

# Electromechanical Brakes and UNECE R13/R13-H

Workshop in Brussels – March 29<sup>th</sup>/30<sup>th</sup>

*Day 1, 10:00 – 12:00*

# 1. Overview of new technical concepts for Electro-Mechanical Brakes

# Electro-Mechanical Brakes (EMB)

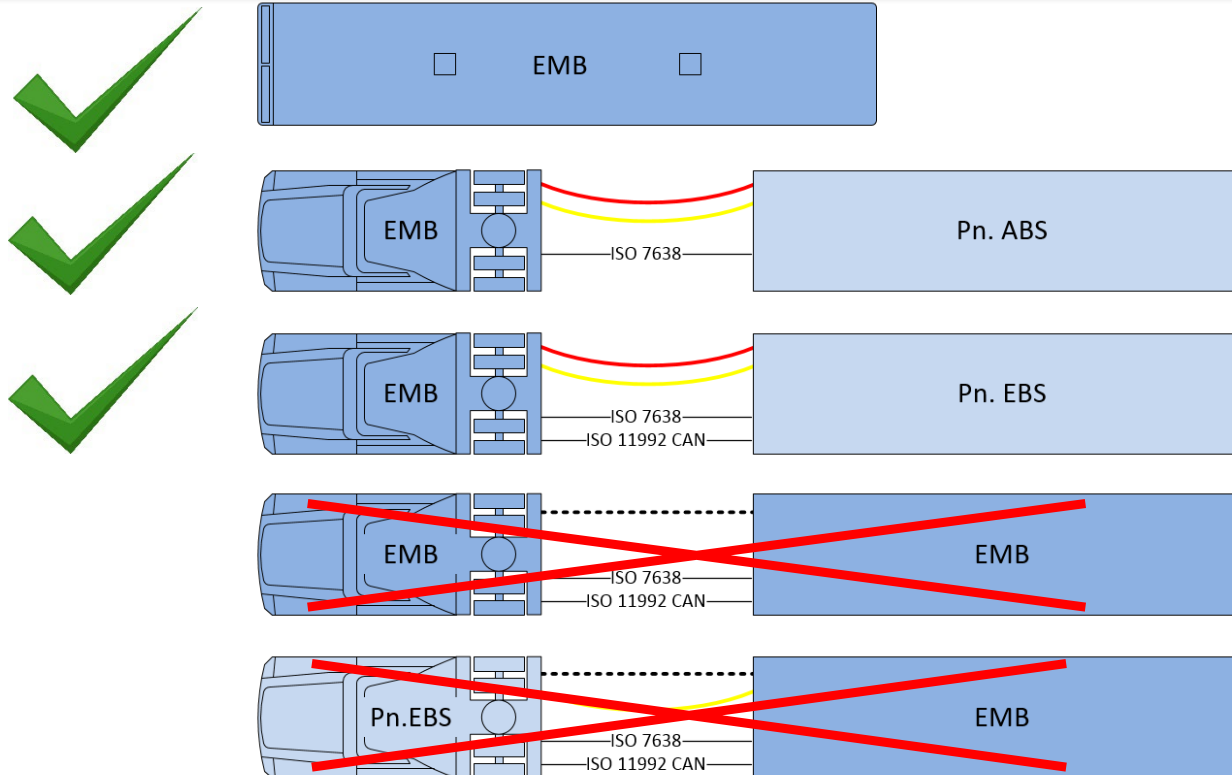
## Purpose and Scope

- Electric transmission:
  - Current regulation for the service braking only addresses electric control transmission
  - The **purpose** of the EMB amendment is to address also electric energy transmission in the regulation
- In a first step for UNECE-R13, the **scope** is limited to EMB on the motor vehicle; the trailer remains as today

# UN R13 and Electro-Mechanical Brakes (EMB)




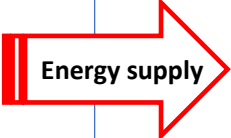


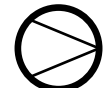







## Amendment scope and motivation

- Motor vehicle with EMB brakes on all axles (not mixed with Pneumatic Or Hydraulic systems)
- Motor vehicle with EMB brakes with “conventional” trailer interface according to current UN R13
- Trailers with EMB excluded from scope
- UN R13-H not included but considered, in particular when creating new definitions



### Advantages and possibilities by amending *Electric Energy Transmission* to UN R13

- Improved energy efficiency in EV's (vs. air compressor)
- Improved braking control
- Elimination of noise emissions from pneumatics

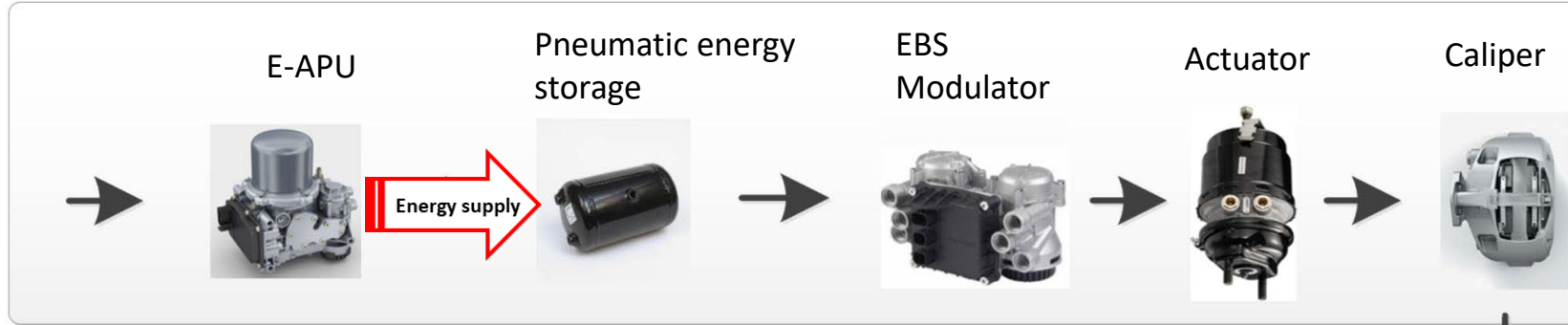
Type of powertrain	Received Energy	Supply		Supplied energy
		source	Conditioning	
 <b>ICE</b>	 <b>MECHANICAL</b>	 <b>COMPRESSOR</b>	+ Governor valve + Air dryer	 compressed air pressurized fluid vacuum low voltage power ...
		 <b>ALTERNATOR</b>	 24V	
		 <b>PUMP</b>		
 <b>BEV</b>				
 <b>ICE</b> ↓  <b>Generator</b> →  <b>TB</b>	 <b>HIGH VOLTAGE POWER</b>	No source	 <b>DC/DC</b>	 low voltage power

