YAMAHA
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YAMAHA ELECTRIC VEHICLE GUIDELINES

Dealer version

www.yamaha-motor.eu

YME Electric Vehicle Guidelines

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Contents

Introduction

You are starting to come in to contact with Yamaha electric vehicles.

In electric vehicles the energy for the drive of the vehicle is not delivered by an internal combustion engine, but by a battery or a combination of an internal combustion engine and battery (Hybrid).

When electric vehicle related work is going to be performed in your workshop(s), or when you are going to work on (or nearby the High Voltage system of) electric vehicles, it is relevant that you are aware of certain aspects that have to be taken care of to:

- protect the safety and health of yourself and others by minimizing risks.

And therefore

- comply with the law.

The purpose of this document is to be a guide in identifying the necessary steps to be taken in your place of work to minimize the risk when working on (or nearby the HV system of) electric vehicles. It includes requirements on:

- The knowledge and skills of the persons who carry out the work.
- The safety procedures that should be followed when carrying out the work.
- The tools, measurement instruments and personal protective equipment (PPE) used.
- Storage, disposal and transport of batteries and vehicles.

These guidelines are not a substitute for any legal documentation, local and international laws and/or standards. Where applicable, references will be made to the relevant official documents, standards and laws.

Always ensure that you adhere to the minimum requirements of the legislation in your country or region.

This document is constructed in such a way that it will guide you in what things you need to consider, what needs to be organised and what items may need to be purchased in order to work safely with electric vehicles.

Appendix 3 can be used to fill out contact details for important parties, e.g. emergency response services.

Abbreviations and definitions

Abbreviation	Meaning
ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road.
CENELEC	European Committee for Electrotechnical Standardisation
CLP	Classification, Labelling and Packaging
Dangerous goods	An object, substance or material that presents an immediate degree of risk to people, property and the environment due to the nature of its physical and chemical properties.
Directives	An official or authoritative instruction
EV IP	Electric vehicle instructed person
EV SP	Electric vehicle skilled person
EV NPCWA	Electric vehicle nominated person in control of the work activity
EV	Electric vehicle
HV	High voltage, classed as 30 Volt and higher for AC voltage and/or 60 Volt and higher for DC voltage.
Legislation	A law or set of laws created by an official body
Li-Ion	Lithium Ion
PPE	Personal Protective Equipment

1. Legislation

When working on (or nearby the HV system of) electric vehicles and/or when dealing with Li-Ion batteries, certain legislation applies. For Europe, the legislation that applies is:

1. Occupational Health and Safety
1. Dangerous goods

The European Union sets legislation in the form of directives, based on the legal foundation established in Article 153 of the Treaty on the Functioning of the European Union.

1.1. Occupational Health and Safety

One of the most important legal acts is the European Framework Directive on Safety and Health at Work (Directive 89/391 EEC, adopted in 1989). It guarantees minimum safety and health requirements throughout Europe while member states are allowed to maintain or establish more stringent measures.

European directives define the essential requirements to ensure a high level of protection of health, safety, consumer protection, or the protection of the environment.

The task of drawing up corresponding standards to meet the essential requirements of the directives is entrusted to the European standardisation organisations (e.g. CEN, CENELEC and ETSI).

CENELEC (European Committee for Electrotechnical Standardisation) is responsible for European standardisation in the area of electrical engineering.

The applicable standard for working on/usage of electrical installations is EN50110.

EN50110 consists of two parts:

- Part 1 of EN50110 contains minimum requirements valid for all CENELEC countries and some additional annexes dealing with safe working on, with, or near electrical installations;
- Part 2 of EN50110 consists of a set of annexes (one per country) which either specify the present safety requirements or give the national supplements to these minimum requirements.

The EN standards are NOT laws but agreements, practical guidelines constructed by, and for the relevant market.

A number of countries have created national standards, norms and regulations, which further detail the implementation of the standards (based on EN50110) for working on (or nearby the HV system of) electric vehicles, e.g.:

- NEN9140 - Netherlands
- NF C18-550 - France
- CEI 11-48 and 11-49 – Italy
- DGUV Vorschrift 3 and DGUV Information 200-006 – Germany

In the end, all these regulations are derived from the EN50110, and will therefore have a lot of similarities between them. In this document, the practical implications of this legislation will be explained.

1.2. Electric vehicle and rechargeable battery pack type approval

Global standards for motor vehicles and electric vehicles are the responsibility of the World Forum for the Harmonization of Vehicles, a permanent working party under the United Nations Economic Commission for Europe (UN ECE). The European Union (and nearly 60 other signatory countries) have agreed to apply a common set of technical specifications to motor vehicles manufactured or sold within their countries.

Specific technical requirements are found in approximately 130 separate regulations, addressing vehicle components like lighting and instrumentation, operational characteristics including crashworthiness or environmental compatibility.

UN ECE Regulation No. 136 (also referred to as R136) is one of these technical requirements and addresses the safety requirements specific to the electric power train of class L road vehicles including rechargeable battery systems. Before a type approval is granted, stringent testing takes places with regards to vibration, thermal shock and cycling, mechanical shock, mechanical integrity, fire resistance, external short circuit protection, overcharge and over-discharge protection, and over-temperature protection.

All Yamaha homologated electric vehicles (i.e. road approved products with a license plate) and rechargeable battery packs have to apply to UN ECE R136 (and all other relevant regulations) in order to be sold and used in the European market.

1.2.1. eBikes and Golf Cars

eBikes

Yamaha offers a range of three eBikes, and a range of eBike Power systems. Both are equipped with an electric supported drive train. The drive train consists of a battery pack, an electric drive motor and controlling devices. eBikes and eBike Power systems do not have a UN ECE R136 approval and thus lack the safety systems as indicated in this regulation. By removing the battery from the battery holder, the electric driveline can be de-energized.

Golf Cars

A Golf Car electric driveline is built with a battery, an inverter, a drive motor and controlling devices. As with eBikes Golf Cars do not have a UN ECE R136 approval and thus lack the safety systems as indicated in this regulation. The battery of a Golf Car cannot be removed without tools. Therefore, when de-energizing a Golf Car driveline system, the battery must be removed by a mechanic, while complying with the safety measures as indicated in this guideline regarding work on HV systems.

Safety hazards

The nominal voltage of the driveline systems for eBikes and Golf Cars is below the threshold of 50VAC and 120VDC. This does not mean that the voltage and electric energy in these vehicles is not dangerous. When working on these systems, confirm that the parts you are working on are voltage free. Do not work on the vehicle when the battery is being charged.

Also apply the safety measures in accordance with chapter 1.3 and 3.6 in this guideline when handling, storing or shipping the batteries of these vehicles.

The indications above will apply to all future Non-Homologated products, such as off road models, bicycles, golf cars, and marine products with electrical support systems that do not have a license plate and thus do not have to apply to UN ECE R136.

1.3. Dangerous goods

Electric vehicles make use of batteries to provide the power to drive the vehicle. The high voltage batteries that YAMAHA uses are Li-Ion batteries. Li-Ion batteries are classed as dangerous goods and therefore, European regulations with regards to handling these goods are in place.

1.3.1. Classification, labelling and packaging (CLP)

The Classification, Labelling and Packaging (CLP) Regulation ((EC) No 1272/2008) is based on the United Nations' Globally Harmonised System (GHS) and its purpose is to ensure a high level of protection of health and the environment, as well as the free movement of substances, mixtures and articles.

CLP is legally binding across the Member States and directly applicable to all industrial sectors. It requires manufacturers, importers or downstream users of substances or mixtures to classify, label and package their hazardous chemicals appropriately before placing them on the market.

One of the main aims of CLP is to determine whether a substance or mixture displays properties that lead to a hazardous classification. In this context, classification is the starting point for hazard communication.

When relevant information (e.g. toxicological data) on a substance or mixture meets the classification criteria in CLP, the hazards of a substance or mixture are identified by assigning a certain hazard class and category. The hazard classes in CLP cover physical, health, environmental and additional hazards.

Once a substance or mixture is classified, the identified hazards must be communicated to other participants in the supply chain, including consumers. Hazard labelling allows the hazard classification, with labels and safety data sheets, to be communicated to the user of a substance or mixture, to alert them about the presence of a hazard and the need to manage the associated risks.

CLP sets detailed criteria for the labelling elements: pictograms, signal words and standard statements for hazard, prevention, response, storage and disposal, for every hazard class and category. It also sets general packaging standards to ensure the safe supply of hazardous substances and mixtures.

The applicability of the CLP regulation depends on the description of the Li-Ion batteries in the Safety Data Sheet. It is possible that they are not classified as the mixture and substances are internal and in a closed compartment!

1.3.2. ADR

The abbreviation ADR stands for the “European Agreement concerning the International Carriage of Dangerous Goods by Road”. The ADR comprises regulations for road transport with regard to packaging, load securing, classification and labelling of dangerous goods. All EU members have agreed to adhere to the ADR. In principle, it applies to the cross-border transport that takes place between at least two of these countries. In itself, the ADR does not relate to domestic transport. Nevertheless, through a European directive (Directive 2008/68/EC), it indirectly also applies to the territory of the member states of the European Union.

The provisions of the ADR are thus legally anchored and mandatory for the transport of dangerous goods. Furthermore, the ADR regulates how infringements or complete disregard of the regulations are handled and sanctioned.

Every two years, the regulations of the ADR are revised and adapted to reflect the latest technical developments and the law.

The regulations describe above all how the goods to be transported are to be classified as dangerous goods and what associated safety measures are to be taken. In addition, the documentation of the transport of dangerous goods, the safety obligations of the persons involved and the corresponding instruction of the persons specifically involved are also described. These include the shipper, transporter and also the recipient of the dangerous goods load. An important component is also the handling in case of an emergency or damage.

The ADR serves the safety in road traffic and requires the trained handling of dangerous goods. Drivers who transport dangerous goods must have a dangerous goods driving licence which includes an ADR certificate. In order to obtain the ADR certificate, a training course and subsequent passing of a theoretical examination is required. In addition, the ADR certificate must be renewed every five years with refresher training and examination.

However, according to ADR, all those involved in the transport and handling of dangerous goods must also prove that they have the appropriate expertise in handling dangerous goods and the dangerous goods regulations. Logistics companies that handle the transport of dangerous goods must appoint a dangerous goods officer.

Vehicles that are to transport dangerous goods also require ADR approval. The approval is granted according to the dangerous goods that the vehicles are allowed to transport.

