained, preventing hazardous situations. Both rigid and flexible pipes carrying fluids, particularly those under high pressure, must be able to withstand the foreseen internal and external stresses and must be firmly attached and/or protected to ensure that no risk is posed by a rupture.	5.11.6.3 Mechanical protection Hydraulic systems shall be arranged and/or covered in such a way that hazards for persons or objects are minimized.	Falls short of the requirements of the Machinery Directive; the requirements must be extended
6	5	1.5.5. Extreme temperatures Steps must be taken to eliminate any risk of injury arising from contact with or proximity to machinery parts or materials at high or very low temperatures. The necessary steps must also be taken to avoid or protect against the risk of hot or very cold material being ejected.	5.1 General ... Risk of burn during hoisting operation caused by contact between the operator's skin and hot surfaces of the winch shall be reduced by following the principles of EN 563.	Governs lifting operations only; heat hazards are also possible during winch operations involving cable skidding; at least these should also be governed by the standard
6	9	1.6.2. Access to operating positions and servicing points Machinery must be designed and constructed in such a way as to allow access in safety to all areas where intervention is necessary during	5.7.2 Rope drum It shall not be possible for ropes to run off the side of the rope drums. NOTE Suitable measures on drums are for example, flanged	Access to the other maintenance points not addressed

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		operation, adjustment and maintenance of the machinery.	drum end plates, frame/housing, or rope guides. Flanged drum end plates shall protrude beyond the rope wound on the drum at the top layer by at least 1,5 x the nominal rope diameter. Drums designed for single-layer winding shall be grooved. Grooving shall be smooth and free from surface defects liable to damage the rope. The edges shall be rounded. These grooves should have a radius of (0,525 to 0,56) x nominal rope diameter. The rope groove depth should be between 0,28 and 0,45 of the nominal rope diameter. The groove pitch shall provide sufficient clearance between adjacent rope turns on the drum, taking into account the rope tolerance. The fixing point of the rope shall be easily accessible for maintenance and replacement of the rope. Rope run-on points in the normal working position of the operating personnel and in the traffic area shall be guarded to prevent accidental ingress of parts of the human body.	

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
8	1	1.1.2. Principles of safety integration (d) Machinery must be designed and constructed to take account of the constraints to which the operator is subject as a result of the necessary or foreseeable use of personal protective equipment.	no equivalent found	Not addressed, although yarding applications in forestry are a particular area of relevance, since the operator is not generally seated in the cab; a risk exclusion exists with regard to negligent use of the personal protective equipment, but not with regard to associated stresses (e.g. work with gloves)
8	2	1.1.6. Ergonomics Under the intended conditions of use, the discomfort, fatigue and physical and psychological stress faced by the operator must be reduced to the minimum possible, taking into account ergonomic principles such as: - allowing for the variability of the operator's physical dimensions, strength and stamina, ... - adapting the man/machinery interface to the foreseeable characteristics of the operators.	5.2.1 Control devices Devices for starting and stopping manually controlled winches shall be fitted with hold-to-run control elements so that the drive energy supply is interrupted when the actuating elements are released. Actuating elements of control devices shall incorporate features that prevent unintentional operation or not wanted movements of the load. (See EN 13557:2003, 5.2.3.1.2.). Actuating elements of control devices shall incorporate features and be arranged and marked in such a way that their assignments, direction of operation and switching state are unmistakably	No explicit inclusion of ergonomic requirements; supplementing required

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
			recognisable, using pictograms (symbols), where appropriate	
8	3	1.2.2. Control devices Control devices must be: ... - positioned in such a way as to be safely operated without hesitation or loss of time and without ambiguity, ... - made in such a way as to withstand foreseeable forces; particular attention must be paid to emergency stop devices liable to be subjected to considerable forces. ... Control devices must be so arranged that their layout, travel and resistance to operation are compatible with the action to be performed, taking account of ergonomic principles.	5.2.1 Control devices Devices for starting and stopping manually controlled winches shall be fitted with hold-to-run control elements so that the drive energy supply is interrupted when the actuating elements are released. Actuating elements of control devices shall incorporate features that prevent unintentional operation or not wanted movements of the load. (See EN 13557:2003, 5.2.3.1.2.). Actuating elements of control devices shall incorporate features and be arranged and marked in such a way that their assignments, direction of operation and switching state are unmistakably recognisable, using pictograms (symbols), where appropriate	Requirements implemented only in part; implementation of the requirement for resistance to stresses and compatibility between directions of movement and of the actions to be performed should be addressed

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
8	3	1.2.2. Control devices Control devices must be: ... - positioned in such a way as to be safely operated without hesitation or loss of time and without ambiguity, ... - made in such a way as to withstand foreseeable forces; particular attention must be paid to emergency stop devices liable to be subjected to considerable forces. ... Control devices must be so arranged that their layout, travel and resistance to operation are compatible with the action to be performed, taking account of ergonomic principles.	5.10.3 Control devices/controls Control devices shall be selected so that no pressure and flow disturbances can occur and their level of performance is kept. Control devices shall be arranged in the control system so that no unintended movements can occur. Control devices in control systems shall be selected and arranged in such a way that in the case of a power failure switching positions are automatically reached by spring force bringing the control into a neutral position. For direct-controlled winches this requirement applies only, when the actuators are released. Controls shall be such, that increasing/decreasing of the actuator-displacement provides increasing/decreasing of the speed of the load.	This aspect is addressed, but the requirements require extension; clarification is necessary of why this requirement is imposed only for pneumatic equipment

