

## **ISPESL Standardization Activities in the Field of Agricultural and Forestry Machineries**

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### **Abstract**

**Article 9 of directive 2006/42/EC (new machinery directive) refers to potentially hazardous machinery and defines specific procedures to deal with them. According to this, National Institute for Occupational Safety and Prevention (ISPESL) during its market surveillance activity reported several non-compliances common to entire group of machines: agricultural self-propelled machines, hydraulic backhoes, telehandlers (self-propelled variable reach trucks), ride-on lawnmowers, log-splitters and risk of roll-over for passenger seat on tractor. ISPESL attending to the international working group for standardization, both CEN and ISO, encouraged the partial or complete revision of the specific standard related to the machinery listed above or, where there are no standards, the development of a new specific standards.**

**Keywords:** new machinery directive, potentially hazardous machineries

### **Introduction**

The directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery provides (article 7) that machinery manufactured in conformity with a harmonised standard, the references to which have been published in the Official Journal of the European Union, shall be presumed to comply with the essential health and safety requirements covered by such an harmonised standard. The European Commission, acting in accordance with the procedure referred to in article 8 of directive 2006/42/EC, may take any appropriate measure connected with the implementation and practical application of this directive. In particular the Commission may take any appropriate measure to restrict the placing on the market of machinery referred to in article 9 (Specific measures to deal with potentially hazardous machinery).

A first measure may be used whenever a product can be deemed hazardous on the basis that the reference harmonised standard does not entirely satisfy the essential health and safety requirements which it covers and which are set out in annex I to directive 2006/42/EC. In this case the Commission may take measures requiring Member States to prohibit or restrict the placing on the market of machinery with technical characteristics presenting risks due to the shortcomings in the standard, or to make such machinery subject to special conditions.

A second measure can be invoked against a machine or an entire group of machines whenever they present the same risk, by virtue of its technical characteristics, of a machine whose free movement has been restricted according to the procedures of the safeguard clause, as defined in article 11.

According to this, ISPESL during its market surveillance activity reported several non-compliances common to entire group of machines. Thus, attending to international working group for standardization, both CEN and ISO, ISPESL encouraged the partial or complete revision of specific standards related to the machinery listed in the next paragraph, or, where there are no standards at all, the development of a new specific working item.

## Standardization activities

ISPESL developed many research activities in order to support the standardization procedure. The following standards are a partial example of the standards which have been revised due to ISPESL market surveillance and standardization activities:

- EN 609-1 Agricultural and forestry machinery - Safety of log splitters - Part 1: Wedge splitters;
- EN 690 Agricultural machinery - Manure spreaders - Safety;
- EN 709 Agricultural and forestry machinery - Pedestrian controlled tractors with mounted rotary cultivators, motor hoes, motor hoes with drive wheel(s);
- EN 836 Garden equipment - Powered lawnmowers – Safety;
- EN 1459 Safety of industrial trucks - Self- propelled variable reach trucks.

Moreover three new working items have been defined for the development of specific EN standards on:

- hydraulic backhoes;
- roll-over risk for agricultural self-propelled machines;
- roll-over risk for passenger seat on agricultural or forestry tractors.

### EN 609-1 log splitters

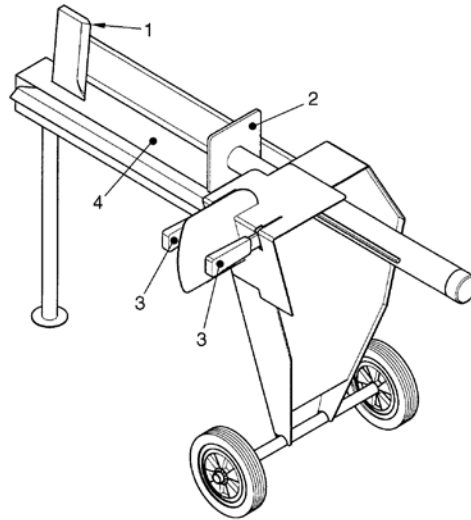
In the last months the agricultural and forestry wedge splitters have been deeply investigated in order to verify if safety problems related to their use or to lack in the reference standard EN 609-1:1999 may arise. This investigation has been developed after that two serious accidents occurred and, consequently, the market surveillance authority reported a presumption of non conformity for the machinery involved. In particular, the safety problem encountered refers to technical measures necessary to prevent the unintentional actuation of two-hand controls used to start the splitting process. ISPESL already aroused this matter in the second half of 2008 during a discussion with manufacturers which led to a rationale and a proposal to amend the standard EN 609-1 submitted to CEN/TC 144/WG 8 at the beginning of 2009. This Italian proposal has been included in the revision process of EN 609-1:1999 started in the second half of 2009. In particular the actual standard EN 609-1:1999 requires that the splitting zone shall be protected by means of an interlocking guard associated with guard locking or alternatively equipping the machine with two-hands control devices. These devices shall meet the requirements defined in clause 4.6 letter b) of EN 609-1:1999 in the following summarized:

- *the two-hands controls shall be of the “hold-to-run” type, i.e. the splitting process is stopped if either manual control is released; and*
- *the wedge/pressure plate shall not return to the starting position if one manual control is in the “On” position; and*
- *it shall be impossible to start the splitting process inadvertently or to operate both manual controls simultaneously with one hand or arm or with other parts of the body (see 9.1 to 9.4 and 9.6 of EN 574:1996); and*
- *the controls shall be laid out in such a way that the operator has an unobstructed view of the splitting zone.*

From above it seems that:

1. the two-hands controls shall not totally conform to EN 574:1996 but shall only meet the requirements stated in 9.1 to 9.4 and 9.6 of the mentioned standard. These clauses refer to general requirements (ergonomic, environmental, etc.). Therefore, the

requirements referring to prevention of defeat defined in clauses 8.1 to 8.6 of EN 574:1996 seems to be not applicable as also represented in figure 1 which reproduces the same picture of the standard EN 609-1:1999, where an horizontal wedge splitter with fixed wedge is shown, and figure 2. In particular the two-hands controls depicted in those figures are clearly not compliant with clause 8.5 of EN 574:1996 “Prevention of defeat using one hand and any other part of the body (e.g. knee, hip)”;



**Figure 1. Horizontal wedge splitter with fixed wedge as shown in figure 2 of EN 609-1:1999**



**Figure 2. Example of an horizontal log splitters where the activation of two-hand controls used to start the splitting process could be made with parts of the body (hand, arm, etc.)**

2. with reference to the simultaneous actuation of the two-hands controls, the standard EN 609-1:1999 states that shall be impossible to operate both manual controls simultaneously with one hand or arm or with other parts of the body and it refers again to clauses 9.1 to 9.4 and 9.6 of EN 574:1996. Thus, it seems that it should be

possible that the two-hands controls are designed to be simultaneously operated by means of:

- one hand and its own arm;
- one hand and other parts of the body;
- one arm and other parts of the body.

With reference to what above mentioned, in some working conditions it could be possible that the operator actuates the two-hand controls without simultaneously using both hands. As a consequence the free hand could be used within the dangerous zone, as already occurred in the two serious accidents previously mentioned. Thus, considering the two serious accidents occurred and the lack of any technical or economical impediment to install devices in order to fulfil the principles of prevention of defeat, which are essential in order to grant the safety level attained by the two-hands controls, ISPESL claimed to include the requirements referring to prevention of defeat defined in clauses 8.1 to 8.6 of EN 574:1996 in the revised version of EN 609-1.

### EN 690 manure spreaders

For manure spreaders the relevant data of accidents occurred in Germany and in Italy showed that it is necessary to implement a safety device in order to prevent unintentional contact with the spreading devices while moving, during maintenance or cleaning operations. In figure 3 an example of spreading device with vertical axis is shown.



**Figure 3. Example of manure spreader with vertical axes rotors rear spreading device**

ISPESL encouraged a complete revision of the standard with particular reference to this issue. Thus, the actual draft of the standard provide that self-propelled manure spreaders shall have a system that prevents engagement of the spreading device moving working parts if the operator is not in the operator's work station and automatically disengages the power transmission of the spreading device when the operator leaves the operator's work station. This requirement shall be also extended to mounted and trailed manure spreaders. In particular for trailed manure spreaders a system able to avoid the spreading device movement while tractor is not travelling shall be provided. If it is necessary to spread the manure while tractor is not travelling, it could be done by using an hold-to-run control from tractor driving position.

