

EV Inspection Guide

2019 Formula SAE Japan (FSAEJ)

JSAE
Formula SAE Japan
EV WG

2019 EV Inspection Guide

Contents

1. Revisions to 2018 FSAE Rules for 2019 FSAE Rules

- Changes to be noted are listed.

Check the FSAE website for the original details.

2. Key Points of EV Inspection:

The usual mistakes will be explained.

- EV inspection procedure
- *Inspection Sheet (Electric) 1 and 2 (Self-Check)
- EV0: Basic electrical systems inspections
- EV1: Inspections with high-voltage system OFF
- EV2: Inspections with high-voltage system ON
- EV3: Rain test

*Inspection Sheet (Electric) will be released on the team page.

3. Key Points of ESF and FMEA: Charging Procedure

4. Others

1. Revisions of 2019 FSAE Rules

Changes to be noted are listed below.

Confirm the changes carefully and take actions accordingly.

- EV.1.4.7, 1.4.8: Violations during dynamic events
- EV.3.2.4: All strong power connectors have been changed to those with interlocks.
- EV.3.3.3: Contactors and switches can no longer be used as maintenance plugs.
- EV.4.1.7, etc.: High-voltage display stickers
- EV.4.3.6: Accumulator attachments
- EV.5.1.8: The number of cells to measure the temperature has been changed to 20% or more of the total number of cells.
- EV.6.4.2, 6.4.6: The plug color has been changed to red for TSMPs and black for GLVMPs.
- EV.7.3.3: An orange circle with a diameter of 50 is required in the middle of the TSMS.
- EV.7.6.1: Open/short detection circuit has been added to the BSPD circuit.

1. 2019FSAEJ Local Rules

■ J2019-19 Scatter Shield (refer to Formula SAE® Rules 2019 EV.2.1.4)

A gap between the hole of the motor casing and the scatter shield is allowed. As for the hole on a vertical surface to the rotation axis, the scatter shield is unnecessary.

■ J2019-20 Thickness of the floor or bottom for Accumulator Container (refer to Formula SAE® Rules 2019 EV.4.2.2 a)

An aluminum sheet thickness of 3.2 mm (0.125 inches) must be accepted up to a negative tolerance of 10%.

■ J2019-21 Accumulator Attachment – Interpretation of Corner Attachments (refer to Formula SAE® Rules 2019 EV.4.3.6 b.)

The phrase “the corner of the segment” in the Formula SAE® Rules 2019 may also be interpreted as “the corner of the container”.

■ J2019-22 Relaxation of Rule Relating to Placement of Temperature Sensor at Cell Negative Terminal (refer to Formula SAE® Rules 2019 EV.5.1.4)

If the team uses a ready-made accumulator consisting of assembled cells (segments) that cannot be disassembled, the temperatures of the positive and negative terminals of the segments, and actual measured data from the measurement points of the temperature sensor installed inside the segment (time series data when charged at maximum current) must be clearly stated on the Electrical Systems Form (ESF). If rule EV.5.1.3 is satisfied by control using these temperature sensor values in its ESF, the team must not be required to satisfy rule EV.5.1.4.

1. 2019FSAEJ Local Rules

■ J2019-23 Ready-To-Drive-Sound (refer to Formula SAE® Rules 2019 EV.6.11.4~EV.6.11.6)

The car doesn't have to make a Ready-To-Drive-Sound.

■ J2019-24 Relaxation of Requirement for Electrical Connections to Use Positive Locking Mechanisms (refer to Formula SAE® Rules 2019 EV.6.5.12~EV.6.5.14)

The requirement to use positive locking mechanisms described in EV.6.5.12~EV.6.5.14 must be regarded as satisfied if the following conditions are all met.

Conditions:- The team can clearly demonstrate that the reasonable axial force or contact pressure has been applied to the connections during the Electrical Technical inspection. (A record of the fastening torque or riveting bonding force is acceptable.)

- Furthermore, the structure must allow no application of external force (tension, torsional, or flexural) from the wiring to the connection.

■ J2019-25 Method of Driving the Tractive Systems Active Light (TSAL) via High-Voltage (refer to Formula SAE® Rules 2019 EV.6.10.1)

To ensure that the TSAL flashes during Accumulator Isolation Relay (AIR) welding even when the Grounded Low Voltage Master Switch (GLVMS) is OFF, the power supply of the TSAL (red) must be taken from the tractive systems (TS) (e.g., via the DC/DC converter or the like) to drive the TSAL. The power supply of the TSAL (red) must NOT be taken from the Grounded Low Voltage (GLV).

1. 2019FSAEJ Local Rules

- **J2019-26 Flashing Requirements of TSAL (Green) (refer to Formula SAE® Rules 2019 EV.6.10.4)**

Rule EV.6.10.4 must NOT apply to the lighting green light.

- **J2019-27 Relaxation of Prohibition of Cell Balancing when Accumulator Isolation Relays (AIR) Are Open (refer to Formula SAE® Rules 2019 EV.7.2.5)**

This rule may be regarded as not applicable providing that the high voltage (HV) portions of the accumulator management system (AMS) are inside the accumulator container.

- **J2019-28 Coloring of Shutdown Buttons (refer to Formula SAE® Rules 2019 EV.7.4)**

EV shutdown buttons must be colored red.

Other than the cockpit mounted shutdown button, switches installed at the driver's seat must not be colored red or orange.

1. 2019FSAEJ Local Rules

■ J2019-29 Relaxation of Rules for EV Chargers (refer to Formula SAE® Rules 2019 EV.9.3)

Teams may be exempted from complying with the three rules described below if all of the following conditions are satisfied: The documents of 'Standard Charging Procedure' and 'Charging Abnormality Procedure' must be submitted at the same time as the Electrical System Form, team members must be fully trained in the application of these two documents to charging operations, these team members must constantly monitor the state of charging while in possession of these documents, and these team members must be capable of taking the appropriate measures if an abnormality occurs during charging.

- (1) The interlock function related to the connection state of connectors described in EV.9.3.4
(However, the method used to confirm the connection state of the charger and accumulator must be clearly stated in the Standard Charging Procedure document.)
- (2) The function to turn off the charger using the AMS described in EV.9.3.6
(However, it must be possible to visually confirm the detection state of the AMS at all times. In addition, the abnormality types of AMS, judgment methods, and charging stop methods must be listed in the Charging Abnormality Procedure document.)
- (3) The function to turn off the charger using the IMD described in EV.9.3.7
(However, it must be possible to visually confirm the detection state of the IMD at all times. In addition, the abnormality types of IMD, judgment methods, and charging stop methods must be listed in the Charging Abnormality Procedure document.)

1. 2019FSAEJ Local Rules

When this rule is applied, the Standard Charging Procedure and Charging Abnormality Procedure documents must be handled as component elements of the Electrical Systems Form (ESF).

In addition, the following items must be entered on the procedure documents.