The ADR registration of the vehicle that transports the dangerous goods must be renewed every year at a technical inspection. Just like the general inspection for motor vehicles, the ADR specific inspection is also carried out by an officially recognised inspection body and only these are entitled to renew the ADR registration.

For the ADR regulations, separate Li-Ion batteries have identification number UN3480 and are classed as Class 9 — miscellaneous dangerous substances and articles.

Further information and examples of the implications of ADR for the day-to-day operation of your business will be given elsewhere in this manual.

Summary

- European legislation is in place to protect occupational health and safety. For working on (or nearby the HV system of) electric vehicles, the applicable standard is EN50110.
- European legislation is in place for handling, storage and transportation of (Li-Ion) batteries. The classification, labelling and packaging regulation ((EC) No 1272/2008) applies depending on the description in the Safety Data Sheets.

2. Why is it dangerous?

2.1. Electrical Hazards

Electrical hazards include leakage current, short, and electrocution.

- Electric current can leak out of a wire due to insufficient insulation and run through a nearby conductor in the vicinity.
- A short can happen when two points in a circuit with different potentials have an electrical contact due to damaged sheathing or other reasons.
- Electric shock in the human body refers to the conduction of electric current to and through the body, which can be felt and potentially result in injury/trauma or even death.

The electrical risk of high-voltage power should be well understood to stay cautious against safety hazards and risks, including electrification.

High voltages in themselves are not necessarily dangerous. However, the possible current that can flow due to the high voltages is. The table below describes the correlation between the effects of electric shock and electric current. The levels of electric shock indicate the effects on the human body when they occur at varying intensity. The contents are classified based on the electric power types (AC and DC) and gender.

Correlation between effects of electric shock and electric current				
Effect of electric shock	DC (Amperage)		AC (Amperage)	
	Male	Female	Male	Female
Current can be felt (min. sensible current)	0.0052 A	0.0035 A	0.0011 A	0.0007 A
Painless shock, free muscular movement	0.009 A	0.006 A	0.0018 A	0.0012 A
Shock with pain, free muscular movement (let-go current)	0.062 A	0.041 A	0.009 A	0.006 A
Shock with pain, let-go threshold (freezing current)	0.074 A	0.05 A	0.016 A	0.0105 A
Shock with intense pain, muscle stiffness, difficulty with breathing	0.09 A	0.06 A	0.023 A	0.015 A
Possibility of ventricular fibrillation (in 0.03 sec of conduction time)	1.3 A	1.3 A	1.0 A	1.0 A

2.2. Thermal hazards

Batteries developed/produced by YAMAHA are Li-Ion batteries. Li-Ion batteries have a high energy density and as such, are ideal for use in electric vehicles.

A downside of Li-Ion batteries is the potential of instability and thermal runaway. Thermal runaway is a process whereby increased temperature will release energy that further increases temperature, resulting in fire. This is a vicious circle, where the thermal event (fire) will become uncontrollable, leading to a destructive result. Due to the construction and chemicals involved, this can even cause (violent) explosions. During a thermal runaway or fire, toxic and/or flammable gasses may also escape from batteries.

When Li-Ion batteries are in good order and handled properly, the risk of thermal incidents is very limited. However, when damaged, handled improperly (e.g. dropped, overcharged, deeply discharged, extreme temperatures (both high and low)) or otherwise defective, Li-Ion batteries can become unstable and thermal events can occur. An increase in temperature, noises (bubbling, hissing, crackling), smoke, leakage can all indicate that a battery has become unstable. However, it is also possible that a thermal event occurs instantly, without warning.

Consideration with regards to managing calamities is therefore critically important. Consider:

- If personnel is not properly instructed/trained, they may act incorrectly and do dangerous things.
- If an electric vehicle or high voltage battery is unstable, or can possibly be unstable, it could ignite without warning. Think about how to deal with this in the workshop to prevent any further calamities or maybe not bring it into the facility in the first place.
- If proper storage of vehicles and batteries is not well thought of, it could potentially cause major calamities, including severe injuries or death and massive financial loss in terms of damage to properties.

Further advice and considerations will be dealt with in various sections of this guideline.

2.3. Chemical hazards

When Li-Ion batteries are in good order and handled properly, they do not form a chemical hazard. However, particular substances, materials and chemicals contained inside Li-Ion batteries can create chemical hazards when they can escape due to damage, leakage, smoke, etc.

Considerations with regards to personal and environmental protection are therefore necessary, especially for storage of (damaged) batteries. Local and national laws and regulations will apply, make sure you are aware of what applies in your region and/or country.

2.4. Other hazards

In vehicles with an internal combustion engine, there are clear signs (particularly through sound) that an engine is running and the vehicle is capable of moving by itself. In an electric vehicle, this is less obvious. Take care when approaching and/or handling an electric vehicle if you are not sure whether the vehicle is on or off as inadvertent use could cause sudden movement.

Another risk to take in account is that certain components of electric vehicles have or can create (large) (electro-)magnetic fields and accompanying forces. These forces can be present in permanent magnets of the rotor, or in electromagnets in the inverter and stator. These risks should be taken into account when performing risk assessments before work is started on electric vehicles.

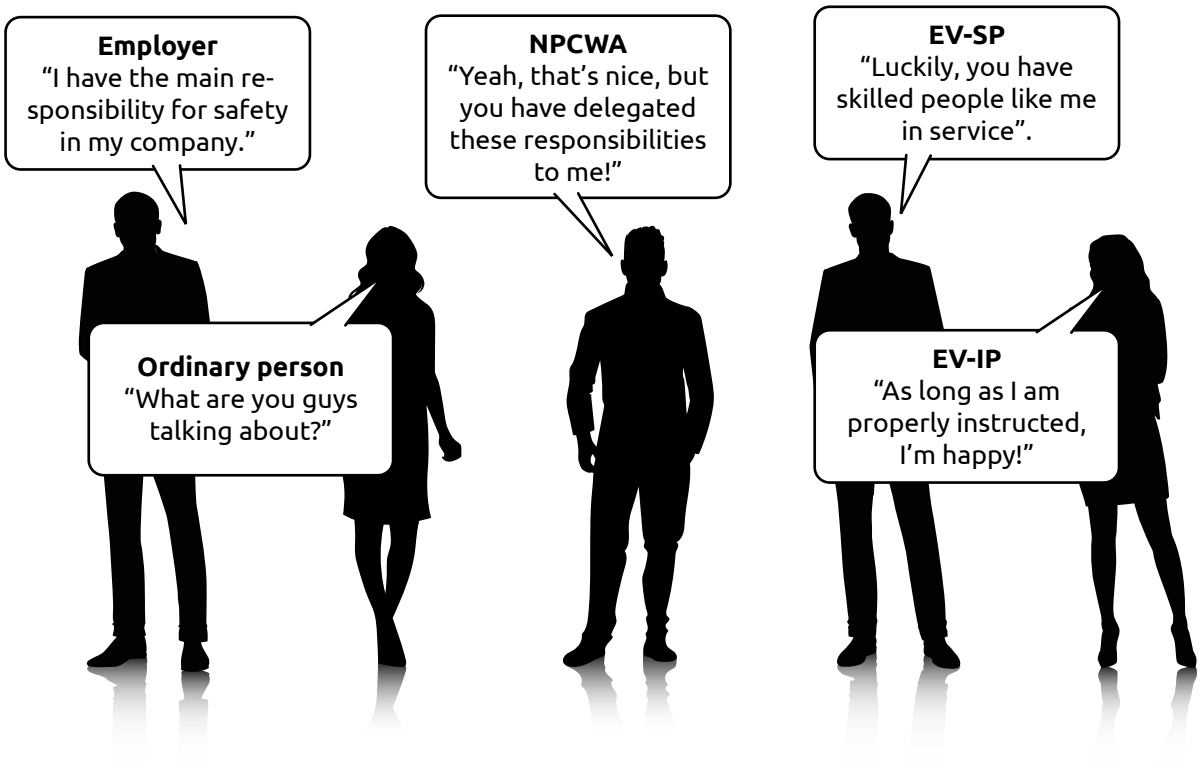
Summary

- Working on (or nearby the HV system of) electric vehicles and batteries can be dangerous due to the risk of electric current, short circuits and electrocution.
- Handling, storage and working on (or nearby the HV system of) electric vehicles and batteries can be dangerous due to the risk of fire and thermal runaway.
- Chemical hazards, although not present when electric vehicles and batteries are in good condition, should be considered when dealing with and handling electric vehicles and batteries.

3. What to organise

3.1. Responsibilities (EN50110)

With regards to occupational health and safety when working on (or nearby the HV system of) electric vehicles, the responsibilities in a company are determined in the EN50110 and the relevant national standards.



The common denominators with regards to occupational health and safety when working on (or nearby the HV system of) electric vehicles are:

The employer
The employer carries the overall responsibility for occupational health and safety in the business.

He/she is also responsible for:

- designating employees with specific EV roles.
- all work equipment and facilities, including tools and PPE. This includes their maintenance and inspections.

Certain responsibilities and duties can be delegated to relevant staff, provided they have the required competencies.

The informed ordinary person
The informed ordinary person is responsible for:

- observing warning signs and staying out of and away from cordoned off areas and vehicles.

Although the ordinary person will not work on (or nearby the HV system of) electric vehicles, it is important that they are informed about the presence of electric vehicles and the potential hazards. Any employee that will not be designated as an EV instructed person, EV skilled person or EV nominated person in control of the work activity is an ordinary person and should be informed about the hazards and their responsibility to become an informed ordinary person.

The EV instructed person (EV IP)
An EV instructed person may not carry out any work on electrical vehicles or equipment under their own responsibility and only carry out work with which they have been properly familiarised. All electrical work must be performed under the control and/or supervision of an EV skilled person.

The EV instructed person is responsible for:

- checking that their PPE is safe.
- isolating the HV system from the power supply sources in accordance with the manufacturer's instruction.
- engaging an EV skilled person when they have assessed there is a risk of an electrical hazard when performing their work.

The EV skilled person (EV SP)

An EV skilled person may carry out electrical work for which they have undergone specialist training independently and on their own responsibility. An EV skilled person always bears technical responsibility, i.e. is responsible for the technical result of the electrical work which he or she has performed.

In addition to the responsibilities of the EV instructed person, the EV skilled person is responsible for:

- verification of the non-live situation when a vehicle has been put in a non-live state, i.e. the HV system has been isolated from all power supply sources.
- establishing the safety of an electric vehicle in relation to the work to be carried out.
- establishing the safety of their own workplace.

