HAZID-arbeidsark

Kommentarer til arbeidsarkene

Arbeidsarkene presenterer tabeller for henholdsvis hydrogensystemet (Tabell B.1) og batterisystemet (Tabell B.3). Lister over risikoreduserende tiltak for begge systemene er gitt i separate tabeller: Tabell B.2 for hydrogensystemet og Tabell B.4 for batterisystemet. Tabell B.5 angir kategorier for sannsynlighet og konsekvens som er brukt i risikorangeringen.

Følgende merkekonvensjoner er anvendt i HAZID-arbeidsarkene og er spesifikke for det enkelte arbeidsark:

- Uønskede hendelser er angitt med forkortelsen «HE» (hazardous event), etterfulgt av et nummer, for eksempel HE1. I HAZID-arbeidsarket for hydrogensystemet viser HE1 til «Leakage from the tank due to small/medium hole in the tank shell during normal operation or under delivery». I HAZID-arbeidsarket for batterisystemet viser HE1 til «Occurrence of a thermal runaway reaction as a result of errors or damage in the energy carrier caused during manufacture or assembly».
- Årsaker angis med prefikset «CA», etterfulgt av et nummer, for eksempel CA1. I HAZID-arbeidsarket for hydrogensystemet viser CA1 til Fatigue. I HAZID-arbeidsarket for batterisystemet er årsakene ikke gitt egne betegnelser, ettersom hver farlig hendelse kun har én tilhørende årsak. Årsakene er derfor beskrevet direkte i arbeidsarket.
- Konsekvenser angis med prefikset «C», etterfulgt av et nummer, for eksempel C1. I HAZID-arbeidsarket for hydrogensystemet viser C1 til «Jet fire». I HAZID-arbeidsarket for batterisystemet viser C1 til «High temperature of the energy carrier».
- Risikoreduserende tiltak omfatter både forebyggende og konsekvensreduserende barrierer. Forebyggende barrierer angis med prefikset «P», etterfulgt av et nummer, for eksempel P1. I HAZID-arbeidsarket for hydrogensystemet viser P1 til «Maintenance and inspection». Konsekvensreduserende barrierer angis med prefikset «M», etterfulgt av et nummer, for eksempel M1. I HAZID-arbeidsarket for hydrogensystemet viser M1 til «Explosion protection document required for site (ATEX) and define safety distance to the zones».
- I HAZID-arbeidsarket for batterisystemet følger barrierene nummereringen som er brukt i listen over risikoreduserende tiltak for batterisystemet i Tabell B.4.
- Kolonneoverskriftene i tabellene er oversatt til norsk, mens de opprinnelige engelske beskrivelsene fra HAZID-arbeidsarkene er beholdt. Dette er gjort for å ivareta både sporbarhet og samsvar med den opprinnelige dokumentasjonen, ettersom HAZID-workshopen ble gjennomført på engelsk.

Tabell B.1 HAZID-arbeidsark for hydrogensystemet

Nr.	System/ aktivitet	Fare	Uønsket hendelse/ Hazardous event (HE)	Årsak	Konsekvens	Sannsynlig-het	Alvorlighets-grad	Risiko	Risikoreduserende tiltak
1	Hydrogen container in normal operation on site or in delivery to the site	Tank containinng pressurized hydrogen gas	HE 1 Leakage from the tank due to small/medium hole (less than 5mm in D) in the tank shell during normal operation or under delivery	CA1 Fatigue CA2 Design error CA3 Material failure Hydrogen embrittlement) CA4 Overpressurisation CA5 Human error CA6 External Impact (Vibration, Collision, Dropped object like stones from the construction site) CA7 Malicious act CA8 Adverse weather and natural disasters	**C1 Jet fire** If immediate ignition (within a few seconds/tenths of seconds after materialization of spontaneous leak in shell). **C2 Explosion** If delayed ignition, space between tanks filled with explosive atmosphere followed by delayed ignition.	Improbable	Critical		P1 Maintenance and inspection P2 The vessel can tolerate the temperature from -40C to +65C P3 Training program and procedures to prevent leakage P13 Security measure (e.g. fencing, serveilance camera, cyber-security, authorized person only) M1 Explosion protection document required for site (ATEX) and define safety distance to the zones M2 Only use EX-certified equipment, minimal use of electricity near hydrogen (ATEX) M3 Natural ventilation of container M4 Prevent presence of small particles (e.g. gravel) that could cause mechanical sparks M5 Ventilation openings for all the equipment M6 Overpressure protection upon fire M7 Fire integrity of system components: a) Tank can sustain heat exposure for a long time b) Safe escape and evacuation from the area c) Operators have radios and will be contacted. d) Evacuation routes and marked zones will be established M8 Explosion and fire walls M9 TPRDs (temperature safety valve) venting H2 to safe location (upwards) M10 Training program and procedures to mitigate the leak M11 Lightning rod M12 Security measure M20 The ground should anyway be concrete as gravel can cause sparks if a jet stream occurs
2	Hydrogen container in normal operation on site	Tank containinng pressurized hydrogen gas	HE 2 Rupture of hydrogen container	CA1 Fatigue CA2 Design error CA3 Material failure (Hydrogen embrittlement) CA4 Overpressurisation CA5 Human error CA6 External Impact (Collision, dropped object like stones from the construction site) CA7 Malicious act CA8 Adverse weather and natural disasters	**C1 Jet fire** If immediate ignition (within a few seconds/tenths of seconds after materialisation of spontanous leak in shell). **C2 Explosion** If delayed ignition, space between tanks filled with explosive atmosphere followded by delayed ignition.	Probable	Critical		P1 Maintenance and inspection P2 The vessel can tolerate the temperature from -40C to +65C P3 Training program and procedures to prevent leakage P13 Security measure (e.g. fencing, serveilance camera, cyber-security, authorized person only) M1 Explosion protection document required for site (ATEX) and define safety distance to the zones M2 Only use EX-certified equipment, minimal use of electricity near hydrogen (ATEX) M3 Natural ventilation of container M4 Prevent presence of small particles (e.g. gravel) that could cause mechanical sparks M5 Ventilation openings for all the equipment M6 Overpressure protection upon fire M7 Fire integrity of system components: a) Tank can sustain heat exposure for a long time b) Safe escape and evacuation from the area c) Operators have radios and will be contacted. d) Evacuation routes and marked zones will be established M8 Explosion and fire walls M9 TPRDs (temperature safety valve) venting H2 to safe location (upwards) M10 Training program and procedures to mitigate the leak M11 Lightning rod M12 Security measure M20 The ground should anyway be concrete as gravel can cause sparks if a jet stream occurs