-Standard Charging Procedure:

Protective equipment, method and procedure for attaching and detaching the accumulator container from the vehicle (including flowchart), chain of command, names of devices, charging completion criteria, items listed in (1) above

-Charging Abnormality Procedure:

Protective equipment, types of abnormal states, actions for handling each abnormality (including flowcharts), chain of command, names of devices, procedure for disconnecting wiring between accumulator container and charger, criteria for restarting or stopping charging after each abnormality, items listed in (2) to (4) above

■ **J2019-30 Failure Modes and Effects Analysis (FMEA) (refer to Formula SAE® Rules 2019 EV.10.2)**

Only From No.55 to 69 except No. 61 described on “FMEA” sheet of 2019 Failure Modes and Effects Analysis Template (File name: 2019-FMEA-Template.xls) are applicable.

1. 2019FSAEJ Local Rules

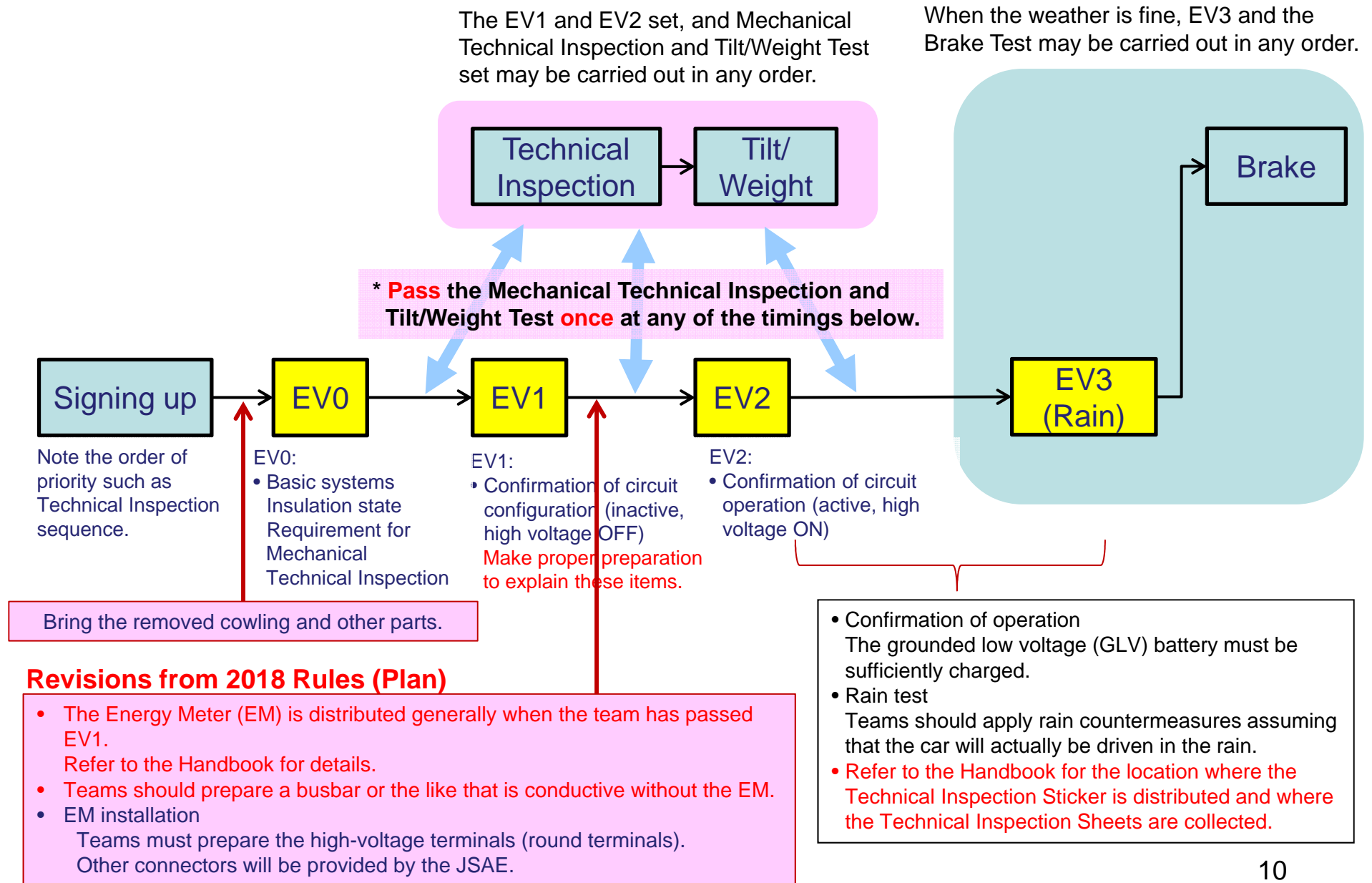
■ J2019-31 Submission of the ESF or FMEA (refer to Formula SAE® Rules 2019 EV.10.3, FSAEJ2019 Participation Rules Article 12)

Re-submission of the Electrical System Form (ESF) or Failure Modes and Effects Analysis (FMEA) may be requested multiple times to ensure that these materials achieve a sufficient degree of completion. In the event that re-submission is required, a maximum of fifty (50) negative points will be penalized depending on the degree of completion of these materials at the final deadline. However, the combined penalty due to the degree of completion and due to the late submission defined in rule EV.10.3 must not exceed fifty (50) negative points in total. In addition, the order of the Electrical Technical Inspection must be determined based on the degree of completion of the ESF and FMEA, as well as the order in which the documentation is received.

Referring to: FSAEJ Website

<http://www.jsae.or.jp/formula/en/about.php#rules>

2. Key Points of Electrical Technical Inspection: Procedure



2. Key Points of Electrical Technical Inspection

Self-check of the overall system

Using the Inspection Sheet (Electric)

- Fill out this sheet before the EV Inspection. It may not be filled out at the Inspection Area at that time.
- The purpose of this sheet is to confirm whether the overall high-voltage system is consistent (voltages, currents, etc.).
- Most of this sheet can be copied from the ESF.

