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Position Paper Assistance Systems on Cranes & Lifting Equipment

Contents

1	Intr	roduction	2
2	Sco	ope	2
3	Cra	anes and lifting equipment functions	2
	3.1	General	2
	3.2	Operating functions	2
	3.3	Safety functions	3
	3.4	Warning and indicating functions	3
	3.5	Assistance functions	3
4	Pro	operties of different types of crane functions	4
Α	nnex /	A: Examples of crane functions	7
	A.2. \	Working Range System (WRS)	10
	A.3. E	Eco Mode - Fuel saving system	12
	A.4 S	Side-Pull Control (SPC)	14
	A.5. S	Surround View System ('Bird View')	16
	A.6. 0	Overload protection	18
	A.7. A	Anti-Collision System (ACS)	20
В	iblioar	aphy	22

1 Introduction

Currently, there exists uncertainty regarding the classification of assistance systems. As a result, the requirements for assistance systems and their functions on cranes and lifting equipment need clarification. FEM Product Group Cranes and Lifting Equipment is concerned that uncertainty may result in unrealistic expectations and requirements related to these systems and functions. This position paper was developed to give guidance on assistance systems and the functions realised thereby.

In general, machines and systems consist of several components which interact with each other and ensure the functionality of a machine or system. Such systems provide functions that allow the operators to use and operate the machine as intended by the manufacturer.

A distinction must be made between different types of functions: Those which are needed to perform basic operating functions, functions dedicated for safety (protective measures for risk reduction), functions to warn and inform the operator and lastly assistance functions which support the operator by improving ergonomics, reducing energy consumption, or increasing efficiency when used. The latter are increasingly being offered to the market by the manufacturers of cranes and lifting equipment. In contrast to the other three types of functions, assistance functions can be overruled or deactivated at any time.

2 Scope

This position paper focuses on the domain of cranes and lifting equipment and differentiates between different types of functions, excluding functions falling under road regulations for travel on public roads.

3 Cranes and lifting equipment functions

3.1 General

Control functions to safely operate cranes and lifting equipment (in the following text "crane functions") are distinguished into following types:

- 1. Operating functions
- 2. Safety functions
- 3. Warning and indicating functions
- 4. Assistance functions:
 - a. providing information
 - b. influencing motion

3.2 Operating functions

Operating functions are functions of the machine which are necessary to fulfil the intended use of the machine.

For cranes and lifting equipment typical operating functions are lifting/lowering of loads, slewing left/right of rotating upper works, boom hoisting (luffing) up/down, and travelling forward/backward of the trolley or the entire crane.

3.3 Safety functions

Safety functions are necessary to reduce the risk of operating machines within their limits.

According to EN ISO 13849-1, a safety function is a function of a machine whose failure and/or faulty behaviour can result in an immediate increase of the risk(s) to the operator and/or persons in the machine environment.

The necessity for safety functions is determined in the risk assessment and covered in product standards. A typical safety function for cranes and lifting equipment is for example the overload protection function.

3.4 Warning and indicating functions

Warning and indicating functions provide necessary information to the operator, enabling him to safely operate the equipment. They are part of the designer's contribution to risk reduction, informing the operator about possible emerging risks and get him prepared to avoid or mitigate these risks (see EN ISO 12100).

3.5 Assistance functions

Assistance functions are either supporting the operator with information or by influencing motion in the operating process to achieve improved ergonomics and efficient operation (e. g. reduction of energy consumption). Assistance functions are not designed to serve as a risk reduction measurement.

At all times, the operator of the crane has control of the crane and is able to override or deactivate the assistance function. When utilizing assistance functions, the responsibility for supervision and safe operation of the crane remains with the operator. The operator must always follow the manufacturer's instructions.

Operators may become accustomed to the comfort of applying the available assistance functions. Especially when training and instructing, it is necessary to point out on a regular basis that the crane operator nevertheless remains responsible for safe operation.

Contrary to safety functions, performance levels according to EN ISO 13849-1 are not specified for assistance functions.

It must be emphasized that the assistance functions considered in this guidance document only correspond to a low to medium level of automation when comparing to SAE J3016 "Levels of Driving Automation" used in the automotive industry. More information can be found in [2,3].