# UN R13 and Electro-Mechanical Brakes (EMB)

## Energy Transmission principles (Pneumatic vs. Electric)

EBS

Pneumatic Energy



Annex 7 part A

5.2.1.27

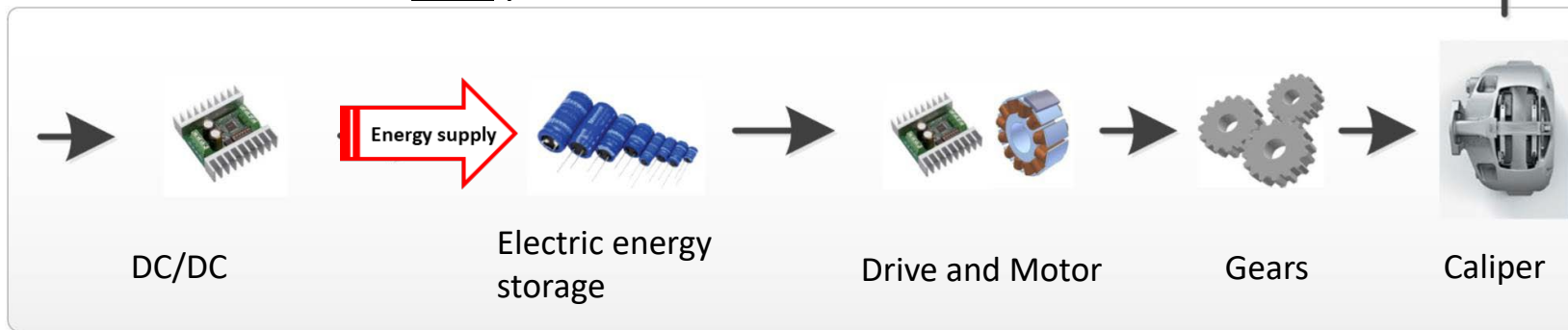
Energy supply

Energy reserve

Actuation

EMB

Electric Energy



Annex 7 **new** part D

**New** 5.2.1.35.

DC/DC

Electric energy storage

Drive and Motor

Gears

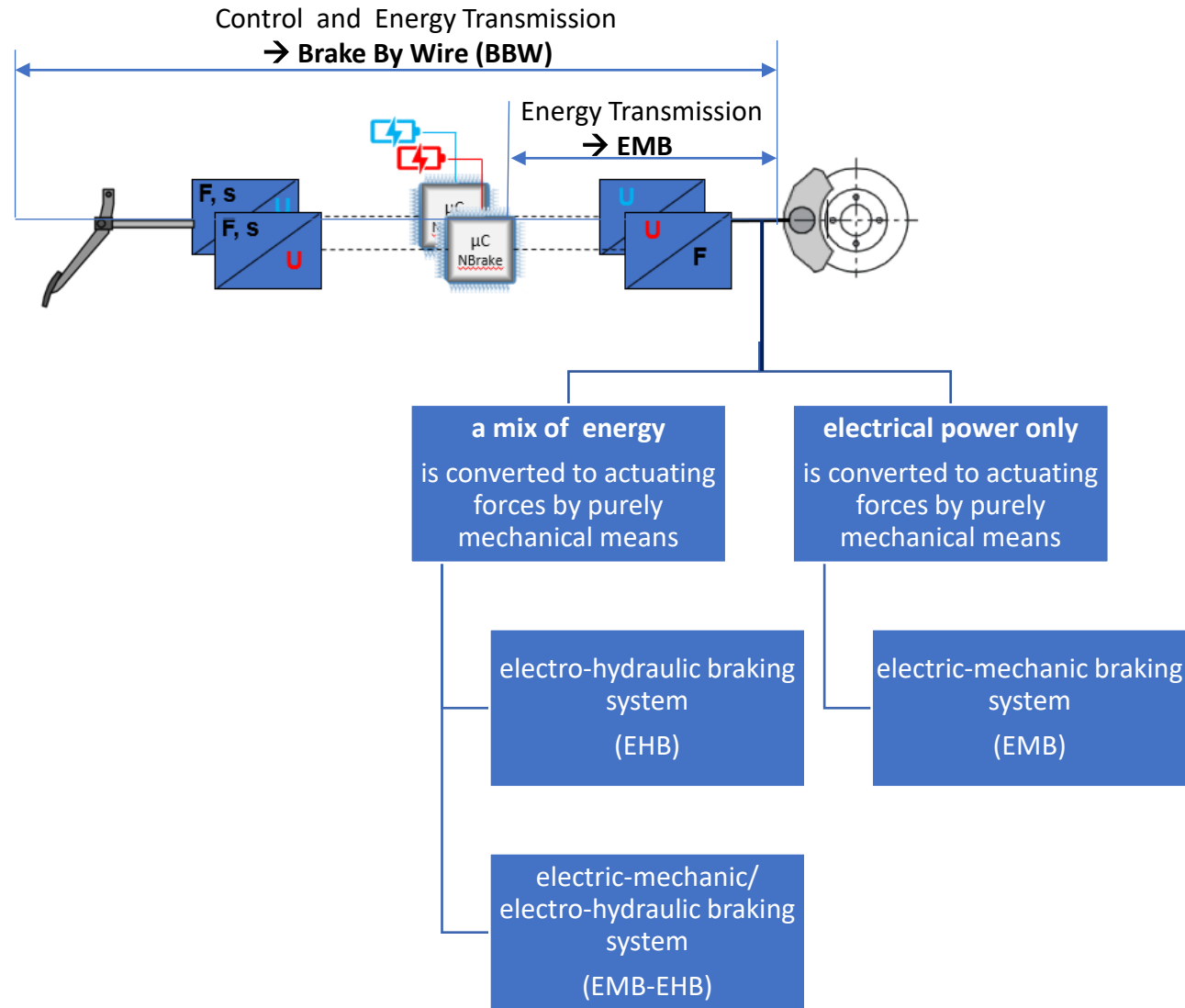
Caliper

# Motivation amending UN R13-H on Full Power Braking Systems

- Full Power Braking Systems are under development as an alternative to conventional hydraulic braking systems.
- Currently potential approvals to UN-R 13H/01 Suppl.4 for such Full Power Braking Systems are unclear due to missing definitions and requirements.

# Classification

## Brake by Wire (BBW) versus Electro Mechanical Brake (EMB)





*Day 1, 13:00 – 18:00*

## 2. Traditional brakes and new concepts

# Main challenges

- Keep same safety level as with current technologies
- Account for new technology, while avoiding design restrictions
- Keep the requirements performance-/function oriented
- Avoid unwanted side-effects on existing regulation
- **Keep R13 and R13-H definitions and principles aligned**
- Example technical challenge:
  - Effect of ageing and temperature on the performance of energy storage devices
- Example regulatory challenge:
  - Ensure energy warnings are displayed to the driver acc. to performance level

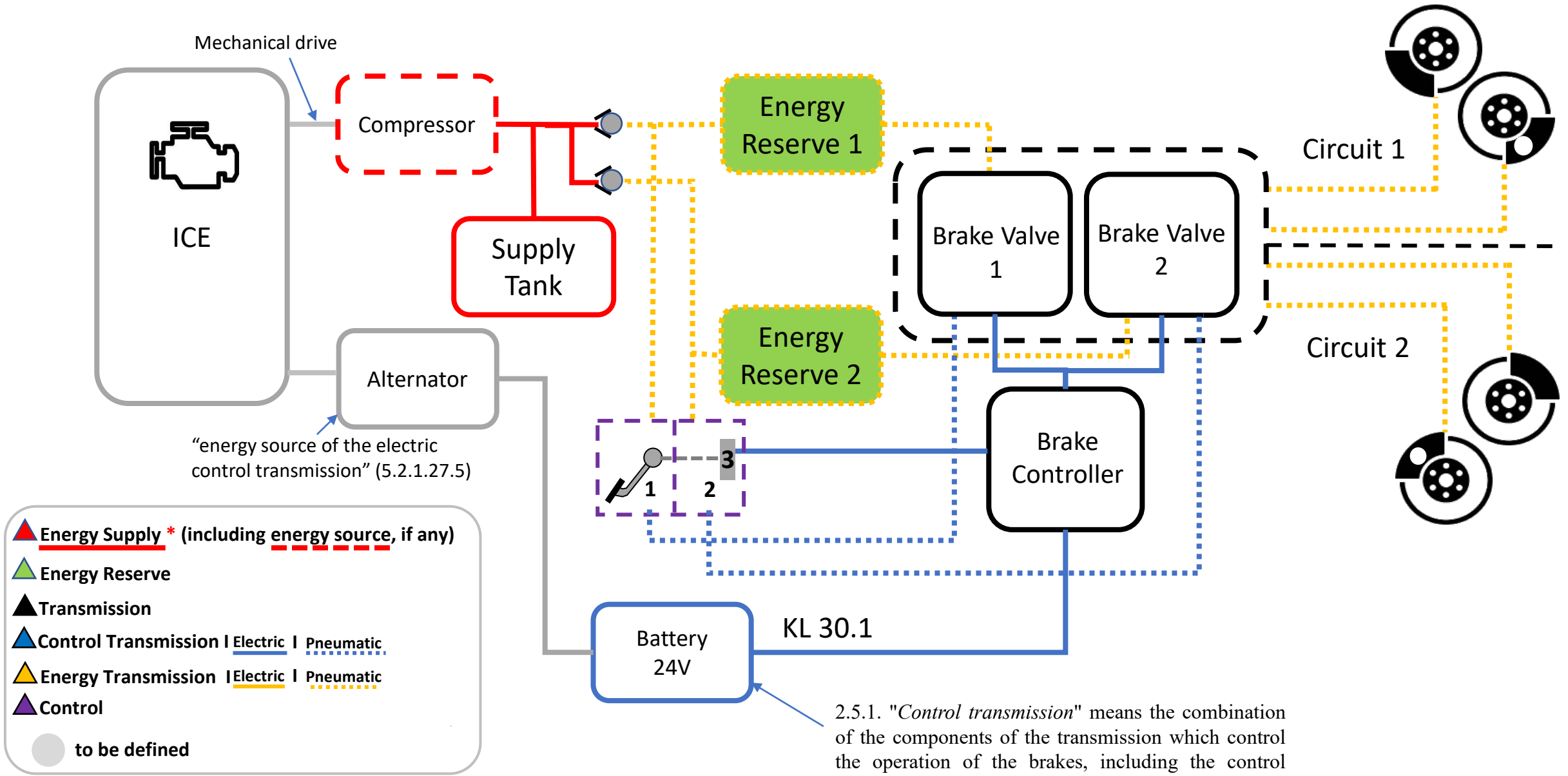
*Day 1, 13:00 – 16:00*

# Traditional brakes and new concepts

## (2a) “Full” EMB for Heavy Duty Motor Vehicles

- I. System Board-net (Energy and Control transmissions)
  - II. Energy Source, Supply ,Storage and friction brake actuation
- 
- Existing typical layout (EBS)
  - Intermediate layout between EBS and EMB
  - Targeted EMB principal layouts