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3	Hydrogen container during the delivery or normal operation on the site	Tank containinng hydrogen gas	HE 3 Leakage due to small hole in tank connection/tank connection valve or tubing/equipment at tank side of isolation valves (V01, V02 and V03) *Addtional info from Westgass: Leaks in valves expected to be dominant source of leaks. Typical failure modes are failure of stem seal and valve in erronous position (based on offshore data)	CA1 Fatigue CA2 Design error CA3 Material failure (Hydrogen embrittlement) CA4 Overpressurisation CA5 Human error (Maloperation) CA6 External Impact (Vibration, collision, dropped object like stones from the construction site) CA7 Malicious act CA8 Adverse weather and natural disasters	C1 Jet fire If immediate ignition (within a few seconds/tenths of seconds after materialisation of spontanous leak in shell). C2 Explosion If delayed ignition, space between tanks filled with explosive atmosphere followded by delayed ignition. If major explosion followed by large leak (Probably caused by CA6External Impact), more powerful explosion.	Improbable	Critical		P1 Maintenance and inspection P2 The vessel can tolerate the temperature from -40C to +65C P3 Training program and procedures to prevent leakage P13 Security measure (e.g. fencing, serveilance camera, cyber-security, authorized person only) M1 Explosion protection document required for site (ATEX) and define safety distance to the zones M2 Only use EX-certified equipment, minimal use of electricity near hydrogen (ATEX) M3 Natural ventilation of container M4 Prevent presence of small particles (e.g. gravel) that could cause mechanical sparks M5 Ventilation openings for all the equipment M6 Overpressure protection upon fire M7 Fire integrity of system components: a) Tank can sustain heat exposure for a long time b) Safe escape and evacuation from the area c) Operators have radios and will be contacted. d) Evacuation routes and marked zones will be established M8 Explosion and fire walls M9 TPRDs (temperature safety valve) venting H2 to safe location (upwards) M10 Training program and procedures to mitigate the leak M11 Lightning rod M12 Security measure M20 The ground should anyway be concrete as gravel can cause sparks if a jet stream occurs
4	Hydrogen container during normal operation	Tank containing hydrogen gas	HE 4 Leakage due to small/medium hole in tubing/equipment at manifold side of isolation valves (V01, V02 and V03) *Addtional info from Westgass: Leaks in valves expected to be dominant source of leaks. Typical failure modes are failure of stem seal and valve in erronous position (based on offshore data)	CA1 Fatigue CA2 Design error CA3 Material failure (Hydrogen embrittlement) CA4 Overpressurisation CA5 Human error (Maloperation) CA6 External Impact (Vibration, collision, dropped object like stones from the construction site) CA7 Malicious act CA8 Adverse weather and natural disasters	C1 Jet fire If immediate ignition (within a few seconds/tenths of seconds after materialisation of spontanous leak in shell). C2 Explosion If delayed ignition, space between tanks filled with explosive atmosphere followded by delayed ignition. If major explosion followed by large leak CA6 External Impact, more powerful explosion	Improbable	Major		P1 Maintenance and inspection P2 The vessel can tolerate the temperature from -40C to +65C P3 Training program and procedures to prevent leakage P4 Excess flow valve P13 Security measure (e.g. fencing, serveilance camera, cyber-security, authorized person only) M1 Explosion protection document required for site (ATEX) and define safety distance to the zones M2 Only use EX-certified equipment, minimal use of electricity near hydrogen (ATEX) M3 Natural ventilation of container M4 Prevent presence of small particles (e.g. gravel) that could cause mechanical sparks M5 Ventilation openings for all the equipment M6 Overpressure protection upon fire M7 Fire integrity of system components: a) Tank can sustain heat exposure for a long time b) Safe escape and evacuation from the area c) Operators have radios and will be contacted. d) Evacuation routes and marked zones will be established M8 Explosion and fire walls M9 TPRDs (temperature safety valve) venting H2 to safe location (upwards) M10 Training program and procedures to mitigate the leak M11 Lightning rod M12 Security measure M20 The ground should anyway be concrete as gravel can cause sparks if a jet stream occurs

Nr.	System/ aktivitet	Fare	Uønsket hendelse/ Hazardous event (HE)	Årsak	Konsekvens	Sannsynlig-het	Alvorlighets-grad	Risiko	Risikoreduserende tiltak
5	Hydrogen container in transportation	Tank containing hydrogen gas	HE 5 Build up static electricy in Hydrogen container during transportation	CA9Potential for static electricity which can cause sparking	C1 Jet fire If immediate ignition (within a few seconds/tenths of seconds after materialisation of spontanous leak in shell). C2 Explosion If delayed ignition, space between tanks filled with explosive atmosphere followded by delayed ignition.	Probable	Marginal		M2 Only use EX-certified equipment, minimal use of electricity near hydrogen (ATEX) M13 All components and the container are seperately grounded. M14 Operators use ATEX approved clothing M20 The ground should anyway be concrete as gravel can cause sparks if a jet stream occurs
6	Hydisp	Hydrogen under high pressure (up to 350 bar) is handled in Hydisp	HE 6 Leak due to small/medium hole in system (e.g. hoses, X-01, piping) during the Hydrogen transfer	CA1Fatigue CA2Design error CA3Material failure (Hydrogen embrittlement) CA4Overpressurisation CA5Human error (Maloperation) CA6External Impact (Collision, dropped object) CA8Adverse weather and natural disasters Failure of downstream PCV valve Dbris, water into the instrument air system during doing disconnection and connection of multi-hose (This can result that actuated valve fail to close on demand and the valve will remain open when closing signal is sent.)	C1 Jet fire If immediate ignition (within a few seconds/tenths of seconds after materialisation of spontanous leak in shell). C2 Explosion C3 Release of hazardous gases	Remote	Marginal		**Preventive barriers** P1 Maintenance and inspection P3 Training program and procedures to prevent leakage P4 Excess flow valve will close on high flow (e.g., large leakage in hose) P5 Hydrogen detection inside the X-01 cabinet. P6Pressure sensor (PIT 13) after pressure reduction in Hydisp will discover anomalies in low pressure part of hydisp P7 Back-pressure regulator valve installed downstream PCV valve, venting to safe location P8 Flush/Purge with nitrogen prevents moisture from entering the pneumatics P9Pressure monitoring (fail-safe) downsteam PCV P10 Limitations in operating the units in areas where cold weather is expected. P13 Security measure (e.g. fencing, serveilance camera, cyber-security, authorized person only) **Mitigating barriers** M1 Explosion protection document required for site (ATEX) and define safety distance to the zones M2 Only use EX-certified equipment, minimal use of electricity near hydrogen (ATEX) M4 Prevent presence of small particles (e.g. gravel) that could cause mechanical sparks M6 Overpressure protection upon fire M7 Fire integrity of system components: a) Tank can sustain heat exposure for a long time b) Safe escape and evacuation from the area c) Operators have radios and will be contacted. d) Evacuation routes and marked zones will be established M8 Explosion and fire walls M10 Training program and procedures to mitigate the leak M12 Security measure M17 Gas detection M18 Container is placed on chassis M20 The ground should anyway be concrete as gravel can cause sparks if a jet stream occurs

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7	Hydisp	Hydrogen under high pressure (up to 350 bar) is handled in external unit (Hydisp)	HE 7 Rupture of equipment in Hydisp due to CA6External Impact	CA6 External Impact (Mechanical impact on skids, due to external personnel vehicles operating in the area) Adverse weather and natural disaster	C1 Jet fire If immediate ignition (within a few seconds/tenths of seconds after materialisation of spontanous leak in shell). C2 Explosion	Remote	Major		P1 Maintenance and inspection P3 Training program and procedures to prevent leakage P4 Excess flow valve will close on high flow (e.g., large leakage in hose) P5 Hydrogen detection inside the X-01 cabinet. P6Pressure sensor (PIT 13) after pressure reduction in Hydisp will discover anomalies in low pressure part of hydisp P7 Back-pressure regulator valve installed downstream PCV valve, venting to safe location P8 Flush/Purge with nitrogen prevents moisture from entering the pneumatics P9Pressure monitoring (fail-safe) downsteam PCV P10 Limitations in operating the units in areas where cold weather is expected. P13 Security measure (e.g. fencing, serveilance camera, cyber-security, authorized person only) M1 Explosion protection document required for site (ATEX) and define safety distance to the zones M2 Only use EX-certified equipment, minimal use of electricity near hydrogen (ATEX) M4 Prevent presence of small particles (e.g. gravel) that could cause mechanical sparks M6 Overpressure protection upon fire M7 Fire integrity of system components: a) Tank can sustain heat exposure for a long time b) Safe escape and evacuation from the area c) Operators have radios and will be contacted. d) Evacuation routes and marked zones will be established M8 Explosion and fire walls M10 Training program and procedures to mitigate the leak M12 Security measure M17 Gas detection M18 Container is placed on chassis M20 The ground should anyway be concrete as gravel can cause sparks if a jet stream occurs
8	Hydisp	Hydrogen under high pressure (up to 350 bar) is handled in Hydisp	HE 8 Vented Hydrogen	Excessive hydrogen vented from fuel cell and Hydisp	C3 Release of hazardous gases	Improbable	Marginal		**Preventive barriers** P16 Ensure the vents are pointing in safe direction.
9	Hydisp	Mixing air and hydrogen	HE 9 Air into hydrogen hose and fuel gas generator set which may damage equipment and cause an explosive atmosphere.	Not purging the system sufficiently prior to start up	C4 Explosion in hose or piping in fuel cell	Improbable	Marginal		P12 Purge with nitrogen before start-up M13 All components and the container are seperately grounded. M19 Tubing and hoses will resist internal explosion