The EV nominated person in control of the work activity (EV NPCWA)

The EV nominated person in control of the work activity carries the overall responsibility of all EV related aspects in the business. If the employer has the relevant (technical) skills and knowledge, he/she can designate him- or herself as EV nominated person in control of the work activity.

In addition to the responsibilities of the EV instructed and EV skilled person, the EV nominated person in control of the work activity is responsible for:

- performing the risk assessments.
- creating work instructions and plans for working on (or nearby the HV system of) electric vehicles.
- selecting the right people to carry out the work.
- give permission to start the work.
- instructing the people who are carrying out work while they are actually doing it.
- ensuring supervision when work is carried out.
- appointing people as EV skilled person or EV instructed person, if delegated to do so.
- appointing people as EV nominated person in control of the work activity for a specific job (standard maintenance work on vehicles that are not damaged), if delegated to do so.

NOTE: The required technical knowledge of an EV nominated person in control of the work activity and EV skilled person for working on (or nearby the HV system of) electric vehicle is the same. The EV nominated person in control of the work activity just has more responsibilities.

3.2. Organisational structure

The employer carries the responsibility to create a safe working environment for his/her personnel. For EV related work, this can be done by implementing an organisational structure within the company that ensures this.

There are a couple of possible scenarios.

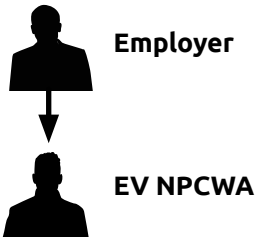
Scenario 1

The organisational structure consists only of the employer/EV NPCWA.
In this case:

- The employer is the EV NPCWA.
- He or she is the only person working on (or nearby the HV system of) electric vehicles.
- The company would normally not have any employees.

Scenario 2

The organisational structure consists of the employer and an EV NPCWA.
In this case:

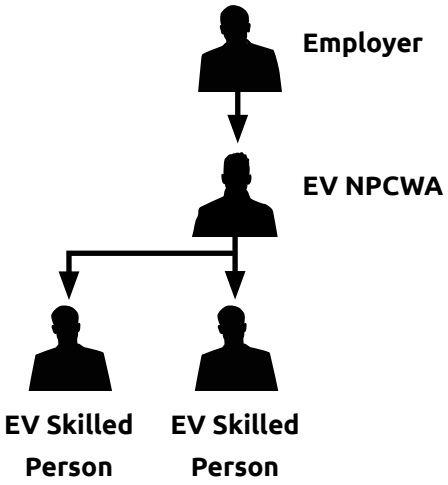


- The employer has designated an EV NPCWA.
- The EV NPCWA is the only person working on (or nearby the HV system of) electric vehicles.
- The company would normally only have one person working in the workshop.

Scenario 3

The organisational structure consists of the employer an EV NPCWA and one or more EV SPs. In this case:

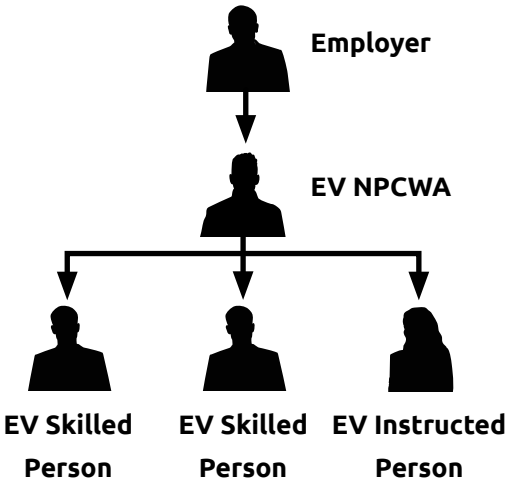
- The employer has designated an EV NPCWA (or is the EV NPCWA himself).
- The EV NPCWA has designated one or more EV SPs.
- The EV NPCWA and the EV SPs are working on (or nearby the HV system of) electric vehicles.
- The company would have a number of employees working in the workshop, where everyone is expected to be able to perform all work on electric vehicles.



Scenario 4

The organisational structure consists of the employer an EV NPCWA and one or more EV SPs and one or more EV IPs. In this case:

- The employer has designated an EV NPCWA (or is the EV NPCWA himself).
- The EV NPCWA has designated one or more EV SPs and one or more EV IPs.
- The EV NPCWA, the EV SPs and EV IPs are working on (or nearby the HV system of) electric vehicles.
- The company would have a number of employees working in the workshop, where some are expected to be able to perform all work on electric vehicles and some are expected to only perform specific work on electric vehicles (e.g. maintenance).



3.3. Designation

As explained, persons working on or in the vicinity of HV electric systems must be designated by the employer.

An employee who is going to be designated must be assessed in advance by the person responsible for the designation.

Designating can only be done when:

1. The person to be designated has the required knowledge, skills and certification. This means that not everyone can be designated just any role. Certain skills, knowledge and certification are required.
2. The person designating has assessed thoroughly if the person to be designated meets the applicable conditions.
3. The person to be designated is convinced he/she meets the applicable conditions.

See Appendix 1 for more information on required skills and knowledge for the various roles.

The first person that needs to be designated is an EV NPCWA. If an employer has the technical skills and knowledge to judge the related tasks and hazards, he/she can designate him- or herself. If not, another person needs to be designated to become the EV NPCWA.

Once designated, the EV NPCWA is responsible for designating relevant people as:

- EV SP.
- EV IP.

The EV NPCWA can also designate another person as EV NPCWA, but only for a specific job or project and limited to the duration of that job or project.

If two or more persons with identical EV designation work on a vehicle or installation, before starting the work one of them has to be assigned “in charge”.

The EV role designation is heavily depending on the existing organizational structure, number of employees and expected work load.

The following applies:

1. At least one EV NPCWA needs to be designated.
2. Anyone working on electrical vehicles will need to be designated at least as EV IP. Remember that they can only work under the supervision of an EV SP or EV NPCWA.
3. Ordinary persons are not designated and are not allowed to work on electric vehicles. They should be made aware of the hazards and their responsibilities though.
4. Designating people for the various roles can only be done once the person to be designated has the required knowledge, skills and certification.

Further information regarding the required training can be found in the chapter “Training”.

3.4. Documentation requirements

3.4.1. Designation letters

Between the employer (or employer’s delegate) and employee, a written and signed agreement must be made according to this designation policy stating the qualifications and authorizations concerning the employee, the job to be performed and the available supervision. These written and signed documents are indicated as “designation letters”.

The designation letter must contain the following information:

- The name of the person to be designated.
- The start and end date of the designation.
- The designation title/role.
- The electric vehicles or electric parts the person is authorized to work on.
- The type of work the person is authorized to perform.
- The place and date of designation.
- The name and function of the designating person.
- Signature of both the designating as designated person.

Note that each employee is an ordinary person by default. This role will not be designated in writing. Designation letters are only set up for the other three roles.

You can find an example of a designation letter in Appendix 2 – Documents

3.4.2. Risk assessments

Before the work on an HV vehicle starts, a risk assessment must be executed. Any risks that are revealed in this risk assessment must be addressed to minimise the chances of an accident occurring. The risk assessment can be an overall document for general, recurring work activities. If the work activities are less frequent or special procedures apply, an individual risk assessment must be drawn up.

In certain circumstances where quick action is required (e.g. emergency situations), risk may also be assessed verbally.

3.4.3. Work instruction

A work instruction must be drawn up detailing the procedure that needs to be followed for the work to be completed. It includes the safety steps to ensure the vehicle is in the non-live state and the actual maintenance and repair work that needs to be done. References to service manuals and technical documentation can be made. The work instruction can be an overall document for general, frequent work activities. If the work activities are less frequent or special procedures apply, an individual work instruction for the work may be drawn up, depending on the risk assessment of the EV NPCWA.

3.4.4. Technical documentation

All installations and/or vehicles with high voltage worked on must be documented. Generally, the applicable manufacturer workshop manuals, service manuals, operating manuals, owner's manuals, dealer bulletins, recall information and wiring diagrams must be available or present at the workplace. Technicians must use these and are considered to work on the vehicle/installation as recommended by the manufacturer.

3.4.5. Calamity process

If a calamity process is already available, ensure that it is adapted to reflect the work on (or nearby the HV system of) electric vehicles.

If there is no calamity process available, create one. This calamity process is normally constructed in collaboration with a calamity process specialist. This process will be specific for the business.

The calamity process (also known as a company emergency plan) lays down how to prepare for emergencies and how to deal with calamities. The calamity process provides the organizational structures, procedures and agreements for emergency situations. The plan describes who has which tasks, responsibilities and authorities in case of calamities and how coordination with emergency services, governmental and other organizations takes place.

Emergency response plans can be drawn up for the actual response to calamities. This describes how to act in the event of different types of calamities.

3.4.6. Documentation storage

For EN50110 there are no requirement with regards to documentation storage. However, consider the following:

- Designation letters should be stored with other personnel administration, i.e. with the HR department.
- Risk assessments for recurring work should be stored near where other occupational health and safety documentation is stored, e.g. with the HR department or management documentation.
- Work instructions for recurring work should be stored near where the work is performed, as the work instruction can serve as step by step process for an EV SP or EV IP.
- Risk assessments and work instructions for specific jobs should be stored with the work order for that specific work.

3.5. Training

3.5.1. Occupational health and safety

As explained, designating people for the various roles can only be done when the person to be designated has the required knowledge, skills and certification.

Therefore, suitable training is required depending on the roles and responsibilities of the employees and local legislation (Occupational health and safety).

In some European markets there are stringent training requirements for people working on (or nearby the HV system of) electric vehicles. In general, training to understand the hazards and enable safe working will be required.

For the different roles the following basic training requirements are:

For an EV IP:

- occupational health and safety (i.e. hazards).
- procedures for safe working (including how to place a vehicle in a non-live state).

For an EV SP:

- All of the above, with the addition of:
- basic electrical knowledge.
- understanding the hazards and first aid.
- calamity prevention.
- knowledge of applied electrical systems.
- basic technical knowledge on drive train components.
- insulation measurements.

For an EV NPCWA:

- All of the above, with the addition of:
- risk assessments.
- work procedures.
- leadership qualities.
- EV-related organisational documentation.
- occupational health and safety legislation.

The mentioned training subjects are the basic requirements in order to be able to designate people.

