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Rough-terrain trucks - Safety requirements and verification - Part 6: Application of EN ISO 13849-1 to slewing and non-slewing variable-reach rough-terrain truck

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Rough-terrain trucks - Safety requirements and verification – Part 6: Application of EN ISO 13849-1 to slewing and non-slewing variable-reach rough-terrain truck

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CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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European foreword

This document (CEN/TR 1459-6:2015) has been prepared by Technical Committee CEN/TC 150 “Industrial Trucks - Safety”, the secretariat of which is held by BSI.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

EN 1459 consists of the following parts, under the general title *Rough-terrain trucks — Safety requirements and verification*:

— *Part 1: Variable-reach trucks*

— *Part 2: Slewing variable-reach trucks*

— *Part 3: Interface between the variable-reach truck and the work platform*

— *Part 4: Additional requirements for variable reach trucks handling freely suspended loads*

— *Part 5: Additional requirements for attachments and attachment interface*

— *Part 6: Application of EN ISO 13849-1 to slewing and non-slewing variable-reach rough-terrain trucks*

Introduction

This Technical Report has been prepared to explain the rationale used to determine the minimum required Performance Levels for rough terrain variable reach trucks as listed in EN 1459 series.

It is intended to provide solid basis to the Performance Level Required (PL_r) required for the Safety Related Part of Control System (SRP/CS) referred to in prEN 1459-1, EN 1459-2 and EN 1459-3. The PL_r have been defined by using approaches from appropriate standards for safety of machinery and proven general principles for design.

The methodology described in this Technical Report may be used by other Technical Committees to assess the risk and determine PL_r for machines covered by other type C-standards.

1 Scope

This Technical Report describes the risk assessment methodology followed to determine the Performance Level required (PL_r), as defined in EN ISO 13849-1:2008, for specific safety related parts of control system (SRP/CS) of rough-terrain variable-reach trucks covered by prEN 1459-1, EN 1459-2 and EN 1459-3.

This Technical Report does not apply to SRP/CS that includes no electrical/electronic components.

NOTE It is the intention of CEN TC150 WG2 to use the same methodology to develop future standards (e.g. further parts of EN 1459).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

prEN 1459-1:2015, *Rough-terrain trucks — Safety requirements and verification — Part 1: Variable-reach trucks*

EN 1459-2:2015 *Rough-terrain trucks — Safety requirements and verification — Part 2: Slewing variable-reach trucks*

EN 1459-3:2015 *Rough-terrain trucks — Safety requirements and verification — Part 3: Interface between the variable-reach truck and the work platform*

EN ISO 12100:2010 *Safety of machinery — General principles for design — Risk assessment and risk reduction (ISO 12100:2010)*

EN ISO 13849-1:2008 *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design (ISO 13849-1:2006)*

ISO/TR 14121-2:2012 *Safety of machinery — Risk assessment — Part 2: Practical guidance and examples of methods*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 12100, prEN 1459-1:2015, EN 1459-2:2015 and EN 1459-3:2015 and the following apply.

3.1
operator
competent person who controls the operation of the truck

3.2
co-worker
trained person who is working in the vicinity of the truck but not in control of the truck

3.3
by-stander
untrained person who is in the vicinity of the truck and not involved in the job site activity

4 General

It is intended that this document be read in conjunction with the corresponding Parts -1, -2 and -3 of this standard (EN 1459).