Nr.	System/ aktivitet	Fare	Uønsket hendelse/ Hazardous event (HE)	Årsak	Konsekvens	Sannsynlig-het	Alvorlighets-grad	Risiko	Risikoreduserende tiltak
10	Hydrogen container	Hydrogen under high pressure (up to 350 bar) is handled in external unit (Hydisp)	HE 10 Build up static electricy in Hydrogen container during transportation	CA10 Improper earthing of skid causing spark	C1 Jet fire	Improbable	Major		M13 All components and the container are seperately grounded.
11	Hydrogen container in delivery	Truck carrying Hydrogen truck	HE 11 Small leak from physical impact to the container/Hydisp due to backing too far	CA5 Human error (e.g. Backing too far)	C1 Jet fire If immediate ignition (within a few seconds/tenths of seconds after materialisation of spontanous leak in shell). C2 Explosion	Occasional	Critical		P11 Prevention of shocks using a passive physical barrier like bumper or supervisor to watch the truck when backing P13 Security measure (e.g. fencing, serveilance camera, cyber-security, authorized person only) M1 Explosion protection document required for site (ATEX) and define safety distance to the zones M2 Only use EX-certified equipment, minimal use of electricity near hydrogen (ATEX) M3 Natural ventilation of container M4 Prevent presence of small particles (e.g. gravel) that could cause mechanical sparks M5 Ventilation openings for all the equipment M6 Overpressure protection upon fire M7 Fire integrity of system components M8 Explosion and fire walls M9 TPRDs (temperature safety valve) venting H2 to safe location (upwards) M10 Training program and procedures to mitigate the leak M11 Lightning rod M12 Security measure M20 The ground should anyway be concrete as gravel can cause sparks if a jet stream occurs
12	Hydrogen container in delivery	Truck carrying Hydrogen truck	HE 12 Hydrogen leakage from due to the collision with other objects on the site	CA5 Human error	C1 Jet fire If immediate ignition (within a few seconds/tenths of seconds after materialisation of spontanous leak in shell). C2 Explosion	Occasional	critical		P11 Prevention of shocks using a passive physical barrier like bumper or supervisor to watch the truck when backing P13 Security measure (e.g. fencing, serveilance camera, cyber-security, authorized person only) P14 Clearing of the site before the truck entry and safe driving route Mitigating barriers M1 Explosion protection document required for site (ATEX) and define safety distance to the zones M2 Only use EX-certified equipment, minimal use of electricity near hydrogen (ATEX) M3 Natural ventilation of container M4 Prevent presence of small particles (e.g. gravel) that could cause mechanical sparks M5 Ventilation openings for all the equipment M6 Overpressure protection upon fire M7 Fire integrity of system components M8 Explosion and fire walls M9 TPRDs (temperature safety valve) venting H2 to safe location (upwards) M10 Training program and procedures to mitigate the leak M11 Lightning rod M12 Security measure M20 The ground should anyway be concrete as gravel can cause sparks if a jet stream occurs

Nr.	System/ aktivitet	Fare	Uønsket hendelse/ Hazardous event (HE)	Årsak	Konsekvens	Sannsynlig-het	Alvorlighets-grad	Risiko	Risikoreduserende tiltak
13	Hydrogen container in delivery	Truck carrying Hydrogen truck	HE 13 Hydrogen leakage due to the truck driving off without proper isolatoin	CA5 Human error	C1 Jet fire If immediate ignition (within a few seconds/tenths of seconds after materialisation of spontanous leak in shell). C2 Explosion	Occasional	Major		P11 Prevention of shocks using a passive physical barrier like bumper or supervisor to watch the truck when backing P13 Security measure (e.g. fencing, serveilance camera, cyber-security, authorized person only) P14 Clearing of the site before the truck entry and safe driving route P15 Anti towing device M1 Explosion protection document required for site (ATEX) and define safety distance to the zones M2 Only use EX-certified equipment, minimal use of electricity near hydrogen (ATEX) M3 Natural ventilation of container M4 Prevent presence of small particles (e.g. gravel) that could cause mechanical sparks M5 Ventilation openings for all the equipment M6 Overpressure protection upon fire M7 Fire integrity of system components: a) Tank can sustain heat exposure for a long time b) Safe escape and evacuation from the area c) Operators have radios and will be contacted. d) Evacuation routes and marked zones will be established M8 Explosion and fire walls M9 TPRDs (temperature safety valve) venting H2 to safe location (upwards) M10 Training program and procedures to mitigate the leak M11 Lightning rod M12 Security measure M20 The ground should anyway be concrete as gravel can cause sparks if a jet stream occurs