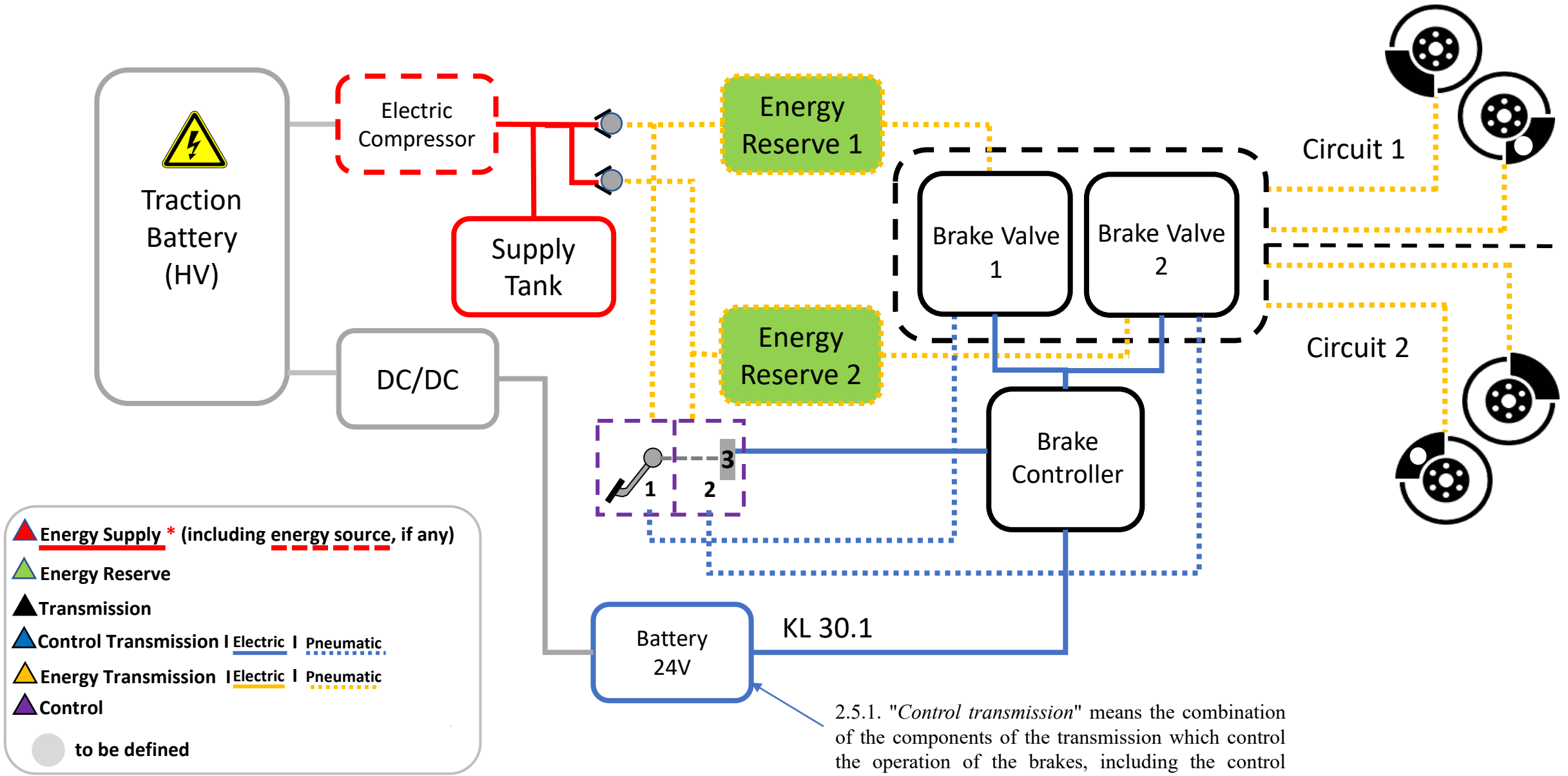
# R13 - Existing typical layout - EBS



2.5.1. "Control transmission" means the combination of the components of the transmission which control the operation of the brakes, including the control function and **the necessary reserve(s) of energy**.

2.(a) Energy transmission = pneumatic  
Control transmission = electric + pneumatic (backup)

