The rise of *EN 17206*, a new EU stage machinery standard

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IMAGINE A WHOLE CONTINENT with about 34 countries, 27 of them making up a union with no real borders anymore and theoretical free trade and official free movements of goods.

Imagine you have a touring show that you want to take across this continent, but every time you cross one of the borders you didn't even realize you crossed, suddenly different rules apply and you may have to change out your rigging equipment, because 100 km down the road from the last show, your equipment is no longer good or legal to use anymore.

Or, imagine you just designed a wonderful machine for a theatre. It meets all the specific requirements of one place and you want to also sell it to the other place 200 km away and all you get is a lot of head-shaking and about 1,000 reasons why this machine or control system cannot possibly be used over there.

Well—a little exaggeration aside—that was the situation in Europe until the summer of 2020.

In order to tackle this situation, a group of people from all across Europe got together, formed a Technical Committee (CEN-TC-433 "Entertainment Technology") and started to work on a Pan-European EN standard for stage machinery and control systems. After five years of work, the new document was officially released in the summer of 2020. The work started from a base document CWA-15902-1 which was also known as "*CEN-25*." The full title of the new document now reads "***EN 17206 Entertainment Technology — Machinery for Stages and Other Production Areas — Safety Requirements and Inspections***."

This is the first EN level standard for this topic. The official release triggers a timer allowing all CEN member states a six-month period to:

1.) withdraw their own national standards covering the same topic
2.) modify other national standards or regulations pointing to a now withdrawn standard
3.) create local language translations if required
4.) publish the document through their own National Standardization Body (such as DIN, BSI, AFNOR, and AENOR).

The huge advantage of an EN standard is the application across all 34 CEN member countries (the European Union 27 and Iceland, North Macedonia, Norway, Turkey, Serbia, Switzerland, and the UK) so that equipment does not need to change once it moves across a border into a country where a different local standard would be calling out different requirements. A machine can now truly be "designed for Europe" and can now be sold in one version across all of Europe.

Although *EN 17206* is not harmonized with the machinery directive, it effectively describes the "state of the art" in this field and is currently the best document there is to trigger a presumption of conformity. In order to solidify this, there is a separate effort starting with the goal of a "standardization request (mandate) for harmonization to the machinery directive" and the citation of *EN 17206* in the Official Journal of the EU. There is a bureaucratic complexity associated with this work as well as a document issue, since some concepts of the standard are within the machinery directive (machines used to move scenery), and others are outside (machines used to transport persons during performances).

This new standard also has implications to the DGUV 17/18 inspection and certification (formerly known as "BGV-C1") process. An independent and VGB-accredited inspector certifies that the machine, control system, and the installation "is safe" meaning it "meets the state of the art," currently using *DIN 56950-1 Entertainment Technology – Machinery Installations – Part 1: Safety Requirements and Inspection.* However, since *DIN 56950-1* is now in the process of being withdrawn and replaced by *EN 17206*, the inspectors will soon be using the new *EN 17206* for their certification work.

DGUV and VBG are German Workplace Insurance and Occupational Health and Safety organizations and the equipment certifications were never intended to be applied outside Germany. However, the certifications are already fairly popular elsewhere, and may now become a lot more relevant across Europe for specifiers and customers. These people would like to know if a product meets the requirements of *EN17206* by means of a formal certification by an independent and accredited person instead of an informal self-certification.

EN 17206 highlights Use Cases

One of the core elements of this document is the introduction of "Use-Cases" describing parameters about how the equipment is used. Based on these Use-Cases, several design requirements, especially for the control system, can be derived.

The Use-Cases are an important tool for the specification of a new system for a venue. A consultant now has an easy tool to specify a "set-up use" system without having to go into details of what safety-functions at which kind of Safety Integrity Levels (SIL) are needed. A simple "*the system shall meet UC1 requirements according to EN 17206*" will describe and take care of the basic control system functions and respective safety requirements.

Use Case	Description	System Use
UC1	No-one in hazard zone during motion, statically determinate load, Speed < 0.2 m/s	Set-Up a Venue
UC2	No-one in hazard zone during motion, statically indeterminate Load, Speed < 0.2 m/s	
UC3	Person(s) in hazard zone during motion, single axis	Scenic Motion
UC4	Person(s) in hazard zone during motion, multiple axis	
UC5	Moving person(s) suspended, single axis	Performer Flying
UC6	Moving person(s) suspended, multiple axis	

Table 1 – Use Cases for upper machinery (hoists)

There are similar categories for lower stage machinery that split up in lifting and horizontal motion. The lifting categories range from UC-LSL1, describing a simple compensator lift with limited travel to UC-LSL6, multiple large platforms lifting a common load at high speeds and with person(s) in the hazard zone.