4 Properties of different types of crane functions

To distinguish between the different crane functions, their properties are described in Table 1. The questions below can serve as a guidance to classify the different types of crane functions:

- Is a control interaction possible?
- What is the purpose of the function?
- When is the function available for the operator?
- Is an activation of the function foreseen or needed?
- Can the operator manually overrule the function?
- Can the function be overridden or muted?
- Which priority has the function?
- Can the function's parameter be modified by the operator?
- Which standard was considered for the function deployment?

Annex A provides several examples of different crane functions and their classification by applying the properties of Table 1.

Table 1: Properties of different types of crane functions

		F	unction types		
Properties	Operating	Safety	Warning and	Assistanc	e functions
	functions	functions	Indicating functions	providing information	influencing motion
Control Interaction	behaviour by int control system.	uence the crane teraction with the	Cannot actively crane behaviour with the control requires user at action.	r by interaction system but tention and	Can actively influence the crane behaviour by interaction with the control system.
Purpose	Necessary to operate the crane as intended.	Necessary to reduce the risk of hazards during operation.	Function providing proper information for the user and is part of the designer's contribution to risk reduction. With this information the user must implement the necessary protective measures.1	Additional fund operator to impand ergonomic operating the control Not necessary crane or fulfil s requirements.	orove efficiency es when crane. to operate the
Availability	Are available whon.	nen an operating mo	ode is switched	and the assista selected by the It can be unsel	e is switched on ance function is e operator. ected by the
Activation	Activated by the crane operator by a control device.	Activated by the crane control when a defined safety-related limitation is exceeded or manually by a switch, e. g. an emergency stop.	Activated by the crane control when a defined safety-related limitation is exceeded or manually by a switch, e. g. activating the horn.	crane operator at any time. Activated when a defined operational threshold is reached or activated by the operator.	
Intervention by operator	In general, not applicable. In case of malfunction operator uses emergency stop.	The operator cannot overrule safety functions.	The operator cannot overrule. Some warning and indicator functions allow an acknowledgement. ³	The operator can intervene and overrule assistance functions at any time.	

Table 1: Properties of different types of crane functions (continued)

	Function types						
Properties	Operating functions	Safety functions	Warning and Indicating functions	Assistand	ce functions		
Function's Override	Overriding by the operator is not needed.	Overriding of a safety function is not allowed. ²	Overriding by the operator is not allowed. ³	Overriding by not needed – t function may be deactivated at	the assistance be activated or		
Priority	Operational functions have priority over and can overrule assistance functions.	Safety functions have the highest priority and can overrule operational functions and assistance functions.	Not app				
Parameter settings	Setting of parameter values of properties of operating function is allowed and can be changed by the operator within the limits foreseen by the manufacturer	Setting of parameter values of properties cannot be changed by the operator.	Setting of parameter values of properties cannot be changed by the operator.	Setting of parameter values of properties (i. e. threshold values) of assistance function is allowed and can be change by the operator within the limit foreseen by the manufacturer.			
Designed and built according to	Applicable product standard.	EN ISO 13849-1 and applicable product standard.	Applicable product standard.				

¹ See EN ISO 12100, Clause 4, Figure 2

² Muting: Temporary automatic suspension of safety functions is possible but safe conditions must be provided by other means (in accordance with EN ISO 13849-1).

³ Muting of warning and indicating functions is also allowed analogous to Footnote 2

Annex A: Examples of crane functions

Typical examples of different crane's functions for different crane types:

Classification / function type	Function title	Crane type
Assistance	A.1. Load-Sway-Reduction (LSR)	Industrial EOT- Cranes
function,	A.2. Working Range System (WRS)	Mobile Cranes
influencing motion	A.3. ECO Mode	Mobile Cranes
	A.4. Side-Pull Control (SPC)	Tower Cranes
Assistance function providing information	A.5 Surround View System ('Bird View')	Mobile Cranes
Safety function	A.6 Overload protection	Industrial EOT- Cranes
_	A.7 Anti-Collision System (ACS)	Tower Cranes