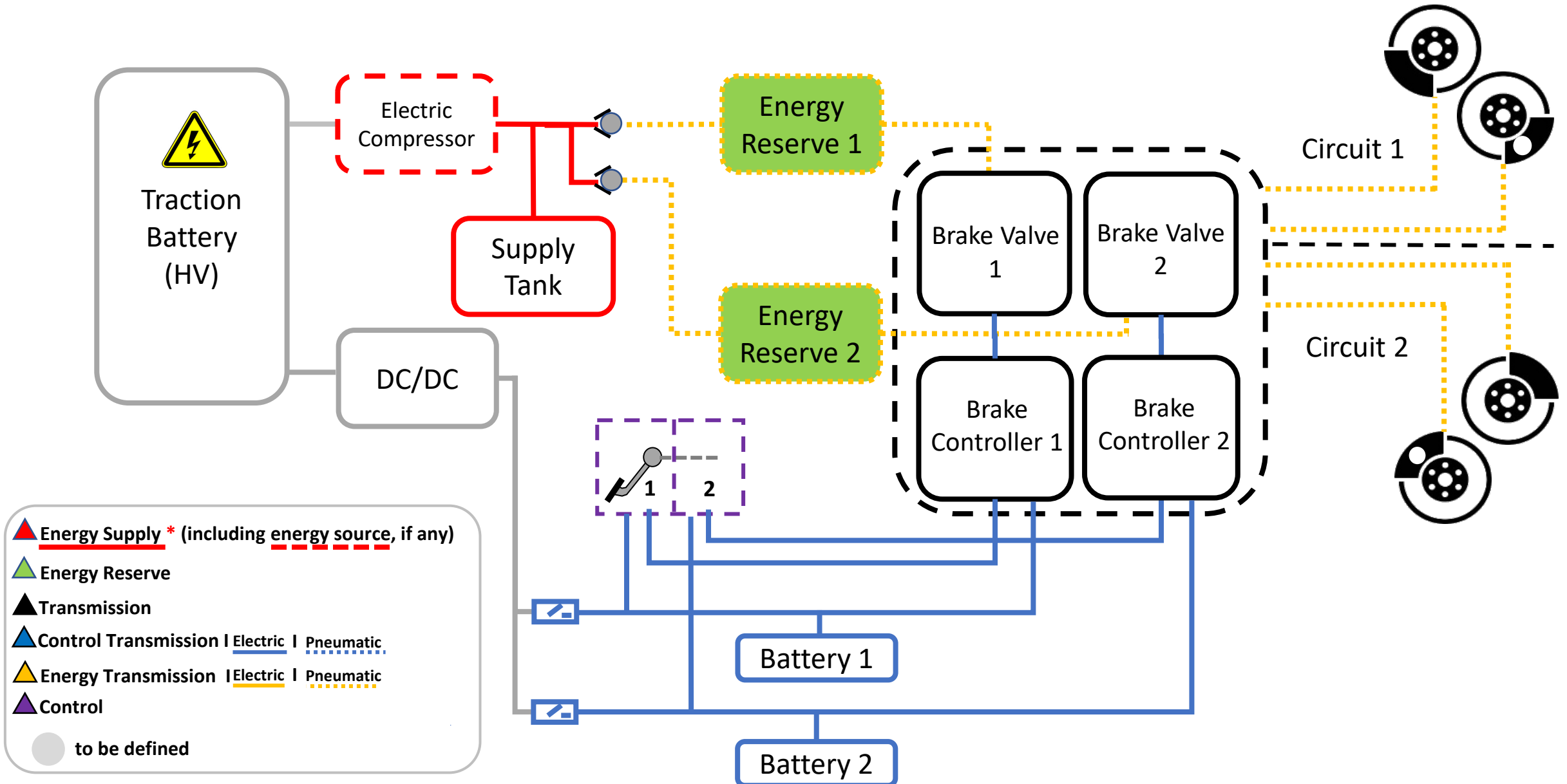
# R13 - Existing typical layout - EBS



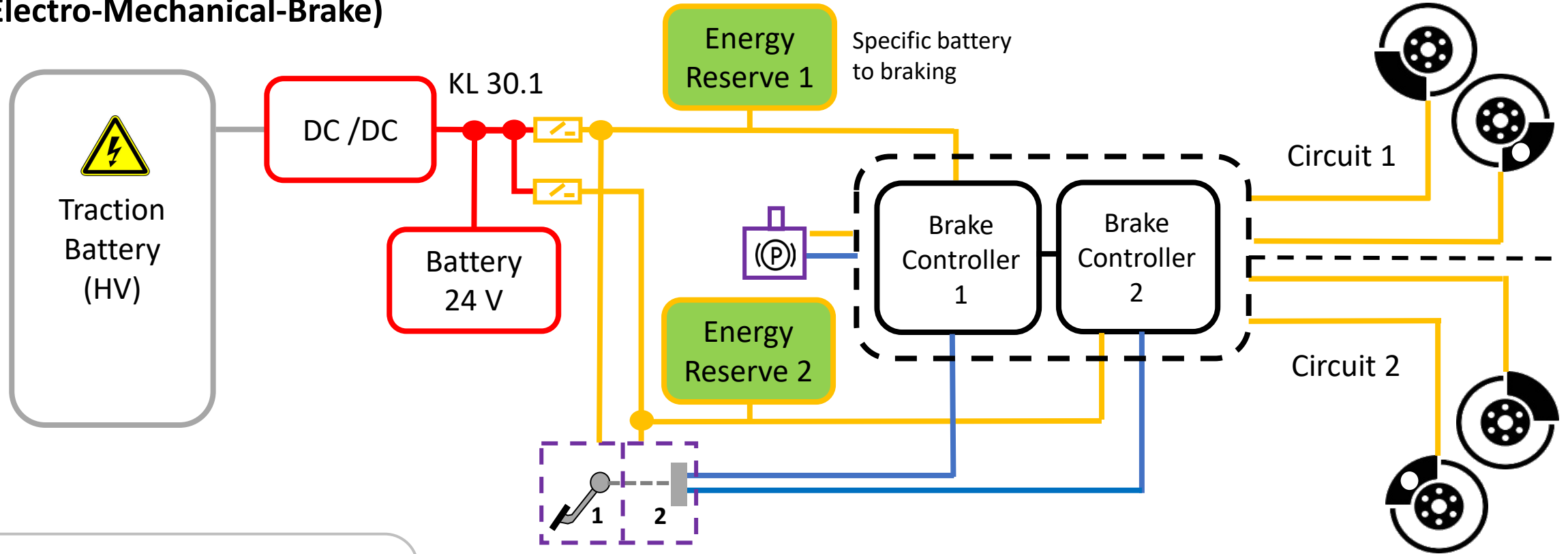
2.5.1. "Control transmission" means the combination of the components of the transmission which control the operation of the brakes, including the control function and **the necessary reserve(s) of energy**.

2.(a) Energy transmission = pneumatic  
Control transmission = electric

# R13 - Intermediate step between EBS and EMB



# R13 EMB Targeted layouts – layout 1a (Electro-Mechanical-Brake)



▲ Energy Supply \* (including energy source, if any)

▲ Energy Reserve

▲ Transmission

▲ Control Transmission

▲ Energy Transmission | Electric | Hydraulic

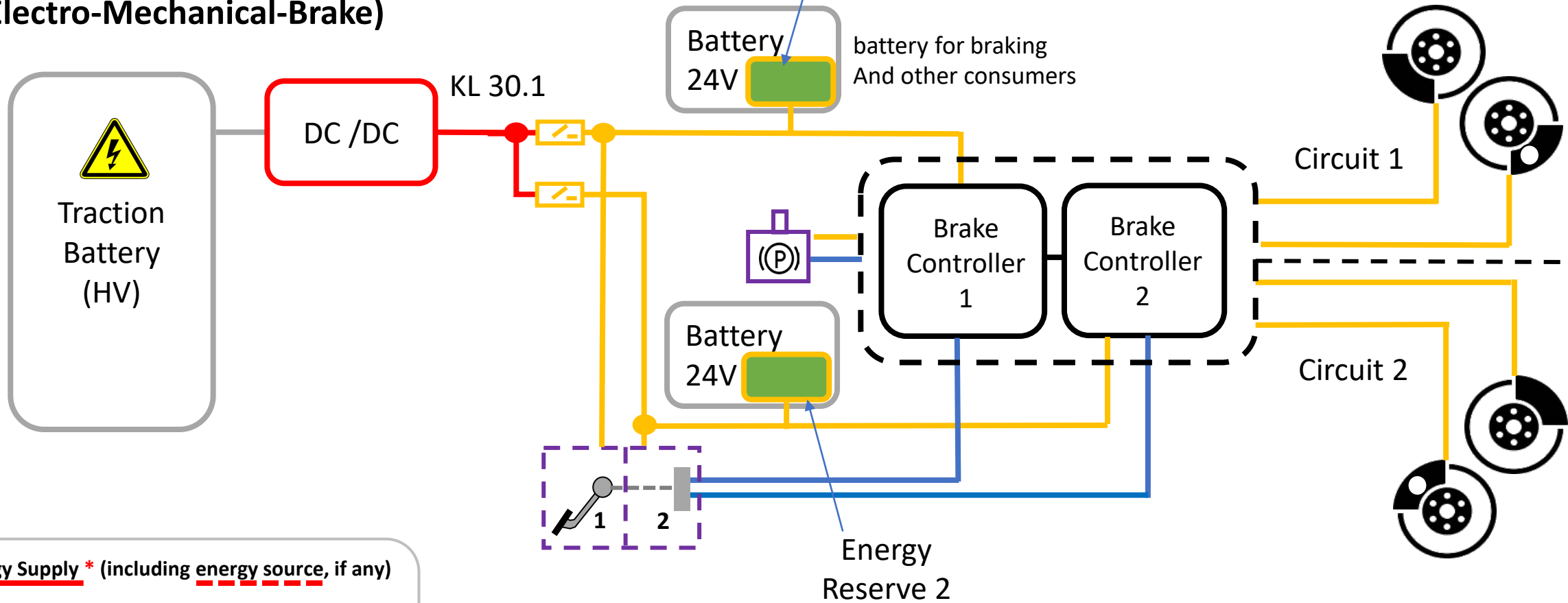
▲ Control

● to be defined



# R13 EMB Targeted layouts – layout 1b (Electro-Mechanical-Brake)

2.(a) Energy transmission = electric  
Control transmission = electric



- ▲ Energy Supply \* (including energy source, if any)
- ▲ Energy Reserve
- ▲ Transmission
- ▲ Control Transmission
- ▲ Energy Transmission | Electric | Hydraulic
- ▲ Control
- to be defined