2017 電気車検シート(EV) ページ1 0828

カーNo. : 検査員記入欄

| | | | | | |
|---------------------|-----------|--|----|----|----|
| 学校: | EVO: 検査員名 | 日付 | 開始 | 終了 | |
| ESF 提出状況 | 合格 / 提出のみ | EVI: 検査員名 | 日付 | 開始 | 終了 |
| ESF提出後の修正 | 有り / 無し | EV2: 検査員名 | 日付 | 開始 | 終了 |
| スマートフォン | 有り / 無し | EV3: 検査員名 | 日付 | 開始 | 終了 |
| スマートフォンでの撮影者と被写体の関係 | 有り / 無し | スマートフォンに撮るESF、SES、おじ絡制作記録。撮立て時の写真が無い場合スマートフォン内部が重要 | | | |

本シートはすべての車両検査が終了するまで車両と一緒に持っていくこと。次の順序で車両を検査に提出すること。

| | | |
|--------------------|----------|--------|
| パート-EVO 基本初電気技術検査 | 機検車検受検可否 | 検査員サイン |
| パート-EVI システム同時技術検査 | | |
| パート-EV2 システム同時技術検査 | | |
| パート-EV3 システム | | |

EV-EVOの検査に合格した後は、自動車検を受けることが出来る。上記、機検車検受検可能欄に「可」及び検査員のサインでOKとする。
EV-EVI、EVII、EVIII及びEVIXの検査のA-11、2の全ての検査に合格したのみEVIX(A-EV3)を受けること。
このシートは全ての電気車検に合格した後、機検車検シートと合わせ機検車検受付へ返却すること。注意：このフォームとルールとの間に相違がある場合はルールを優先する。

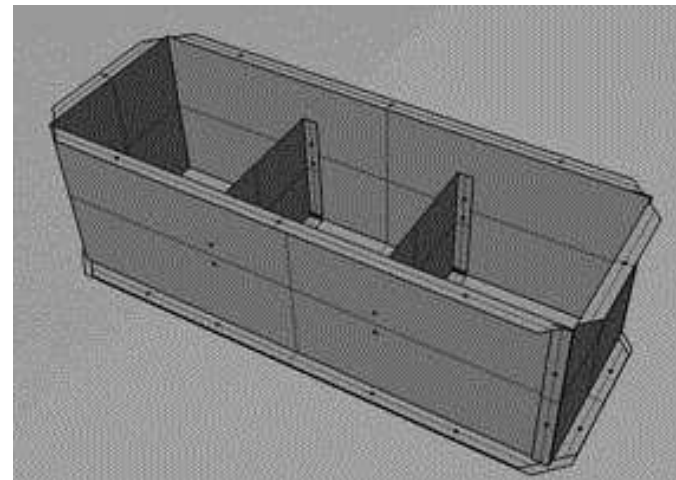
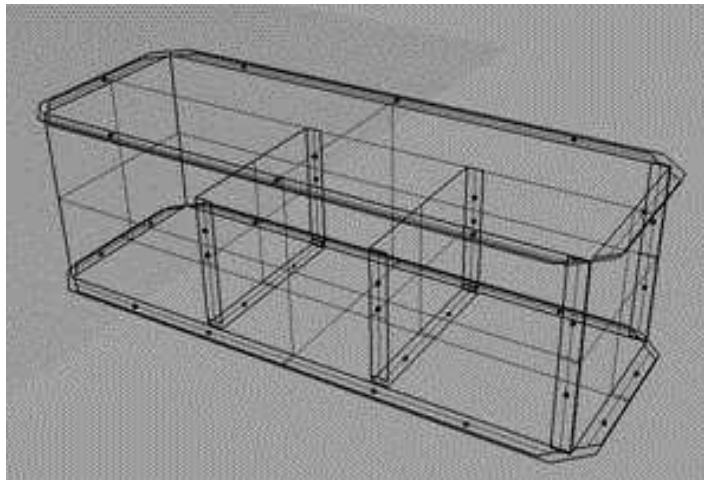
セルフチェック、申請項目 電気車検前に、自己チェックし記入して受付へ提出すること。注：表ページも同様

| | | | | | |
|------------------|-----------------------------------|--------------------|-----------------------------------|--------------------|--------------------------------|
| モーター | 最大出力[W]: EV1.28 | 最大許容電圧[V]: EV2.2 | AMIS | モーター | 速度監視 監視電圧/全セル数/設定電圧 |
| | | モーター温度[V]: EV2.1 | EV3.5 | | 電圧監視 監視電圧/全セル数/設定電圧 |
| モーターロー | 最大許容電圧[V]: EV1.28 | 種類: | セル電圧[V]: EV3.3 | セル電圧[V]: EV3.4 | AMIS: 1) 故障ありのセル数 |
| 電池 | 最大許容電圧[V]: EV1.28 | 電圧(分極) [V]: EV3.4 | セル電圧監視[A]: EV3.4 | セル電圧監視[A]: EV3.4 | セル電圧監視[A]: EV3.4 |
| 電池 | セル電圧監視[A]: EV3.4 | セル最大電圧[V]: EV3.4 | 最大電圧[V]: EV3.4 | 動作確認抵抗はセルが用表する事 | 動作確認抵抗はセルが用表する事 |
| HVD分析位置 | 分断後の電圧検出[V]: EV3.4 | [V]: EV3.4 | 高電圧A/A/V-[DC部] | 連続電流[A]: EV3.4 | 最少断面積[mm ²]: EV3.4 |
| | 連続電流[A]: EV3.4 | ケーブル電線規格[A]: EV3.4 | ケーブル電線規格[mm ²]: EV3.4 | ケーブル電線規格[A]: EV3.4 | ケーブル電線規格[A]: EV3.4 |
| 高電圧ケーブル | ケーブル電線規格[mm ²]: EV3.4 | 高電圧ケーブル | ケーブル電線規格[A]: EV3.4 | ケーブル電線規格[A]: EV3.4 | ケーブル電線規格[A]: EV3.4 |
| | 高電圧ケーブル | ケーブル電線規格[A]: EV3.4 | ケーブル電線規格[A]: EV3.4 | ケーブル電線規格[A]: EV3.4 | ケーブル電線規格[A]: EV3.4 |
| 過電流保護器、ヒューズ(DC部) | 規格標準電流[A]: EV3.4 | 過電流保護器、ヒューズ(DC部) | 規格標準電流[A]: EV3.4 | 規格標準電流[A]: EV3.4 | 規格標準電流[A]: EV3.4 |
| | 規格標準電流[A]: EV3.4 | | | | |
| セル電圧監視装置 | 仕様: EV3.4 | セル電圧監視装置 | 仕様: EV3.4 | セル電圧監視装置 | 仕様: EV3.4 |
| | 仕様: EV3.4 | | | | |
| セル電圧監視装置 | 仕様: EV3.4 | セル電圧監視装置 | 仕様: EV3.4 | セル電圧監視装置 | 仕様: EV3.4 |
| | 仕様: EV3.4 | | | | |

2. Key Points of Electrical Technical Inspection

Self-check of accumulator container

- Create the accumulator container following the design guidelines of EV.4.2.2 since the standard accumulator container is not defined.
- Please bring drawings and photographs if the configuration is difficult to see at the Technical Inspection Area.
 - If these are not prepared, teams may be asked to dismantle the container.