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
11	2	1.2.2. Control devices ... From each control position, the operator must be able to ensure that no-one is in the danger zones, or the control system must be designed and constructed in such a way that starting is prevented while someone is in the danger zone. If neither of these possibilities is applicable, before the machinery starts, an acoustic and/or visual warning signal must be given. The exposed persons must have time to leave the danger zone or prevent the machinery starting up. Where there is more than one control position, the control system must be designed in such a way that the use of one of them precludes the use of the others, except for stop controls and emergency stops.	no equivalent found	Risk exclusion with regard to visibility; multiple operating positions must however be observed (skyline crane)
11	6	1.2.4.4. Assembly of machinery In the case of machinery or parts of machinery designed to work together, the machinery must be designed and constructed in such a way that the stop controls, including the emergency stop devices, can stop not only the machinery itself but also all related equipment, if its continued operation may be dangerous.	no equivalent found	May be relevant to winches (for example operation of detachable winches and skidding with occasional operation of the winch); this is not addressed

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
11	13	1.6.3. Isolation of energy sources Machinery must be fitted with means to isolate it from all energy sources. Such isolators must be clearly identified. They must be capable of being locked if reconnection could endanger persons. Isolators must also be capable of being locked where an operator is unable, from any of the points to which he has access, to check that the energy is still cut off. In the case of machinery capable of being plugged into an electricity supply, removal of the plug is sufficient, provided that the operator can check from any of the points to which he has access that the plug remains removed. After the energy is cut off, it must be possible to dissipate normally any energy remaining or stored in the circuits of the machinery without risk to persons. As an exception to the requirement laid down in the previous paragraphs, certain circuits may remain connected to their energy sources in order, for example, to hold parts, to protect information, to light interiors, etc. In this case, special steps must be taken to ensure operator safety.	5.2.1 Control devices Devices for starting and stopping manually controlled winches shall be fitted with hold-to-run control elements so that the drive energy supply is interrupted when the actuating elements are released. Actuating elements of control devices shall incorporate features that prevent unintentional operation or not wanted movements of the load. (See EN 13557:2003, 5.2.3.1.2.)	Heavy reliance upon the dead-man's control; the need for requirements governing the base vehicle should be examined; interlocking of the state is desirable; risk exclusion exists for the power supply

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
12	2	1.2.2. Control devices Control devices must be: - located outside the danger zones, except where necessary for certain control devices such as an emergency stop or a teach pendant, - made in such a way as to withstand foreseeable forces; particular attention must be paid to emergency stop devices liable to be subjected to considerable forces. ... Where there is more than one control position, the control system must be designed in such a way that the use of one of them precludes the use of the others, except for stop controls and emergency stops. ... Where machinery has several starting control devices and the operators can therefore put each other in danger, additional devices must be fitted to rule out such risks. If safety requires that starting and/or stopping must be performed in a specific sequence, there must be devices which ensure that these operations are performed in the correct order.	no equivalent found	Multiple operating positions are not generally relevant (except in the case of skyline cranes); the robustness of the controls is however very important, and should be governed

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
12	4	1.2.4.2. Operational stop Where, for operational reasons, a stop control that does not cut off the energy supply to the actuators is required, the stop condition must be monitored and maintained.	no equivalent found	The need for provisions should be examined, in order for the safety objectives to be adequately implemented
12	7	1.2.5. Selection of control or operating modes The control or operating mode selected must override all other control or operating modes, with the exception of the emergency stop.	5.2.3 Emergency stop function Winches shall be provided with an emergency stop function. The emergency stop function shall be available and operational at all times, regardless of the operating mode.	Relevant to traction winches (adjustment, possibly directional function, travel); the point should be governed by the standard in order for incorrect operation to be avoided
12	10	1.4.2.2. Interlocking movable guards Interlocking movable guards must be associated with an interlocking device that: - prevents the start of hazardous machinery functions until they are closed and - gives a stop command whenever they are no longer closed. ... Interlocking movable guards must be designed in such a way that the absence or failure of one of their components prevents starting or stops the hazardous machinery functions.	5.1 General Winches shall comply with the safety requirements and or protective measures of this clause. In addition, the winches shall be designed in accordance with the principles of EN ISO 12100-1 and EN ISO 12100-2 for hazards relevant but not significant, which are not dealt with by this document. Winches shall be classified in groups of mechanism in accordance with ISO 4301-1 in accordance with the operational requirements and conditions of application.	Guards required, but no coupling to movements

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
			Winches shall be designed in accordance with FEM 1.001, booklets 1, 2, 3, 4, 8 and 9 and FEM 9.901. NOTE For the calculation, EN 13001-1, EN 13001-2, and CEN/TS 13001-3-1 are available. After publication of these documents as harmonized European Standards, CEN/TC 147/WGP 7 will check to see how to update this European Standard and to make reference to these documents. Winches shall be designed taking into account the static and dynamic forces which may occur at intended use. Forces which occur due to the activation of the rated capacity limiter and the emergency stop device shall be taken into account. Accessible parts shall not have sharp edges, sharp angles or protruding parts that can cause injury. This can be achieved by e.g. de-burring, flanging, trimming, sand blasting. Connections and individual components of winches shall incorporate features so that they cannot self-loosen. Moving transmission parts	

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
			(shafts, fans, wheels, gears, belts, couplings) shall be designed, positioned or guarded in order to protect against the risks associated with possible contact of exposed persons during the intended use …	
12	12	1.6.3. Isolation of energy sources ... After the energy is cut off, it must be possible to dissipate normally any energy remaining or stored in the circuits of the machinery without risk to persons.	no equivalent found	No requirements in the standard for pneumatically driven winches; the need for provisions should be examined