Additional (technical) training on vehicles, emergency response training and further vocational education may be required, based on the companies requirements and/or local or national legislation.

3.5.2. Dangerous goods

As mentioned, the ADR legislation requires the trained handling of dangerous goods.

Drivers who transport dangerous goods must have a dangerous goods driving licence which includes an ADR certificate.

In order to obtain the ADR certificate, a training course and subsequent passing of a theoretical examination is required.

According to ADR, all those involved in the transport and handling of dangerous goods must also prove that they have the appropriate expertise in handling dangerous goods and the dangerous goods regulations.

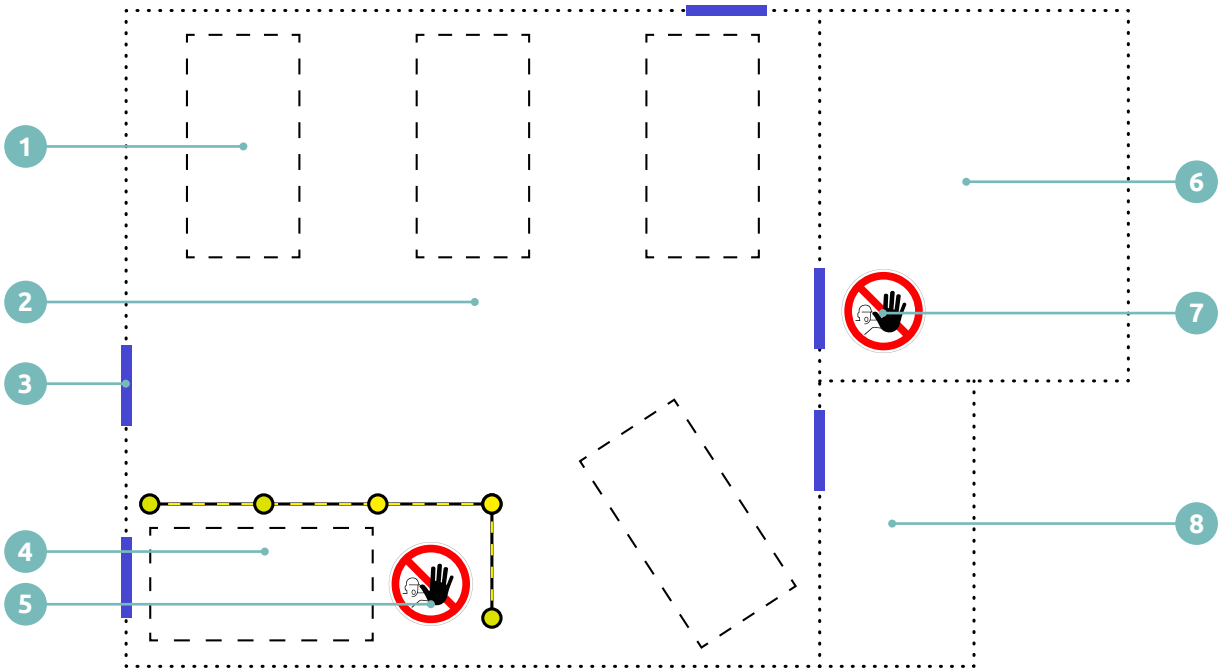
3.6. Facility layout, storage and transport

3.6.1. Facility layout

General workplace and process risk assessments must be conducted for all HV areas, e.g. storage facilities and workshops.

Working and operating procedures are then developed on the basis of these assessments. This can result in the alteration, conversion or extension of storage facilities and workshop stations or workplaces to ensure compliance with (electrical) safety requirements.

Workplace



1. Regular workplace
2. Workshop
3. Access door
4. Dedicated EV workplace (in front of an access door, minimum 1,5 meters space in all directions)
5. Signage and enclosure
6. Reception (or other publicly accessible area)
7. Signage to prevent unauthorised access to EV workplace
8. EV NPCWA office (with direct line of sight to dedicated EV workplace)

The following principles apply:

- Depending on the amount of workplaces available and required, create one or more dedicated HV workplaces where all HV related work will be performed.
- Mark or put an enclosure around any electric vehicle or HV workplace which is suspected of posing an electrical hazard (but also any high voltage battery pack that is not new and in its original transport packaging).
- Ensure there is enough moving space around a dedicated HV workplace, with a minimum of 1,5 meters space in all directions.
- Locate the HV workplace(s) in a direct and unobstructed line to an external door that is wide enough for the vehicle to be moved in and out of the workshop easily.
- Place the required tools, equipment and personal protective equipment in a fixed location under control of the EV NPCWA or therefore delegated person. It should be easily accessible to ensure safe working and efficiency.
- The EV NPCWA or EV SP should be able to supervise the workplace if the work activity requires supervision.

Obviously, the workplace must also comply with regular applicable laws, acts and standards. All tools, aids and PPE must also comply with the applicable laws, acts and standards.

The EV NPCWA is overall responsible to check the availability, as well as the good condition of all tools, equipment and PPE. Start of work is not allowed if tools, equipment and PPE are not present or in poor condition. Additionally, all designated personnel that are to perform EV related work will also check the condition of all tools, equipment and PPE.

As soon as it is noticed that equipment is failing during the work, the work must be aborted immediately, and appropriate action taken to resolve the issue before the work can be restarted.

Charging location

- Create a dedicated location or space for charging high voltage batteries and vehicles. This location should be easily evacuated and if possible, be fire-resistant or retardant.
- The charging location should not be combined with the storage facility for batteries.
- When combining the charging space with another part of your facility, consider whether this does not create additional risk.
- When charging, use a dedicated socket for each charger and/or a dedicated separately fused circuit for each charger. DO NOT use multiple chargers on one socket or extension leads.
- Use only approved and suitable chargers for the product you are charging.

Ensure that the electrical infrastructure used for charging Li-Ion batteries adheres to the relevant standards and norms for your country. If there is no national standard, EN50110 applies.

3.6.2. Storage

At the moment, there are no general European guidelines for storage of new Li-Ion batteries. However, there may be national or local legislation that applies, so make yourself acquainted with them.

Safety considerations with regards to storage of Li-Ion batteries and electric vehicles that contain Li-Ion batteries are as follows:

New or used batteries/electric vehicles.

Since HV battery packs involve an increased fire hazard, a purpose-designed external container for storage of (Li-Ion) battery packs is required. This is valid from a minimum storage quantity of 1 unit.

The storage container should be a safe distance from other objects. A distance of 15 meters is considered a safe distance. If external storage is not feasible or possible, internal storage or an architectural equivalent can be considered.

A suitable storage container should be able to contain a fire for a minimum duration of time. The duration of time depends on the distance to other buildings or structures. The shorter the distance, the longer the storage container should be able to contain a fire. An indication of time and distance is as follows:

Distance to other building or structure	Time that fire needs to be contained
less than 5 meters	60 minutes
more than 5 meters, less than 10 meters	30 minutes
more than 10 meters	no requirements

An internal storage area should be able to contain a fire for 60 minutes.

If internal storage is used, the space should have at least one external wall that contains a door. It should also have at least two escape routes with applicable signage and lighting. If the distance from any point in the space to an escape route is less than 15 meters, one door is sufficient.

Regardless of whether the storage is internal or external, ample access should be available for emergency services. Consider the access ways, size of doors and gates and access to water.

Any storage facility should have protection to prevent possible leakage of battery chemicals into the ground.

Never charge separate HV batteries in the storage facility.

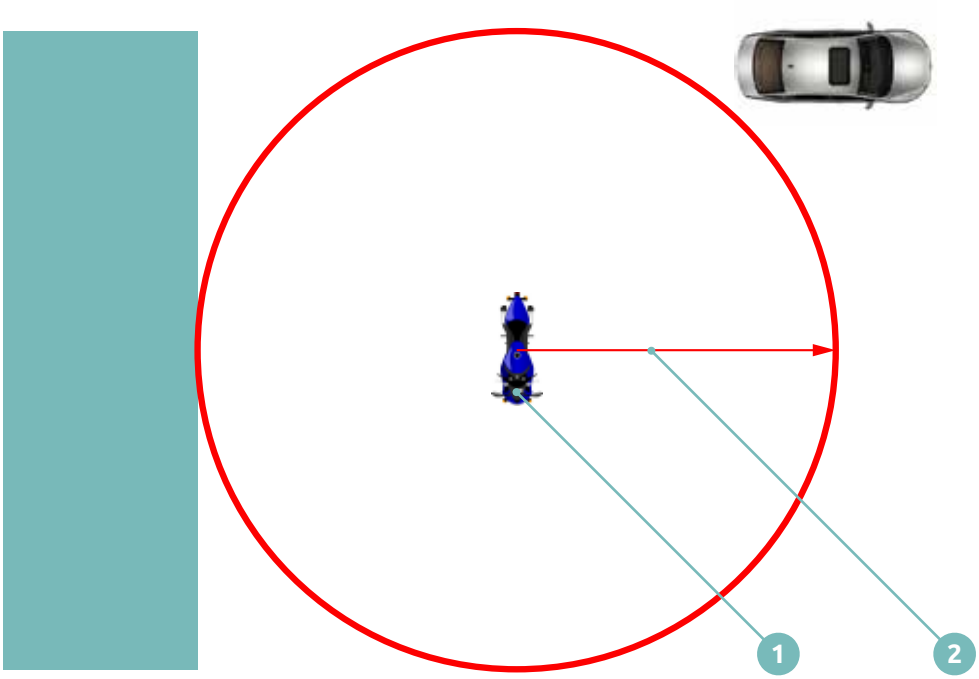
Consult with your insurance company, fire department and local government to ensure that you are adhere to the relevant rules and regulations for your situation.

Damaged high voltage batteries/electric vehicles

A damaged HV battery could ignite anytime up to 24 hours or more after being damaged. If you cannot determine the condition of the battery, suspect that the HV battery is damaged or that damage to the electric vehicle may cause the HV battery to become unstable, consult the EV NPCWA for a risk assessment and depending on the outcome of the risk assessment, leave the vehicle or battery where it is or move the vehicle or battery to an external isolation area for safety. **Damaged HV batteries or electric vehicles should never be stored inside.**

An isolation area is a safe zone used to monitor a damaged electric vehicle or HV battery. The ideal isolation area should be:

- 12m in diameter minimum.
- Have 6m minimum clearance distance between the vehicle or HV battery and other objects or buildings.
- Outside without a roof or overhead obstructions.