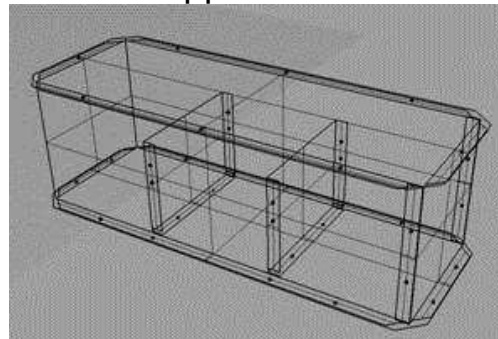


Review: Accumulator Container

EV.4.2.2: Configuration of accumulator container

| EV.4.2.2 | Item | Outline |
|-----------|---|---|
| Materials | a | Floor or bottom Steel: 1.25 mm (0.049 inch) / Aluminum: 3.2 mm (0.125 inch) |
| | b | External vertical walls Steel: 0.9 mm (0.035 inch) / Aluminum: 2.3 mm (0.09 inch) |
| | c | Internal vertical walls Steel: 0.9 mm (0.035 inch) / Aluminum: 2.3 mm (0.09 inch) Must be minimum of 75% of the height of the external vertical walls |
| | d | Covers and lids Steel: 0.9 mm (0.035 inch) / Aluminum: 2.3 mm (0.09 inch) |
| | e | Joining method of floor and walls Welds and/or fasteners: Fasteners must be 6 mm Metric Grade 8.8 or stronger. |
| Joining | | Weight in each section The accumulator container must be divided into sections by vertical walls. A maximum of 12 kg is allowed in any section. |
| | f | Number of fasteners between floor and any vertical wall (internal or external) At least 2 |
| | | Fasteners between internal and external vertical walls Must be located in the top half of the internal vertical wall |
| | | Number of fasteners for each section Sections containing 8 kg or less: minimum of 2 fasteners connecting any two vertical walls |
| | | Number of fasteners for each section Sections containing between 8 and 12 kg: minimum of 3 fasteners connecting any two vertical walls |
| | g | Plate folding or bending The folding or bending of plates to create flanges or eliminate joints between walls is acceptable. |
| | h | Location of cover or lid fasteners Covers or lids must be fastened with a minimum of one fastener for each external vertical wall per section. |
| | i | Alternate materials Alternate materials are allowed with proof of equivalency following rule T.3.31. Proof of equivalency must be documented in the Structural Equivalency Spreadsheet (SES) and test samples must be available at the Technical Inspection. |
| j | Use of smaller bolts One 6 mm bolt may be substituted with two 5 mm or three 4 mm bolts. | |

The guidelines of EV.4.2.2 is not applicable if iron or aluminum materials are not used (such as CFRP).



Assumptions of guidelines

Longitudinal: 40G

Lateral: 40G

Vertical: 20G

Review: Accumulator Container

EV.4.2.3: Securing of cells and/or segments inside the container

- The cells and segments must not move in the container with a load of 40G in the longitudinal (front/rear) direction, 40G in the lateral (left/right) direction, and 20G in the vertical (up/down) direction.
- Calculations and/or test results must be included in the SES.
- The fastener must have a strength of 6 mm Metric Grade 8.8 bolt (1/4 inch Metric Grade 5 bolt in the SAE standard) or more. (Refer to T.10.2 and T.10.3.)
(The example of fasteners are listed on the next page.)

EV.4.3.5/4.3.6/4.3.7: Attachment of container to major structure

The design must follow one of the two rules listed below.

- EV.4.3.6: Corner Attachments and Analysis
- EV.4.3.7: Load Based Analysis of the Accumulator Container

Reference: Acceptable T.10.2 Fasteners

From the Explanation of The Technical Inspection Guide 2019 on the FSAEJ official website.

HARD LOCK NUTS FOR BEARING **FINE U NUTS**
ベアリング用ハードロックナット/ファインUナット®

● CADデータフォルダ名: 14_Bearings_with_Holder

| Type | 材質 | 硬度 | 表面処理 | |
|------|---------|--------|------------|------|
| HLB | — | — | パーカー | |
| HLBM | SS400相当 | — | 非電解ニッケルめっき | |
| HLBC | HLBU | S45C相当 | 22~28HRC | パーカー |
| HLBS | — | SUS304 | — | |

＊第2ナット凸部（ボス）の中心とねじの中心には所定のスレが設けてあります。
 †薄型タイプ（HLBU）は第2ナット（上ナット）より取り付けてください。

ねじ精度 JIS B0211 6H (2級)

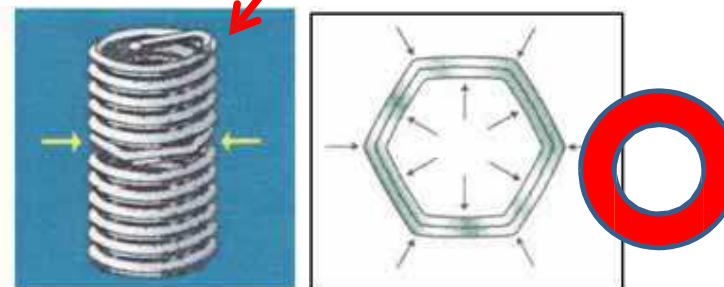
Grooved nut



Hard lock nut



Helicoil



Present evidence that this coil is used since it cannot be confirmed visually.

図.1 ヘリコイル全体図

図.2 緩み止め機構

雄ナット、雌ナット二つ一組で使用
 詳細 <http://www.hardlock.co.jp/hl/02.php>

Reference: Acceptable T.10.2 Fasteners

From the Explanation of the 2019 Mechanical Technical Inspection Rules



U nut

http://www.vht.co.jp/ctlg/01.asp?pf_id=



Wedge lock nut

http://www.vht.co.jp/ctlg/01.asp?pf_id=

Present evidence for parts that cannot be determined from the outside.