A.1. Load-Sway-Reduction function

Function-Name	Load-Sway-Reduction (LSR)
Purpose	Load-Sway-Reduction is a useful assistance function for the damping of load sway and easier handling of loads. Especially for beginners without previous experience and training the exact positioning of a swinging load is a time-consuming task.
Description of the main principle	The LSR-Function of EOT-Cranes is integrated in the crane control system: The drives for crane and trolley travel of the cranes with load sway damping are infinitely speed-controlled via a frequency inverter. The main task is performed by the crane control system in combination with a sensor that detects the deflection of the rope at the rope anchorage point (including inclined pull) and actively counteracts it if it detects a load sway. Since the LSR-control measures the actual rope angle deflection, the oscillation of the load is effectively minimized in every operating situation. Also load oscillations that existed before the start of a movement are detected and thus actively compensated.
Classification According to Table 1	See next Page of this document
Result	Assistance function (influencing motion)

INPUT:

Properties of "LSR function"

OUTPUT:

The LSR is an **Assistance Function** (influencing motion)

			Function types			
	Operating functions	Safety functions	Warning and Indicating	Assistand	ce.	A
			functions	providing information		cing cing
Properties Control Interactio	Can actively influence to by interaction with the co		Cannot actively influence the interaction with the control suser attention and action.		Can ac influence behavio	rely the cran ir by
Purpose	Necessary to operate the crane as intended.	Necessary to reduce the risk of hazards during operation.	Function providing proper information for the user and is part of the designer's contribution to risk reduction. With this information the user must implement the necessary protective measures.	Additional functions improve efficiency, i consumption or imp when operating the Not necessary to op fulfil safety requiren	control for the op- reduce ene- rove ergor crane. perate the o	ystem. ator to
Availability	Are available when an o	operating mode is swite		Are available when switched on and the is selected by the ol	e assistanc perator.	mode is function
Activation	Activated by the crane operator by a control device.	Activated by the crane control when a defined safety-related limitation is exceeded or manually by a	Activated by the crane control when a defined safety-related limitation is exceeded or manually by a switch, e. g. activating the horn	operator at any time. Activated when a defined op threshold is reached or activate operator.		
Intervention by operator	In general, not applicable. In case of malfunction operator uses emergency stop.	switch, e. g. an emergency stop. The operator cannot overrule safety functions.	The operator cannot overrule. Some warning and indicator functions allow an acknowledgement. ³	The operator can intervene an assistance functions at any tin		overrule).
Function's Override	Overriding by the operator is not	Overriding of a safety function is	Overriding by the operator is not allowed. ³	Overriding by the op – the assistance fur	nction may	t needed
Priority	needed. Operational functions have priority over and can overrule assistance functions.	not allowed. ² Safety functions have the highest priority and can overrule operational functions and assistance functions	Not applicat	activated or deactive	ated at any Lowest pr	
Parameter setting	Setting of parameter values of properties of operating function is allowed and can be changed by the operator within the limits foreseen by the	functions. Setting of parameter values of properties cannot be changed by the operator.	Setting of parameter values of properties cannot be changed by the operator.	Setting of paramete (i. e. threshold value function is allowed a by the operator with by the manufacturer	es) of assis and can be in the limit	ance hanged
Designed and bui	manufacturer Applicable product standard.	EN ISO 13849-1 and applicable product standard.	Applicable product standard.			

See EN ISO 121 0, Clause 4, Figure 2
 Muting: Tempora y automatic suspension of safety functions is possible but safe conditions must be provided by other means (in a cordance with EN ISO 1384 -1).
 Muting of warnin, and indicating functions is also allowed analogous to Footnote 2

A.2. Working Range System (WRS)

Function-name	Working Range System (WRS)
Purpose	The Working Range System is used by the crane operator to restrict the working range of the crane. It is a helpful system when working on cramped job sites.
Description of the main principle	The crane operator can restrict the total height, radius, angle of rotation and hoisting rope path. The maximum approved speed of movement depends on the distance from the set boundary. The movement is reduced continuously until standstill at the boundary. If the boundary is reached, the movement is switched off. All movements that exceed the boundary are blocked. The shutdown is retained even if you turn off monitoring. In order to release movements again, you must initiate a movement away from the boundary in the opposite direction. The Working Range System can be switched on or off by the crane operator.
Classification according Table 1	See next Page of this document
Result	Assistance function (influencing motion)