1. Damaged high voltage battery/electric vehicle
2. Minimum clearance radius of 6 meters

Once an electric vehicle/battery is placed in the isolation area, mark the area to make people who are not involved aware of the possible hazards. If possible, the vehicle/battery should be placed in an upright position, If any smoke, sparks, flames, gurgling, bubbling sounds or excessive increase in temperature are noticed during storage, immediately call emergency services. Maintain clear access to the stored vehicle/battery for monitoring and emergency response, if needed.

End-of-life high voltage batteries/electric vehicles.

End-of-life high voltage batteries and/or electric vehicles should be disposed of as dangerous goods. NEVER dispose of them as general waste. Please refer to the common scenarios in the next paragraph. National and local laws apply, so you need to be aware of these.

3.6.3. Transport

For the purpose of transport and handling, Li-Ion batteries are considered dangerous goods.

Dangerous goods training is required to (package and) transport a Li-Ion battery, in order to apply to the ADR regulations. This also includes shipment of non-critical batteries for warranty return as well as recycling. Specialist transport companies dealing with transporting dangerous goods should be contacted to transport Li-Ion batteries.

This means that Li-Ion batteries cannot just be transported like, e.g. an engine control module. If there is a requirement to transport separate Li-Ion batteries yourself, it is your responsibility to obtain and maintain the applicable certifications as required by law.

Exemption

The ADR regulations do not apply to the carriage of dangerous goods by private individuals if packaged for retail sale and intended for their personal or domestic use in normal conditions of carriage.

This means that customers (private individuals) can transport Li-Ion batteries without having to adhere to ADR regulations, but that any business related transport of Li-Ion batteries by employees is not allowed, unless you adhere to the ADR regulations, as explained in the legislation section of this document.

Transportation of Li-Ion batteries and Electric vehicles

Electric vehicles

Electric vehicles (classed as UN3171, Battery powered vehicles, Class 9) in normal use (i.e. new or second hand customer units that are picked up or delivered, which have no technical issues), are exempted from dangerous goods regulations, and can be transported without ADR certification. Normal safety considerations (upright transport, secure latching, etc.) apply.

Note that for shipment by airfreight or ocean freight, electric vehicles are fully regulated dangerous goods. Special training and certification is required to transport normal electric vehicles by any means other than road transport (i.e. rail, sea, air).

Electric vehicles which have crashed, or suffered some trauma or mis-handling, and where the Li-Ion battery is still fitted to the vehicle are a fully regulated dangerous good as far as transport is concerned. Electric vehicles should never be moved by a non-specialist transport company if there is a potentially damaged battery, danger of heat generation from the battery, or danger of fire. Special training, dangerous goods certification and special packaging are required to transport crashed vehicles, or vehicles with damaged batteries.

Li-Ion battery

Li-Ion batteries are considered to be dangerous goods for transportation purposes. HV batteries are UN3480, Li-Ion battery, Class 9 for transport. Special training and certification is required to package and ship normal or damaged Li-Ion batteries by any means (road, rail, ocean, air).

All transport of Li-Ion batteries, when not installed in an electric vehicle (see above) fall under the ADR regulations.

A Li-Ion battery, after normal use, must always be packaged in strong packaging (preferably the original packaging or suitable alternative packaging) and never just banded, unprotected to skid, where damage in transportation may be possible. Transportation by road only is recommended. Li-Ion batteries are prohibited from transport on passenger aircraft, and highly restricted by any other modes of transportation.

Common scenarios

Below are recommended actions for shipment and transport of Li-Ion batteries under most common scenarios.

Fully consider any unusual history of the electric vehicle or Li-Ion battery (ie. damaged, dropped, or submersion). This information may be vital to decide whether the Li-Ion battery needs to be treated as normal (normal use/normal condition) or damaged (non-normal use or abnormal condition).

Li-Ion battery (Normal use/ normal conditions)

- If the Li-Ion battery has normal history, and is showing no physical signs of capability to produce a dangerous evolution of heat, fire, or short circuit, then it can be transported as a normal Li-Ion battery (UN3480) following ADR regulations.
- In this case use the same packaging in which the replacement Li-Ion battery arrived from Yamaha, or suitable alternative packaging if the battery came with the unit.
- If sent for warranty, follow instructions provided by YAMAHA for return of Li-Ion battery and maintain proof of shipment for your warranty claim.

- Mark and label the package with all applicable markings for UN3480, Li-Ion battery, Class 9.
- If sent for recycling, it should be marked as “lithium battery for recycling” and contact your local “recycling” party on what you plan to send.

Li-Ion battery (Non-normal use or abnormal conditions)

- If the Li-Ion battery does not have a normal history, or is showing damages or physical signs of capability to produce a dangerous evolution of heat, fire, or short circuit, then it can be transported only as a “damaged” Li-Ion battery (UN3480) following ADR regulations.
- In this case DO NOT use the same packaging in which the replacement Li-Ion battery, arrives from Yamaha. Damaged Li-Ion batteries require special packaging (fireproof materials), flame retardant material (vermiculite or other), and special documentation and freight carriers.
- A specialist transport provider who will have the special packaging, and expertise to assist in preparing these “damaged” batteries for safe transportation has to be contacted to organize the transport.
- Mark and label the crate with all applicable markings for “Damaged/ Defective Li-Ion batteries” under UN3480, Li-Ion battery, Class 9.
- If sent for warranty, follow instructions provided by YAMAHA for return/scrappage of Li-Ion battery and maintain proof of shipment or scrappage for your warranty claim.
- If sent for recycling, it should be marked as “lithium battery for recycling” and contact your local “recycling” party on what you plan to send.

3.7. Insurance

As electric vehicles and especially the high voltage batteries bring certain risks, it is important that these risks are discussed with your insurance company.

Each insurance company will deal with this subject in their own way, but there are subjects that will be part of the conversation with all insurance companies.

- Storage of high voltage batteries
  As high voltage batteries are the core risk for thermal incidents, insurance companies will have guidelines in place for what is accepted and not accepted with regards to storage of high voltage batteries. Differentiation can be made for:
  - New batteries
  - Used batteries
  - Defective batteries

  Storage and transport of vehicles and high voltage batteries is also discussed in Section 3.6
- Handling of high voltage batteries
  Preparing high voltage batteries for use or preparing them for transport is another subject that insurance companies are interested in, as it also carries risk. Guidelines may be available.
- Charging of high voltage batteries
  Charging of high voltage batteries (whether in or out of the vehicle) is something that insurance companies will be interested in and will probably have guidelines for.
- Processes for evacuation and fire prevention/fire resistance
  Insurance companies will need to know what processes and measures are in place for when an accident does happen. This is probably not very different from the current information that has been discussed and documented with the insurance company, but the additional types of risks involved with electric vehicles will demand further discussions to take place with the insurance company.

Although different insurance companies can have different conditions, rules and guidelines, some general advice can be given. Please note that some of these have also been discussed in other sections of this document.

- Store used and/or defective high voltage batteries outside of the building, a safe distance from other buildings and structures.
- Create a dedicated location or space for charging high voltage batteries and vehicles. This location should be easily evacuated and if possible, be fire-resistant or retardant. When combining this space with another part of your facility, consider whether this does not create additional risk.
- Do not charge high voltage batteries or vehicles unattended.
- Do not charge a vehicle while it is being repaired.
- Keep the number of high voltage batteries or vehicles stored in a single space limited. An exact number cannot be given, it depends on the guidelines of the insurance company, type and size of batteries and specifications of the space.
- When charging, use a dedicated socket for each charger and/or a dedicated separately fused circuit for each charger. DO NOT use multiple chargers on one socket or extension leads.
- Use only approved and suitable chargers for the product you are charging.
- Ensure that the electrical infrastructure used for charging Li-Ion batteries adheres to the relevant standards and norms for your country. If there is no national standard, EN 50110 applies.

Liability insurance

Apart from the insurance for the facility, considerations need to be made with regards to liability insurance.

Commercial liability insurance provides insurance coverage for lawsuits arising from injury to employees and the public, and property damage caused by an employee, as well as injuries suffered by the negligent action of employees.

Although this insurance is not specifically related to the working on (or nearby the HV system of) electric vehicles, discussing this new aspect of the business with the insurance company is important.

The insurance company may request further details with regards to the implemented process to prevent accidents, including delegation of responsibility and training.

Other considerations

Some business related operations may not take place directly at your facility, e.g. organising an event. When these operations require a separate insurance, don't forget to include the electric vehicle aspects into your discussions with the insurance company.

Summary

Organisational structure

- For occupational health and safety, EN50110 specifies the responsibilities for people working on (or nearby the HV system of) electric vehicles in a company.
- In order to adhere to EN50110, an EV specific organisational structure needs to be put in place. This structure should consist of an EV NPCWA, EV SPs and EV IPs (if required).

Designation

- Everyone in the EV specific organisational structure needs to be designated by the employer (or the EV NPCWA), in writing.
- Designating an employee for one of the EV specific roles requires that person to have the relevant knowledge, skills and certification.

Documentation

- Having the correct documentation is important to prove that working on (or nearby the HV system of) electric vehicles is performed according to the relevant rules and regulations.
- Consider where to store the various documentation.
- Requirements for the documentation can be more stringent than the YAMAHA guidelines due to national or local legislation.

Training

- Training is required for everyone working on (or nearby the HV system of) electric vehicles. Designating someone as an EV NPCWA, EV SP or EV IP can only be done once they have the required knowledge and certification.
- Don't forget to also instruct/inform any ordinary person with regards to their responsibilities.
- Transport of dangerous goods (Li-Ion batteries) requires dedicated training to be able to adhere to the ADR regulations.
- Consider additional first aid training as working on (or nearby the HV system of) electric vehicles brings new risks.

Facility layout

- Create one or more dedicated workplaces for work on electric vehicles.
- Create a dedicated area for charging electric vehicles and batteries. Do not combine this area with the storage area for batteries.
- An external isolation area should be available where damaged and/or unstable vehicles and batteries can be moved to.
- When organising the layout for working on (or nearby the HV system of) electric vehicles and batteries, consider access for emergency services.

Storage

- Although there are currently no European rules for storage of electric vehicles and batteries, national and local laws may apply.
- Preferably store new and/or used batteries in a dedicated storage container outside the building. If this is not feasible, create a dedicated space for storage inside.
- Damaged and/or unstable batteries (also when fitted to vehicles) should never be stored inside, but in a dedicated outside isolation area. Ensure that no chemicals or fluids can leak into the ground.