Annex 4 – comparison ISO 19472 – Directive 2006/42/EC – points not satisfied

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
1	3	1.2.4.3. Emergency stop ... The device must: - have clearly identifiable, clearly visible and quickly accessible control devices,	no equivalent found	Not mentioned; the author recommends examination of whether the safety objectives are adequately implemented
1	9	3.3. CONTROL SYSTEMS If necessary, steps must be taken to prevent unauthorised use of controls. In the case of remote controls, each control unit must clearly identify the machinery to be controlled from that unit.	no equivalent found	Remote controls not addressed; protection against unauthorized use assured at most for self-propelled machinery; requirement only for OPS; the author recommends examination of whether the safety objectives are adequately implemented
1	12	3.6.1. Signs, signals and warnings ... Remote-controlled machinery which, under normal conditions of use, exposes persons to the risk of impact or crushing must be fitted with appropriate means to signal its movements or with means to protect persons against such risks. The same applies to machinery which involves, when in use, the constant repetition of a forward and backward movement on a single axis where the area to the rear of the machine is not directly visible to	no equivalent found	Remote controls are not addressed; the hazard exists for self-propelled machinery; ISO 19472 requires OPS at least for the driver's position; the author recommends examination of whether the safety objectives are adequately implemented

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		the driver.		
1	13	4.1.2.7. Movements of loads during handling The operating position of machinery must be located in such a way as to ensure the widest possible view of trajectories of the moving parts, in order to avoid possible collisions with persons, equipment or other machinery which might be manoeuvring at the same time and liable to constitute a hazard.	no equivalent found	Visibility is not addressed; the author recommends examination of whether the safety objectives are adequately implemented

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
2	7	1.7.4.2. Contents of the instructions (j) instructions relating to installation and assembly for reducing noise or vibration;	no equivalent found	The requirement is not implemented but is relevant where winches are mounted on vehicles in fixed form; it may also be relevant to detachable winches; the author recommends examination of whether the safety objectives are adequately implemented
3	6	1.6.2. Access to operating positions and servicing points Machinery must be designed and constructed in such a way as to allow access in safety to all areas where intervention is necessary during operation, adjustment and maintenance of the machinery.	no equivalent found	No provisions governing safety during maintenance; the author recommends examination of whether the safety objectives are adequately implemented
3	7	1.6.4. Operator intervention Machinery must be so designed, constructed and equipped that the need for operator intervention is limited. If operator intervention cannot be avoided, it must be possible to carry it out easily and safely.	no equivalent found	No provisions governing safety during maintenance; the author recommends examination of whether the safety objectives are adequately implemented
5	2	1.3.2. Risk of break-up during operation ... Where a risk of rupture or disintegration remains despite the measures taken, the parts concerned must be mounted, positioned and/or	no equivalent found	ISO 19472 makes no reference to hydraulics, which no longer reflects the state of the art; the author recommends examination of whether the safety objectives are adequately implemented

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		guarded in such a way that any fragments will be contained, preventing hazardous situations. Both rigid and flexible pipes carrying fluids, particularly those under high pressure, must be able to withstand the foreseen internal and external stresses and must be firmly attached and/or protected to ensure that no risk is posed by a rupture.		
6	5	1.5.5. Extreme temperatures Steps must be taken to eliminate any risk of injury arising from contact with or proximity to machinery parts or materials at high or very low temperatures. The necessary steps must also be taken to avoid or protect against the risk of hot or very cold material being ejected.	no equivalent found	Not addressed; the risk analysis may have revealed that this risk requires no provisions; the author recommends examination of whether the safety objectives are adequately implemented
8	1	1.1.2. Principles of safety integration (d) Machinery must be designed and constructed to take account of the constraints to which the operator is subject as a result of the necessary or foreseeable use of personal protective equipment.	no equivalent found	Generally operated with gloves, should therefore be observed; the standard (ISO 2860) for service openings cited in FDIS ISO 11850 makes provision for example for Arctic clothing; the author recommend examination of whether the safety objectives are adequately implemented

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
10	1	1.1.3. Materials and products The materials used to construct machinery or products used or created during its use must not endanger persons' safety or health. In particular, where fluids are used, machinery must be designed and constructed to prevent risks due to filling, use, recovery or draining.	no equivalent found	ISO 19472 makes no reference to hydraulics, which no longer reflects the state of the art; the author recommends examination of whether the safety objectives are adequately implemented
10	2	1.5.6. Fire Machinery must be designed and constructed in such a way as to avoid any risk of fire or overheating posed by the machinery itself or by gases, liquids, dust, vapours or other substances produced or used by the machinery.	no equivalent found	This aspect is not addressed in the standard; since risks of this type exist, a normative provision should be formulated
10	3	1.6.3. Isolation of energy sources Machinery must be fitted with means to isolate it from all energy sources. Such isolators must be clearly identified. They must be capable of being locked if reconnection could endanger persons. Isolators must also be capable of being locked where an operator is unable, from any of the points to which he has access, to check that the energy is still cut off. In the case of machinery capable of being plugged into an electricity supply, removal of the plug is sufficient, provided that the operator	no equivalent found	This aspect is not addressed in the standard; the author recommends examination of whether the safety objectives are adequately implemented and whether for example the base vehicle need be addressed as the power source