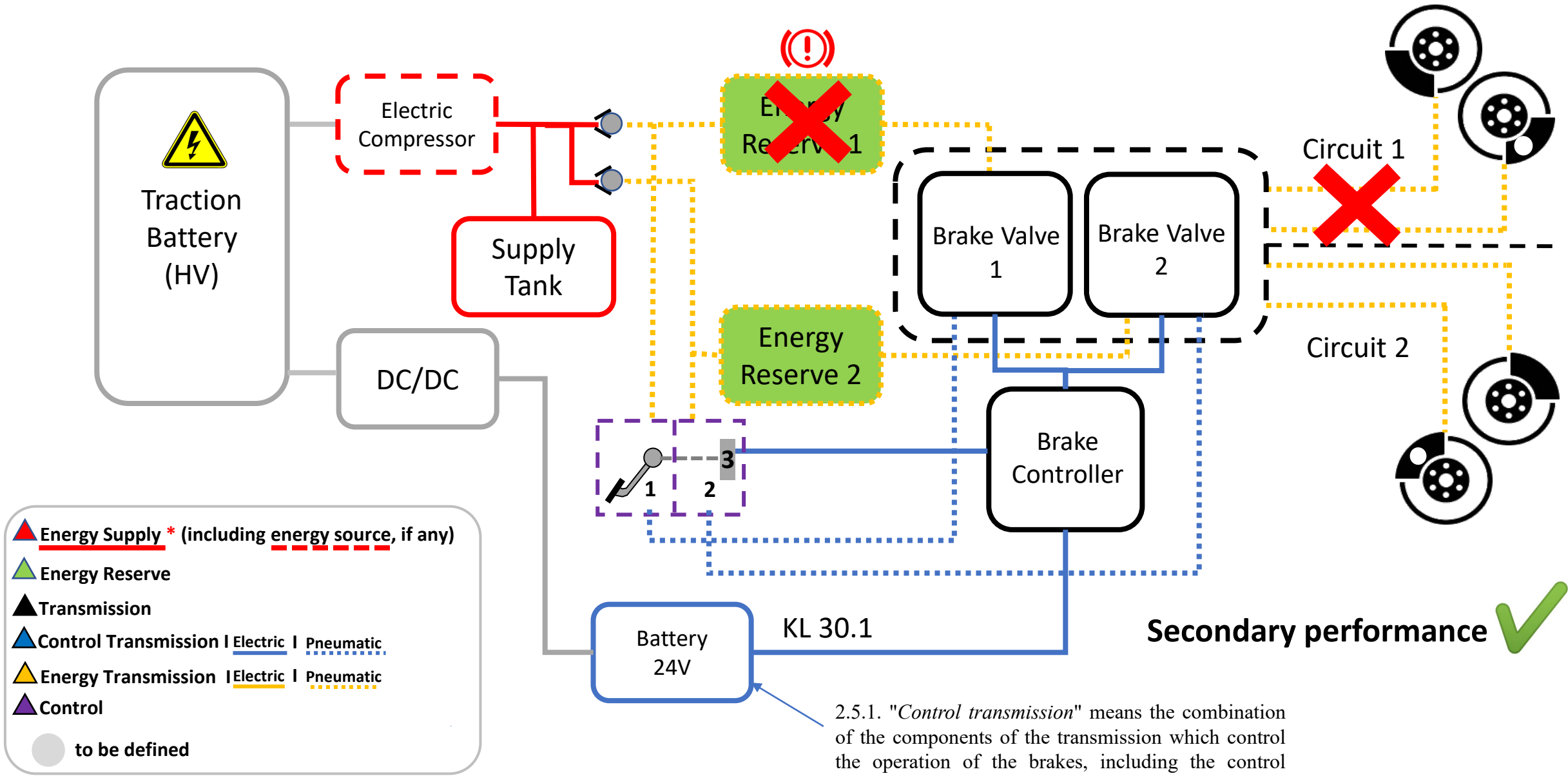
### III. Performance requirements for single failure

### 5.2.1.2.7.2.

If the service braking force and transmission depend exclusively on the use, controlled by the driver, of an energy reserve, **there shall be at least two completely independent energy reserves, each provided with its own transmission likewise independent**; each of them may act on the brakes of only two or more wheels so selected as to be capable of **ensuring by themselves the prescribed degree of secondary braking** without endangering the stability of the vehicle during braking; in addition, **each of the aforesaid energy reserves shall be equipped with a warning device** as defined in paragraph 5.2.1.13. below. In each service braking circuit in at least one of the air reservoirs a device for draining and exhausting is required in an adequate and easily accessible position;

2.(a) Energy transmission = pneumatic  
Control transmission = electric + pneumatic (backup)

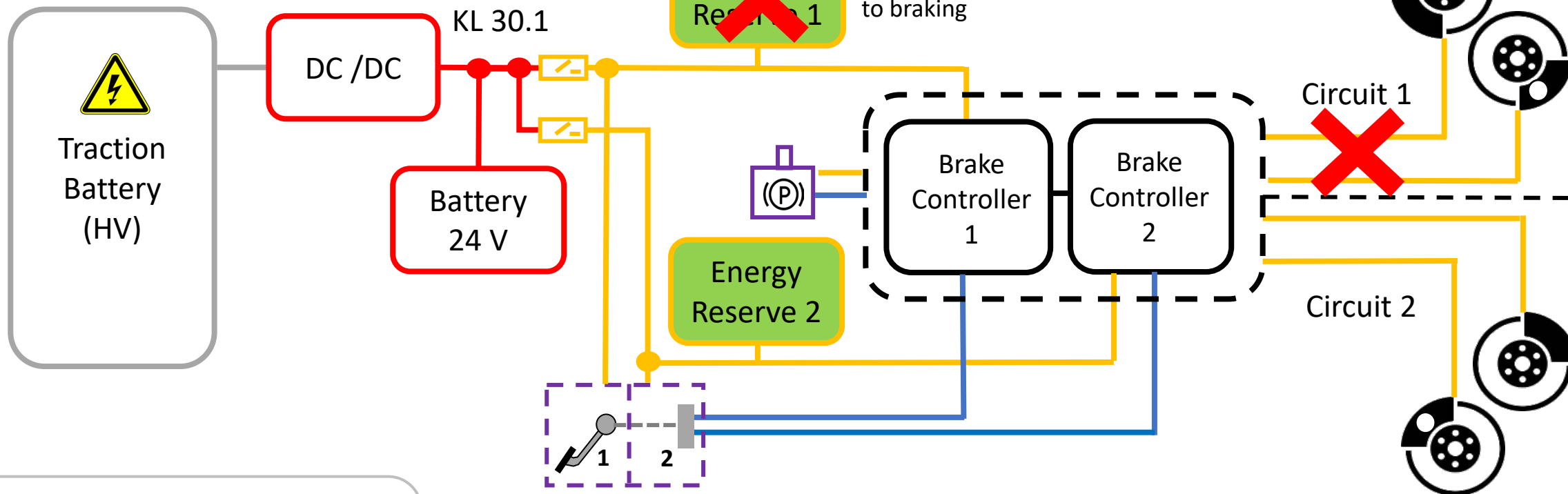
# R13 - Existing typical layout - EBS



Secondary performance ✓

2.(a) Energy transmission = electric  
Control transmission = electric

# R13 EMB Targeted layouts – layout 1a (Electro-Mechanical-Brake)



- ▲ Energy Supply \* (including energy source, if any)
- ▲ Energy Reserve
- ▲ Transmission
- ▲ Control Transmission
- ▲ Energy Transmission | Electric | Hydraulic
- ▲ Control
- to be defined

Secondary performance ✓

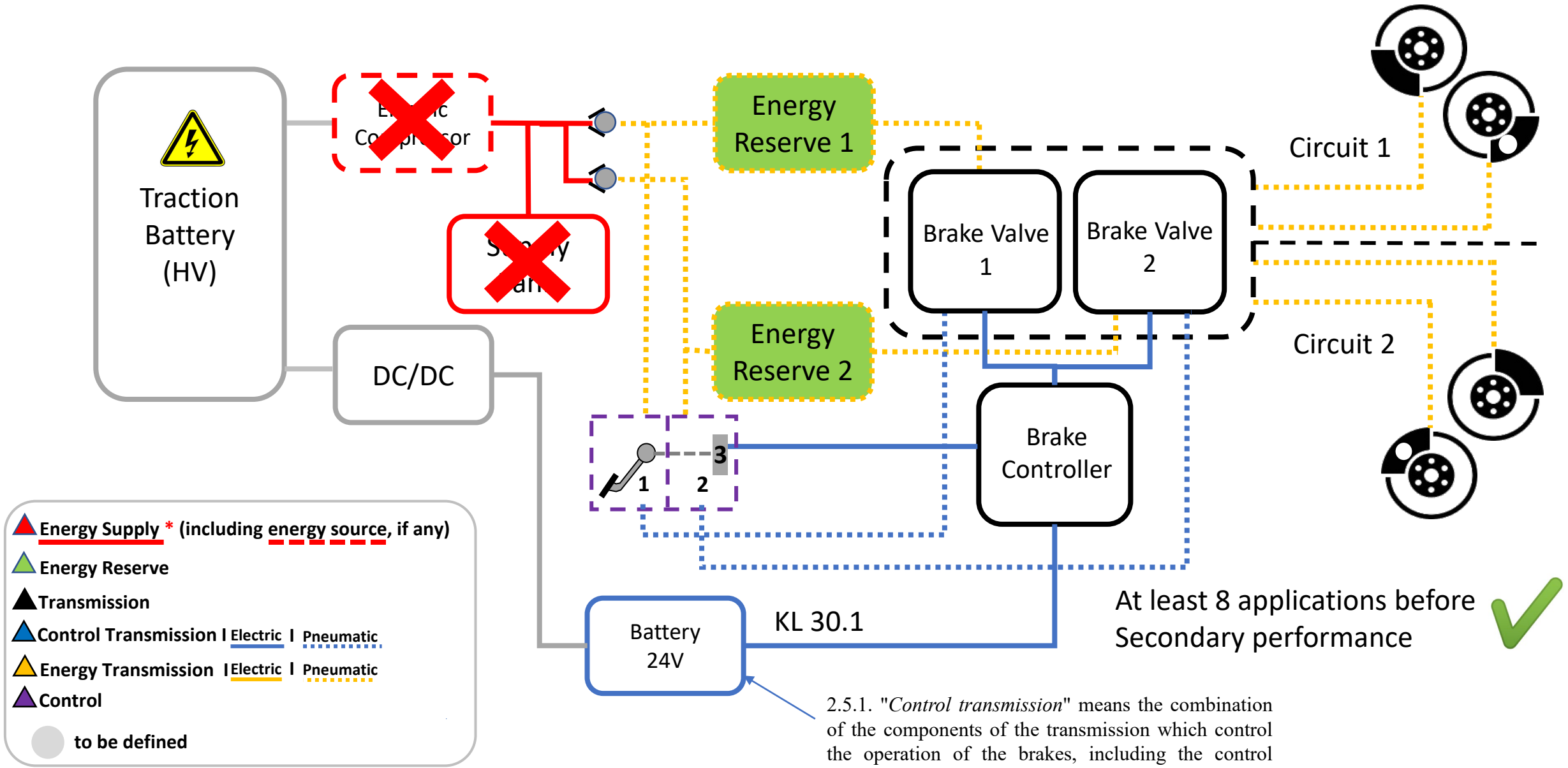
## UN R13 Today

### 5.2.1.5.

Where use is made of energy other than the muscular energy of the driver, there need not be more than one source of such energy (hydraulic pump, air compressor, etc.), but the means by which the device constituting that source is driven shall be as safe as practicable.

