Recommendation for minimum standards and expectations of (converted) electrical building site machinery > 125 kW

Formulated by ENI

Date: 18-01-2022, version 1.2 (updates will follow)

Introduction

ENI (Emission-free Network Infra) works in a unique ecosystem of front-runners (construction companies, contractors, energy companies and suppliers) to develop emission-free building site machinery. There is currently an inadequate supply of standard production heavy duty emission-free machinery, and expectations are that the market demand will not be met in the coming years. The conversion of conventional machines to emission-free power systems is therefore an important route.

However, conversion needs to take place safely and the safety must be comparable with that of conventional machines. Whether the conversion takes place by specialised conversion companies or by own personnel, electrification must not result in additional risks at the building site. ENI has therefore formulated a list of recommendations for minimum standards regarding safety and sustainability when converting building site machinery.

Minimum standards for converted emission-free building site machinery:

Safety

Requirement	Expectation	Notes
General		
CE marking Machine directive 2006/42/EC (incl. Handbook and machine Risk Inventory)	in accordance with statutory obligation Directive 2006/42/EC	See enclosed list of examples ** Standards to be applied. Each machine type may be subject to a different combination of regulations and directives.
Safety of machines - Integrated production systems - General requirements	EN-ISO 11161:2007	
Energy carrier		
Safety of external Battery storage (containers)	in accordance with: PGS-37	
Safety of Exchange batteries regarding insulation values and leakage current protection	NEN 9140 safe working on e-vehicles	Appendix 4 of the NEN norm describes the requirements for cabling, provisions for high-voltage shut-off and the placement of battery packages. The insulation value must be checked after any repair and/or conversion work, using a mega-ohmmeter (Megger).
Safe operation of battery energy storage systems	in accordance with NEN 4288	
Simple visual recognition of electrical/hydrogen installations and machines	minimum: safety pictograms according to NEN 4288	
Safe Hydrogen filling stations	in accordance with: PGS-35	

Machine		
Safety of machines-General design principles-Risk assessment and risk reduction	EN-ISO 12100:2010	Fail safes which are compulsory in the design process
ElectroMagnetic Compatibility(EMC)	in accordance with: R10_5 and/or IEC 61000-6-2	
Protection against electrocution and leakage current	Use of Earth leakage monitor such as RI155 Bender	
Roadworthy machinery ready for RDW testing (e.g. excavators, mobile crane, tractors) and machinery to be used on public roads (according to NL Department of Public works (RWS) rules)	in accordance with directive R100.02	Exchange batteries in accordance with R100.02 are individually tested and can be transported as standard materials. Exchange batteries in accordance with R100.01 must be transported as hazardous goods, i.e. in a collision-proof container, for example. When exchanging batteries, this may also mean that only authorised personnel may make the exchange.
Single versions and small series (<15 pieces/year) and non-roadworthy machines	in accordance with directive R100.01 specifically for battery packages: IEC62619 (not yet harmonised in the EU)	
Functional safety of series produced Vehicles on public roads	**ISO26262:2018**	Only applicable to series production. Applies to safety-related systems which include one or more electrical and/or electronic (E/E) Systems and which are installed in series produced road vehicles, including buses, trucks and motorcycles.

Besides the fact that machinery must comply with the applicable norms and directives, the **related documentation** must be in order and be effective. At a building site, this is essential for formulation of, for example,

- **SHE and Emergency response plans** (think for example in terms of relevant information for risk inventory, the fire services and the authorities)
- **Training and working instructions** for users and other employees. Think in terms of rules for the use of (high-voltage) current, instructions for the exchange of batteries or charging of machinery, site layout with the appropriate safety parameters, toolboxes, workplace inspections or RACI (roles and responsibilities) matrices.

Charging connector conventions

Requirement	Expectation	Notes
20-300 kW capacity	CCS2/type 2	The scope of ENI is limited to building site machinery > 125 kW. It therefore makes no comment on smaller capacity.
> 300 kW capacity	MCS	EU standard is currently being developed.