INPUT: Properties of "Working Range System"

OUTPUT:

The WRS is an **Assistance Function** (influencing motion)

			Function types			•
	Operating functions	Safety functions	Warning and Indicating functions	Assistance	e tun	
				providing information		encing otion
Properties					1	
Control Interactio	Can actively influence to by interaction with the co		Cannot actively influence the interaction with the control suser attention and action.		Can ac influence behavious	rely the crane ir by n with the
Durmana	Naccesami to anarota	Necessary to	Function providing proper	Additional functions f	control	ystem. ator to
Purpose	Necessary to operate the crane as intended.	reduce the risk of hazards during operation.	Function providing proper information for the user and is part of the designer's contribution to risk reduction. With this information the user must implement the necessary protective	improve efficiency, re consumption or impr when operating the c Not necessary to ope fulfil safety requireme	educe ene ove ergor crane. erate the o	gy mics
			measures.1			
Availability	Are available when an o	operating mode is switc	hed on.	Are available when an operation switched on and the assistance is selected by the operator.		mode is function
				It can be unselected operator at any time.		e
Activation	Activated by the crane operator by a control device.	Activated by the crane control when a defined safety-related limitation is exceeded or manually by a	Activated by the crane control when a defined safety-related limitation is exceeded or manually by a switch, e. g. activating the hom	Activated when a det threshold is reached operator.		tional d by the
		switch, e. g. an emergency stop.				
Intervention by operator	In general, not applicable. In case of malfunction operator uses emergency stop.	The operator cannot overrule safety functions.	The operator cannot overrule. Some warning and indicator functions allow an acknowledgement. ³	The operator can inte assistance functions		overrule).
Function's Override	Overriding by the operator is not needed.	Overriding of a safety function is not allowed. ²	Overriding by the operator is not allowed. ³	Overriding by the open - the assistance fundativated or deactivated	ction may	t needed e ime.
Priority	Operational functions have priority over and can overrule assistance functions.	Safety functions have the highest priority and can overrule	Not applicat		Lowest pr	rity
		functions and assistance functions.				
Parameter setting	Setting of parameter values of properties of operating function is allowed and can be changed by the operator within the	Setting of parameter values of properties cannot be changed by the operator.	Setting of parameter values of properties cannot be changed by the operator.	Setting of parameter (i. e. threshold values function is allowed by the operator within by the manufacturer.	s) of assis nd can be n the limit	ance
	limits foreseen by the manufacturer					
Designed and bui according to	Applicable product standard.	EN ISO 13849-1 and applicable	Applicable product standard.			
¹ See EN ISO 121 0,	Clause 4. Figure 2	product standard.				

See EN ISO 121 0, Clause 4, Figure 2
 Muting: Temporary automatic suspension of safety functions is possible but safe conditions must be provided by other means (in cordance with EN ISO 1384 -1).
 Muting of warnin, and indicating functions is also allowed analogous to Footnote 2

A.3. Eco Mode - Fuel saving system

Function-Name	ECO Mode
Purpose	The system automatically adjusts the engine speed to save fuel and reduce energy consumption.
Description of the main principle	The ECO-Mode can be turned on and off by the operator. When activated the system automatically increases engine speed to operator specified working speed when functions are operated, and then decreases the engine speed to idle speeds when no functions are being operated for a certain period of time.
Classification According to Table 1	See next Page of this document
Result	Assistance function (influencing motion)

INPUT:

Properties of "ECO Mode"

OUTPUT:

The ECO Mode is an **Assistance Function** (influencing motion)