The horizontal category also describes six categories, starting with a single revolve (UC-LSH1) all the way to multiple stage wagons transporting a common load with persons in the hazard zone (UC-LSH6).

Safety Function or Measure	UC1	UC2	UC3	UC4	UC5	UC6
Emergency Stopa – category 0 or 1	HR	HR	HR (CAT 1)	HR (CAT 1)	HR (CAT 1)	HR (CAT 1)
Stop on "Deadman" Release – category 0, 1, or 2	HR	HR	HR	HR	HR	HR
Protection against position Deviation	-	-	HR	HR	HR	HR
…						

Table 2 – Excerpt, recommended Safety Function for various Use Cases

Control system safety functions

Several stage machinery standards around the globe, such as *ANSI E1.6-1*, *BSI 7905*, *DIN-56950-1*, and also *EN 17206* provide a detailed description of a number of control system safety functions within the body of the document. When reading these descriptions, there was confusion about which of these functions need to be present on a specific system. The common thought "All of them and all in SIL-3" is simply not the right answer, since what needs to be present and at what level depends on the use of the system and an associated risk assessment.

Utilizing the Use-Cases, *EN 17206* tries to solve this dilemma by providing an informative table with guidance of which safety functions should be present (Recommended (R) or Highly Recommended (HR)) on a hoist, based on the use case.

Design factors and failure exclusion

A common way to mitigate risks of failures is to "make it bigger" or "use two." This is also the basic *EN 17206* principle to stage machinery for lifting and suspending loads above people. This is one of the key differences to the normal lifting industry.

EN 17206, Chapter 5.1: "*The basic safety concept laid down in this document is based on the principles of intrinsic safety or single fault safety design. This is achieved either through doubling the working coefficient in calculations (designing for twice the characteristic load) or through redundancy.*"

In other words, a machine capable of lifting 1,000 kg in the construction industry can only be used to lift and suspend 500 kg in entertainment above people (provided it meets all other requirements of *EN 17206*).

It is the same idea for brakes, where industrial equipment usually has one brake, in entertainment we often ask for two in order to provide the additional safety if one of the brakes happens to fail.

The same principle applies in the control systems: If a specific control system function needs to be extra-safe, doubling the circuitry will help. The "stop at the end of travel" safety function is a perfect example for this. Machines usually have two limit switches at the end of travel in each direction: initial and overtravel. If the initial limit switch fails, there is still the overtravel limit switch that should take care of ultimately stopping the machine.

EN ISO 12100			Entertainment Industry	
Hazard Type	Hazard Origin	Potential Consequences	Risk Origin	Hazardous Event
Mechanical	Acceleration Deceleration	Crushing	Lack of stability	Incorrect dimensioning of structural elements and components.
			Incorrect loading, overloading, exceeding specified overturning moments	Improper force or load transmission, stability calculations not carried out for load at failure.
			Uncontrolled movements	Exceeding specified travel limits.

Table 4 – Excerpt, guidance for Risk Assessment

ELL or "Entertainment Load Limit"

Common terms such as Working Load Limit (WLL) or Safe Working Load (SWL) were always confusing in the entertainment industry because with doubling the design factors (effectively halving the load) it was never clear if the given number was already de-rated or not.

Usually for entertainment-specific machines this is the case, whereas for chain hoists this is sometimes a gray area. On common hardware, such as slings and shackles, the indicated value is definitely not de-rated. Sling manufacturers specifically selling into the entertainment market often provide both numbers (WLL 1000 kg/load limit for the entertainment industry 500 kg).

In order to simplify this and make sure that there are no misunderstandings, the term Entertainment Load Limit (ELL) was created. The number given here is now free of ambiguities and it describes the maximum load this equipment can be used in the entertainment industry to move and suspend loads above people.

Risk assessment guidance

Annex A of the standard provides a laundry list of common risks that may originate from the machinery and it can be used as the basis of a risk assessment required by the machinery directive. This list is closely modeled after *ISO 12100: Safety of Machinery — General Principles for Design — Risk Assessment and Risk Reduction*, which is harmonized to the machinery directive. Although the list is very extensive, it is not exhaustive, and it is possible that there are additional risks which would need to be looked at as well. But then again, there are not that many hoists being powered by nuclear energy or steam and these kinds of risks listed in *ISO 12100* can be ignored.