A building site is a location where many parties converge. Consortiums, suppliers, subcontractors – must all work together in a limited space. The use of someone else's building site infrastructure is a day-to-day occurrence. Rendering charging infrastructure uniform in terms of connectors, charging protocols and batteries is therefore essential in order to

continue to guarantee safety in the longer term. **ENI therefore stands for standardisation and exchangeability in this field.**

Sustainability

Battery packages have a number of life cycles: Add text on 1st life, 2nd life, end of life

There are also various aspects of sustainability regarding machinery and in particular the battery packages. These include aspects in the supply chain of materials, such as the use of minerals from conflict regions, and the production methods applied. A battery factory in Asia will be subject to different environmental requirements than European factories, for example. We have limited ourselves to a number of aspects below, in which we expect ENI members to be able to exercise direct influence.

Requirement	Expectation	Notes
Uniform performance indices and accessible monitoring (according to OCPP 2.01)	Comparable data which is easily accessible via API, for example.	Clear Gross/net differences and a uniform calculating method between suppliers, with recognisable indices for performance, e.g.: battery capacity, charging speeds and power.
Recycling programme for batteries (and machines)	in accordance with IL&T rules (EU legislation)	Contractor must have indemnification for end-of-life processing of batteries. This remains the responsibility of the manufacturer/seller. See also: IL&T website The buyer of a battery is responsible for the safe transport of that battery, after its use phase, to an official recycling party. Please note: extra rules apply to the export of electric vehicles to countries outside the EU.
Environmental product declarations (EPD) for the entire machine/installation	Following on from the EPD of the manufacturer	EPD of OEM supplier must be adjusted by converter
ECI factor of the machines	According to ECI method	The Environmental Cost Indicator (ECI) is becoming increasingly common in infra construction tenders Emission-free machinery can be advantageous in this calculation as long as accurate data is available in the National Environmental database. Manufacturers must have this calculated via LCA (Life Cycle analysis).
Exchangeability of batteries between various manufacturers' machines	Standardisation of battery and charging infrastructure is high on the wish list of contractors.	We are aware that this will require greater efforts in order to arrive at a standard. ENI is therefore calling on the industry to accelerate the energy transition by developing and applying standardised batteries.

Tip when contracting conversion work: Discuss the repair/maintenance conditions and the warranty schemes beforehand, in order to provide clarity on losses caused by repair and/or maintenance.

This list of minimum standards was formed by a round table of ENI participants who represent both converters and users: UMS, New Electric, CapGemini Engineering, ELEO, Heijmans and GMB, with HAN as external knowledge partner.

** Sample list of directives and norms for the conversion of a tracked excavator.

This example has been added to give an impression of the number of directives applicable to the conversion of machines. This list can vary per type of machine. Source UMS