Transport

- Electric vehicles in normal use, are exempted from dangerous goods regulations.
- Li-Ion batteries in normal use are classed as dangerous goods, regulations for transport apply.
- Electric vehicles and Li-Ion batteries that are damaged or unstable, are classed as dangerous goods, specialist transport procedures apply.

Insurance

- The insurance company will have to be informed of the introduction of electric vehicle in the dealership. They may already have specific guidelines and rules in place. Discuss all aspects and don't forget liability insurance.

4. What to buy

4.1. Tooling

4.1.1. Insulated tooling

To be used when working on or near live parts, even if they are shrouded. Remember that all high voltage systems in a vehicle are considered live, until proven otherwise! During the de-energizing process, the insulated tooling must be used. Other work on live systems is prohibited!

4.1.2. Two-pole voltage detector

A two-pole voltage absence tester must be used to check for the absence of voltage on the high voltage system after it has been de-energised. The use of a two-pole voltage absence tester prevents possible errors with settings and incorrect connection of measuring leads. The two-pole voltage absence tester should be checked for proper operation immediately before and after use. Testing must be performed on a known voltage source (e.g, 12V battery).

Please note, regular multimeters are capable to indicate the absence of voltage on a de-energised high voltage system, but since they require certain settings to be selected and measuring leads to be connected, this can increase the risk of making errors and therefore Yamaha Motors Europe does not permit the use of a regular multimeter.

4.1.3. Mega-ohm meter

A mega-ohm meter is used to measure the electrical resistance of insulators, e.g. the high voltage cables in an electric vehicles.

The UN ECE R136 stipulates that the insulating resistance between the high voltage conductor and the electrical chassis must have a minimum value of 500 Ohm/Volt of the working voltage, measured with at least half the operating voltage of the system.

The insulating capacity must be tested at the time of re-commissioning the high voltage system after work has been performed on the components in question.

A mega-ohm meter will put a high DC voltage at a specified current capacity on the component and show the resistance to that voltage. Normal multimeters are not capable of delivering high enough voltage for an approved measurement.

4.1.4. Milli-ohm meter

A milli-ohm meter is used to measure the resistance over the connection between the housings of different parts of the high voltage system.

The UN ECE R136 stipulates that the resistance between the exposed conductive parts (housings) and the electrical chassis must be lower than 0,1 Ohm when there is a current flow of at least 0,2 Ampere.

The connection must be checked at the time of re-commissioning the high voltage system after work has been performed on the components in question.

Milli-ohm meters use a parallel measurement with 4 wires and a calibrated current to measure low resistance in order to identify poor connections. Normal multimeters are not precise enough to measure these low resistances.

4.1.5. Infrared thermometer or heat-sensing camera

In order to check the temperature of a battery, an infrared thermometer or heat-sensing camera can be used. This will indicate unexpected temperature increase and hence, give an indication of a battery becoming unstable upon which the relevant safety measures can be taken.

4.2. PPE

The protective equipment indicated in this guideline is recommended by YAMAHA. Use equipment specified by the laws and regulations of your country.

4.2.1. Rubber gloves

Insulation rubber gloves should be worn whenever work is performed in an area within 10 cm where live parts might be touched. These can be complemented with thin inner gloves for hygienic purposes.

4.2.2. (Leather) safety gloves

Although not required for electrical protection, leather safety gloves are advised to protect the rubber gloved from damages. When used, these are worn over the rubber gloves.

4.2.3. Face mask

A face mask should be worn when a person's head can come within 50 cm or bare live parts that might be touched. In addition, when working on parts where there is a risk of short circuit, a face mask should be worn. Applicable standards apply (see table in section 4.4).

Please note that safety goggles only protect the eyes and not the face and hence, are not suitable as protective equipment for working on electric vehicles.

4.2.4. Work coat

A work coat provides protection in case the person's own clothing contains metal parts. It also protects the arms in case the person's own clothing doesn't have sleeves.

4.3. Workshop equipment

4.3.1. Instruction/workshop manual/technical documentation

Information about the electric vehicle that is relevant to the work to be carried out should be up-to-date and available.

4.3.2. Warning signs, cones, barriers

The boundaries of the workplace should be clearly and visibly indicated. The used warning signs, cones or barriers have to comply with European standards.

Barriers provide a better prevention from un-authorised persons entering the working zone than cones or warning signs. Be careful that the use of barriers does not create a trip hazard.

A safety warning in the form of a card or leaflet should be clearly visible in the working zone indicating who is the EV NPCWA for the work.

Warning! Electrical work carried out.

Do not turn ON vehicle. Do not touch vehicle.

Responsible person:

.....

4.3.3. Safety hook

Tool recommended to have available, in order for a 2nd party to be able to safely release a person in case of electrocution.

4.3.4. Insulation cover/insulation mat

Used in case live parts in an electric vehicle might be touched. With the use of an insulation cover or mat, the risk to inadvertently touch these parts can be mitigated.

4.3.5. Insulation tape and sleeves

To insulate any disconnected connections and to prevent possible contact or shorting, insulation and or sleeves can be used.

4.3.6. Safe

The vehicle keys and the service connector or switch used to isolate the electric vehicle during the work must be securely stored away from the vehicle to protect against switching the high voltage system back on again. Carrying it on one's person is possible, but keyless operated vehicles still pose a risk. A separate safe to lock away the keys and service connector or switch is recommended.

4.4. European standards for tooling and equipment

In general, the following marking shows that the tools and the protective equipment comply with the standards:

Marking according to IEC

The following standards apply to tooling, PPE and workshop equipment for use with electric vehicles.

Tooling	European Standard
Two-pole voltage detectors	ENIEC 612433
Hand tools	ENIEC 60900

Personal Protective Equipment	European Standard
Protective clothing against arcs	IEC 61482-2
Gloves and mitts	ENIEC 60903
Gloves and mitts with mechanical protection	EN 50237
Insulating clothing	EN 50286
Face mask	EN 166 (provided with a 1 000 V symbol)

Workshop Equipment	European Standard
Warning signs	ENIEC 61310-2
Insulating matting	ENIEC 61111
Insulating blankets	ENIEC 61112

Summary

- Specific tooling should be available when working on electric vehicles, particularly insulated hand tools and certain measuring equipment.
- Personal Protective Equipment should be available and in good order for anyone working on (or nearby the HV system of) electric vehicles.
- Certain workshop equipment is required to ensure that occupational health and safety can be catered for.
- When purchasing any tooling, PPE or workshop equipment, ensure that they adhere to European and national or local laws and regulations.

5. Working on EV – basic principle

5.1. Dead working

5.1.1. Intrinsically safe electric vehicle (i.e. production vehicles)

The safe working on electric vehicles is based on the following principle:

All electric vehicles must be considered unsafe until proven safe by a designated person, e.g. EV SP or EV NPCWA. An EV IP is not allowed to prove this.

Electrical work may not be started until protective measures have been taken against electric shock, short-circuits and potential arcing. Generally, work on live parts of electrical vehicles is prohibited. Therefore the electrical system of the vehicle should be placed in a non-live (dead) state prior and for the duration of the work.

Part of the protective measures is a risk assessment that should be performed for all operations on, with or near the vehicle before the work commences. This risk assessment is performed by the EV NPCWA. During this risk assessment, the EV NPCWA assesses potential dangers and dangerous effects which can result from the planned activity and could harm people, the environment and/or equipment.

A work instruction describing how the work shall be carried out shall be developed by the EV NPCWA based on the risk assessment and the work shall be carried out in accordance with this work instruction. Parts of the work instruction will be based on the workshop manual and specific manufacturer's instructions for the vehicle in question.

Ensuring a non-live state is a critical part of the safe working and hence, the work instruction.

The following five safety steps form the basis of ensuring a non-live, de-energised state:

- Isolate from voltage source
- Safeguard against reconnection to voltage source
- Verify the non-live, de-energised state
- Earth and short-circuit (where applicable)
- Shroud or safeguard adjacent live parts (where applicable)

The reinstating of the electric vehicle to the live state should also be described in the work instruction. If work on the high voltage system has taken place, the integrity of the high voltage system should be confirmed by an EV SP or EV NPCWA before the vehicle is put back to the live state.

Recurring work operations on identical vehicles under the same conditions (e.g. maintenance work) can be covered with one risk assessment and one work instruction. However, if there any deviations from the conditions or the state of the vehicle, a new risk assessment and work instruction must be performed and created.

Do not spin the driven wheel when working on an electric vehicle as this could result in high voltage being created by the electric drive motor, which may not be isolated from the high voltage system.

5.2. Live working

Working on live parts of electric vehicles in principle is not permitted and YAMAHA will not advise or demand workshops to perform inner service of Li-Ion Batteries (= YAMAHA prohibits the opening of the battery pack), as it contravenes the basic principles of occupational health and safety regulations and is almost always a violation of those regulations. Live work presents increased risk of electric shock and arcing.