Functional safety guidance

The Safety Integrity Level (SIL) requirements of individual safety-functions (sometimes wrongly called "the control system" e.g. "the control system shall be SIL-3") has always been a big problem in specifications and expectations. Unlike other documents, *EN 17206* does not have a single line in the standard stating "*Safety function X shall meet SIL-3*." In reality, the SIL rating requirements have to be determined by a risk assessment. The determination of how much risk-reduction the control system needs to provide, results in how high the SIL for individual safety functions needs to be. This can be achieved by the application of various standards (such as *IEC 61508*, *IEC 62061* or, *ISO 13849*) using their respective risk graphs, resulting in a required SIL (or Performance Level (PL)) for each individual safety function.

The trouble with these functional safety standards and the risk assessment parameters used as the input for the risk graphs is that they are primarily written around manufacturing machines such as punch-presses, drills, saws, or conveyer belts, and it is hard to directly translate these parameters to the machines and control systems in the entertainment environment.

Annex D of *EN 17206* provides guidance and an "entertainment industry calibration" for these risk parameters (such as duration in hazard zone, ability to avoid hazard, and severity of the hazard).

These parameters have different numbers associated depending on the Use-Case of the system described in Annex-B.

Documentation of safety functions

One of the big problems for architects or mechanical designers designing the grid-structure is always to get accurate numbers of the imposed loads to the building originating from the stage machinery—not only the static load, but, more importantly, the possible dynamic loads.

There is another problem here: It is

EN ISO 13849-1 Probability of Avoidance (P)	Use Case	EN 62061 Probabilities of avoiding or limiting harm (Av)
P1	UC1, UC2	1
P2	UC3, UC4	3
P2	UC5, UC6	5

Table 5 – Excerpt, guidance for functional safety evaluations

Safety Function	Parameter	value	Units	Design or Test Data
Stop on hold to run ("deadman") release	Category of stop [0, 1 or 2]			
	SIL/PL			
	Deceleration rate		ms^{-2}	
	Worst-case system reaction time		ms	
	Worst-case stopping distance from time of activation		mm	

Table 6 – Excerpt, safety function documentation

very difficult to get information about the implemented safety functions and their respective SIL. This makes choosing the right control system for a project or simply comparing control systems difficult. The standard requires that mechanical data of the results of safety function actuation, as well as the SIL of each specific safety function is published. Annex D provides an example table that shows things such as: Emergency Stop: SIL, reaction time, maximum deceleration, maximum travel distance to standstill.

Examples

Conducting a Risk-Assessments and evaluating safety functions to minimize risks can be a daunting task and is not always easy and straightforward. Annex G provides several examples about how to do this, starting at very simple setup scenarios and going all the way to 3D performer flying.

Conclusion

EN 17206 is the first pan-European EN standard describing stage machinery and control systems. It allows the same design, free movement of equipment across borders, and use for temporary and permanently installed equipment across Europe. With Use-Cases, specification of new systems becomes a lot simpler with less ambiguities about what needs to be supplied. The term ELL cleans up the dilemma of using equipment with the correct loads and the functional safety requirements and SIL requirement are now more clearly defined. All in all, a huge and long overdue step forward towards a common European market for stage machinery. ■

Michael Lichter started working in the entertainment industry over 30 years ago designing console electronics and writing software, but also commissioning systems in opera houses, theme parks, TV studios, and cruise ships. He has been in charge of developing machinery control systems in Europe and the US for more than 18 year and works at Electronic Theatre Controls in the role of Senior Technical Product Manager for Stage Machinery Control Systems. Michael has also been involved with writing standards for ESTA since 2007. He chaired the *EN 17206* controls section task group, was a member of the ESTA *ANSI E1.6-1 – 2019 Entertainment Technology – Powered Hoist Systems* task group and chaired the ESTA *ANSI E1.44 – 2014 (R2019) Common Show File Exchange Format for Entertainment Industry Automation Control Systems – Stage Machinery* task group. He is now actively working in the German DIN working group "Stage Machinery," is a delegate for the CEN-TC-433 "Entertainment Technology," member of CEN-TC-433-WG-1 "Machinery," and ESTA TSP Rigging as well as Controls Protocols Working Groups.

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