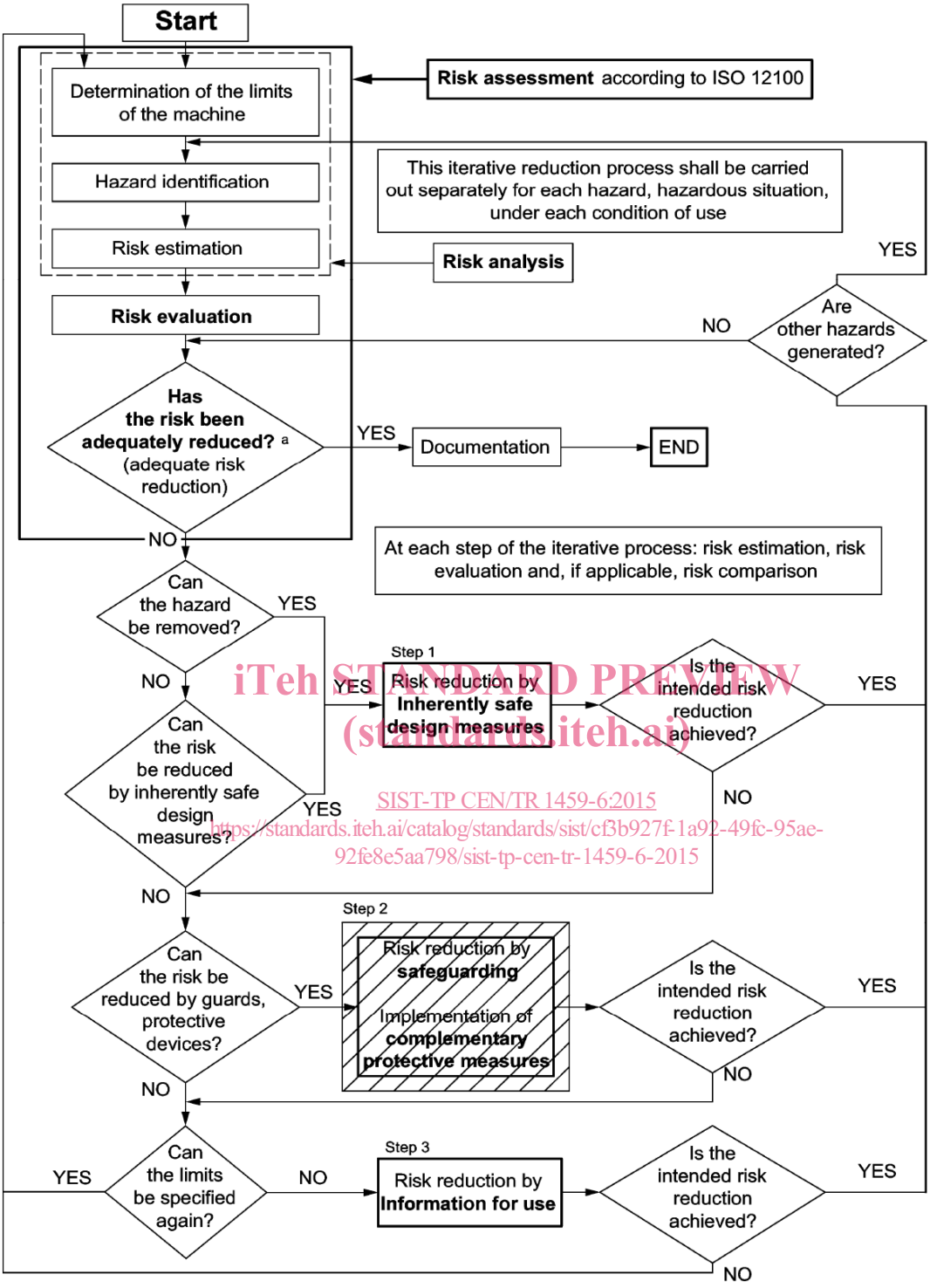
EN ISO 13849-1 applies to the safety related parts of control system including the design of software, regardless of the type of technology and energy used (electrical, electronic, hydraulic, pneumatic, mechanical, etc.), for all kinds of machinery.

For safety functions that comprise mechanical parts only, no specific performance level is necessary.

There are many control systems fitted to trucks but not all will be subject to the requirements of EN ISO 13849-1.

EN ISO 13849-1 is relevant for cases where a risk assessment according to EN ISO 12100 has initiated a risk reduction measure that relies on a safety-related control system. In those cases the safety-related control system has to perform a safety function. The application of EN ISO 13849-1 is restricted to those cases only (see figures 1 and 2).

Systems may be subject to specific requirements in other standards e.g ISO 6292 - *Powered industrial trucks and tractors — Brake performance and component strength*.



Interrelation with ISO 13849-1 in case risk reduction/protective measures are connected with the control system

[a] The first time the question is asked, it is answered by the result of the initial risk assessment.