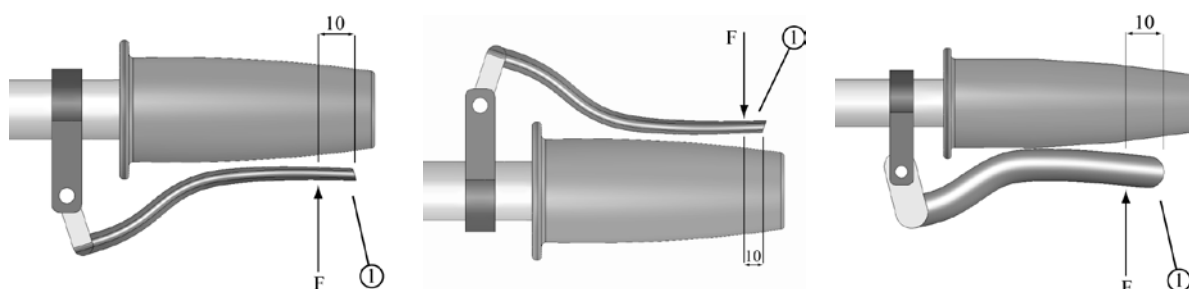
### EN 709 pedestrian controlled tractors with mounted rotary cultivators, motor hoes, motor hoes with drive wheel(s)

Most of the several accidents occurred with motor hoes and pedestrian controlled had the same type of dynamic. In particular, the common feature was that the hold-to-run control

was by-passed by the operator. In fact, this was due to the matter that in the most part of the pedestrian controlled tractor with mounted rotary-cultivators or motor hoes, when the hold-to-run control is released, the engine of the machines switches off. This condition creates some restraints for operator who, in order to avoid repetitive stops in his working activity due to release of the hold-to-run control during turns and/or stop manoeuvres, excludes the safety device and locks it in the working position. Therefore, in case of an emergence, this device is not able to stop the motion of the operating tools, with serious consequences for the operator. The lock of safety device is not necessary if the hold-to-run control, when is released, does not switch off the engine but only interrupts the movement of the operating tools. This can be achieved by means of a inverted clutch, for example. In this case the operator is not induced to exclude the safety device.

ISPESL research activity on this kind of machines led to the partial revision of the standard EN 709 adding some important requirements. In particular:

- now releasing the hold-to-run control(s) shall not stop the engine but shall stop only the operating tools;
- the force required to maintain the hold-to-run control in the engaged position shall not be greater than 27,5 N when the hold-to-run control is located on only one handlebar. If the hold-to-run control is located so that it can be operated by either or both hands when they are holding the handle-grips, the force required to maintain the hold-to-run control in the engaged position shall not be greater than 35 N (see figure 4 for the location of the activation force).



**Figure 4. Location of the activation force: 1: end of the control, F: force required to maintain the hold-to-run control**

- service and parking brake systems shall be provided to stop the pedestrian controlled tractor's motion in both forward and reverse directions if a force of more than 250 N, applied at the centre of the wheel axle and parallel to the slope, is required to hold the pedestrian controlled tractor, with the mounted rotary cultivator touching the ground, on a 30% (16,7°) slope.

Furthermore, the previous version of the standard did not provide for the risk due to the inertia of working tools, which continue moving after the hold-to-run control is released. The revision of the standard provides that the tools of pedestrian controlled tractors and motor hoes shall stop from their maximum rotational speed within 2 seconds after the operator releases the hold-to-run control. The last requirement added concerns the maximum travel speed. The previous version of the standard did not define the maximum travel speed of the machine compatibly with the pace of a driver on foot. Now, for pedestrian controlled tractors and motor hoes with drive wheel(s) with the power soil working tool mounted, the maximum travel speed shall not exceed 8 km/h in forward direction and 3,6 km/h in reverse direction.

### EN 836 – ISO 5395-3 powered lawnmowers

The main concern refers to stability of self propelled ride-one lawnmowers. In fact the actual version of standard EN 836 requires that if the lawnmower is stable on a tilting table at 20° in the lateral test and 30° in the longitudinal one it is not necessary to fit a roll-over protective structure. Considering the recent fatal accidents occurred due to the roll-over of ride-on lawnmowers and that there are no technical difficulties, in the revision process of standard ISO 5395-3, which when finished will affect also the EN 836 according to the Vienna agreement, Italy asked to fit with a ROPS all the ride-on lawnmowers having a mass equal to or greater than 400 kg. Moreover, in order to reduce the risk of unintentional activation of the operator presence control (OPC) engaged by the seat or integrated into it, Italy asked to introduce a minimum activation force and a test procedure as follow:

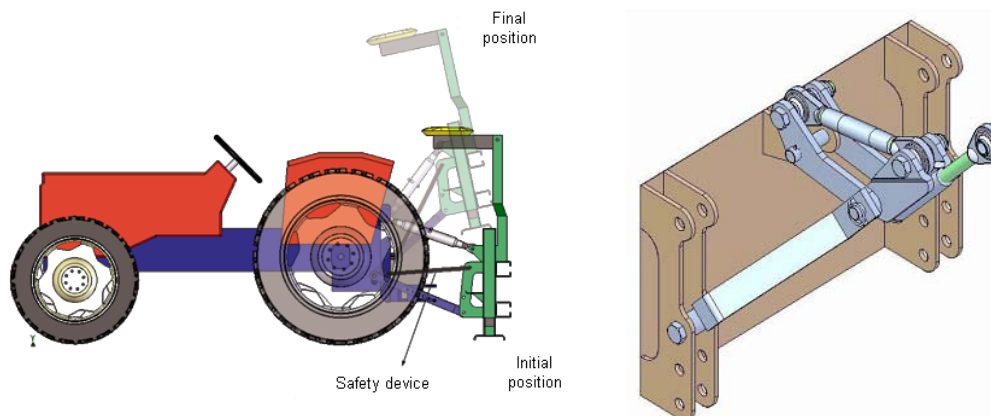
- 350 N, if measured in the centre of a rigid circular plate of 350 mm of diameter placed on the centre of the seat; and
- 150 N, if measured in the centre of a rigid circular plate of 100 mm of diameter placed on the seat with the centre of plate vertically aligned with the centre of each sensor.

### EN 1459 self- propelled variable reach truck

The main concerns refers to hazard related to travel movements without operator at controls. In fact, the actual standard EN 1459 specifies that it is sufficient to use the parking brake and the gear in neutral for fulfilling the safety requirement, thus it exclusively depends on the operator, despite of the presence of technical solution already used on other kinds of machines technically similar. Moreover, the same standard at point 5.1.2 *Unintentional movements* refers to point 5.9.5 of EN 1175 for battery powered trucks where it is specified that “*a separate and independent from the accelerator device shall automatically prevent the travel movement when the operator is not at the control, for example a switch under the seat...omissis...*”. Thus, on the same kind of machines but battery powered a technical solution which does not depend on the operator has been adopted for reducing the risk. As a consequence ISPESL asked CEN, and obtained, to amend the standard EN 1459 concerning this safety requirement. So, the necessity of an operator presence control related to travel movement of self-propelled variable reach truck has been included.

### Hydraulic backhoes

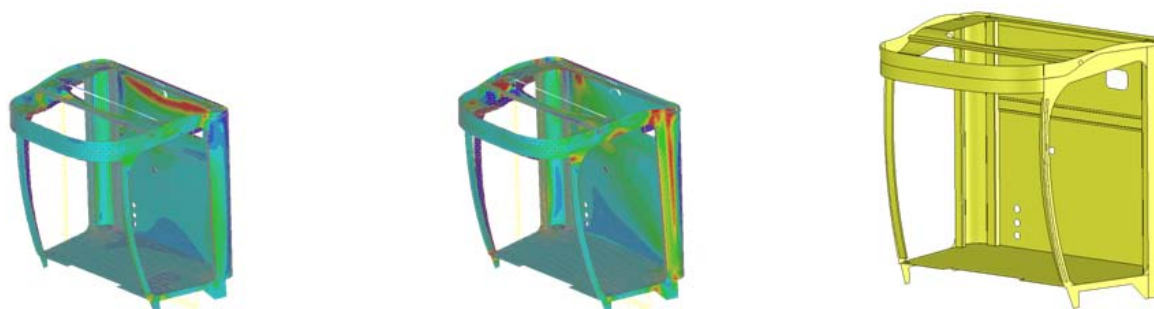
The main concerns refers to the unsuspected relative motion between tractor and the attached hydraulic backhoes which determines the risk of crushing for the operator while seating on the hydraulic backhoes (see figure 5 on the left). Actually, the safety devices used for not allowing this relative motion are not integrated with the machine itself. Thus, the application of these devices depends on the operator. Several fatal accidents in Italy are recorded related to this aspect. As a consequence ISPESL and the Italian manufacturer associated in Unacoma are involved in the development of a specific EN standard for this kind of machines in order to define, among the others, also the safety requirements related to the mentioned risk. In figure 5 on the right a possible solution regarding a integrated protective device is presented.