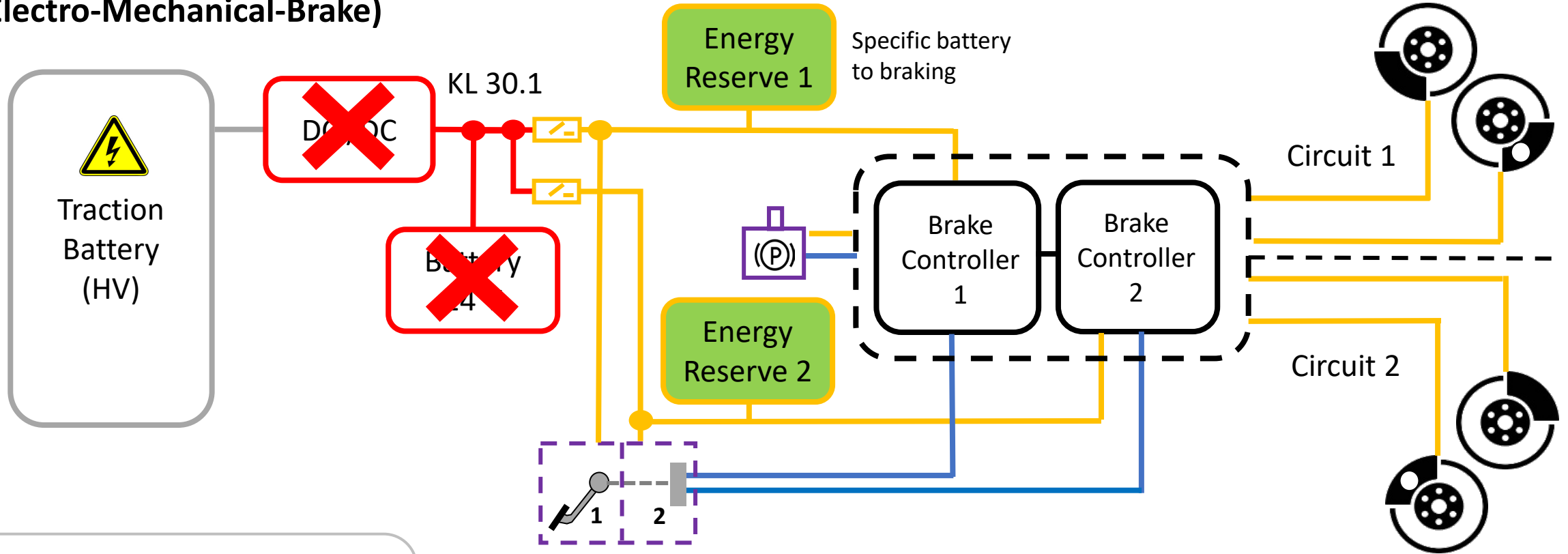
2.(a) Energy transmission = pneumatic  
Control transmission = electric + pneumatic (backup)

# R13 - Existing typical layout - EBS



2.(a) Energy transmission = electric  
Control transmission = electric

# R13 EMB Targeted layouts – layout 1a (Electro-Mechanical-Brake)



- ▲ **Energy Supply \*** (including energy source, if any)
- ▲ **Energy Reserve**
- ▲ **Transmission**
- ▲ **Control Transmission**
- ▲ **Energy Transmission** | Electric | Hydraulic
- ▲ **Control**
- **to be defined**

At least 8 applications before Secondary performance ✓



# Proposed definitions

**"Energy source"** means a device which receives energy and converts it into the required form (i.e. medium). An energy storage device is not considered as a source.

e.g. compressor, pump, alternator...

But not the traction battery nor a DC/DC converter

**"Energy supply"** means all parts, including an energy source, if any, that are necessary to supply energy for the operation of the braking system. The supplied energy can be used to be stored in the energy storage devices and/or can be used directly to feed the control transmission and/or the energy transmission.

e.g. DC/DC converter

**"Energy reserve"** means the stored energy needed for the operation of the braking system.

*Day 1, 16:30 – 18:00*

## Traditional brakes and new concepts

(b) Provision of Energy for braking systems on passenger cars  
*(ICE and BEV)*

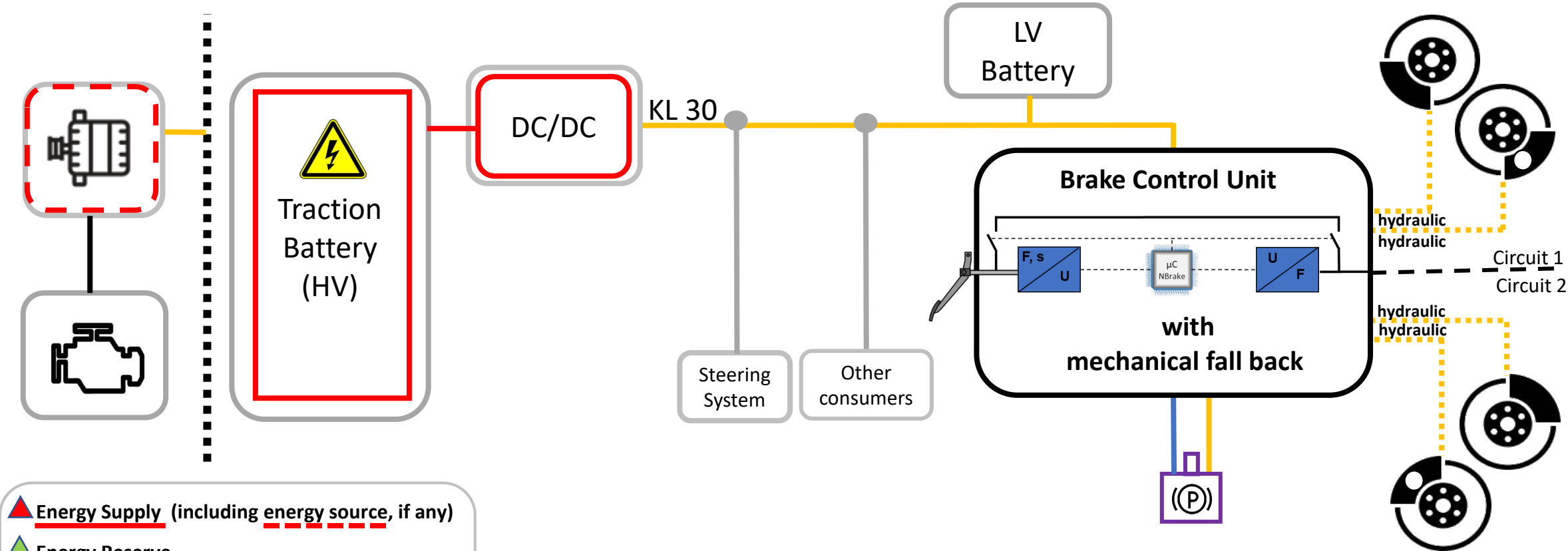
(c) Hybrid brake system on passenger cars  
*(e.g. hydraulic front-, electro mechanic rear axle)*

### **Passenger Car layouts**

- electro-mechanical-brake
- electro-hydraulic-brake
- electro-mechanical-brake / electro-hydraulic-brake