Tablle B.2 Risikoreduserende tiltak for hydrogensystemet

Utstyr	Barrierer	Allerede implementert	Skal implementeres	Kommentarer
Kluge site	P1 Maintenance and inspection	x		
Kluge site	P2 Operator response in an unwanted situation (Detection of leak, initiation of shutdown).	x		
Hydrogen container	P3 The vessel can tolerate the temperature from -40C to +65C, the design limitations is – 40C to +65C	x		
Hydisp	P4 Excess flow valve will close on high flow (e.g. large leakage in hose)	x		The excess flow valve is on the container and will stop flow out of it in case of sudden large leakage etc. downstream this valve. The excess flow valve is right before the outlet of the container. However, it will not be relevant for a leakage that happens before this.
Hydisp	P5 Hydrogen detection inside the X-01 cabinet.	x		
Hydisp	P6 Pressure sensor (PIT 13) after pressure reduction in Hydisp will discover anomalies in low pressure part of hydisp	x		
Hydisp	P7 Back pressure regulator valve installed downstream PCV valve, venting to safe location	x		
Hydisp	P8 Flush/Purge with nitrogen prevents moisture from entering the pneumatics	x		
Hydisp	P9 Pressure monitoring (fail-safe) downsteam PCV	x		
Hydisp	P10 Limitations in operating the units in areas where cold weather is expected.		x	It is recommended that the criteria for this should be defined
Kluge site	P11 Prevention of shocks using a passive physical barrier like bumper or supervisor to watch the truck when backing	x		
Hydisp	P12 Purging with nitrogen before the start-up	X		Air must be purged away in the piping to avoid that it comes air in the fuel cell. This can be done a) first with nitrogen and then with hydrogen, or b) directly with hydrogen (simplicity vs. safety). It is not decided which of a) or b) shall be used.
Hydisp	P13 Security measure (e.g. fencing, serveilance camera, cyber-security)	x		
Kluge site	P14 Clearing of the site before the truck entry and safe driving route		x	
Truck	P15 Anti-towing device		x	
Hydisp	P16Ensure the vents are pointing in safe direction.	x		The HyDisp also have a "vent stack" vent out hydrogen during purging procedure. This vent stack must point in a safe direction.
General	M1 Explosion protection document required for site (ATEX) and define safety distance to the zones	x		
Container	M2 Only use EX-certified equipment, minimal use of electricity near hydrogen (ATEX)	x		
Container	M3 Natural ventilation of container	x		So far the distance of 20 metres is used based on a safety analysis where 20 meters to permanent work places (people in general) is recommended. The distance can be lower when we have the walls surrounding the container is in place.
Container	M4 Prevent presence of small particles (e.g. gravel) that could cause mechanical sparks	x		
All equipment	M5 Ventilation openings	x		The hydrogen equipment is designed as open as possible to mitigate the consequences of leakages.
All equipment	M6 Overpressure protection upon fire	x		
All equipment	M7 Fire integrity of system components: a) Tank can sustain heat exposure for a long time b) Safe escape and evacuation from the area c) Operators have radios and will be contacted. d) Evacuation routes and marked zones will be established	x		
Container	M8 Explosion and fire walls	x		
Container	M9 TPRDs (temperature safety valve) venting H2 to safe location (upwards)	x		
Kluge site	M10 Training program for operators and other procedures to mitigate (reduce) operational risk.	x		There is a (manual) shutoff button on the container, and WEST Gass will also implement shotoff button outside the area, so that an incident can be stopped by an human operator. However it should be noted that Hydrogen leak detection is known to be challenging, and the migitation measures may be limited. WEST gass is aware of that both detection and fast enough reaction can be hard. WEST gass will identify possible dangerous situations in case of leak and provide solutions to respond some of these.
Container	M11 Lightning rod		x	
Kluge site	M12 Security measure	x		
Container	M13 All components have separate grounding	x		
Kluge site	M14 Operators use ATEX approved clothing	x		
Hydisp	M15 Solenoid valves will close in case of loss of power (Fail safe)	x		
Hydisp	M16 Larger leaks in other banks can be detected by changes in pressure.	x		

Utstyr	Barrierer	Allerede implementert	Skal implementeres	Kommentarer
Hydisp	M17 Gas detection	x		
Hydrogen container	M18 Container is placed on chassis	x		
Hydisp	M19 Tubing and hoses will resist internal explosion	x		
Kluge site	M20 The ground should anyway be concrete as gravel can cause sparks if a jet stream occurs		x	

Tabell B.3. HAZID-arbeidsark for batterisystemet

Nr.	System/ aktivitet	Fare	Uønsket hendelse/ Hazardous event (HE)	Årsak	Konsekvens	Sannsynlig-het	Alvorlighets-grad	Risiko	Risikoreduserende tiltak
1	Energy carrier	Electro-chemical hazard of energy carrier	HE1 Occurrence of a thermal runaway reaction as a result of errors or damage in the energy carrier caused during manufacture or assembly.	Manufacturing or assembly error energy carriers	C1 High temperature of the energy carrier C2 Fire in the energy carrier C3 Explosion in the energy carrier C4 Pressure build-up in the energy carrier C5 Release of hazardous vapours/gases	Improbable	Marginal		1. EOS and energy carrier standard 2. Entry control upon receipt of energy carriers to EOS 3. Traceability 4. Installation of energy carrier in accordance with the manufacturer's requirements 17. Commissioning inspection of EOS 31. General documentation requirement – Registration for EOS system 32. General Documentation Requirements – Retention Period 33. Competance of personnel NEN 3140
2	Energy carrier	Electro-chemical hazard of energy carrier	HE2 Occurrence of a thermal runaway reaction as a result of errors or damage caused by an external impact on the energy carrier because it comes out of suspension, e.g. due to settlement, design error.	Damage caused by an external impact on the energy carrier because it comes out of suspension, e.g. due to settlement, design error.	C1 High temperature of the energy carrier C2 Fire in the energy carrier C3 Explosion in the energy carrier C4 Pressure build-up in the energy carrier C5 Release of hazardous vapours/gases	Improbable	Marginal		1. EOS and energy carrier standard 4. Installation of energy carrier in accordance with the manufacturer's requirements 5. Procedure for dealing with possibly damaged energy carriers 29. Periodic control 30. Check mobile EOS after installation 31. General documentation requirement – Registration for EOS system 32. General Documentation Requirements – Retention Period 33. Competance of personnel NEN 3140
3	Energy carrier	Electro-chemical hazard of energy carrier	HE3 Occurrence of a thermal runaway reaction as a result of a short circuit in the energy carrier (for example due to rain, flooding).	Short circuit in the energy carrier (for example due to rain, flooding).	C1 High temperature of the energy carrier C2 Fire in the energy carrier C3 Explosion in the energy carrier C4 Pressure build-up in the energy carrier C5 Release of hazardous vapours/gases	Improbable	Marginal		6. IP rating 7. Placement EOS 8. Climate control for EOS 35. Lightning protection and security electrical installations
4	EOS	Environmenta l hazard	HE4 Creation of a thermal runaway reaction as a result of a lightning strike in the EOS.	Lightning strike in EOS	C1 High temperature of the energy carrier C2 Fire in the energy carrier C3 Explosion in the energy carrier C4 Pressure build-up in the energy carrier C5 Release of hazardous vapours/gases	Improbable	Marginal		35. Lightning protection and security electrical installations 36. Lightening protection system parts
5	EOS	Human error	HE5 Creation of a thermal runaway reaction as a result of over/under charge	Errors caused by the charging process (charging and discharging) continuing to charge the energy carrier at a state of charge of technical maximum capacity / 100% (the value at which the thermal runaway is started as determined by the producer); Errors or damage in the energy carrier are caused by the deep discharge.	C1 High temperature of the energy carrier C2 Fire in the energy carrier C3 Explosion in the energy carrier C4 Pressure build-up in the energy carrier C5 Release of hazardous vapours/gases	Improbable	Marginal		19. Monitor EOS 31. General documentation requirement – Registration for EOS system 32. General Documentation Requirements – Retention Period 33. Competance of personnel NEN 3140