Super slit nut

詳細 <http://nke-inc.jp/enginia:ssn.html>



Muscle nut

詳細 http://ishitoku.co.jp/muscle_nut/

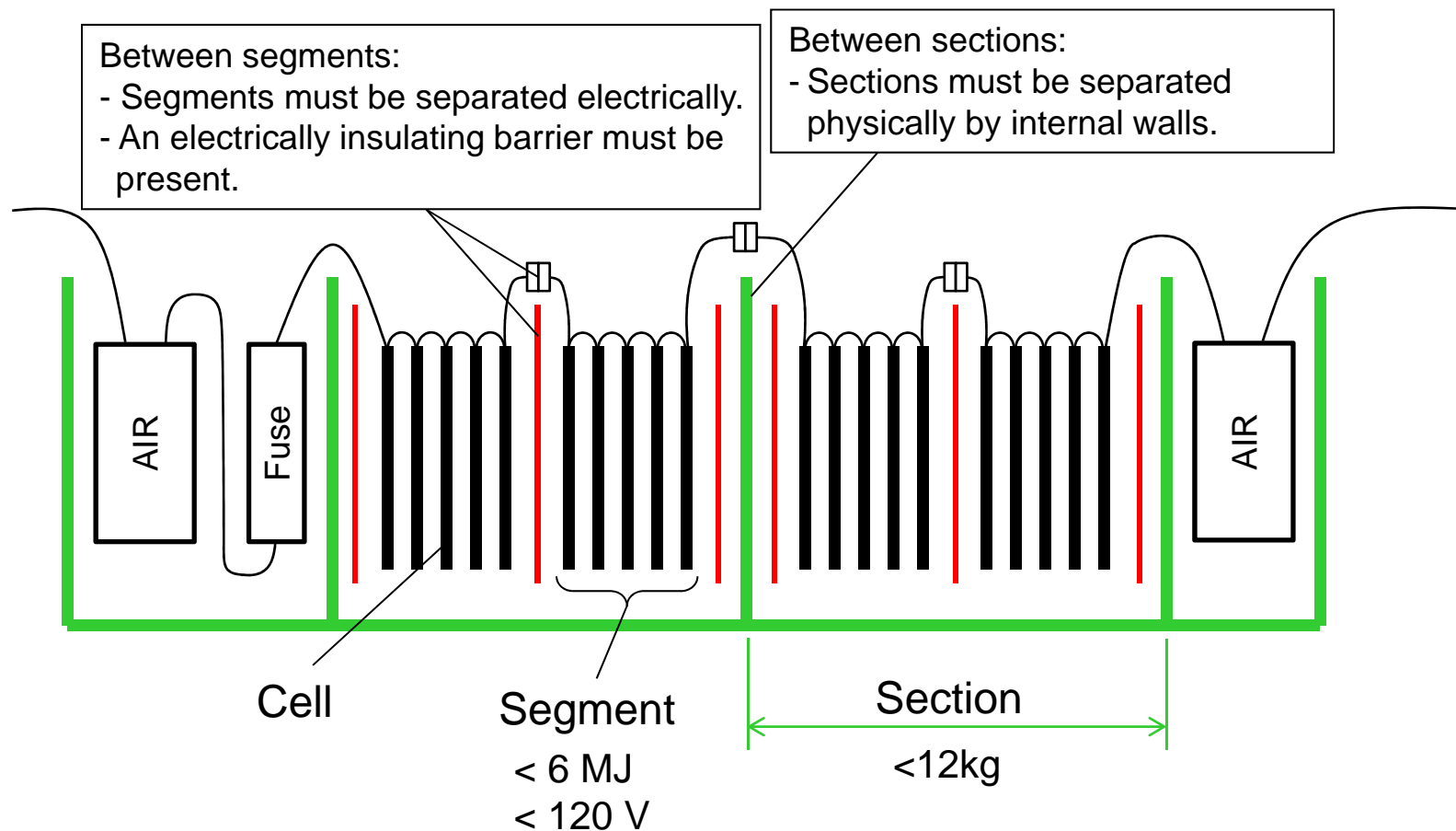
Judgment will be made based on the following fastener requirements.

- The device system can be confirmed visually.
- Positive locking mechanisms do not rely on the clamp force for locking.
- The nut and bolt will not become completely loose even if they have become loosened a little.

2. Key Points of Electrical Technical Inspection

Review: Terminology related to the accumulator

- Electrical capacity: cell(s) < segment(s) (< container)
- Physical size: section(s) < container



2. Key Points of Electrical Technical Inspection

EV0: Basic electrical systems inspection

Teams may take the Mechanical Technical Inspection after passing this inspection.

- ◆ Shutdown buttons:
 - Two shutdown buttons must be located behind the driver's compartment at approximately head height, one at each side of the car. The diameter of the buttons must be at least 40 mm.
 - One shutdown button must be located around the steering wheel. The diameter must be at least 24 mm.
 - A label consisting of "a red spark on a **white-edged blue triangle**" must be affixed close to all shutdown buttons.

- ◆ Resistance measurement using Tractive System Measuring Points (TSMP)
 - Before the Electrical Technical Inspection, teams must prepare to enable measurement using the TSMP (these measuring points are often set far back into the car).
 - **Wiring leading to the TSMP must be orange because high voltage is applied! (Caution is required.)**
 - **The TSMP must be a red 4 mm shrouded banana jack.**




2. Key Points of Electrical Technical Inspection

- ◆ GLVMP (GND measuring point)
 - This measuring point should be connected using a thick low-resistance wire since it is used for measuring the contact resistance.

- ◆ HVD
 - The "HVD" label should be attached to the back surface rather than the side to make it easier to see from the rear.
 - The HVD must be mounted to the location specified in EV.6.2 Positioning of Tractive System Parts and must not deviate from that position.
 - An untrained person must be able to remove the HVD within 10 seconds. (Some teams even attach a diagram.)
 - It must be possible to disconnect the HVD without removing the cowl or any bodywork.
 - Opening a lid or cover is acceptable. However, if the process is not intuitive, it will be impossible to comply with the 10-second rule.
 - Open the AIRs when the HVD is removed.

Review: Lightning bolt/spark

Review: Display of lightning bolt/spark for high voltage

| EV.4.1.7 | Accumulator container | ISO 7010-W012 (triangle with black lightning bolt on yellow background)  | <ul style="list-style-type: none"> Triangle side length of at least 100mm The text “Always Energized” |
|----------------------|-------------------------------|--|---|
| EV.6.6 | Tractive System Enclosures | | <ul style="list-style-type: none"> The text “High Voltage” |
| EV.7.3.3 | Tractive System Master Switch | | <ul style="list-style-type: none"> Be labeled “HV” or “TS” |
| EV.7.4.5 EV.7.4.6 | Shutdown Buttons | The international electrical symbol consisting of a red spark on a white-edged blue triangle  |  |

All the label texts must be in English. (Japanese is not acceptable.)

2. Key Points of Electrical Technical Inspection

EV1: Technical Inspections when high voltage system is OFF

- ◆ Attachment condition of cables
 - Cables must not be fixed to each other. All cables must be fastened securely to the body.
 - Cables should be wrapped in corrugated sheaths: Cables will break if the cover is damaged. (This is a cause of grounding faults and electrical shocks.)
 - All cables should be appropriately gathered together and fixed to the body (do not leave them in an untidy state): This is a cause of incorrect connections and other faults.
 - Use different color wiring. If all the wires are the same color, it will be confusing when checking the wiring after an issue occurs.
- ◆ Installation method of tractive system accumulators
 - It must be possible to remove the tractive system accumulator from the car without disassembling the accumulator container.

2. Key Points of Electrical Technical Inspection

- ◆ Confirmation of electrical safety of tractive system accumulator
 - Teams must prepare photographs of the state inside the accumulator container. It is very difficult and time consuming to open the container during the Electrical Technical Inspection.
 - Segments must be separated electrically without requiring the use of a tool. It is prohibited to use hand tightened nuts in the separation structure. Connectors and service plugs must be used.
- ◆ Confirmation of wiring of the tractive system supply
 - All tractive system power must flow through the energy meter.
 - When accumulator containers are connected in parallel, the accumulator containers must be wired to a single point.
 - **Teams are strongly recommended to install their own energy meter.**
 - **This meter can be used to collect data for analysis by each team.** Data measured by the energy meter distributed at the event will not be provided to teams.
 - This energy meter is also useful as a backup in case an issue occurs.