			Function types			
	Operating functions	Safety functions	Warning and Indicating	Assistan	ce	A
			functions	providing information		cing
Properties					1	<u> </u>
Control Interaction	Can actively influence t by interaction with the o		Cannot actively influence the interaction with the control suser attention and action.		Can ac influence behavior interact	rely the crar ir by on with th vstem.
Purpose	Necessary to operate the crane as intended.	Necessary to reduce the risk of hazards during operation.	Function providing proper information for the user and is part of the designer's contribution to risk reduction. With this information the user must implement the necessary protective	Additional functions improve efficiency, consumption or impwhen operating the Not necessary to of fulfil safety requirents.	for the opereduce endorove ergororane.	ator to
			measures.1			
Availability	Are available when an	pperating mode is switc	ched on.	Are available when an operati switched on and the assistant is selected by the operator.		mode is function
Ĭ				It can be unselected operator at any time		le
Activation	Activated by the crane operator by a control device.	Activated by the crane control when a defined safety-related limitation is exceeded or manually by a	Activated by the crane control when a defined safety-related limitation is exceeded or manually by a switch, e. g. activating the horn	Activated when a defined op threshold is reached or activ operator.		
Ĭ		switch, e. g. an emergency stop.				
Intervention by operator	In general, not applicable. In case of malfunction operator uses emergency stop.	The operator cannot overrule safety functions.	The operator cannot overrule. Some warning and indicator functions allow an acknowledgement. 3	The operator can in assistance function		overrule).
Function's Override	Overriding by the operator is not	Overriding of a safety function is	Overriding by the operator is not allowed. ³	Overriding by the o – the assistance ful		t needed
9	needed.	not allowed.2	operator to tret allerted.	activated or deactiv		ime.
Priority	Operational functions have priority over and can overrule assistance functions.	Safety functions have the highest priority and can overrule operational functions and	Not applicat	ble.	Lowest pr	rity
		assistance functions.				
Parameter setting	Setting of parameter values of properties of operating function is allowed and can be changed by the operator within the	Setting of parameter values of properties cannot be changed by the operator.	Setting of parameter values of properties cannot be changed by the operator.	Setting of paramete (i. e. threshold valu function is allowed by the operator with by the manufacture	es) of assis and can be nin the limit	ance hanged
	limits foreseen by the manufacturer					
Designed and bui	Applicable product standard.	EN ISO 13849-1 and applicable	Applicable product standard.			

Muting: Tempore y automatic suspension of safety functions is possible but safe conditions must be provided by other means (in with EN ISO 1384 -1).
 Muting of warning and indicating functions is also allowed analogous to Footnote 2

A.4 Side-Pull Control (SPC)

Function-Name	Side-Pull Control (SPC)
Purpose	The Side-Pull Control (SPC) is a function to avoid side pull and reduced swinging when lifting a load from the ground by an automatic alignment of the jib and the trolley above the load.
Description of the main principle	The Side-Pull Control (SPC) function for tower cranes is integrated in the crane control system and can be switched off or overruled at any time. When made available by the operator, the SPC can be activated or de-activated by means of a push button.
	The function is performed by the crane control system in conjunction with a sensor that detects the deviation of the hook block relative to the rotation angle of the jib and the radial position of the trolley and actively counteracts during the lifting operation.
	Since the SPC measures the actual deflection of the hook block, the deflection of the hook block is reduced to a minimum during the lifting of the load.
Classification according to Table 1	See next page of this document
Result	Assistance function (influencing motion)

INPUT: Properties of SPC

OUTPUT:

The SPC is an **Assistance Function** (influencing motion)