Overview of applicable standards Hyundai HX260AL

Directive or Standard?	Name of directive or standard	Description (English)	Omschrijving (Nederlands)	Applicable	On EC-DoC?
	Europese Product Directives				
Directive	2006/42/EG	**Machinery Directive (MD)** Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast).	**Machinerichtlijn:** Richtlijn 2006/42/EG van het Europees Parlement en de Raad van 17 mei 2006 betreffende machines en tot wijziging van Richtlijn 95/16/EG (herschikking).	Yes	Yes
Directive	2014/30/EU	**(EMC) Directive** Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility (recast).	**EMC-richtlijn:** RICHTLIJN 2014/30/EU VAN HET EUROPEES PARLEMENT EN DE RAAD van 26 februari 2014 betreffende de harmonisatie van de wetgevingen van de lidstaten inzake elektromagnetische compatibiliteit (herschikking).	Yes	Yes
Directive	2014/35/EU	**Low Voltage Directive (LVD)** Directive 2014/35/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits.	**Laagspanningsrichtlijn:** RICHTLIJN 2014/35/EU VAN HET EUROPEES PARLEMENT EN DE RAAD van 26 februari 2014 betreffende de harmonisatie van de wetgevingen van de lidstaten inzake het op de markt aanbieden van elektrisch materiaal bestemd voor gebruik binnen bepaalde spanningsgrenzen.	Yes	No
	Type A standard				
	Risk Assessment				
EN standard	EN-ISO 12100:2010	Safety of machinery - General principles for design - Risk assessment and risk reduction.	Basisbegrippen, algemene ontwerpbeginselen - Deel 1: Basisterminologie, methodologie.	Yes	Yes
EN standard	ISO/TR 14121-2:2012	Safety of machinery - Risk assessment - Part 2: Practical guidance	Risicobeoordeling - Deel 2: Praktische gids en voorbeelden van methoden.		No
	Type B standards				
EN standard	EN-ISO 11161:2007	Safety of machinery - Integrated manufacturing systems - Basic requirements.	Veiligheid van machines - Geïntegreerde productiesystemen - Algemene eisen.	Yes	Yes
	Safety distances				
EN standard	EN-ISO 13854:2019	Safety of machinery - Minimum gaps to avoid crushing of parts of the human body.	Veiligheid van machines - Minimumafstanden ter voorkoming van het beknelden van menselijke lichaamsdelen.	Yes	Yes
EN standard	EN-ISO 13857:2019	Safety of machinery - Safety distances to prevent hazard zones being reached by upper and lower limbs.	Veiligheidsafstanden ter voorkoming van het bereiken van gevaarlijke zones met de bovenste en onderste ledematen.	Yes	Yes
	Mechanical guards				
EN standard	EN-ISO 14120:2015	Safety of machinery - Guards - General requirements for the design and construction of fixed and movable guards.	Afschermingen - Algemene eisen voor het ontwerpen de constructie van vaste en beweegbare afschermingen.	Yes	Yes
	Interlocking devices				
EN standard	EN-ISO 14119:2013	Safety of machinery - Interlocking devices associated with guards - Principles for design and selection.	Veiligheid van machines - Blokkeerinrichtingen gekoppeld aan afschermingen - Grondbeginselen voor het ontwerpen de keuze.	Yes	Yes
				Yes	
	Electrical equipment				
EN standard	EN 60204-1:2018	Safety of machinery - Electrical equipment of machines - Part 1: General requirements.	Elektrische uitrusting van machines - Deel 1: Algemene eisen.	Yes	Yes
EN standard	EN-ISO 14118:2018	Safety of machinery - Prevention of unexpected start-up.	Veiligheid van machines - Voorkoming van onbedoeld starten.	Yes	Yes
	Hydraulic power				
EN standard	EN-ISO 4413:2010	Hydraulic fluid power - General rules and safety requirements for	Hydrauliek - Algemene regels en veiligheidseisen voor systemen en hun componenten.	Yes	Yes
	Electronic Control Systems				
EN standard	EN-ISO 13849-2:2012	Safety of machinery - Safety-related parts of control systems - Part 2: Validation	Veiligheid van machines - Onderdelen van besturingssystemen met een veiligheidsfunctie - Deel 2: Validatie.	Yes	No
EN standard	EN 62061:2021	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems	Functionele veiligheid van veiligheidsgerelateerde elektrische, elektronische en programmeerbare elektronische besturingssystemen.	Yes	Yes