Nr.	System/ aktivitet	Fare	Uønsket hendelse/ Hazardous event (HE)	Årsak	Konsekvens	Sannsynlig-het	Alvorlighets-grad	Risiko	Risikoreduserende tiltak
6	Energy carrier	Electro-chemical hazard of energy carrier	HE6 Occurrence of a thermal runaway reaction as a result of errors or damage caused by the aging of the energy carriers.	Aging of energy carrier	C1 High temperature of the energy carrier C2 Fire in the energy carrier C3 Explosion in the energy carrier C4 Pressure build-up in the energy carrier C5 Release of hazardous vapours/gases	Improbable	Marginal		19. Monitor EOS 20. Preventive shutdown based on alarms 32. General Documentation Requirements – Retention Period 33. Competance of personnel NEN 3140
7	EOS	Thermal radiation	HE7 Occurrence of a thermal runaway reaction as a result of errors or damage caused by an external impact on the energy carrier.	Mechanical Impact from outside	C1 High temperature of the energy carrier C2 Fire in the energy carrier C3 Explosion in the energy carrier C4 Pressure build-up in the energy carrier C5 Release of hazardous vapours/gases	Improbable	Marginal		12. Location selection and collision protection of EOS 13. Location selection and collision protection – mobile EOS 14. Location choice – company premises 15. Location choice – wind turbine
8	EOS	Thermal radiation	HE8 Creation of a thermal runaway reaction due to heating of the energy carrier(s) due to a fire within the EOS, but outside the energy carrier compartment. Potential consequences:	Internal radiation from fire outside the energy carrier compartment (e.g. Fire within the EOS)	C1 High temperature of the energy carrier C2 Fire in the energy carrier C3 Explosion in the energy carrier C4 Pressure build-up in the energy carrier C5 Release of hazardous vapours/gases C6 High temperature of the EOS	Improbable	Marginal		19. Monitor EOS 20. Preventive shutdown based on alarms 37. Safety distances
9	General	Thermal radiation	HE9 Creation of a thermal runaway reaction due to heating of the energy carrier(s) due to a fire outside the EOS.	External fire	C1 High temperature of the energy carrier C2Fire in the energy carrier C3 Explosion in the energy carrier C4 Pressure build-up in the energy carrier C5 Release of hazardous vapours/gases C6 High temperature of the EOS	Improbable	Marginal		19. Monitor EOS 20. Preventive shutdown based on alarms 21. Shutdown based on detection
10	EOS	Thermal radiation	HE10 Creation of a thermal runaway reaction due to a high or low temperature of the energy carrier(s).	High or low temperature in the EOS	C1 High temperature of the energy carrier C2 Fire in the energy carrier C3 Explosion in the energy carrier C4 Pressure build-up in the energy carrier C5 Release of hazardous vapours/gases	Improbable	Marginal		8. Climate control 19. Monitor EOS 20. Preventive shutdown based on alarms
11	Energy carrier and EOS	Thermal radiation	HE11 Occurrence of a thermal runaway reaction as a result of errors or	Wrong treatment / Human error	C1 High temperature of the energy carrier C2 Fire in the energy carrier	Improbable	Marginal		26. Check before replacement energy carrier 27. Current manual 30. Check mobile EOS after installation 31. General documentation requirement – Registration for EOS system

Nr.	System/ aktivitet	Fare	Uønsket hendelse/ Hazardous event (HE)	Årsak	Konsekvens	Sannsynlig-het	Alvorlighets-grad	Risiko	Risikoreduserende tiltak
			damage caused by incorrect human actions.		C3 Explosion in the energy carrier C4 Pressure build-up in the energy carrier C5 Release of hazardous vapours/gases				32. General Documentation Requirements – Retention Period 33. Competance of personnel NEN 3140
12	EOS	Malicious act	HE12 Occurrence of a thermal runaway reaction as a result of errors or damage due to vandalism.	Vandalism	C1 High temperature of the energy carrier C2 Fire in the energy carrier C3 Explosion in the energy carrier C4 Pressure build-up in the energy carrier C5 Release of hazardous vapours/gases	Improbable	Marginal		16. Camera system requirement 18. Protection against unauthorized person 19. Mointor EOS 44. Control access to the EOS
13	Energy carrier	Thermal radiation	HE13 Fire in the energy carrier	Start of fire in the energy carrier as a result of a thermal runaway	C7 Exposure to high temperatures and combustion products C8 Escalation to other energy carrier modules (S17) C9 Escalation to Environment (S19)	Improbable	Marginal		19. Monitor EOS 21. Shutdown based on detection 22. Emergency stop device 23. Switch off module 24. Remove energy carrier after thermal runaway or fire 34. Instruction personnel – risk awareness 38. Extinguishing water connection 39. Accessibility of the EOS 40. Emergency plan 41. Emergency plan – to test 42. Icons to EOS
14	One cell block in the battery module	Thermal radiation	HE14 Instantaneous failure due to a pressure build-up or explosion in the energy carrier/battery pack due to a thermal runaway.	Pressure build-up or explosion inside energy carrier (battery module)	C10 High pressure build-up in EOS C11 Integrity EOS failure C12 Fire and escalation to other energy carrier modules (S17) C13 Persons present in EOS or surroundings hit by flying objects	Improbable	Marginal		9. Integrity EOS 19. Monitor EOS 22. Emergency stop device 23. Switch off module 24. Remove energy carrier after thermal runaway or fire 34. Instruction personnel – risk awareness 39. Accessibility of the EOS 41. Emergency plan – to test 42. Icons to EOS
15	Other battery compartments	Thermal radiation	HE15 Explosion in EOS installation – ignition of released gases	Explosion in EOS installation – ignition of released gases	C10 High pressure build-up in EOS C11 Integrity EOS failure C 12 Fire and escalation to other energy carrier modules (S17) C13 Persons present in EOS or surroundings hit by flying objects	Improbable	Marginal		9. Integrity EOS 11. Emergency ventilation 19. Monitor EOS 22. Emergency stop device 23. Switch off module 24. Remove energy carrier after thermal runaway or fire 34. Instruction personnel – risk awareness 39. Accessibility of the EOS 40. Emergency plan 41. Emergency plan – to test 42. Icons to EOS Safety signs must be affixed to the outside of an EOS.
16	Other battery compartments	Thermal radiation	HE16 Heating of the energy carrier to high temperatures.	Heating of the energy carrier to high temperatures (above 120)	C8 Escalation to other energy carrier modules C14 Hot contact surface and burns when touched	Improbable	Marginal		19. Monitor EOS 21. Shutdown based on detection 22. Emergency stop device 23. Switch off module 24. Remove energy carrier after thermal runaway or fire 34. Instruction personnel – risk awareness 39. Accessibility of the EOS 40. Emergency plan 41. Emergency plan – to test 42. Icons to EOS Safety signs must be affixed to the outside of an EOS.

Nr.	System/ aktivitet	Fare	Uønsket hendelse/ Hazardous event (HE)	Årsak	Konsekvens	Sannsynlig-het	Alvorlighets-grad	Risiko	Risikoreduserende tiltak
17	One battery compartment	Thermal radiation	HE17 Escalation to energy carriers in the EOS due to fire in an energy carrier or battery module	Escalation of fire in an energy carrier or battery module.	C15 Flying projectiles C16 The release of vapour to the environment	Highly Improbable	Major		38. Extinguishing water connection 39. Accessibility of the EOS 40. Emergency plan 41. Emergency plan – to test 42. Icons to EOS 43. Explosion hatch
18	One battery compartment	Thermal radiation	HE18 Failure of the integrity of the EOS due to a pressure build-up due to release (hazardous vapours).	Pressure build-up within the EOS due to release (hazardous vapours).	C15 Flying projectiles C16 The release of vapour to the environment	Highly Improbable	Major		39. Accessibility of the EOS 40. Emergency plan 41. Emergency plan – to test 42. Icons to EOS 43. Explosion hatch
19	EOS	Thermal radiation	HE19 Escalation of the consequences of the occurrence of a thermal runaway to the vicinity of the EOS.	Escalation to the environment	C17 Fire escalation to other buildings or installations	Improbable	Marginal		39.Accessibility of the EOS 40. Emergency plan 41. Emergency plan – to test 42. Icons to EOS
20	EOS	Thermal radiation	HE20 Release of hazardous vapors such as hydrogen fluoride, lithium oxide and hydrochloric acid as a result of a thermal runaway reaction, fire or leakage	Release of hazardous fume	C18 Release of hazardous vapours C19 Exposure of persons to fumes	Improbable	Marginal	L	10. Ventilation system 11. Emergency ventilation 28. Ventilation system – check and maintenance 39. Accessibility of the EOS 40. Emergency plan 41. Emergency plan – to test 42. Icons to EOS