**Figure 5. Example of hydraulic backhoes relative motion (on the left) and proposed safety device (on the right)**

Roll-over risk for agricultural self-propelled machines

Agricultural self-propelled machines present roll-over risk without fitting a ROPS. Thus ISPESL is developing a research activity with the aim of evaluating the transversal and/or longitudinal roll-over risk in order to define the necessary safety actions for this kind of machines during their normal use. First of all the presence of proper roll-over protective structures on this kind of machines has been inspected. Thanks to some manufacturers, who placed technical drawings to ISPESL disposal, the resistance level of actual cabs has been investigated. In particular, finite element analysis has been developed on this cabs. The sequence of loads and the level of energy to be absorbed by the protective structure have been deduced from ISO 8082: 2003 and from the principal international standards for earth-moving machines (EN 13510:2002), because of the lack of a specific standard. In figure 6 a CAD model of a cab and the related FEM analysis results are reported as an example of the developed research activity.



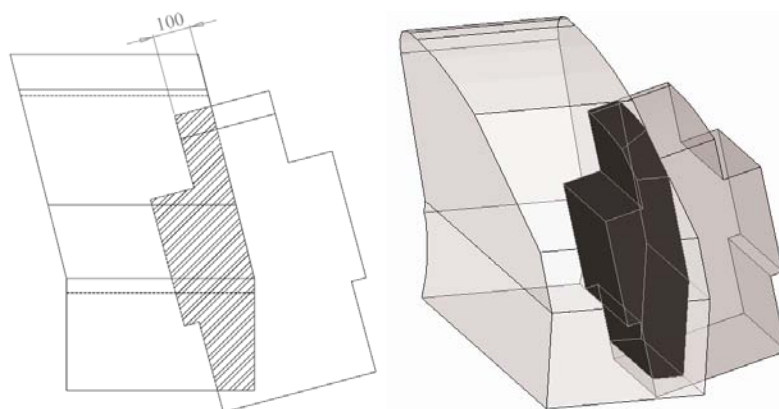
**Figure 6. Example of finite element analysis on cab fitted on agricultural self-propelled machines**

The results of these simulations revealed that the cabs actually mounted on this kind of machines have no mechanical properties such to preserve the safety volume of the operator in case of roll-over. In fact the plastic deformation of these structures were such to come completely inside the safety volume of the operator. Moreover the resistance properties were lower than the 30% of the minimum values stated by the international standards. In other words the cabs actually installed on self-propelled machines, which weight could reach the value of 20.000 kg during working operations, could guarantee the safety of the operator in

case of roll-over only if they were installed on machines weighting at most 2.000 kg. Thus, it is possible to say that the technical solutions to reduce the roll-over risk of the agricultural self-propelled machines actually on market are not aligned with the state-of-the-art concerning technical knowledge adopted for self-propelled machines used in other working fields as for example earth-moving machines. Hence, ISPESL is involved into a CEN new working item for the definition of a standard on the protection against roll-over and tip over for this kind of machines.

#### Roll-over risk for passenger seat on agricultural or forestry tractors

Nowadays, agricultural and forestry tractors equipped with passenger seat do not ensure passenger protection against roll-over. For this reason CEN set a specific task force led by ISPESL for defining safety requirements and acceptance criteria with reference to this topic. At the moment a deflection limiting volume for passenger and its interaction with the operator clearance zone have been defined (see figure 7).



**Figure 7. Passenger deflection limiting volume and its interaction with operator clearance zone**

The testing procedure is going to be defined in order to complete the required task.

#### **Conclusions**

The examples herein reported reveal how the research activity joined to the market surveillance one are important for ISPESL standardization activity development. In fact, when amendments to a standard which is considered not to entirely satisfy the essential health and safety requirements which it covers is requested, it is necessary to deeply know the machine for the risk dealt and how it is technically possible to reduce it. Moreover, in several cases the raised issues result from accidents, sometimes fatal. Thus, facing the problem and forcing for improving the standard in order to define specific safety requirements and the related acceptance criteria has often a relevant social impact.