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		can check from any of the points to which he has access that the plug remains removed. ... As an exception to the requirement laid down in the previous paragraphs, certain circuits may remain connected to their energy sources in order, for example, to hold parts, to protect information, to light interiors, etc. In this case, special steps must be taken to ensure operator safety.		
10	4	3.5.2. Fire Depending on the hazards anticipated by the manufacturer, machinery must, where its size permits: - either allow easily accessible fire extinguishers to be fitted, or - be provided with built-in extinguisher systems.	no equivalent found	No reference to fire prevention and protection; this is an issue, for example when agricultural tractors are used; the author recommends examination of whether the safety objectives are adequately implemented
11	1	1.2.1. Safety and reliability of control systems Particular attention must be given to the following points: - the machinery must not start unexpectedly, - the machinery must not be prevented from stopping if the stop command has already been given, - no moving part of the machinery or piece held by the machinery must fall	no equivalent found	No requirements concerning wireless controls (remote controls); the author recommends examination of whether the safety objectives are adequately implemented

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		or be ejected, - automatic or manual stopping of the moving parts, whatever they may be, must be unimpeded, - the protective devices must remain fully effective or give a stop command, - the safety-related parts of the control system must apply in a coherent way to the whole of an assembly of machinery and/or partly completed machinery. For cable-less control, an automatic stop must be activated when correct control signals are not received, including loss of communication.		
11	2	1.2.2. Control devices ... From each control position, the operator must be able to ensure that no-one is in the danger zones, or the control system must be designed and constructed in such a way that starting is prevented while someone is in the danger zone. If neither of these possibilities is applicable, before the machinery starts, an acoustic and/or visual warning signal must be given. The exposed persons must have time to leave the danger zone or prevent the machinery starting up. Where there is more than one control position, the control system must be	no equivalent found	Visibility requirements for winches only of limited benefit; risk exclusion therefore appears appropriate

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		designed in such a way that the use of one of them precludes the use of the others, except for stop controls and emergency stops.		
11	5	1.2.4.2. Operational stop Where, for operational reasons, a stop control that does not cut off the energy supply to the actuators is required, the stop condition must be monitored and maintained.	no equivalent found	In contrast to EN 14492-1, ISO 19472 does not require the power to be cut off; this is required at most by implication; the author recommends examination of whether the safety objectives are adequately implemented
11	6	1.2.4.4. Assembly of machinery In the case of machinery or parts of machinery designed to work together, the machinery must be designed and constructed in such a way that the stop controls, including the emergency stop devices, can stop not only the machinery itself but also all related equipment, if its continued operation may be dangerous.	no equivalent found	May be relevant to winches in some circumstances (for example operation of detachable winches and skidding with occasional operation of the winch). This is not addressed; emergency-stop not referred to at all; integration of the emergency stop of the winch into the system of the base vehicle is however eminently important for many applications (e.g. traction winches); the author recommends examination of whether the safety objectives are adequately implemented

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
11	7	1.2.5. Selection of control or operating modes If, for certain operations, the machinery must be able to operate with a guard displaced or removed and/or a protective device disabled, the control or operating mode selector must simultaneously: - disable all other control or operating modes, - permit operation of hazardous functions only by control devices requiring sustained action, - permit the operation of hazardous functions only in reduced risk conditions while preventing hazards from linked sequences, - prevent any operation of hazardous functions by voluntary or involuntary action on the machine's sensors. If these four conditions cannot be fulfilled simultaneously, the control or operating mode selector must activate other protective measures designed and constructed to ensure a safe intervention zone. In addition, the operator must be able to control operation of the parts he is working on from the adjustment point.	7.1 Instruction handbook Winches shall be equipped with an instruction handbook in accordance with ISO 3600. When the winch is incorporated in a machine such as a skidder, the information listed in this subclause may be included in the appropriate sections of the complete machine manuals. The instruction handbook shall give complete instructions for the safe use and maintenance of the winch and, where applicable, at least the following information: ...	For this safety objective, the standard effectively relies solely on the instruction handbook; a requirement would be appropriate for all maintenance to be performed with the machine stopped; the author recommends examination of whether the safety objectives are adequately implemented

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
11	13	1.6.3. Isolation of energy sources Machinery must be fitted with means to isolate it from all energy sources. Such isolators must be clearly identified. They must be capable of being locked if reconnection could endanger persons. Isolators must also be capable of being locked where an operator is unable, from any of the points to which he has access, to check that the energy is still cut off. In the case of machinery capable of being plugged into an electricity supply, removal of the plug is sufficient, provided that the operator can check from any of the points to which he has access that the plug remains removed. After the energy is cut off, it must be possible to dissipate normally any energy remaining or stored in the circuits of the machinery without risk to persons. As an exception to the requirement laid down in the previous paragraphs, certain circuits may remain connected to their energy sources in order, for example, to hold parts, to protect information, to light interiors, etc. In this case, special steps must be taken to ensure operator safety.	6.6.3 Power controls shall, when released, automatically return to the brake applied neutral position, except in the disconnect or free spool position.	Not adequately substantiated; heavy reliance upon the dead-man's circuit; the author recommends that the requirements of the directive be implemented in the standard

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
12	2	1.2.2. Control devices Control devices must be: - located outside the danger zones, except where necessary for certain control devices such as an emergency stop or a teach pendant, - made in such a way as to withstand foreseeable forces; particular attention must be paid to emergency stop devices liable to be subjected to considerable forces. ... Where there is more than one control position, the control system must be designed in such a way that the use of one of them precludes the use of the others, except for stop controls and emergency stops. ... Where machinery has several starting control devices and the operators can therefore put each other in danger, additional devices must be fitted to rule out such risks. If safety requires that starting and/or stopping must be performed in a specific sequence, there must be devices which ensure that these operations are performed in the correct order.	no equivalent found	Emergency stop missing in ISO 19472; the author recommends examination of whether the safety objectives are adequately implemented