Properties			Function types			
•			Wouning and	Assistar	nce functions	-
	Operating functions	Safety functions	Warning and Indicating functions	providing information	influenci	ing motion
Control Interaction	Can actively influence behaviour by interact system.		Cannot actively influe behaviour by interact system but requires u action.	ion with the control	Can active the crane interaction control sys	influence haviour b vith the em.
Purpose	Necessary to operate the crane as intended.	Necessary to reduce the risk of hazards during operation.	Function providing proper information for the user and is part of the designer's contribution to risk reduction.	Additional functions f improve efficiency an operating the crane. Not necessary to opesafety requirements.	d ergonomic	r to when or fulfil
			information the user must implement the necessary protective measures.1			
Availability	Are available when a	n operating mode is sv	ritched on.	Are available when a switched on and the colocted by the operation	assistance f	ode is iction is
Ĭ				It can be unselected any time.	by the crane	perator a
Activation	Activated by the crane operator by a control device.	Activated by the crane control when a defined safety-related limitation is exceeded or	Activated by the crane control when a defined safety-related limitation is exceeded or	Activated when a defined operation reached or activated by the operato		threshold
		manually by a switch, e. g. an emergency stop.	manually by a switch, e. g. activating the horn.			
Intervention by operator	In general, not applicable. In case of malfunction operator uses	The operator cannot overrule safety functions.	The operator cannot overrule. Some warning and indicator functions	The operator can inter- assistance functions at		ule
			acknowledgement. 3			
Function's override	Overriding by the operator is not	Overriding of a safety function is not allowed 2	Overriding by the operator is not allowed 3	Overriding by the operassistance function ma	y be activated	
Priority	Operational functions have priority over and can overrule assistance functions.	Safety functions have the highest priority and can overrule operational functions and assistance functions.	Not ap	Not applicable Lowest		iority
Parameter settinç	Setting of parameter values of properties of operating function is allowed and can be changed by the operator within the limits foreseen by the manufacturer.	Setting of parameter values of properties cannot be changed by the operator.	Setting of parameter values of properties cannot be changed by the operator.	Setting of parameter threshold values) of a allowed and can be of within the limits fores	assistance fu changed by t	perties (i. ction is poperator anufacture
Designed and bu	Applicable product standard.	EN ISO 13849-1 and applicable product	Applicable product standard.			

See EN ISO 12 00, Clause 4, Figure 2

Muting of warn ry automatic suspension of safety functions is possible but safe conditions must be provided by other means (in accordance 49-1).

g and indicating functions is also allowed analogous to Footnote ²

A.5. Surround View System ('Bird View')

Function-Name	Surround View ('Bird View')
Purpose	The surround view system ('Bird View') provides a video signal that shows the crane and its immediate surrounding ambient area from an elevated viewpoint. This allows the crane operator to perceive the crane's surroundings and to recognise people or obstacles around the crane. In addition, the maximum outrigger position and the slewing radius of the counterweight can be projected into the surround view signal as an augmented reality. In this way, the crane operator is supported in efficiently position or relocated the crane in narrow working areas.
Description of the main principle	The surround view system ('bird view') consists of several cameras installed at different locations on the crane. The signals of all cameras are processed by dedicated software and combined into a video signal that shows the current crane position from a bird's perspective. The crane operator can watch the crane's surroundings to detect people or obstacles when positioning the crane on the job site. In addition, the software can project the possible outrigger reach and the tail swing of the counterweight on the display which supports the crane operator to detect possible collisions with obstacles before crane operation.
Classification According to Table 1	See next Page of this document
Result	Assistance function (providing information)

INPUT: Properties of SVS "Surround View System"

OUTPUT:

The SVS is an **Assistance Function** (providing information)

	Operating functions	Safety functions	Function types Warning and Indicating functions		istance functions		
Proportion			Tunctions	provi inform		influencing motion	
Properties Control Interaction	Can actively influence the crane behaviour by interaction with the control system.		Cannot actively influence the crane interaction with the control system user attention and action.			Can actively influence the cran behaviour by interaction with the control system.	
Purpose	Necessary to operate the crane as intended.	Necessary to reduce the risk of hazards during operation.	Function providing proper information for the user and is part of the designer's contribution to risk reduction. With this information the user must implement the necessary protective measures.	improve e consumpt when ope Not neces	unctions for the operator to ciciency, reduce energy on or improve ergonomics ating the crane. ary to operate the crane or requirements.		
Availability	Are available when an o	operating mode is switch	ched on.	switched is selecte	is selected by the operator.		
				operator a			
Activation	Activated by the crane operator by a control device.	Activated by the crane control when a defined safety-related limitation is exceeded or manually by a	Activated by the crane control when a defined safety-related limitation is exceeded or manually by a switch, e. g. activating the horn	Activated threshold operator.	reached or activated by the		
		switch, e. g. an emergency stop.					
Intervention by operator	In general, not applicable. In case of malfunction operator uses emergency stop.	The operator cannot overrule safety functions.	The operator cannot overrule. Some warning and indicator functions allow an acknowledgement. ³		or can intervene and overrule functions at any time.		
- II I				0 11			
Function's Override	Overriding by the operator is not	Overriding of a safety function is	Overriding by the operator is not allowed.3	Overriding – the assi	ance func	rator is not needed tion may be	
Priority	needed. Operational functions have priority over and can overrule assistance functions.	not allowed. ² Safety functions have the highest priority and can overrule operational	Not applicat	activated deactiva		ed at any time. owest priority	
Ĭ		functions and assistance functions.					
Parameter setting	Setting of parameter values of properties of operating function is allowed and can be changed by the operator within the	Setting of parameter values of properties cannot be changed by the operator.	Setting of parameter values of properties cannot be changed by the operator.	(i. e. thres function is by the ope	arameter values of properties old values) of assistance allowed and can be changed ator within the limits foreseen ufacturer.		
	limits foreseen by the manufacturer						
Designed and bui according to	Applicable product standard.	EN ISO 13849-1 and applicable product standard.	Applicable product standard.				