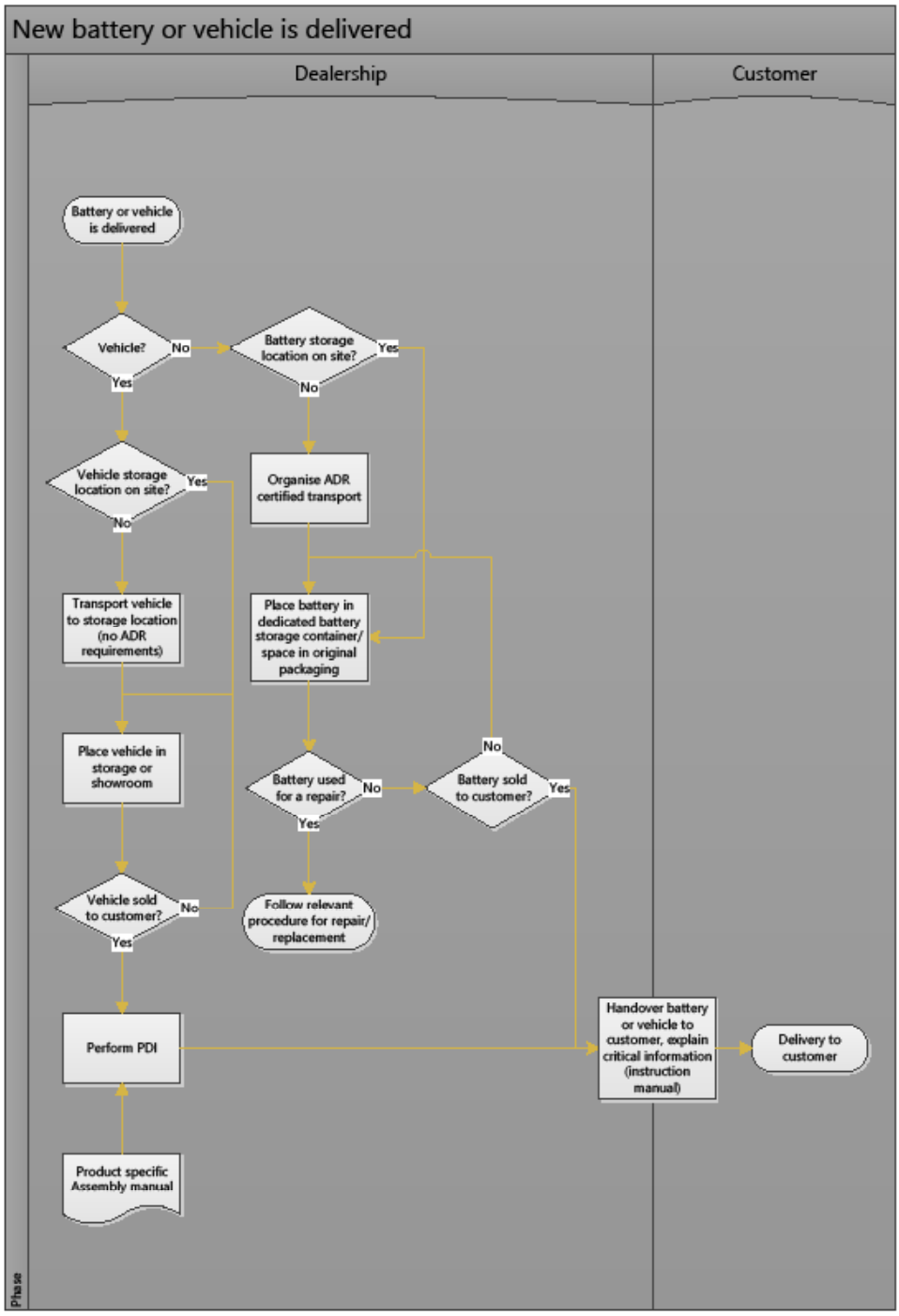
In case a vehicle cannot be put in a non-live state, i.e. that high voltage battery cannot be isolated from the high voltage system, contact your distributor.

Summary

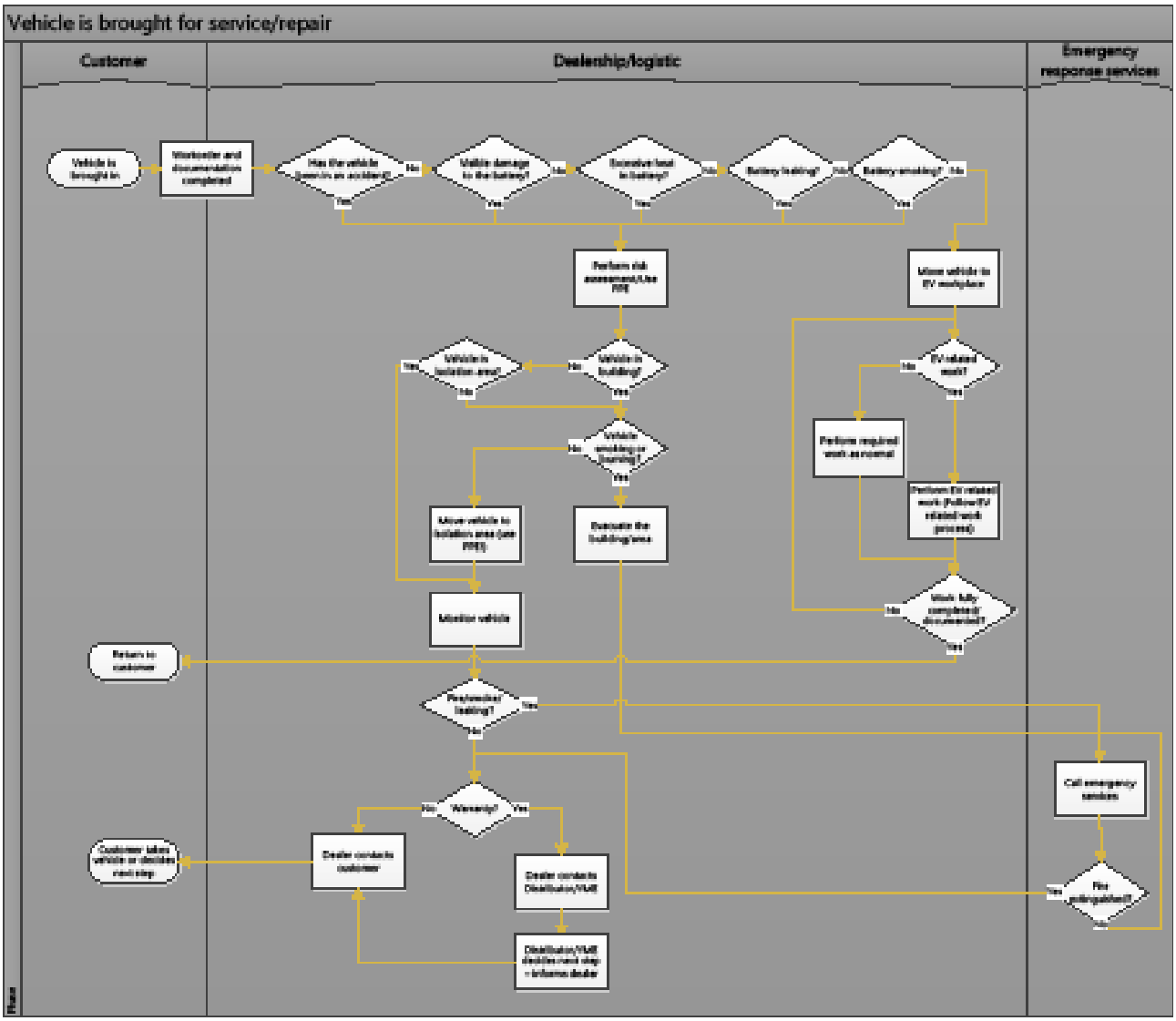
- Performing EV related work follows certain safety steps to ensure the health and safety of the people involved.
- Any EV related work starts with a risk assessment and will be done according to the prepared work instruction.
- Working safely can only be done in a non-live, de-energised state, which the vehicle will have to be put into.
- EV related work on prototype or pre-production vehicles requires a dedicated risk assessment and work instruction. EV IPs should not perform any EV related work on prototype or pre-production vehicles.
- Live working is not permitted.

6. What if?

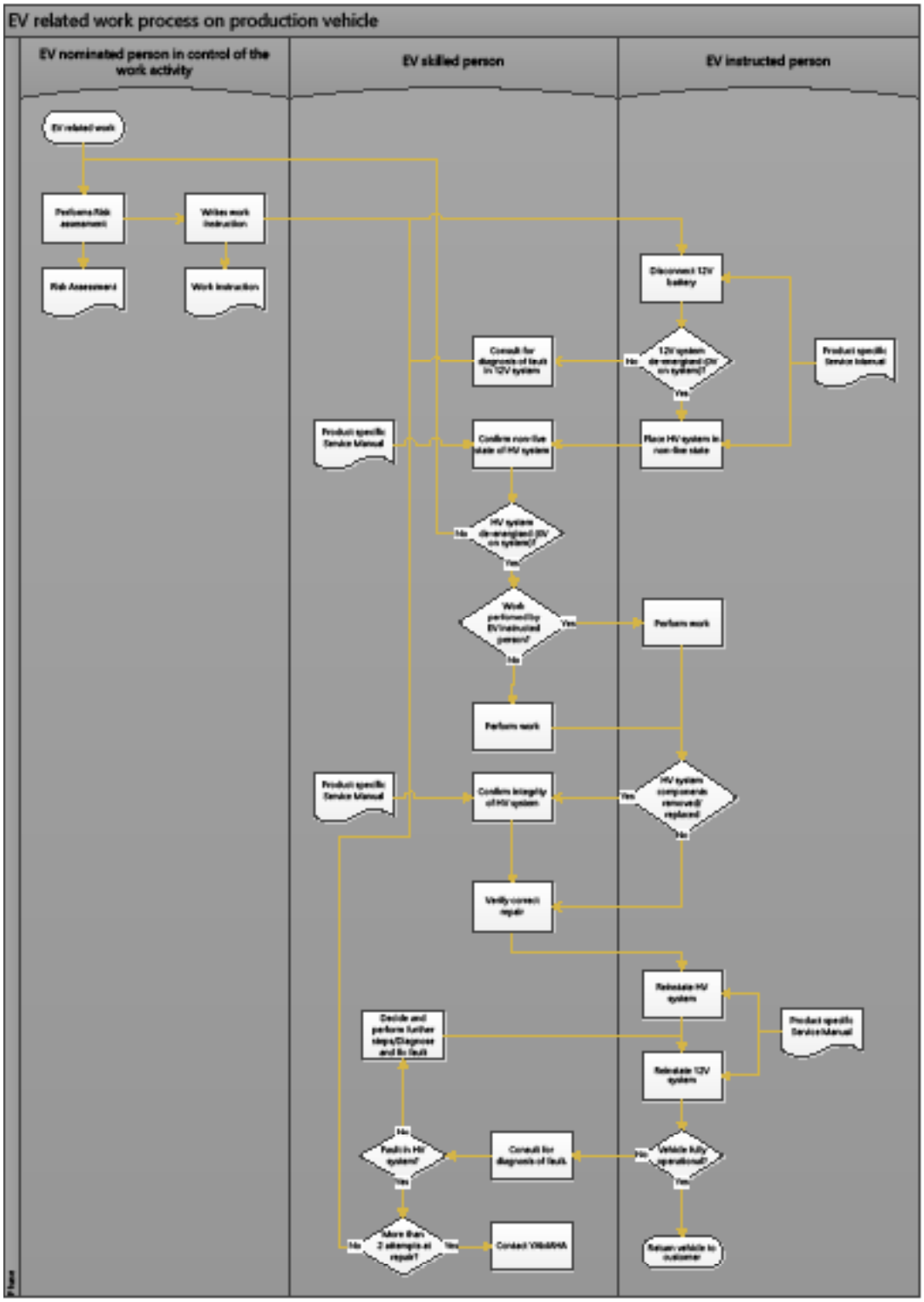
Flowchart 1 – A new vehicle or battery is delivered to the dealership.