Tabell B.4 Risikoreduserende tiltak for batterisystemet

Utstyr	Barrierer	Allerede implementert	Skal implementeres	Beskrivelse
EOS	1. EOS and energy carrier standard	x		EOS and energy carrier standard The EOS, including the energy carriers, must at least meet the minimum safety requirements such as: Overcurrent protection; Short-circuit protection; Over-temperature protection; Overvoltage protection; Imbalance protection; Pressure relief energy carriers. EOSs that comply with IEC 62933-5-2 (EOS as a whole) and NEN-EN-IEC 62619 (energy carriers) meet these minimum safety requirements.
Energy carrier/ EOS	2. Entry control upon receipt of energy carriers	x		Entry control upon receipt of energy carriers Upon receipt of the energy carriers for the EOS, a visual check is made of the repackaging and packaging on the following points: Damage to the outer packaging (container); damage to the packaging; whether the product / packaging has been in contact with water.
Energy carrier	3. Traceability	x		Traceability The energy carrier that is built into the EOS must be identified in such a way (for example, provided with a serial number, production number or production date) that a recall action can be taken in the event of a defective energy carrier being recalled.
Energy carrier	4. Installation of energy carrier in accordance with the manufacturer's requirements	x		Installation of energy carrier in accordance with the manufacturer's requirements: Energy carriers must be provided with instructions and installation instructions from the manufacturer with regard to: Design EOS; Racks/racks for placing energy carriers Connections, electrically and in terms of control Mounting climatically The energy carriers must be mounted and connected in accordance with the instructions and mounting instructions. For mobile EOSs, the energy carriers must be securely mounted within the EOS (e.g. by placing in racks, cabinets, etc.) in such a way that short circuits, unintentional activation of the EOS and significant movement relative to the load unit during shocks and loads

Utstyr	Barrierer	Allerede implementert	Skal implementeres	Beskrivelse
				normally encountered during transport are prevented. To this end, the manufacturer must carry out a risk analysis (minimum standardization, calculations and simulations) to demonstrate the resistance of the EOS with regard to the vibration and shock conditions of transport modes specified by the manufacturer. The above must be guaranteed by a quality management system that meets the requirements of NEN-EN-ISO 9001 or is equivalent.
EOS	5. Procedure for dealing with possibly damaged energy carriers	x		Procedure for dealing with possibly damaged energy carriers The user of the EOS must have a procedure, made available by the supplier, for handling potentially damaged energy carriers. The procedure deals with matters such as reporting, isolation, identification, storage (in accordance with PGS 37-2), safe disposal, etc.
EOS	6. IP rating	x		IP rating For new construction, the IP rating and construction of the EOS must be at least IP54. IP54 means that the housing is dust and splash proof. For existing EOSs, any ventilation grilles present must meet the IP54 requirement.
EOS	7. Placement EOS	x		Placement EOS A new EOS is designed and positioned to be protected from external influences, taking local conditions into account. External influences are, for example, rising damp, inflowing water, etc. The person responsible for the installation takes into account the possible consequences of external influences when having an EOS designed and installed.
EOS	8. Climate control	x		Climate control It must be ensured that in the EOS: Excessive moisture formation is prevented and any moisture that is released is efficiently removed; The temperature in the energy carrier compartment remains within the operational specifications of the manufacturer. The EMS must monitor the climate in the EOS (direct link with climate control or with its own sensors). If insulation of the EOS is used as part of the temperature control it must comply with fire class A or B according to EN13501-1 or equivalent

Utstyr	Barrierer	Allerede implementert	Skal implementeres	Beskrivelse
EOS	9. Integrity EOS	x		Integrity EOS The architectural/structural integrity of the EOS must be maintained after an explosion. An explosion plane has been installed in the outer wall or roof of the EOS room. The explosion area has such dimensions that a pressure wave that occurs as a result of an explosion in the installation room of the EOS can escape without causing damage to the structure. The ratio between the net and gross volume of the installation space of the EOS must be at least a factor of 2. In existing situations, this can be deviated from after consultation with the competent authority. This may be acceptable, for example, if there are no vulnerable objects in the vicinity or if the explosion risk is limited due to the type of energy carrier used.
EOS	10. Ventilation system			Ventilation system The accessible part of the EOS is equipped with a mechanical ventilation system that is calculated for a ventilation rate of at least 6 times the gross content of the EOS per hour. The ventilation is designed in such a way that under normal operating conditions the air in the entire room is continuously refreshed at least twice the gross content per hour. As an alternative to continuous ventilation, it is also possible to ventilate the EOS at maximum capacity before entering, in combination with an interlock that prevents entry until the CO level is below 20 ppm. After access to the EOS has been released, the mechanical ventilation system continues to operate. The air in the entire room is then refreshed at least twice an hour. The mechanical ventilation system may only be switched off after the personnel have left the room and the entrance has been locked again. The exhaust of the ventilation must be installed as high as possible in the EOS. The outlet of the mechanical ventilation system must be at least 5 m from window and suction openings of surrounding objects.
EOS	11. Emergency ventilation	x		Emergency ventilation In case of CO or smoke detection in the energy carrier compartment, the ventilation must provide the energy carrier compartment with fresh air at maximum power. If a fire extinguishing system is present in the EOS, the control of the emergency ventilation must be adjusted accordingly. If an extinguishing system is activated, the ventilation must be switched

Utstyr	Barrierer	Allerede implementert	Skal implementeres	Beskrivelse
				off. At the entrance to the EOS, there must be a provision for the fire brigade to bridge the control of the emergency ventilation. In existing situations, this can be deviated from after consultation with the competent authority. This may be acceptable, for example, if there are no vulnerable objects in the vicinity or if the explosion risk is limited due to the type of energy carrier used.
EOS	12. Location selection and collision protection of EOS	x		Location selection and collision protection An EOS installed outside is, in relation to the permitted speeds of vehicles and traffic intensity near the storage location, placed in such a way that there is no risk of collision. If such a place is not available, a sufficiently shielding construction has been installed. This requirement is in any case met if the construction consists of protection against collision in the form of an effective crash barrier construction in accordance with the guidelines of Rijkswaterstaat.
Mobile EOS	13. Location selection and collision protection - mobile EOS	x		Location selection and collision protection - mobile EOS When a mobile EOS is placed in a location where vehicles can come close to an EOS, effective measures must be taken with regard to the risk of collision. No additional measures are necessary for vehicles that can and are allowed to drive on site at a maximum speed of 15 km/h without sharp protruding parts that can pierce a wall of an EOS, such as fork-lift truck spoons. In the case of higher speeds and/or protruding parts, collision protection devices, which ensure that the EOS cannot be damaged, will be mandatory.
Site	14. Location choice - company premises	x		Location choice – company premises An EOS installed outside on a company site is placed outside the reach of (mobile) cranes and other hoisting equipment. If this is not possible, the EOS must be fitted with a physical shield against falling objects.
EOS	15. Location choice – wind turbine	x		Location choice – wind turbine An EOS installed outside within the 10-6 per year site-specific risk contour of a wind turbine is sufficiently resistant to ice debris and ice erosion.
Site	16. Camera system requirements	x		Camera system requirements A camera system must remain out of the normal reach of third parties. In the event of vandalism, the camera must be repaired or replaced within 48 hours.