Reference: Details of energy meter connection

Energy Meter Specification:

https://tech.jsae.or.jp/formula/2019team/news/No.1_%E3%80%90For_EV_Only%E3%80%91Energy_Meter_Specification.pdf

EMs will be distributed to the EV teams on the day of the event. See the Team Handbook for details.

Each team should prepare the round high-voltage terminals.



These connectors will be provided by the JSAE.

2. Key Points of Electrical Technical Inspection

- ◆ Firewall
 - There must be an **electrically insulating layer** surrounding the driver **on the driver's side**.
 - There must be no holes near the driver. Gaps of pass-throughs for wiring must be sealed.
 - If a battery is located at the side, the insulation must cover the side of the driver. The escape route must be secured.
- ◆ Confirmation of contact safety of high-voltage system
 - All high-voltage terminals and the like must be isolated by covers and gaps filled with silicon or the like. The inspectors will confirm whether contact is possible using a 6 mm diameter probe ~~or finger~~.
- ◆ Accumulator Management System (AMS) (Battery Management System (BMS))
 - If a team purchases an accumulator (cells) that is integrated with an AMS or BMS, consider using it as-is (without making any changes).
 - AMS wiring should be collected together tidily and not left in an untidy state. Ensure a clean arrangement by placing a board in the container or adopting another measure.

2. Key Points of Electrical Technical Inspection

◆ Tractive system parts

Tractive system parts must be installed in locations designated in EV.6.2 Positioning of Tractive System Parts to protect the parts from rear and side collisions.

Note: The main purpose is to protect high-voltage parts from direct damage if a collision occurs.

If the car clearly deviates from that purpose (for example, if rigid components that accompany these parts protrude from the above position), this will be pointed out during the Technical Inspection.

- E.g. 1: When the motor is within the above position, but the transmission (i.e., a robust rigid component coupled with the motor) protrudes from the above position.
- E.g. 2: When the accumulator container is within the above position, but its cooling fan (i.e., a rigid component that directly accompanies the accumulator container) protrudes from the above position.

2. Key Points of Electrical Technical Inspection

◆ Confirmation of shutdown circuit

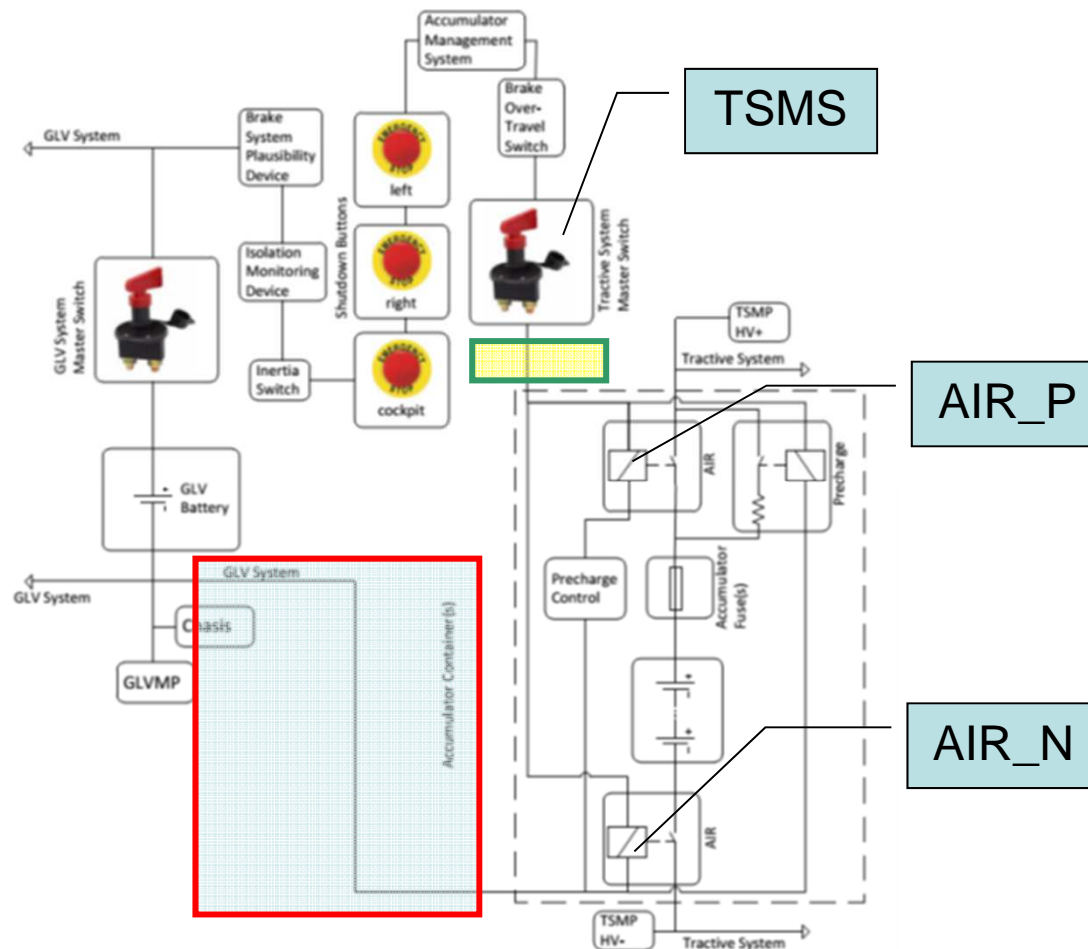
- This will be confirmed using the ESF or the like.
- Teams should print out and bring a large copy of the circuit diagram (A2 or A3 size) that is easy to read. If the diagram is too small, it is hard to see.
- Bring two types of diagrams: one that shows the overall configuration, and one that shows individual areas.

Revision: Shutdown Circuit and Systems

EV.7.3 Master Switches

Key points:

- No interlocks may be connected in the area in the diagram on the left.
- Only pre-charge circuitry and hardwired interlocks may be located in the area. (EV.7.3.3)



2. Key Points of Electrical Technical Inspection

- ◆ Confirmation of Accelerator Pedal Position Sensors (APPS)
 - Two entirely separate sensors must be used as APPS. Both the power wires and output wires must be independent and **cannot be shared**.
 - Each APPS must have a separate detachable connector. **The dedicated Technical Inspection switch box may also be used.**
 - In a past APPS connector detaching test, a team was unable to stop the motor, which resulted in abnormal high-speed rotation of the motor. In order to prevent such dangerous situations, teams must check in advance.
- ◆ Accelerator pedal return springs
 - **Each return spring must be capable of returning the pedal to the fully released position** when the other is not functional.
 - Weak springs inside the APPS are not acceptable. Either two springs must be used that are recognizable when viewed from the outside, or the teams must explain the internal structure.