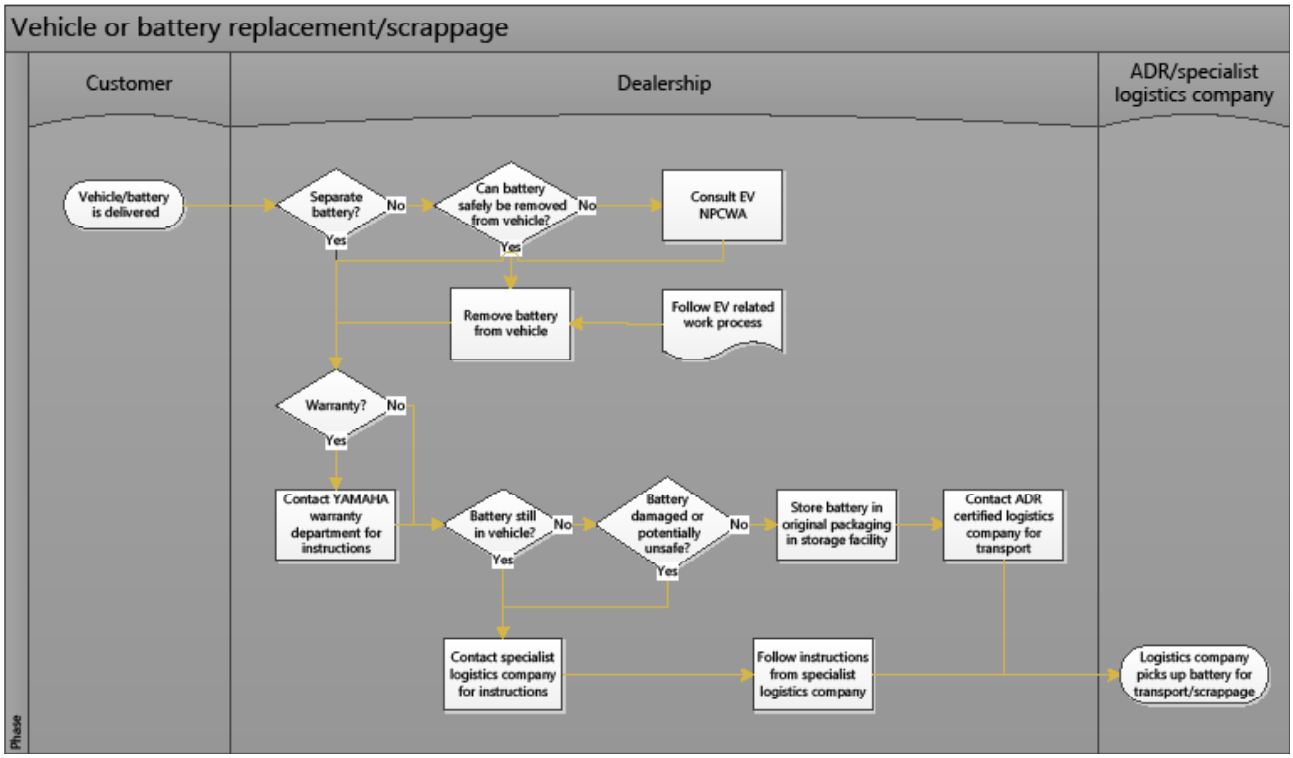
Flowchart 2 – A vehicle is brought in for service or repair



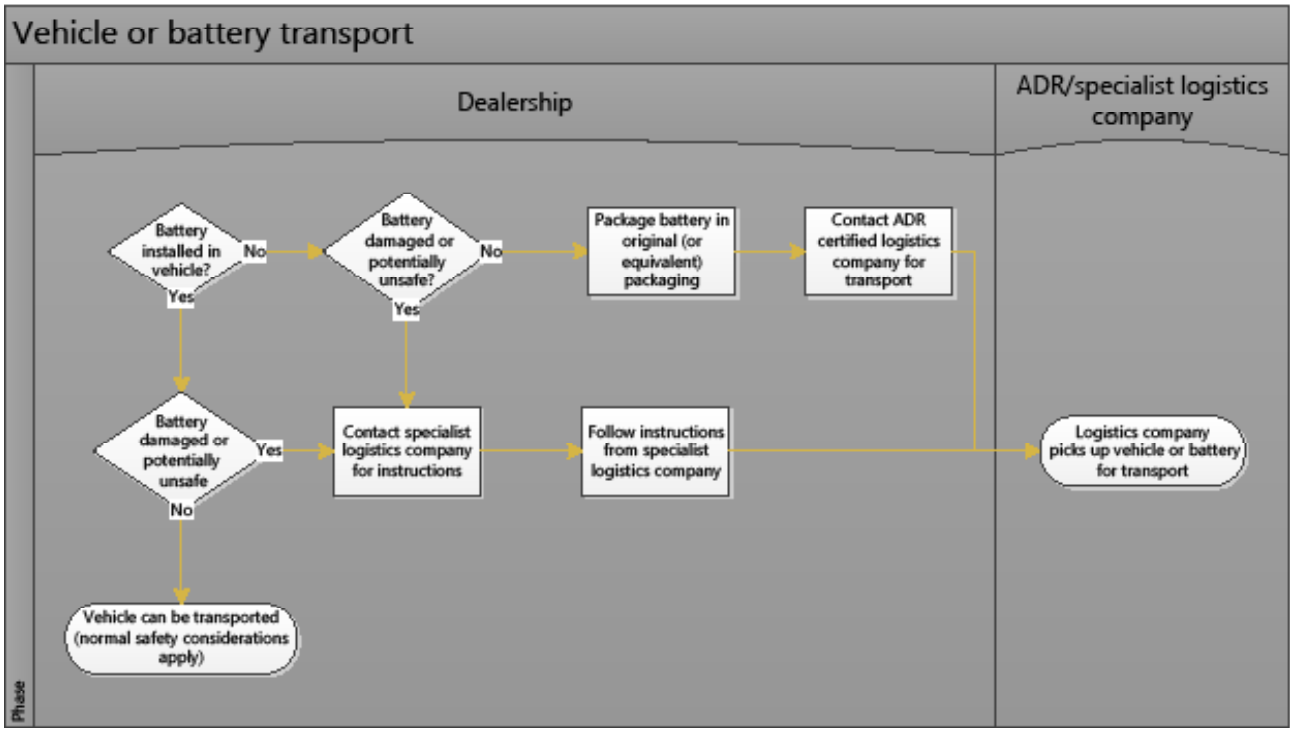
Flowchart 3 – EV related work process



Flowchart 4 – Vehicle or battery replacement or scrappage



Flowchart 5 – Vehicle or battery transport



Appendix 1 – Skills and knowledge for specific roles

Where a person is to be designated for a certain EV role and charged with the tasks and responsibilities that accompany the designation, the person designating needs to verify the skills and knowledge of the person.

The person designating may consider vocational qualifications, vocational experience gained, certificates, training and instruction.

The required skills and knowledge for the specific EV roles to be assessed before designation can take place are as follows:

EV NPCWA and EV SP

- Does the person to be appointed have sufficient knowledge of electricity?
- Does the person to be appointed have sufficient experience of electrotechnical work?
- Does the person to be appointed have sufficient:
    - understanding of the electricvehicles on which work shall be carried out, and
    - practical experience of such work?
- Does the person to be appointed have sufficient understanding of the possible hazards that may occur while work is carried out and of the precautions to be observed?
- Is the person to be appointed sufficiently skilled to identify at all times whether the work can be continued safely?
- Does the person to be appointed have sufficient managerial capacities?
- Does the person to be appointed have sufficient amounts of the proper tools, devices, and personal and other protective equipment?

EV IP

- Which specifically listed work activities is the person to be appointed allowed to carry out?
- On what types of electric vehicle, or parts of types of electric vehicle, is the person to be appointed allowed to work?
- Has the person to be appointed been sufficiently instructed and have they been given the instructions that are necessary for the work to be carried out?
- Is the person basically skilled to recognize possible risks and dangers.
- Is the performed work which the person is appointed to generally executed correctly.

Appendix 2 – Documents

Example Risk assessment

Risk assessment														
	Work-area													
	Working group/person													
	Activity													
	Risks/dangers detected and their impact			Evaluation of the risk/danger				Description or required actions		Consultant		Deadline		Effective?
				Great	Medium	Small	Action required Yes/no					Completed		Yes/no

Example Work instruction

Work instruction			
Date:	Filled in by:	Checked:	Approved:
Activity: *(Activity for which the document is created.)*			
1. Area of application			
Activity to which the work instruction applies/for which persons it is valid.			
2. Risks to people and the environment			
Dangers/effects which can result from this activity.			
3. Protective measures and rules of behaviour			
Protective actions/work operations to be applied in this activity.			
4. Action in the event of a problem			
Actions to be taken in the event of problems in the course of the work and persons to be informed.			
5. Action in the event of an accident / first aid			
Actions to be taken in the event of an accident; persons to be informed.			
6. Checks by the person responsible for the work			
Activities to be carried out before starting the work itself.			

7. Work sequence and safety measures
Step by step description of the activity and appropriate safety precautions, workshop manual and other manufacturer information should be used.
8. Completion of the work
Activities to be carried out after the work has been completed.

Example Designation letter

Designation letter

Person to be designated: .....

Name: .....

Date of birth: .....

Task: .....

Department: .....

will be designated as of .....

by undersigned person for the role of .....

until (date) .....

This designation applies to the following vehicle(s) or installation(s):

.....

.....

The following limitations are applicable:

.....

.....

The person to be designated declares to be aware of the (relevant European/national/local legislation) and has received the necessary instructions and training.

By signing this document I declare that I understand and agree with the statements above.

Signature	

Place: .....

Date: .....

Signature of person designating, the responsible person, on behalf of the employer:

Name: .....

Signature	

Signature of the person to be designated:

Name: .....

Signature	

Appendix 3 – Emergency information

Please use this list to fill out the emergency information relevant for your location.

Firebrigade: .....

Ambulance: .....

Police: .....

Responsible person for health and safety in company.

Name: .....

Contact details: .....

ADR Logistics company: .....

Name: .....

Contact details: .....

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