EN standard	IEC 61784-3-series	Industrial communication networks - Functional safety fieldbuses	Industriële communicatienetwerken - Functionele veiligheidsveldbussen	Yes	No
	Emergency stop				
EN standard	EN-ISO 13850:2015	Safety of machinery - Emergency stop function - Principles for design.	Noodstopvoorzieningen, functionele aspecten. Ontwerpbeginselen.	Yes	Yes
	User instructions				
EN standard	EN IEC/IEEE 82079-1:2020	Preparation of information for use (instructions for use) of products - Part 1: Principles and general requirements (IEC/IEEE 82079-1:2019).	Voorbereiding van gebruiksaanwijzingen - Structuur, inhoud en presentatie - Deel 1: Algemene uitgangspunten en gedetailleerde eisen.	Yes	No
EN standard	EN-ISO 20607:2019	Safety of machinery - Instruction handbook - General drafting principles.	Machineveiligheid - Instructiehandboek - Algemene regels voor het opstellen.	Yes	No
	Type C standards				
EN standard	EN 474-5:2006+A3:2013	Earth-moving machinery - Safety - Part 5: Requirements for hydraulic excavators.	Grondverzetmachines - Veiligheid - Deel 5: Eisen voor hydraulische graafmachines.	Yes	Yes
EN standard	EN 818-1:1996+A1:2008	Short link chain for lifting purposes - Safety - Part 1: General conditions of acceptance.	Kortschalmige kettingen voor hijsdoeleinden - Veiligheid - Deel 1: Algemene acceptatievoorwaarden.	Yes	No
	RoHS-requirements				
EN standard	EN 50581:2012	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances	Technische documentatie voor de beoordeling van elektrische en elektronische producten met betrekking op de restrictie van gevaarlijke stoffen	Yes	No
	EMC-requirements				
EN standard	EN 61000-6-1:2019	Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity standard for residential, commercial and light-	Elektromagnetische compatibiliteit (EMC) - Deel 6-1: Generieke EN normen - Immuniteit voor huishoudelijke, handels- en lichtindustriële omgevingen.	Yes	No
EN standard	EN 61000-6-3:2007	Electromagnetic compatibility (EMC) - Part 6-3: Generic Standards - Emission standard for residential, commercial and light-	Elektromagnetische compatibiliteit (EMC) - Deel 6-3: Algemene EN normen - Emissie EN normen voor huishoudelijke, handels- en lichtindustriële omgevingen	Yes	No
	Other standards				
ISO Standard	ISO 6469-1:2019	Electrically propelled road vehicles — Safety specifications — Part	Elektrisch aangedreven wegvoertuigen - Veiligheidsspecificaties - Deel 1: Oplaadbare energieopslagsystemen (RESS).	Yes	Yes
ISO Standard	ISO 6469-2:2018	Electrically propelled road vehicles — Safety specifications — Part	Elektrisch aangedreven wegvoertuigen - Veiligheidsspecificaties - Deel 2: Functionele veiligheidsvoorzieningen en bescherming tegen storingen.	Yes	Yes
ISO Standard	ISO 6469-3:2018+A1:2020	Electrically propelled road vehicles — Safety specifications — Part	Elektrisch aangedreven wegvoertuigen - Veiligheidsspecificaties - Deel 3: Elektrische veiligheid.	Yes	Yes
ISO Standard	ISO 6469-4:2015	Electrically propelled road vehicles — Safety specifications — Part	Elektrisch aangedreven wegvoertuigen - Veiligheidsspecificaties - Deel 4: Elektrische veiligheid na een botsing.	Yes	No
IEC standard	IEC 62752:2016	In-Cable Control and Protection Device for mode 2 charging of electric road vehicles (IC-CPD).	In-Cable Control and Protection Device voor mode-2-laden van elektrische wegvoertuigen (IC-CPD).	Yes	No
EN Standard	EN-ISO 17409:2020	Electrically propelled road vehicles — Conductive power transfer	Elektrisch aangedreven wegvoertuigen - Vermogensoverdracht via geleidende verbinding - Veiligheidseisen.	Yes	No
IEC standard	IEC 61851-1:2017	Electric vehicle conductive charging system - Part 1: General requirements.	Geleidend laadsysteem voor elektrische voertuigen - Deel 1: Algemene vereisten.	Yes	No
IEC standard	IEC 61851-23	Electric vehicle conductive charging system - Part 23: DC electric vehicle charging station.	Geleidend laadsysteem voor elektrische voertuigen - Deel 23: DC-laadstation voor elektrische voertuigen.	Yes	No
ISO Standard	ISO 15118-serie	Road Vehicles - Vehicle to Grid Communication Interface.	Wegvoertuigen - communicatie-interface tussen voertuig en netwerk.	Yes	No