2. Key Points of Electrical Technical Inspection

◆ Confirmation of contact state (electrical shock protection by potential equalization)

The inspectors will confirm whether the prescribed locations are connected to the chassis ground at or below the required resistance.

- Locations that teams often forget:
 - Steering wheel surface
 - Parts operated by the driver attached to plastic panels (switches, etc.)
- Smart teams directly connect ground wires and do not rely on bolt joints. Paint and the like often prevents conductance.
- When conductive parts such as CFRP, honeycomb core, and metal fiber are used within the prescribed areas (use of conductive parts has increased in recent years).

Special measures are required to ensure a sufficiently low contact resistance with carbon parts.

E.g.: Incorporating metal meshes into the carbon fiber, ensuring definite the **Grounding wire** with the aluminum honeycomb (core) as the measurement point.

2. Key Points of Electrical Technical Inspection

EV2: Finally, Technical Inspections when high voltage system is ON

- ◆ Confirmation of start-up method
 - The easiest confirmation method is to use the "ready-to-drive mode" indicator. Teams have designed cars in the past in which even the driver could not confirm "ready-to-drive mode"
- ◆ Tractive System Active Light (TSAL)
 - If there is a high voltage between AIR and the inverter, we recommend turning TSAL on the power supply between AIR and HVD. (To warn you when the accumulator output can not be shut down, such as AIR welding)
- ◆ Confirmation of high-voltage system shutdown
 - When the GLV master switch is turned OFF, the voltage might not drop in 5 seconds. Teams should examine the relationship between the GLV master switch and the discharge circuit.

2. Key Points of Electrical Technical Inspection

- ◆ Confirmation of tractive system accumulator pack operation indication
 - When high voltage is present on the outer side of the AIR, **the indicator must operate even when the container is removed from the body.**
 - An analog voltmeter is permitted.
- ◆ Confirmation of safety when Brake System Encoder (BSE) error occurs
 - The brake sensor used for error detection must be used for the brake override (EV.2.4).
 - It is strongly recommended that the same sensor as this be used for the brake sensor in the Brake System Plausibility Device (BSPD, EV.7.6), which is the final measure against the car running out of control.

2. Key Points of Electrical Technical Inspection

◆ Confirmation of BSPD operation

- Each team must consider how to prove BSPD operation (the method may be described on the ESF).
- Confirmation by non-operation of the brake override is not the preferred method.
- Teams should assume that it will not be possible to confirm at the Technical Inspection Area with the power of 5 kW or more actually delivered. A normal method is to use a pseudo signal that indicates 5 kW or more.
- A requirement to include the shutdown circuit when detecting a 5kW sensor, disconnection of the hard braking sensor, or short circuit is added from 2019. (EV.7.6.1.c)
This should be made possible with a hard circuit (window comparator circuit etc.) without using the microcomputer.

◆ Confirmation of Insulation Monitoring Device (IMD)

- Cautions when using the IMD manufactured by Bender (supplied by Protrad):
 - Connect the two ground wires separately.
 - Teams should thoroughly discuss the addition of a voltage detection function (when purchasing a new one).
When this detection function activates, shutdown will take place before the high voltage builds up.

2. Key Points of Electrical Technical Inspection

◆ Confirmation of operation of IMD

- Teams must prepare the resistance (of at least 250 Ω/V) that triggers detection and operation during the Technical Inspection.

◆ Confirmation of charger

Cautions regarding the Standard Charging Procedure and Charging Abnormality Procedure documents:

- Both should be expressed as flow charts.
- Use diagrams (photographs) to make them easier to understand.
- **Refer to the local rule J2019-29 Easing Charger Equipment for the indications required.**
- **Both procedures are handled as component elements of the ESF. If there are any items left blank or mistaken, the procedures need to be submitted again.**

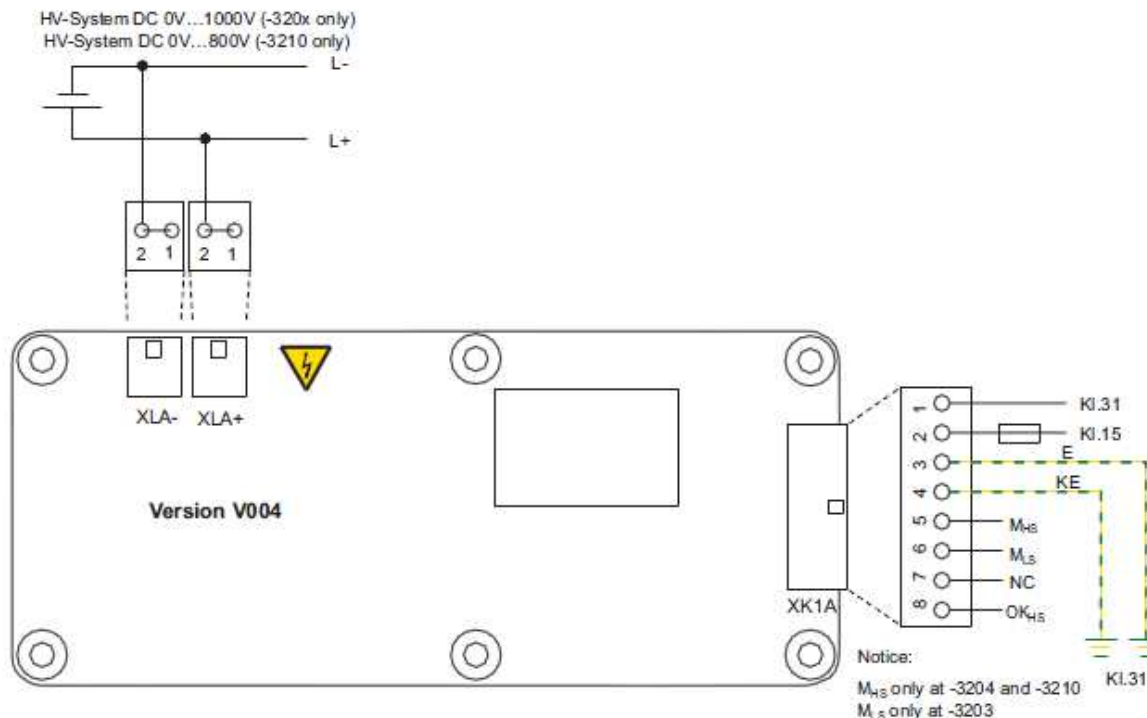
Review: Insulation Monitoring Device (IMD)

Key points:

- The two reference ground wires of the IMD must be connected to the chassis separately.
- During the Technical Inspection, one or two of the reference ground wires will be disconnected to check that a failure occurs.

Teams should test in advance whether a failure is detected under both of these conditions.