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
12	3	1.2.4.1. Normal stop Machinery must be fitted with a control device whereby the machinery can be brought safely to a complete stop. Each workstation must be fitted with a control device to stop some or all of the functions of the machinery, depending on the existing hazards, so that the machinery is rendered safe. The machinery's stop control must have priority over the start controls. Once the machinery or its hazardous functions have stopped, the energy supply to the actuators concerned must be cut off.	6.6.3 Power controls shall, when released, automatically return to the brake applied neutral position, except in the disconnect or free spool position.	Together with automatic application of the brakes, the dead-man's circuit is the most important safety device and is in any case required by the Machinery Directive (4.2.1); the author recommends examination of whether the safety objectives are adequately implemented
12	4	1.2.4.2. Operational stop Where, for operational reasons, a stop control that does not cut off the energy supply to the actuators is required, the stop condition must be monitored and maintained.	no equivalent found	Examination required of whether the safety objective must be adopted in the standard
12	5	1.2.4.3. Emergency stop Machinery must be fitted with one or more emergency stop devices to enable actual or impending danger to be averted. The following exceptions apply: - machinery in which an emergency stop device would not lessen the risk, either because it would not reduce the stopping time or because it would not enable the special measures required	no equivalent found	Emergency stop and emergency off not referred to in the standard; the author recommends examination of whether the safety objectives are adequately implemented

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		to deal with the risk to be taken, - portable hand-held and/or hand-guided machinery. The device must: - have clearly identifiable, clearly visible and quickly accessible control devices, - stop the hazardous process as quickly as possible, without creating additional risks, - where necessary, trigger or permit the triggering of certain safeguard movements. Once active operation of the emergency stop device has ceased following a stop command, that command must be sustained by engagement of the emergency stop device until that engagement is specifically overridden; it must not be possible to engage the device without triggering a stop command; it must be possible to disengage the device only by an appropriate operation, and disengaging the device must not restart the machinery but only permit restarting. The emergency stop function must be available and operational at all times, regardless of the operating mode. Emergency stop devices must be a back-up to other safeguarding measures and not a substitute for them.		

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
12	8	1.2.6. Failure of the power supply The interruption, the re-establishment after an interruption or the fluctuation in whatever manner of the power supply to the machinery must not lead to dangerous situations. Particular attention must be given to the following points: ... - the machinery must not be prevented from stopping if the command has already been given, ... - automatic or manual stopping of the moving parts, whatever they may be, must be unimpeded, - the protective devices must remain fully effective or give a stop command.	6.5.1 The brake system or equivalent shall automatically be applied within 1 s when the power to the drum is disconnected. A release mechanism may be included to allow free spooling.	Here again, stopping is effectively possible only by means of hold-to-run control devices and then automatic application of the brakes (see above); the author recommends examination of whether the safety objectives are adequately implemented
12	10	1.4.2.2. Interlocking movable guards Interlocking movable guards must be associated with an interlocking device that: - prevents the start of hazardous machinery functions until they are closed and - gives a stop command whenever they are no longer closed. ... Interlocking movable guards must be designed in such a way that the	6.9.3 Machines with access doors or guards which can be opened or removed to expose machine elements which continue to rotate or move after the power is disengaged shall have, in the immediate area, a readily visible evidence of rotation, or an audible indication of rotation, or a suitable safety sign.	The Machinery Directive clearly requires stopping, whereas ISO 19472 requires only a warning of movement; ISO 19472 nevertheless still provides better implementation of the safety objective than EN 14492-1

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		absence or failure of one of their components prevents starting or stops the hazardous machinery functions.		
12	12	1.6.3. Isolation of energy sources ... After the energy is cut off, it must be possible to dissipate normally any energy remaining or stored in the circuits of the machinery without risk to persons.	no equivalent found	Not referred to; the author recommends examination of whether the safety objectives are adequately implemented

Annex 5 – comparison EN 13525 – Directive 2006/42/EC – points not satisfied

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
1	2	1.2.2. Control devices Control devices must be: - clearly visible and identifiable, using pictograms where appropriate, ... Machinery must be fitted with indicators as required for safe operation. The operator must be able to read them from the control position. From each control position, the operator must be able to ensure that no-one is in the danger zones, or the control system must be designed and constructed in such a way that starting is prevented while someone is in the danger zone. If neither of these possibilities is applicable, before the machinery starts, an acoustic and/or visual warning signal must be given. The exposed persons must have time to leave the danger zone or prevent the machinery starting up.	no equivalent found	No requirement that the controls be visible; other visibility requirements also missing; the author recommends examination of whether the safety objectives are adequately implemented
1	5	1.4.1. General requirements Guards and protective devices must: ... - cause minimum obstruction to the view of the production process, and...	no equivalent found	No visibility requirements; the author recommends that implementation of the safety objectives be examined

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
1	7	1.7.3. Marking of machinery All machinery must be marked visibly, legibly and indelibly with the following minimum particulars: - the business name and full address of the manufacturer and, where applicable, his authorised representative, - designation of the machinery, - the CE Marking (see Annex III), - designation of series or type, - serial number, if any, - the year of construction, that is the year in which the manufacturing process is completed. It is prohibited to pre-date or post-date the machinery when affixing the CE marking.	6.2 Marking The marking shall comply with 6.4 of EN ISO 12100-2:2003. All machines shall be marked legibly and indelibly with at least the following information: - name and address of the manufacturer; - year of construction; - designation of series and type; - serial number, if any; - nominal rotational frequency and direction of rotation of the power input connection (marked by an arrow), when applicable; - mass in kilograms; - nominal power in kW, when applicable	The reference to marking where this is a statutory requirement is omitted; the need for amendment should be examined
3	13	3.5.1. Batteries 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 rollover or tipover and to avoid the accumulation of vapours in places occupied by operators. Machinery must be designed and constructed in such a way that the battery can be disconnected with the aid of an easily accessible device provided for that purpose.	4.2.2.3 Where an electric starter is used to start the integral power source, unauthorised activation of the starter shall be avoided by using one or more of the following methods: - a key operated ignition or starting switch, - a lockable cover for the ignition or starting switch; - a security ignition or starting lock; - a lockable battery disconnection switch.	The requirement refers to hazards arising owing to the mobility of machines; further requirements must be formulated, since the batteries are generally transported on the machine; the standard does not specifically require a disconnection switch, but merely states it as a possibility