with EN ISO 1384 -1).

³ Muting of warnin, and indicating functions is also allowed analogous to Footnote 2.

A.6. Overload protection

Function-Name	Overload protection
Purpose	According EN 14492-2, hoists with a rated capacity of 1.000 kg or more shall be fitted with a rated capacity limiter. The rated capacity limiter shall be designed to prevent overloading of the hoist. It shall also limit the forces transmitted to the supporting structure. Overloading means exceeding the designed operating forces.
Description of the main principle	The Overload protection Function is a direct acting capacity limiter and is integrated in the crane control system. A load sensor provides the load-value. If the limit value is exceeded, the drive will be stopped with a safety-related stop function of category 0 or 1 according to EN 60204-32.
Classification According to Table 1	See next Page of this document
Result	Safety function

INPUT: Properties of "Overload protection function "

OUTPUT: The Overload protection function is a Safety Function

Properties				Function types Warning and	Assistance functions		
	functions	~		Indicating functions	providing information	influencing motion	
Control teraction	Can actively influence the crane behavio interaction with the control system.				on with the control the crane behaviour		
Purpos	Necessary to operate the crane as intended.	Necessary to reduthe risk of hazards during operation.	е	Function providing proper information for the user and is part of the designer's contribution to risk reduction. With this information the user must implement the necessary protective measures.1	Additional functions for the operator to improve efficiency, reduce energy consumption and ergonomics when operating the crane. Not necessary to operate the crane or fulfil safety requirements.		
Availabi y	Are available when an operating mode is		witch	ed on.	Are available when an operating mode is switched on and the assistance function selected by the operator. It can be unselected by the crane operation any time.		
Activati	Activated by the crane operator by a control device.	Activated by the c control when a de safety-related limitation is excee or manually by a switch, e. g. an emergency stop.		Activated by the crane control when a defined safety-related limitation is exceeded or manually by a switch, e. g. activating the horn.	Activated when a de threshold is reached operator.	•	
Intervei on by operator	In general, not applicable. In case of maintenant or operator uses emergency stop.	The operator can overrule safety functions.	t	The operator cannot overrule. Some warning and indicator functions allow an acknowledgement. ³	The operator can intervene and overrule assistance functions at any time.		
Function S Overrid	Overriding by the operator is not needed.	Overriding of a sa function is not allowed. ²	ty	Overriding by the operator is not allowed. ³	Overriding by the operator is not needed – the assistance function may be activated o deactivated at any time.		
Priority	Operational functions have priority over and can overrule assistance	Safety functions he highest priority can overrule operational functional and assistance functions.		Not ap	Lowest priority		
Parame er settings	Setting of parameter values of properties of operating function is allowed and can be changed by the operator within the limits foreseen by the manufacturer	Setting of parame values of properticannot be change the operator.	by	Setting of parameter values of properties cannot be changed by the operator.	Setting of parameter values of properties (i. e threshold values) of assistance function is allowed and can be changed by the operator within the limits foreseen by the manufacturer.		
Design and built according to	Applicable product standard.	EN ISO 13849-1 a applicable produc standard.	d	Applicable product standard.			