Utstyr	Barrierer	Allerede implementert	Skal implementeres	Beskrivelse
EOS	17. Commissioning inspection	x		Commissioning inspection A new EOS may only be taken into use after a commissioning inspection has taken place in which the correct functioning of all systems and protections as described in this PGS has been checked. In the case of an EOS park, the composition of the EOSs must also be checked before commissioning.
EOS	18. Protection against unauthorized person	x		Protection against unauthorized person: An EOS is adequately protected against unauthorized persons. The shielding can consist of the construction of the EOS itself (EOS in a container), a physical shield or permanent (camera) surveillance. The physical shielding can consist of walls (buildings), fences or ditches of sufficient width. In any case, a fixed fence of at least 1.8 m high made of non-combustible material with at least two opposite access doors is sufficient as protection.
EOS	19. Monitor EOS	x		Monitor EOS An EOS must have a system for continuous monitoring of (if required): functioning (system alarms, overcharge or deep discharge signals); abnormal increases in temperature; temperature levels; fire. Timely follow-up, as referred to in 20.Preventive shutdown based on alarms and 21.Shut down based on detection , of signals of a (possible) thermal runaway or a fire or explosion must be ensured.
EOS	20. Preventive shutdown based on alarms	x		Preventive shutdown based on alarms The person responsible for the installation of the EOS must be able to intervene remotely in the event of signals from system alarms that could lead to the failure of the EOS. The person responsible for the installation must verify the notification based on the signals (error messages, temperature sensors, smoke and fire alarms, etc.). If a fire or explosion is confirmed, the emergency services must be notified immediately. The person responsible for the installation must be able to activate an emergency stop remotely. The monitoring of the EOS must continue to function after the emergency stop has been activated.

Utstyr	Barrierer	Allerede implementert	Skal implementeres	Beskrivelse
				The BMS and/or the EMS of the EOS may not, at the moment that the person responsible for the installation has intervened, disable the disconnection or arrange it in any other way. If the person responsible for the installation does not respond in time, the EOS must be able to switch off autonomously by a decision from the BMS and/or the EMS. The person responsible for the installation of the EOS may not render the BMS and/or the EMS inoperative or otherwise arrange the electronic control at the moment that they have intervened. Both the BMS and/or EMS and the system controller must be able to de-energize the system when an excessive temperature is detected, in order to remove electricity as a possible energy source from the fire/temperature increase as much as possible. When de-energizing the system, both the AC power supply and the DC power supply of the energy carriers must be switched off. It must be visible on site that the system has actually been switched off. To this end, the EOS must be provided with a status indication on the outside of the EOS in accordance with NEN-EN-IEC-60204-1. For existing EOSs, this measure can be completed by means of an 22. Emergency stop device that can be activated remotely.
EOS	21. Shutdown based on detection	x		Shut down based on detection The EOS must switch off autonomously in the event of smoke, fire and explosion detection by a decision from the Battery Management System (BMS) and/or the Energy Management System (EMS). The intervention of one of these systems may not be revoked by the other system. Both systems must be able to physically switch off the charging process. The external monitoring must continue to function after the emergency stop has been activated. When switching off, the person responsible for the installation must receive a signal. The person responsible for the installation of the system may not disable the BMS and/or the EMS the moment they have intervened or arrange the electronic control in any other way. It must be visible on site that the system has actually been switched off. To this end, the EOS must be provided with a status indication on the outside of the EOS according to Table 2 . For existing EOSs, the status indication can be limited to a red light during an emergency stop.

Utstyr	Barrierer	Allerede implementert	Skal implementeres	Beskrivelse
EOS	22. Emergency stop device	x		Emergency stop device The EOS shall have an emergency shutdown facility for manual shutdown of the EOS with the same functionality as the automatic shutdown referred to in 21.Shut down based on detection if this follows from the risk assessment. In the case of an EOS park, it is allowed to be at sub-level. In this situation, the tripping range of the emergency stop is the part of the total system that is dependent on each other in terms of safety and electrical protection. In practice, this is the combination of energy carriers, converters, transformer and control systems or a substation with underlying systems.
EOS	23. Switch off module	x		Switch off module The disconnection of the EOS as referred to in 20.Preventive shutdown based on alarms and 21.Shut down based on detection must take place as close as possible to the module.
EOS	24. Remove energy carrier after thermal runaway or fire	x		Remove energy carrier after thermal runaway or fire As soon as a thermal runaway or fire has occurred in a module (which has not led to propagation), this module must be removed as soon as possible, but at the latest within 24 hours. The removed module must be disposed of from the ADR/VLG in accordance with special provision 376. Before reactivating the EOS, it must be tested in accordance with the manufacturer's instructions to ensure that it is safe to use again.
EOS	25. Access the EOS	x		Access the EOS It has been ensured that only authorized persons have access to the EOS. Access to the EOS (for example an access door or a hatch in the side) can only be opened by an authorized person (installation manager, maintenance engineer). Apart from regular inspection, maintenance and repair work, all access to the EOS is closed and locked. The lock consists of a cylinder lock with the safety mark SKG** or higher. A container lock is provided with the SCM quality mark with a padlock CEN class 4 or higher. An alternative locking is permitted provided it is demonstrably equivalent. When using a key, it is kept in a place inaccessible to unauthorized persons.
Energy carrier	26. Check before replacement energy carrier	x		Check before replacement energy carrier Prior to replacement, a new energy carrier to be placed in the EOS must be checked for external damage and defects. A rejected energy carrier is considered defective and is stored accordingly.

Utstyr	Barrierer	Allerede implementert	Skal implementeres	Beskrivelse
EOS/Kluge -Site	27. Current manual	x		Current manual An up-to-date manual is available in or near the EOS, describing the technical installation. The front page of the manual lists the supplier's contact details.
EOS	28. Ventilation system – check and maintenance	x		Ventilation system – check and maintenance If present, the person responsible for the installation of the EOS has the mechanical (emergency) ventilation system periodically checked for proper operation and maintained by an expert. The registration of the inspection and maintenance are recorded in the logbook. The checks take place in accordance with the deadline prescribed by the manufacturer
EOS	29. Periodic control – EOS	x		Periodic control An EOS must be checked periodically, at least annually. During this periodic check, at least the following subjects, if applicable, must be addressed: inspection of the energy carriers and electrical installation (visual + check operation) visual inspection of the container (filters, external damage, pressure relief device, etc) inspection and service of the air conditioning and heating system inspection and service of the fire extinguishing system inspection and service of the inverters and transformers
Mobile EOS	30. Check mobile EOS after installation	x		Check mobile EOS after installation After placing a mobile EOS, it must be checked for at least the following points: (mechanical) damage due to transport, both the EOS itself and the energy carriers Presence of correct electrical connection(s) for the purpose for which the EOS is installed The EOS may not be used until any shortcomings have been resolved.
Kluge-site	31. General documentation requirements – Registration system	x		General documentation requirements – Registration system A registration system must be maintained for each EOS that must comply with Article 3.4 of the Working Conditions Decree. A repair and maintenance log must be present with every installation, which also records adjustments. An off-site copy of this repair and maintenance log must be kept with the person responsible for the installation. The latest revision of all documents below must be available from the EOS:

Utstyr	Barrierer	Allerede implementert	Skal implementeres	Beskrivelse
				design drawings/schematics; user manual; information sheet system; log; maintenance protocol; commissioning test (17.Commissioning inspection) periodic checks (29.Periodic control - EOS) The documentation must always be up to date and available at the EOS. The registration system can be stored in hard copy or in an electronic form.
Kluge-site	32. General Documentation Requirements – Retention Period	x		General Documentation Requirements – Retention Period The registration system of the EOS is at least preserved: as long as the EOS has not been permanently deleted; as long as the consequences of any incident during the use or disposal phase of the EOS have not been fully dealt with.
Kluge-site	33. Competence requirements in accordance with NEN 3140	x		Competence requirements in accordance with NEN 3140 Personnel who carry out work on the installation must have sufficient expertise and be at least qualified as a Competent Person (VP). A VP has completed electrical engineering training at WEB level 3 (Education and Vocational Education Act). A designation policy must ensure that employees only perform tasks for which they are qualified.
EOS	34. Instruction personnel – risk awareness	x		Instruction personnel All persons who perform work in an EOS must be aware of the hazardous aspects of lithium-containing energy carriers and the measures to be taken in the event of irregularities. These persons must also be aware of the internal emergency plan.
EOS	35. Lightning protection and security-electrical installations	x		Lightning protection and security-electrical installations The required lightning protection and protection of electrical installations in the EOS follows from the protection class determined on the basis of NEN-EN-IEC 62305-2. If lightning protection and protection of the electrical installations in the EOS is required, these must comply with NEN-EN-IEC 62305-3 and NEN-EN-IEC 62305-4 respectively. The design, replacement and installation of the earthing and lightning protection is carried out by an expert who issues a statement showing that the installation complies with the aforementioned standards.