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
4	4	1.7.4.2. Contents of the instructions (o) the conditions in which the machinery meets the requirement of stability during use, transportation, assembly, dismantling when out of service, testing or foreseeable breakdowns;	6.1 Instruction handbook Comprehensive instructions and information on all aspects of maintenance and the safe use of the machine shall be provided in the instruction handbook. It shall comply with Clause 5 of EN 12100-2:2003. In particular the following points shall be emphasised: ... r) information on correct methods of hitching/attaching, supporting, tying-down and lifting the machine, including the allowed loading on those points;	EN ISO 12100-2 also includes no specific provisions; the author recommends examination of whether the safety objectives are adequately implemented
8	2	1.1.6. Ergonomics Under the intended conditions of use, the discomfort, fatigue and physical and psychological stress faced by the operator must be reduced to the minimum possible, taking into account ergonomic principles such as: - allowing for the variability of the operator's physical dimensions, strength and stamina, ... - adapting the man/machinery interface to the foreseeable characteristics of the operators.	no equivalent found	No provisions governing adjustment of the control actions, for example for discharge, speed, switching on, operational stopping, or loading; the author recommends examination of whether the safety objectives are adequately implemented

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
8	2	1.1.6. Ergonomics Under the intended conditions of use, the discomfort, fatigue and physical and psychological stress faced by the operator must be reduced to the minimum possible, taking into account ergonomic principles such as: - allowing for the variability of the operator's physical dimensions, strength and stamina, ... - adapting the man/machinery interface to the foreseeable characteristics of the operators.	4.5.6 If the infeed or discharge chutes /conveyors have to be folded for transport or maintenance they shall have for the purpose two handles located at a distance of at least 300 mm from the nearest articulation point. These handles can be integral parts of the machine provided they are designed and positioned in accordance with good ergonomic principles and clearly identified. The force required to fold and to reassemble any such chute/conveyor shall not exceed 250 N when measured at the handle provided. Means shall be provided to lock the foldable parts in their folded position.	No provisions governing further control actions; it is assumed that no further actuating forces are relevant; the author recommends examination of whether the safety objectives are adequately implemented
8	3	1.2.2. Control devices Control devices must be: ... - positioned in such a way as to be safely operated without hesitation or loss of time and without ambiguity, ... - made in such a way as to withstand foreseeable forces; particular attention must be paid to emergency stop devices liable to be subjected to considerable forces. ...	no equivalent found for requirements concerning the emergency stop device	No requirements for the emergency stop device; provision for emergency stop only by means of a control bar, for which the standard contains provisions concerning the actuating forces; design requirements should be formulated for the control bar

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		Control devices must be so arranged that their layout, travel and resistance to operation are compatible with the action to be performed, taking account of ergonomic principles.		
8	3	1.2.2. Control devices Control devices must be: ... - positioned in such a way as to be safely operated without hesitation or loss of time and without ambiguity, ... - made in such a way as to withstand foreseeable forces; particular attention must be paid to emergency stop devices liable to be subjected to considerable forces. ... Control devices must be so arranged that their layout, travel and resistance to operation are compatible with the action to be performed, taking account of ergonomic principles.	4.2.2.2 Where the machine is powered by an integral power source, e.g. an internal combustion engine or an electric motor, the engine or motor start is regarded as the operator's control for starting the chipping components, infeed components and integral conveyors (where fitted).	No requirements are imposed upon the characteristics and safety of this control on the external power source machinery (minimum requirements); if the concept is followed, it must be ensured at least by provisions in the standards that the control devices of the base vehicle/the power source machinery satisfy the requirements (e.g. by the statement of suitable base vehicles)
8	3	1.2.2. Control devices Control devices must be: ... - positioned in such a way as to be safely operated without hesitation or loss of time and without ambiguity, ... - made in such a way as to withstand foreseeable forces; particular attention	4.2.1 General All machines shall have separate controls for starting/stopping the chipping components and for starting/stopping the infeed action meeting the requirements given below in 4.2.2, 4.2.3, 4.2.4. The safety and reliability of control system shall meet the	No requirements are formulated concerning the resistance of the controls to stress; this is particularly important for the infeed stop control; requirements for this purpose should be added

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		must be paid to emergency stop devices liable to be subjected to considerable forces. ... Control devices must be so arranged that their layout, travel and resistance to operation are compatible with the action to be performed, taking account of ergonomic principles.	requirements given in 4.2.5. Controls for stopping the chipping components shall also stop the infeed action.	
8	3	1.2.2. Control devices Control devices must be: ... - positioned in such a way as to be safely operated without hesitation or loss of time and without ambiguity, ... - made in such a way as to withstand foreseeable forces; particular attention must be paid to emergency stop devices liable to be subjected to considerable forces. ... Control devices must be so arranged that their layout, travel and resistance to operation are compatible with the action to be performed, taking account of ergonomic principles.	4.2.2.1 Where the machine is powered by an external power source, e.g. a tractor power take-off or a hydraulic system, the tractor power-take-off start control or hydraulic system control is regarded as the operator's control for starting the chipping components, infeed components and integral conveyors (where fitted).	Satisfied when the controls of the tractor are compliant with the Machinery Directive; tractors however no longer fall within the scope of the Machinery Directive; observance of the requirements for the control devices should therefore be ensured by normative provisions (for example by the statement of permissible power source machinery)
10	2	1.5.6. Fire Machinery must be designed and constructed in such a way as to avoid any risk of fire or overheating posed by the machinery itself or by gases,	no equivalent found	Fire prevention and protection against fire is not addressed with regard to dust and accumulation of material, nor is the issue of temperature