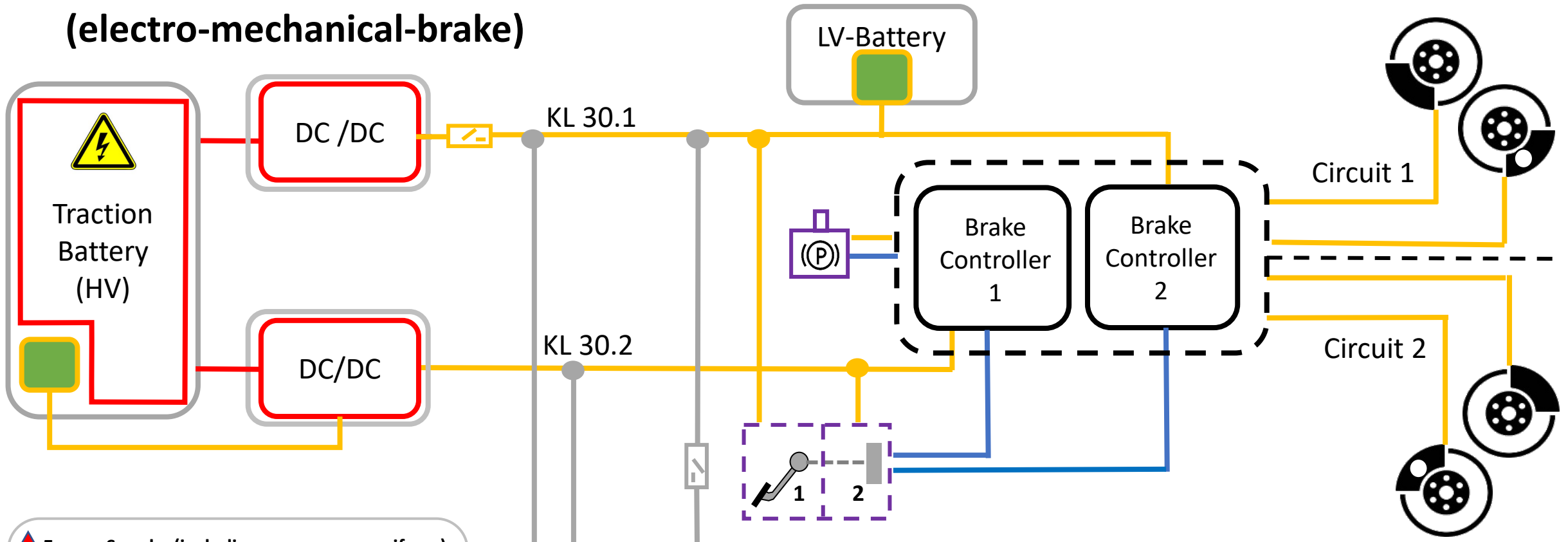
# R13H today's layout – Full Power Braking Systems with mechanical fallback

UN R13-H, para. 5.2.2.9.



- ▲ Energy Supply (including energy source, if any)
- ▲ Energy Reserve
- ▲ Transmission
- ▲ Control Transmission
- ▲ Energy Transmission | Electric | Hydraulic
- ▲ Control
- ▲ Not exclusively used by braking system, but total vehicle functions, e.g. Steering

# R13H Targeted layouts – layout 1a # (electro-mechanical-brake)

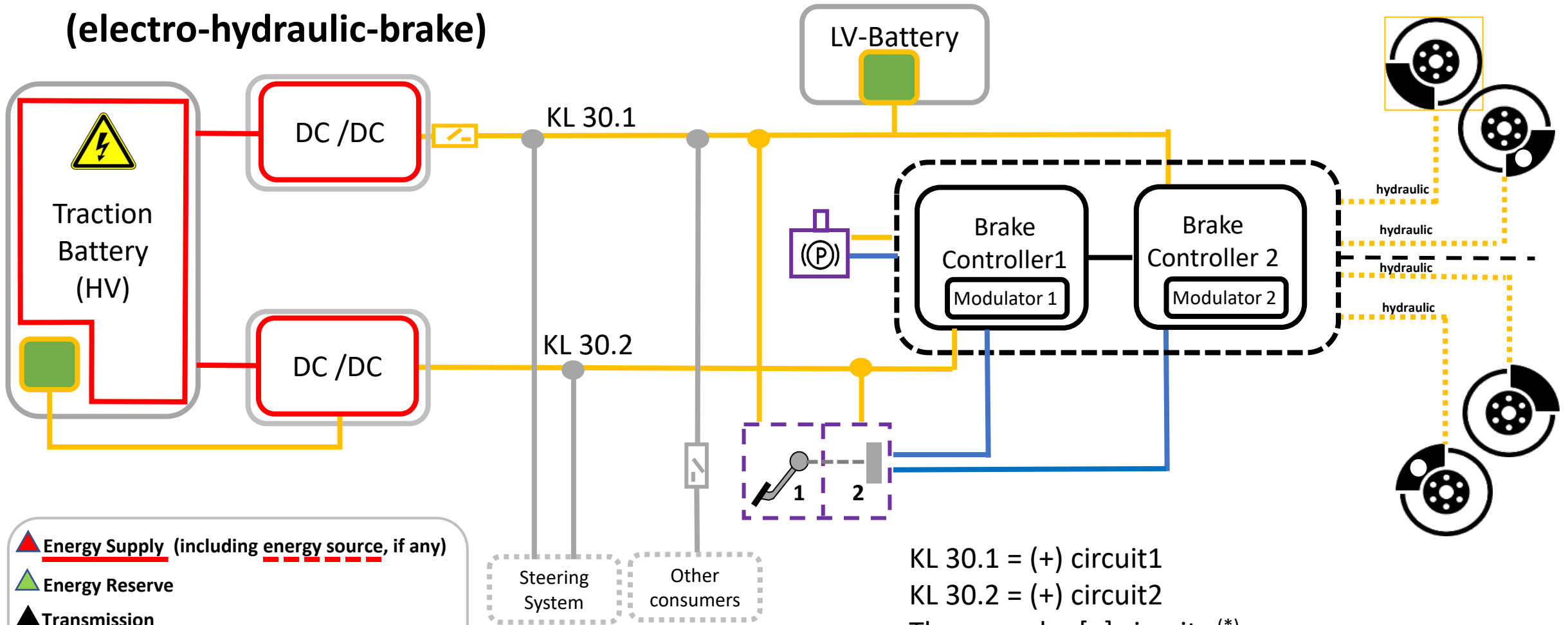


- ▲ **Energy Supply** (including energy source, if any)
- ▲ **Energy Reserve**
- ▲ **Transmission**
- ▲ **Control Transmission**
- ▲ **Energy Transmission** | Electric | Hydraulic
- ▲ **Control**
- ▲ **Not exclusively used by braking system, but total vehicle functions, e.g. Steering**

KL 30.1 = (+) circuit1  
 KL 30.2 = (+) circuit2  
 There can be [n] circuits (\*)

(\*) 5.2.8. The action of the service braking system shall be distributed between the wheels of one and the same axle symmetrically in relation to the longitudinal median plane of the vehicle.