Utstyr	Barrierer	Allerede implementert	Skal implementeres	Beskrivelse
EOS	36. Lightning protection system parts	x		Lightning protection system parts The components of a lightning protection system comply with the NEN-EN-IEC 62561 series insofar as the relevant part is applicable.
Kluge-site	37. Safety distances	x		Safety distances In derogation from M11, fire resistance can also be achieved by means of distance: if the distance from the EOS to the facility boundary, another structure belonging to the facility, or other flammable objects is at least 5 m, the fire resistance must be at least 30 minutes; if the distance from the EOS to the facility boundary, another structure belonging to the facility, or other flammable objects is at least 10 m, no fire resistance requirement applies. Within these distances, no storage of flammable substances or activities that pose a risk of fire (with the exception of maintenance work) can take place that could cause a fire or along which a fire could spread to the EOS.
EOS	38.Extinguishing water connection	x		Extinguishing water connection The EOS is preferably protected against fire propagation, at least at module level, for example based on UL9540A. If the EOS does not have fire propagation certification, the EOS must be equipped with a fire extinguishing water connection. The extinguishing water connection must meet the requirements of the fire brigade (Storz coupling nok81 or another form of extinguishing water supply as agreed with the regional fire brigade). In the presence of a fire extinguishing water connection, the energy carrier compartment or the EOS as a whole must: withstand the hydrostatic pressure of the maximum water height that can be reached; be so watertight that sufficient water can be supplied to control a thermal runaway. If an energy carrier compartment can be flooded, there is a facility to actively cool or drain the compartment during or afterwards, for example by means of a ball valve. The fire extinguishing water connection is fitted with a non-return valve on the inside to prevent fire or smoke from escaping through the fire extinguishing water connection in the event of a fire. With an indoor EOS, a fire extinguishing water connection is only possible when placed on the ground floor or in the basement. Fire propagation certification is therefore necessary when placed on another floor. A fire extinguishing system may also be designed in such a way that it can prevent fire propagation

Utstyr	Barrierer	Allerede implementert	Skal implementeres	Beskrivelse
				as referred to in the first paragraph. This must be demonstrated by the supplier of the system by means of certification. In this case, the requirements regarding resistance to hydrostatic pressure and watertightness do not apply.
EOS	39. Accessibility of the EOS	x		Accessibility of the EOS The EOS must always be accessible for emergency services. The emergency services must be able to access the site at all times. The emergency services must be able to access the EOS. This must be clearly described in the emergency plan. The (temporary) placement of objects may not hinder access to the EOS for the fire service. When placing objects that themselves have an increased risk, careful consideration must be made.
Kluge-site	40. Emergency plan	x		Emergency plan An up-to-date emergency plan (see Appendix E for an example) on how to act in the event of incidents is available. An incident is in any case understood to mean the occurrence of a thermal runaway and a leakage of electrolyte. The emergency plan is aimed at limiting and managing calamities, accidents and protecting employees and the living environment. This emergency plan must be available with the EOS installation manager and the emergency services. This emergency plan contains at least: Contact information of involved parties A description of the monitoring How the alarm is arranged (24/7) How to respond to the alarm Scenario descriptions in the event of a fire alarm Map showing fire extinguishing facilities Information on access to the EOS site Drawings and coding of the EOS Technical information of the EOS (power, capacity, etc.) What to do after an incident (clean up any electrolyte leaks, clean up fire extinguishing water, etc.)
Site	41. Emergency plan – to test	x		Emergency plan – to test The emergency plan shall be reviewed and tested at least every three years and updated as necessary. If the contingency plan is updated, the following will be taken into account:

Utstyr	Barrierer	Allerede implementert	Skal implementeres	Beskrivelse
				changes of a technical and organizational nature in the emergency services; the changes in safety awareness that can have important consequences for the risks of accidents.
EOS	42. Icons to EOS	x		Icons to EOS Safety signs must be affixed to the outside of an EOS. In any case, this concerns the open fire and smoking ban, as laid down in the NEN-EN-ISO 7010 standard under number P003. In addition, the following warning pictograms must be affixed: Electrocution hazard, NEN-EN-ISO 7010 number W012 Battery charging warning, NEN-EN-ISO 7010 number W026 Falling ice warning, NEN-EN-ISO 7010 number W039 The falling ice warning only applies to an EOS placed outside in the immediate vicinity of a wind turbine. The safety signs must always be affixed in a clearly visible place on the outside of the EOS.
EOS	43. Explosion hatch	x		An explosion vent or rupture panel is a safety device to protect equipment or buildings against excessive internal, explosion-incurred pressures, by means of pressure relief. An explosion vent will relieve pressure from the instant its opening (or activation) pressure pstat has been exceeded. This hatch is placed in container roof to lead the forces upwards.
EOS	44. Control access to the EOS	x		Control access to the EOS It has been ensured that only authorized persons have access to the EOS. Access to the EOS (for example an access door or a hatch in the side) can only be opened by an authorized person (installation manager, maintenance engineer). Apart from regular inspection, maintenance and repair work, all access to the EOS is closed and locked. The lock consists of a cylinder lock with the safety mark SKG** or higher. A container lock is provided with the SCM quality mark with a padlock CEN class 4 or higher. An alternative locking is permitted provided it is demonstrably equivalent. When using a key, it is kept in a place inaccessible to unauthorized persons.

Tabell B.5 Risikoklassifisering

Risk Classification			**People**					
RED – Intolerable – Can not be tolerated – Is not accepted – Must be reduced			More than 100 deaths	10 – 100 deaths	1 – 10 deaths	Permanent major injury	Recoverable major injury	Minor injury
Yellow – Tolerable – Can be tolerated – Additional barriers implemented if ALARP			**Facility**					
Green – Broadly Acceptable. There is not requirement for ALARP			Total loss of facility	Facility out of service >6 months	Facility out of service <6 months	Major damage to facility	Damage to operational critical systems	Operational critical systems temporarily disabled
			Environment					
ALARP – (As low as Reasonably Practicable)			Significant, prolonged or widespread damage to habitat or species. Damage >10 years	Major damage to a habitat or species. Damage 1-10 years	Small cale, short term damage to a habitat or species. Damage 1 month to 1 year	Minor local damage to habitat or species. Damage up to one month	Minor local damage to habitat or species. No sustained damage	Minimal local environmental impact with no damage to a habitat or species
Frequency Definition	**Event Frequency**	**Annual Probability of level of harm**	**Catastrophic**	**Disastrous**	**Critical**	**Major**	**Marginal**	**Negligible**
Likely to occur repeatedly on the system during its life	**Frequent**	1 in 10						
Likely to occur from time to time on the system during its life	**Probable**	1 in 100						

May occur once on the system during its life	**Occasional**	1 in 1000						
Unlikely to occur on the system during its life, but likely to occur at sometime within the total delivered systems	**Remote**	1 in 10.000						
Very Unlikely to occur on the system during its life, but likely to occur at some time within the total delivered systems	**Improbable**	1 in 100.000						
Extremely unlikely to occur on the system during its life, but likely to occur at some time within the total delivered systems	**Highly Improbable**	1 in 100.000.000						
Extremely rare event	**Incredible**	> 1 in 100.000.000						