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		liquids, dust, vapours or other substances produced or used by the machinery.		rise; the author recommends examination of whether the safety objectives are adequately implemented
10	3	1.6.3. Isolation of energy sources Machinery must be fitted with means to isolate it from all energy sources. Such isolators must be clearly identified. They must be capable of being locked if reconnection could endanger persons. Isolators must also be capable of being locked where an operator is unable, from any of the points to which he has access, to check that the energy is still cut off. … As an exception to the requirement laid down in the previous paragraphs, certain circuits may remain connected to their energy sources in order, for example, to hold parts, to protect information, to light interiors, etc. In this case, special steps must be taken to ensure operator safety.	no equivalent found	Isolation is not explicitly required; the author recommends examination of whether the safety objectives are adequately implemented
11	1	1.2.1. Safety and reliability of control systems Particular attention must be given to the following points: - the machinery must not start unexpectedly, - the parameters of the machinery	No equivalent found for requirements concerning cable-less control	No reference to wireless controls, although their importance is increasing; the author recommends examination of whether the safety objectives are adequately implemented

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		must not change in an uncontrolled way, where such change may lead to hazardous situations, - the machinery must not be prevented from stopping if the stop command has already been given, - automatic or manual stopping of the moving parts, whatever they may be, must be unimpeded, - the protective devices must remain fully effective or give a stop command, … For cable-less control, an automatic stop must be activated when correct control signals are not received, including loss of communication.		
11	1	1.2.1. Safety and reliability of control systems Particular attention must be given to the following points: - the machinery must not start unexpectedly, - the parameters of the machinery must not change in an uncontrolled way, where such change may lead to hazardous situations, - the machinery must not be prevented from stopping if the stop command has already been given, - automatic or manual stopping of the moving parts, whatever they may be, must be unimpeded, - the protective devices must remain	4.2.2 Starting the machine 4.2.2.1 Where the machine is powered by an external power source, e.g. a tractor power take-off or a hydraulic system, the tractor power-take-off start control or hydraulic system control is regarded as the operator’s control for starting the chipping components, infeed components and integral conveyors (where fitted). 4.2.2.2 Where the machine is powered by an integral power source, e.g. an internal combustion engine or an electric motor, the engine or motor start	Not compliant with the Machinery Directive, which requires that the machine itself be designed such as to be inherently safe for intentional starting; the author recommends examination of whether the safety objectives are adequately implemented

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		fully effective or give a stop command, … For cable-less control, an automatic stop must be activated when correct control signals are not received, including loss of communication.	is regarded as the operator's control for starting the chipping components, infeed components and integral conveyors (where fitted). 4.2.2.3 Where an electric starter is used to start the integral power source, unauthorised activation of the starter shall be avoided by using one or more of the following methods: - a key operated ignition or starting switch, - a lockable cover for the ignition or starting switch; - a security ignition or starting lock; - a lockable battery disconnection switch.	
11	2	1.2.2. Control devices ... From each control position, the operator must be able to ensure that no-one is in the danger zones, or the control system must be designed and constructed in such a way that starting is prevented while someone is in the danger zone. If neither of these possibilities is applicable, before the machinery starts, an acoustic and/or visual warning signal must be given. The exposed persons must have time to leave the danger zone or prevent the	4.2.4.2.6 In the case of machines with an integrated feed conveyor, the infeed stop controls hall meet the requirements of 4.2.4.2.4. Instead of meeting the location requirements of 4.2.4.2.1 the infeed stop controls shall be provided at the sides and at the outer end of the conveyor. Any reverse action of the conveyor shall have a hold-to-run control located within reach of the operator but outside of reach to	Visibility requirements are not formulated; the author recommends examination of whether the safety objectives are adequately implemented

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		machinery starting up. Where there is more than one control position, the control system must be designed in such a way that the use of one of them precludes the use of the others, except for stop controls and emergency stops.	the danger zones and in a position providing good visibility of the conveyor and the infeed components.	
11	8	1.2.6. Failure of the power supply The interruption, the re-establishment after an interruption or the fluctuation in whatever manner of the power supply to the machinery must not lead to dangerous situations. Particular attention must be given to the following points: - the machinery must not start unexpectedly, … - the machinery must not be prevented from stopping if the command has already been given, … - automatic or manual stopping of the moving parts, whatever they may be, must be unimpeded, - the protective devices must remain fully effective or give a stop command.	4.2.2 Starting the machine 4.2.2.1 Where the machine is powered by an external power source, e.g. a tractor power take-off or a hydraulic system, the tractor power-take-off start control or hydraulic system control is regarded as the operator’s control for starting the chipping components, infeed components and integral conveyors (where fitted). 4.2.2.2 Where the machine is powered by an integral power source, e.g. an internal combustion engine or an electric motor, the engine or motor start is regarded as the operator’s control for starting the chipping components, infeed components and integral conveyors (where fitted). 4.2.2.3 Where an electric starter is used to start the integral power source, unauthorised	Bringing of the German terminology into line with that of the Machinery Directive would be advantageous; "Starten" is used here instead of "Ingangsetzen"; in addition, no specific provisions are formulated for the safety objective; the standard relies upon proper design of the start facility; the author recommends examination of whether the safety objectives are adequately implemented