# R13H Targeted layouts – layout 2a # (electro-hydraulic-brake)

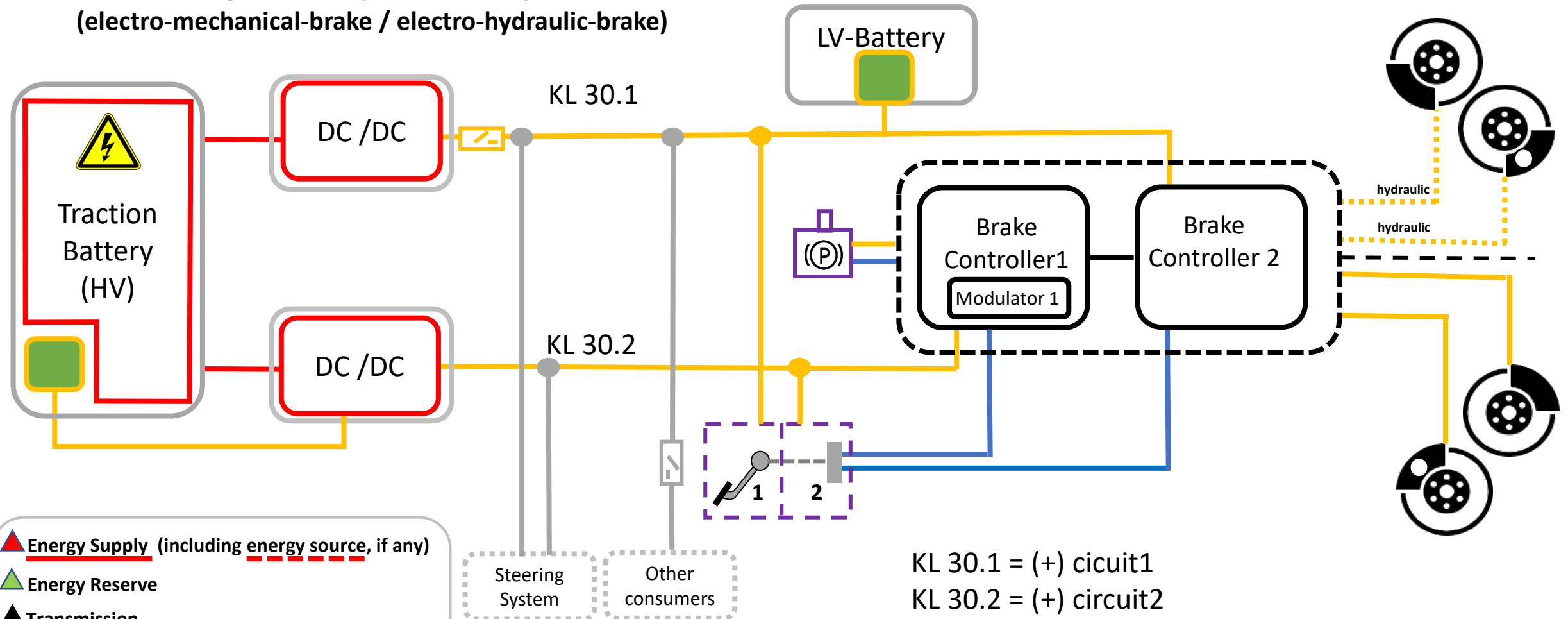


- ▲ **Energy Supply** (including energy source, if any)
- ▲ **Energy Reserve**
- ▲ **Transmission**
- ▲ **Control Transmission**
- ▲ **Energy Transmission** | Electric | Hydraulic
- ▲ **Control**
- ▲ **Not exclusively used by braking system, but total vehicle functions, e.g. Steering**

KL 30.1 = (+) circuit1  
 KL 30.2 = (+) circuit2  
 There can be [n] circuits (\*)

(\*) 5.2.8. The action of the service braking system shall be distributed between the wheels of one and the same axle symmetrically in relation to the longitudinal median plane of the vehicle.

# R13H Targeted layouts – layout 3a# (electro-mechanical-brake / electro-hydraulic-brake)



- ▲ **Energy Supply** (including energy source, if any)
- ▲ **Energy Reserve**
- ▲ **Transmission**
- ▲ **Control Transmission**
- ▲ **Energy Transmission** | Electric | Hydraulic
- ▲ **Control**
- ▲ **Not exclusively used by braking system, but total vehicle functions, e.g. Steering**

KL 30.1 = (+) circuit1  
 KL 30.2 = (+) circuit2  
 There can be [n] circuits (\*)

(\*) 5.2.8. The action of the service braking system shall be distributed between the wheels of one and the same axle symmetrically in relation to the longitudinal median plane of the vehicle.

*Day 2, 9:00 – 12:00*

## 3. Past activities

- Brief review, Structure list and format of exiting documents

*Day 2, 9:00 – 12:00*

## 4. UN R13 and UN R13-H

- Scope of amendment and affected sections and paragraphs, see embedded document below (UN R13).



Correlation R13  
R13-H and affecte



# Electrical Energy Storage device

## Addressing the effect of ageing - example

### New definitions:

“*Certified Usable Performance (CUP)*” means the maximum usable performance of an electrical energy storage device available for an electro-mechanical braking system determined at the time of type approval.

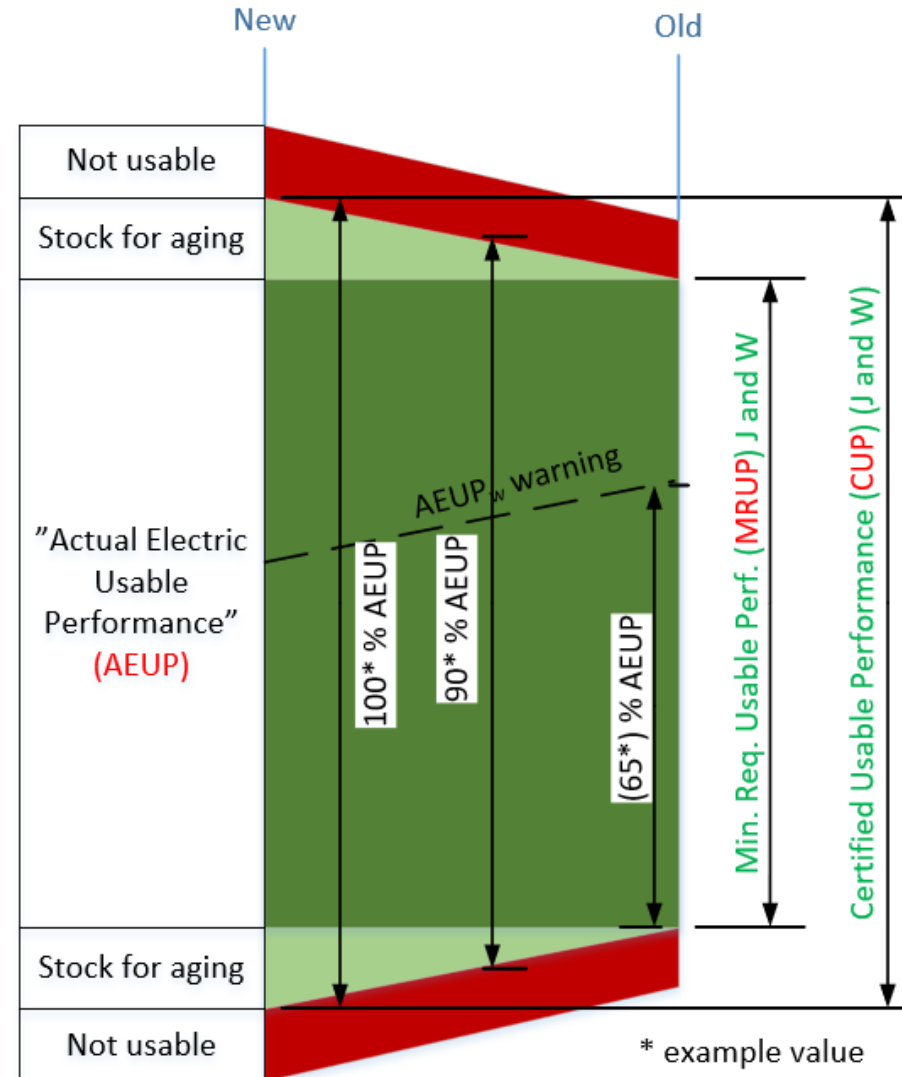
“*Minimum Required Usable Performance (MRUP)*” means the minimum usable performance of an electrical energy storage device available for an electro-mechanical braking system to fulfil the relevant requirements of this Regulation.

“*Actual Electric Usable Performance (AEUP)*” is the level of energy stored in an electrical energy storage device, as well as its available power, at a given time. It is defined as a percentage of the CUP value.

### New proposal

The “*usable performance*” means the portion of the performance of an electrical energy storage device that is actually available to the supplied system (e.g. the system may not use the maximum theoretical performance).

→ Still pending discussion and proposal will be updated during Q2 2023



# Content of the planned amendments to UN R13-H

1. Introduce and amend definitions for energy supply, energy source, and energy reserve. To ensure a harmonization with UN R13.
2. Link the demonstration of the independency among the energy reserves (electrical) to annex 8.
3. Additions and clarifications to requirements of electric control transmission regarding Full Power Braking Systems (i.e., para. 5.2.20).
4. Clarify and align the required capacity of electrical energy reserves to hydraulic energy reserves (*e.g., para. 5.2.4.2., 5.2.14., annex 4*).
5. Amend trigger conditions in case of loosing one brake circuit (*reference: para. 5.2.3@ hydraulic systems: warning at a differential pressure of more than 15.5 bar*)

*Day 2, 13:00 – 15:00*

## UN R13 and UNR13-H

- Approach and harmonization e.g. Energy Transmission
- Ambitions: Keep R13 and R13-H definitions and principles aligned (ref. Day 1 principal layouts)

# Proposed definitions

**"Energy source"** means a device which receives energy and converts it into the required form (i.e. medium). An energy storage device is not considered as a source.

e.g. compressor, pump, alternator...

But not the traction battery nor a DC/DC converter

**"Energy supply"** means all parts, including an energy source, if any, that are necessary to supply energy for the operation of the braking system. The supplied energy can be used to be stored in the energy storage devices and/or can be used directly to feed the control transmission and/or the energy transmission.

e.g. DC/DC converter

**"Energy reserve"** means the stored energy needed for the operation of the braking system.

*Day 2, 15:30 – 16:00*

## Wrap up and next steps

- Format and structure of future work - Discussion