Figure 1 — Process flow chart

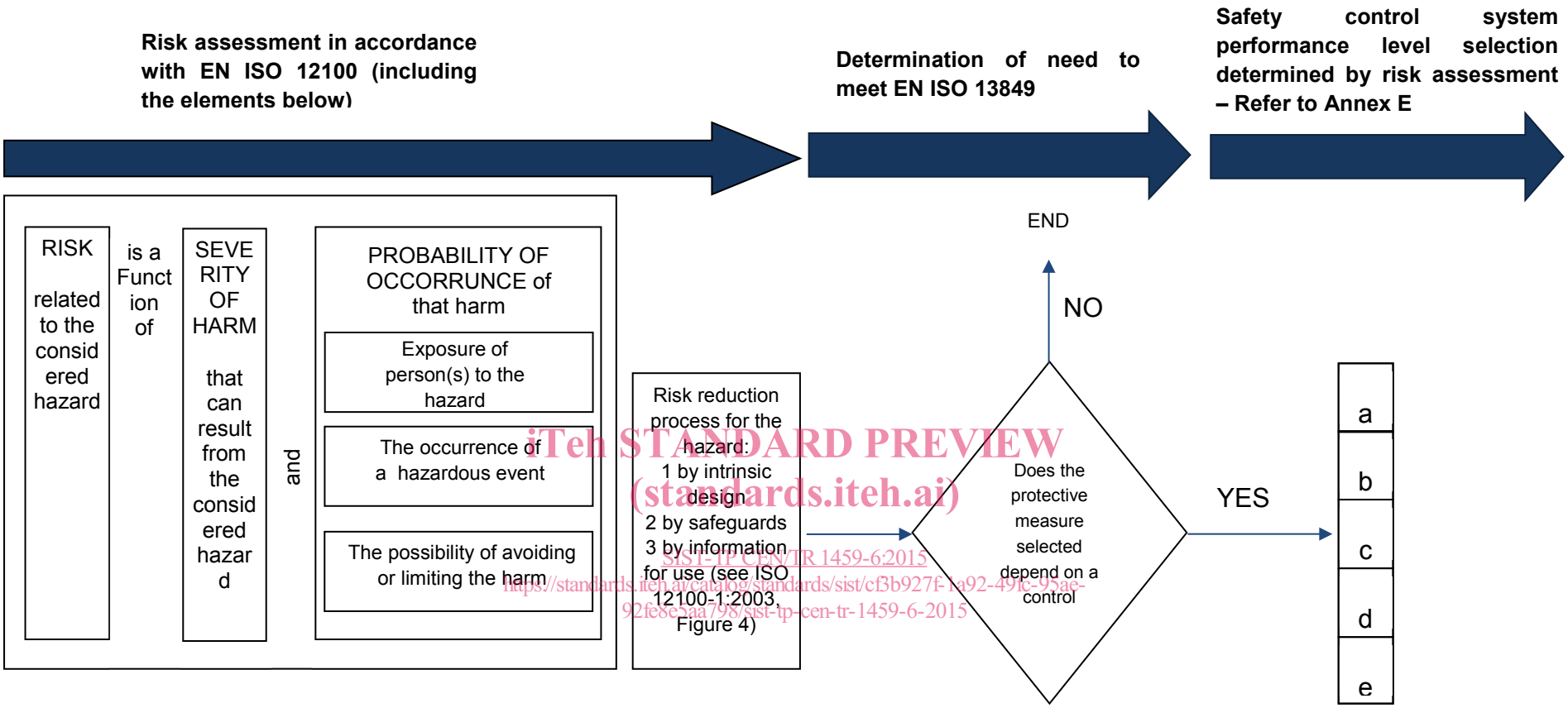


Figure 2 — Abbreviated EN ISO 12100/EN ISO 13849-1 process drawing distinction between risk assessment and control system performance selection

5 Description of the procedure followed to determine PL_r for SRP/CS of trucks

The first stage of meeting EN ISO 13849-1 is to take the risk assessment/risk reduction output from following EN ISO 12100 and to check whether the protective measure selected depends on the control system.

In order to perform the EN ISO 12100 assessment correctly for trucks with respect to EN ISO 13849-1 compliance, any existing control system which has been added / modified for achieving safety should be disregarded at a first stage so that the risk they are addressing can be understood. This is important to get the correct inputs if the system is later determined as SRP/CS and requires a PL_r to be determined.

The following key stages were applied to determine PL_r for SRP/CS:

a) Identify which functions of the truck involve SRP/CS and identify the relevant clauses in the standard. Determine control systems (mechanical, hydraulic, pneumatic, electrical/electronic, electro-mechanical, electro-hydraulic…) that are necessary for the truck to carry out its intended function 8.2 and Annex A)

b) Determine the intended truck limits as per EN ISO 12100:2010 clause 5.3 (see 8.1)

c) Perform risk assessment in accordance with EN ISO 12100:2010 clauses 5.5 and 5.6 (see Annex E)

d) Take into account any risk reduction measures (intrinsic design and safeguards) and re-assess the system to determine if the intended risk reduction has been achieved at this point any existing control systems that are known to be used/added/modified for achieving safety should be considered as a risk reduction measure. (see 8.3, Annex E and EN ISO 12100:2010 clause 5.6)

e) Determine if the protective measure selected is dependent upon a control system (and is therefore SRP/CS). If it is not the process ends here.

f) If the protective measure is dependent upon a control system, use the information from the EN ISO 12100 Risk Assessment to determine the EN ISO 13849-1 performance level that applies to that system (this should consider that other non-control system risk reduction measures intended to be fitted are in-place) (see Annex E)

NOTE The integrity of control systems which are not subject to EN ISO 13849-1 are to be ensured by following sound engineering practice and by following relevant technical requirements and standards as applicable. EN ISO 13849-1 imposes an extra burden to SRP/CS due to the nature and importance of these in providing safety to exposed persons.