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			activation of the starter shall be avoided by using one or more of the following methods: - a key operated ignition or starting switch, - a lockable cover for the ignition or starting switch; - a security ignition or starting lock; - a lockable battery disconnection switch.	
11	14	3.3.1. Control devices … Where their operation can lead to hazards, notably dangerous movements, the control devices, except for those with preset positions, must return to the neutral position as soon as they are released by the operator.	no equivalent found	No requirements concerning control devices other than for the infeed stop control; a control device for example for swivelling of the discharge chute is also conceivable in this context; applicability to larger machines is therefore placed in doubt; the author recommends examination of whether the safety objectives are adequately implemented
12	2	1.2.2. Control devices Control devices must be: - located outside the danger zones, except where necessary for certain control devices such as an emergency stop or a teach pendant, - made in such a way as to withstand foreseeable forces; particular attention	4.2.1 General All machines shall have separate controls for starting/stopping the chipping components and for starting/stopping the infeed action meeting the requirements given below in 4.2.2, 4.2.3, 4.2.4. The safety and reliability of control system shall meet the	No requirement concerning location or identifiability, except with regard to the infeed stop control; the author recommends examination of whether the safety objectives are adequately implemented

Requirement code	Requirement number	Text of the directive	Text of the standard	Comments
		must be paid to emergency stop devices liable to be subjected to considerable forces. ... Where there is more than one control position, the control system must be designed in such a way that the use of one of them precludes the use of the others, except for stop controls and emergency stops. ... Where machinery has several starting control devices and the operators can therefore put each other in danger, additional devices must be fitted to rule out such risks. If safety requires that starting and/or stopping must be performed in a specific sequence, there must be devices which ensure that these operations are performed in the correct order.	requirements given in 4.2.5. Controls for stopping the chipping components shall also stop the infeed action.	
12	2	1.2.2. Control devices Control devices must be: - located outside the danger zones, except where necessary for certain control devices such as an emergency stop or a teach pendant, - made in such a way as to withstand foreseeable forces; particular attention must be paid to emergency stop devices liable to be subjected to considerable forces. ...	No equivalent found for requirement concerning durability	No requirement concerning the durability of the control devices, especially concerning the infeed stop control; the author recommends examination of whether the safety objectives are adequately implemented

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		Where there is more than one control position, the control system must be designed in such a way that the use of one of them precludes the use of the others, except for stop controls and emergency stops. ... Where machinery has several starting control devices and the operators can therefore put each other in danger, additional devices must be fitted to rule out such risks. If safety requires that starting and/or stopping must be performed in a specific sequence, there must be devices which ensure that these operations are performed in the correct order.		
12	5	1.2.4.3. Emergency stop Machinery must be fitted with one or more emergency stop devices to enable actual or impending danger to be averted. The following exceptions apply: - machinery in which an emergency stop device would not lessen the risk, either because it would not reduce the stopping time or because it would not enable the special measures required to deal with the risk to be taken, - portable hand-held and/or hand-guided machinery. The device must: - have clearly identifiable, clearly	4.2.4.1 General All machines shall have an infeed stop control. The design, position and function of the infeed stop control shall allow the operator when in the designated operating position, if entangled in the wood being fed into machine, to stop the infeed action. The operator shall be able to engage the infeed stop control, in the direction of infeed, by using parts of the body other than just the hands (e.g. shoulder, elbow, torso, hip, legs, etc.). To achieve this, it	The use of the infeed stop control should be assigned correctly (as a protective device) within the safety hierarchy of the Machinery Directive; the experience of the accident insurance institutions is however that the infeed stop control significantly improves the safety of wood chippers; an emergency stop facility nevertheless appears appropriate, at least for the infeed facility

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		visible and quickly accessible control devices, - stop the hazardous process as quickly as possible, without creating additional risks, - where necessary, trigger or permit the triggering of certain safeguard movements. Once active operation of the emergency stop device has ceased following a stop command, that command must be sustained by engagement of the emergency stop device until that engagement is specifically overridden; it must not be possible to engage the device without triggering a stop command; it must be possible to disengage the device only by an appropriate operation, and disengaging the device must not restart the machinery but only permit restarting. The emergency stop function must be available and operational at all times, regardless of the operating mode. Emergency stop devices must be a back-up to other safeguarding measures and not a substitute for them.	shall meet the positional requirements given in 4.2.4.2 and functional requirements in 4.2.4.3. Whilst these requirements shall be fulfilled, the design, position and function of the infeed stop control shall seek to minimise inadvertent activation (nuisance tripping) by wood and branches as they are fed into the machine; and opportunities for the operator to remove, disconnect, disable, defeat, or jam the control.	

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12	6	1.2.4.4. Assembly of machinery In the case of machinery or parts of machinery designed to work together, the machinery must be designed and constructed in such a way that the stop controls, including the emergency stop devices, can stop not only the machinery itself but also all related equipment, if its continued operation may be dangerous.	4.2.4.3.3 Movement of the infeed stop control from zone B to position C, as defined in 4.2.4.2.4, shall stop infeed action. Actuation to the emergency stop position shall have priority over any other controls used to operate the infeed components as defined in 4.2.4.3.6.	Understandably, the emergency stop facility required by EN 13525 halts only the infeed facility; no other stop facility is specified; the author recommends examination of whether the safety objectives are adequately implemented