¹ See N ISO 12100, Clause 4, Figure 2

² Mutin

Temporary automatic suspension of safety functions is partie but safe conditions must be provided by other means (in accordance with EN ISC 13849-1).

Mutin of warning and indicating functions is also allowed analogo to Footnote 2

A.7. Anti-Collision System (ACS)

Name	Anti-Collision System (ACS)				
Purpose	In an Anti-Collision System (ACS) for tower cranes, a safety function is implemented to prevent collisions between cranes and/or obstacles in the working range of the respective cranes.				
Description of the main principle	In an Anti-Collision System (ACS), the control systems of the cranes involved are connected via a network in which their respective status, position and speed data are exchanged in real time.				
	This is usually done by means of Anti-Collision Devices (ACD) that are additionally mounted on each crane and linked to the respective crane control system. The Anti-Collision Function (ACF) is implemented in these devices as a safety function and interacts with the crane's control commands to slow down or stop movements in dangerous directions to prevent a collision with another crane or an object in the crane's working range.				
	Before operation, when commissioning the Anti-Collision Function (ACF), crane- and site-specific parameters are considered, e. g. deformation of the crane, expected size of the load, possible pendulum angle of the load (due to crane acceleration and/or wind) or required safety distance.				
	NOTE: Requirements for anti-collision systems for tower cranes are specified in the product standard EN 17076:2020 which refers to EN ISO 13849-1.				
Classification according to Table 1	See next page of this document				
Result	Safety function				

INPUT: Properties of OUTPUT: The ACS is "ACS" a **Safety Function**

Char				Function types			
		1			Assistance functions		
	Operating functions	Safety fu	ctions	Warning and Indicating functions	providing information	influencing motion	
Control Intera on	Can actively influence the crane behaviour by interaction with the system.		ontrol	Cannot actively influe behaviour by interact system but requires u action.	ion with the control the crane behaviour behav		
Purpose	Necessary to operate the crane as intended.	Necessar reduce the hazards d operation.	to risk of ring	Function providing proper information for the user and is part of the designer's contribution to risk reduction. With this information the user must implement the necessary protective measures.	Additional functions for the operator to improve efficiency and ergonomics when operating the crane. Not necessary to operate the crane or fulfil safety requirements.		
Availability	Are available when an operating		ode is sw	vitched on.	Are available when an operating mode is switched on and the assistance function is selected by the operator. It can be unselected by the crane operator at		
					any time.		
Activation	Activated by the crane operator by a control device.	Activated to crane continuous a defined sime exceeded of manually to switch, e. genergency	an	Activated by the crane control when a defined safety-related limitation is exceeded or manually by a switch, e. g. activating the horn.	Activated when a defined operational threshold is reached or activated by the operator.		
Intervention by operator	In general, not applicable. In case of melfunction operator uses emergency stop.	The operat overrule sa tunctions.	cannot ety	The operator cannot overrule. Some warning and indicator functions allow an acknowledgement. 3	The operator can intervene and overrule assistance functions at any time.		
Function's override	Overriding by the operator is not	Overriding safety fundamental	f a on is not	Overriding by the operator is not allowed. ³	Overriding by the operator is not needed – the assistance function may be activated or deactivated at any time.		
Priority	Operational functions have priority over and can overrule assistance functions.	Safety fund have the h priority and overrule of functions a assistance	can rational	Not ap	applicable Lowest priority		
Parameter se ngs	Setting of parameter values of properties of operating function is allowed and can be changed by the operator within the limits foreseen by the manufacturer.	Setting of p values of p cannot be by the ope	rameter perties anged tor.	Setting of parameter values of properties cannot be changed by the operator.	Setting of parameter values of properties (i. of threshold values) of assistance function is allowed and can be changed by the operator within the limits foreseen by the manufacture		
Designed and puilt according to	Applicable product	EN ISO 138 applicable p standard.		Applicable product standard.			

^{12100,} Clause 4, Figure 2

See EN ISC
 Muting: Ter with EN ISC
 Muting of w orary automatic suspension of safety function 3849-1).
Solution and indicating functions is also allowed s is possible but safe conditions must be provided by other means (in accordance

nalogous to Footnote ²

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