6 Risk assessment methodology

EN ISO 12100 does not define a risk assessment method but does define the elements to be considered. Users of the above standard are free to choose a risk assessment method and ISO/TR 14121-2 provides practical guidance and examples. It should be noted that the informative “Risk Graph” as presented in EN ISO 13849-1 is not a risk assessment tool that fulfils the needs of EN ISO 12100 as it does not include the important component of “probability of occurrence”. It also offers limited selection of exposure, possibility of avoidance or limiting harm and severity as compared to other documented risk graphs (see for example ISO/TR 14121-2, A.4).

The risk graph in EN ISO 13849-1 is a tool to determine a PL_r but is not a risk assessment method, this tool was used to determine risks associated with a press and therefore its value is limited in relation to mobile machinery. See 8.3 for risk evaluation of trucks.

Document ISO/DTR 18670 *Safety of machinery — How EN ISO 12100 relates to EN ISO 13849-1* gives more explanation on this point, for instance in clause 4.1 it's written that:

"*For the correct application of EN ISO 13849-1 basic input information resulting from the application of the overall risk assessment and risk reduction process for the particular machine design is necessary. Based on this input information the safety-related parts of the control system can be appropriately designed according to EN ISO 13849-1. Information resulting from a detailed design of safety-related parts of the control system relevant for its integration into the machine design has then to be considered in the overall risk assessment and risk reduction process according to EN ISO 12100.*"

"…Consequently all necessary input information for the selection of the PL_r (elements of risk values for the considered hazardous situation) are available from the overall risk assessment and risk reduction process according to EN ISO 12100.

Therefore a separate risk assessment for the application of EN ISO 13849-1 is not necessary. The graph given in EN ISO 13849-1:2006, Figure A.1 is used only to select the PL_r for safety functions and is not intended to be used as a risk estimation method for the overall machine according to EN ISO 12100."

The risk evaluation used for trucks is based on the Kinney method machinery safety[1)] .

7 Risk Assessment Process

7.1 Determination of Machine limits

The following limits of use for the trucks is determined first in accordance with ISO 14121 to assist with the risk assessment.

a) Intended use:

- Starting
- Driving
- Load handling
- User stabilizers
- Operation (right side window breakage)
- Maintenance
- Lifting of persons (only EN 1459-3)
-

b) Foreseeable misuse:

- Overriding of LLMC-LLMI and other safety devices (not emergency situation)
- Use of stabilizers to displace the machine
- Improper use of forks and other attachments

1) Fine, W.T. 1971. Mathematical Evaluation for controlling Hazards, Journal of Safety Research. Kinney, G & Wiruth A. 1976, Practical Risk Analysis for Safety management

— Overload of the platform (only EN 1459-3)

— Overriding of controls in normal operation condition (only EN 1459-3)

— Use not integrated platform (only EN 1459-3)

c) Limit to the use of the machine by persons:

— 95% men

— Mostly between 18-60 years, occasionally between 14-18 years and more than 60

— Right hand operator (dominant hand usage)

— Visual limits for placing loads (17-18 m), more for driving (visibility measured at 12 m considered as the reaction time as per EN 15830)

— Hearing limits (regularly checked and medically approved to operate the machine)

— Physical size: 5-95 percentile of human size distribution

— Strength: level for steering and braking in case of failure

— level of training and experience of the operator: newcomers (not trained) and experienced (rely too much on the experience, less prepared to adapt to new machine and devices).

— Increased legal obligation for a training for the operator

— experience or ability of the users

- operators (refer to above)
- maintenance persons
- trainees
- general public (they should not be entitled to operate machines if they are not properly trained)

— exposure of other persons

- other operators
- co-workers in the vicinity
- non-employees and visitors in the vicinity including children (work site supervisor's responsibility)

d) Space limits

— Range of movements (travelling, boom movement, stabilizers movement, cab and guards movement)

— Range of movements (boom movement, platform movement) (only EN 1459-3)

— Space required to interact with the machine

— For the operator