Wiring diagrams



Connector XLA+

Pin 1+2 L+ Line voltage

Connector XLA-

Pin 1+2 L- Line voltage

Connector XK1A

Pin 1 Kl. 31 Chassis ground

Pin 2 Kl. 15 Supply voltage

Pin 3 Kl. 31 Chassis ground

Pin 4 Kl. 31 Chassis ground (sep. line)

Pin 5 M_{HS} Data Out, PWM (high side)

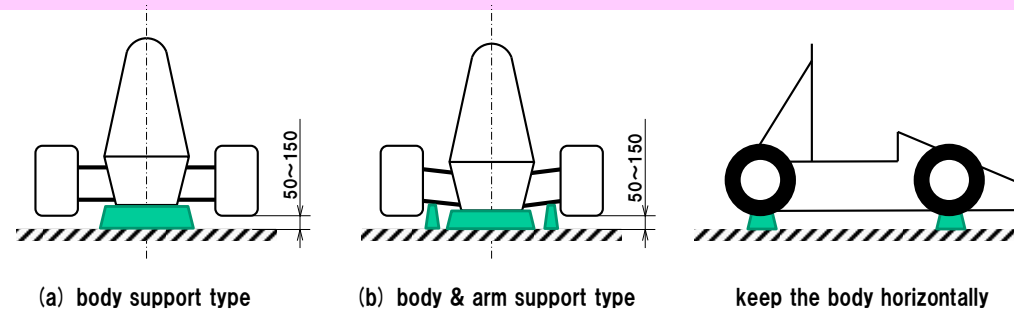
Pin 6 M_{LS} Data Out, PWM (low side)

Pin 7 n.c.

Pin 8 OK_{HS} Status Output (high side)

2. Key Points of Electrical Technical Inspection

EV3: Rain Test



- Each team should prepare a stand (above figure) that can hold the car with all four wheels approximately 50 to 150 mm above the ground.
- Seals will be attached to plastic covers and the like used as a countermeasure against rain. → These cannot be removed.
 - Use a structure that does not use tape or the like to seal against rain.
- In the event of an emergency, teams should bring enough insulated gloves for the people required to lift the car up.
- This test can be failed in circumstances other than an insulation failure (electrical leakage) (e.g., sensor signal disruption leading to shutdown).

Reference: Brake Test

- After accelerating, the system must be stopped by pressing the **shutdown button** before braking.
- Since it is more difficult to lock the tires with an EV than a gasoline-powered car, the same design may not work.
 - This is caused by higher weight and the rotational inertia of the motor applied to the drive wheels.

CAEREFUL Operations in the EV Inspections

- Why can't you calm down? 😞

The team members will be asked to perform various operations during the EV Inspections. Just chill out.

- ✓ Jacking up the car
- ✓ Rotating the motor
- ✓ Measuring potential
- ✓ Charging

Accumulator container must be removed from the car for charging.

- ✓ Operations involving touching the components placed inside the accumulator container must be carried out **in the Charging Area**.

Although the following operations will not be carried out at the Inspection Area, Check the next pages just for your information.

- ✓ High-voltage wiring connection
- ✓ Wiring inside the accumulator container

Safety in High-voltage wiring connection

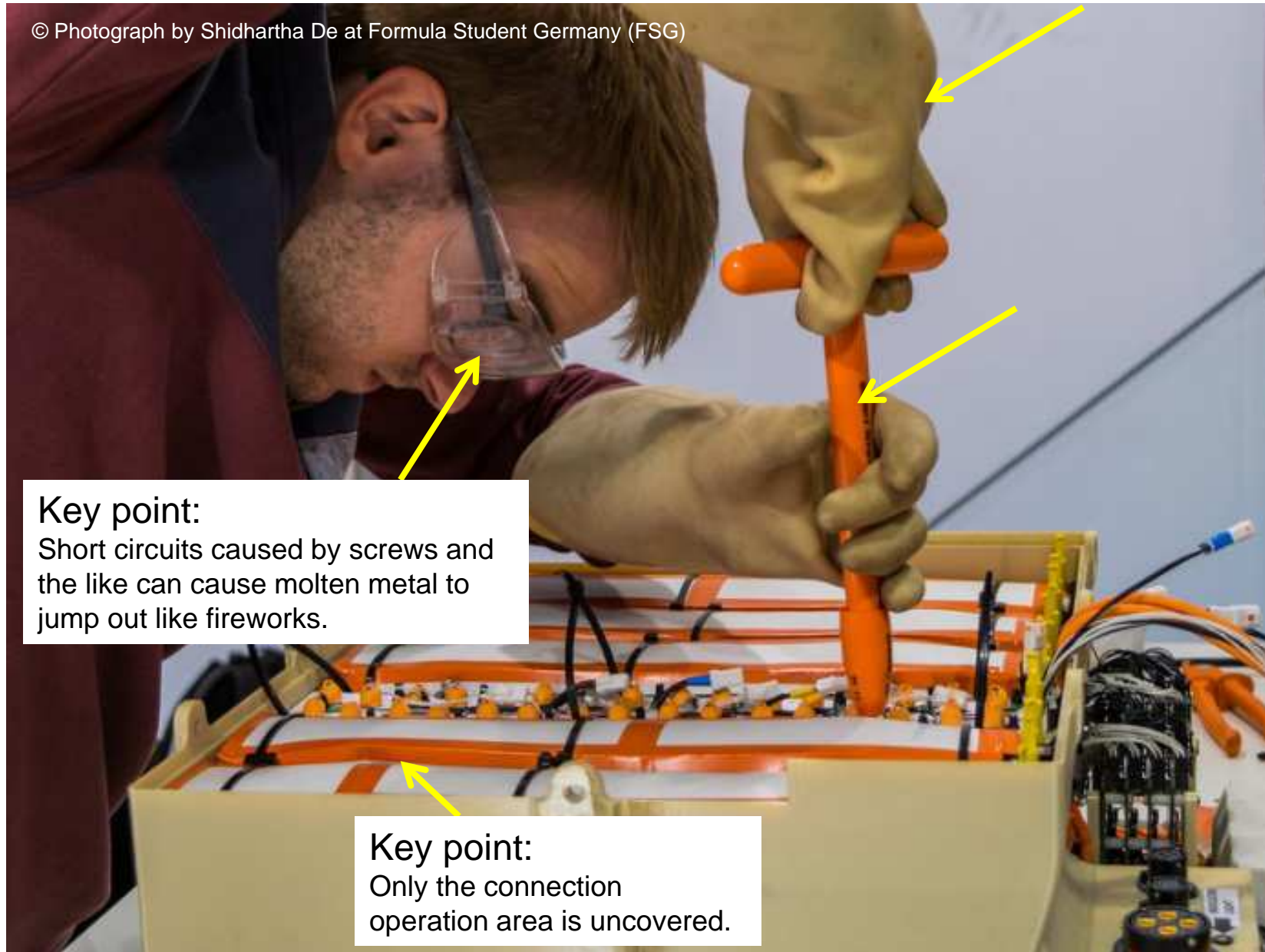
© Photograph by Shidhartha De at Formula Student Germany (FSG)

Key point:

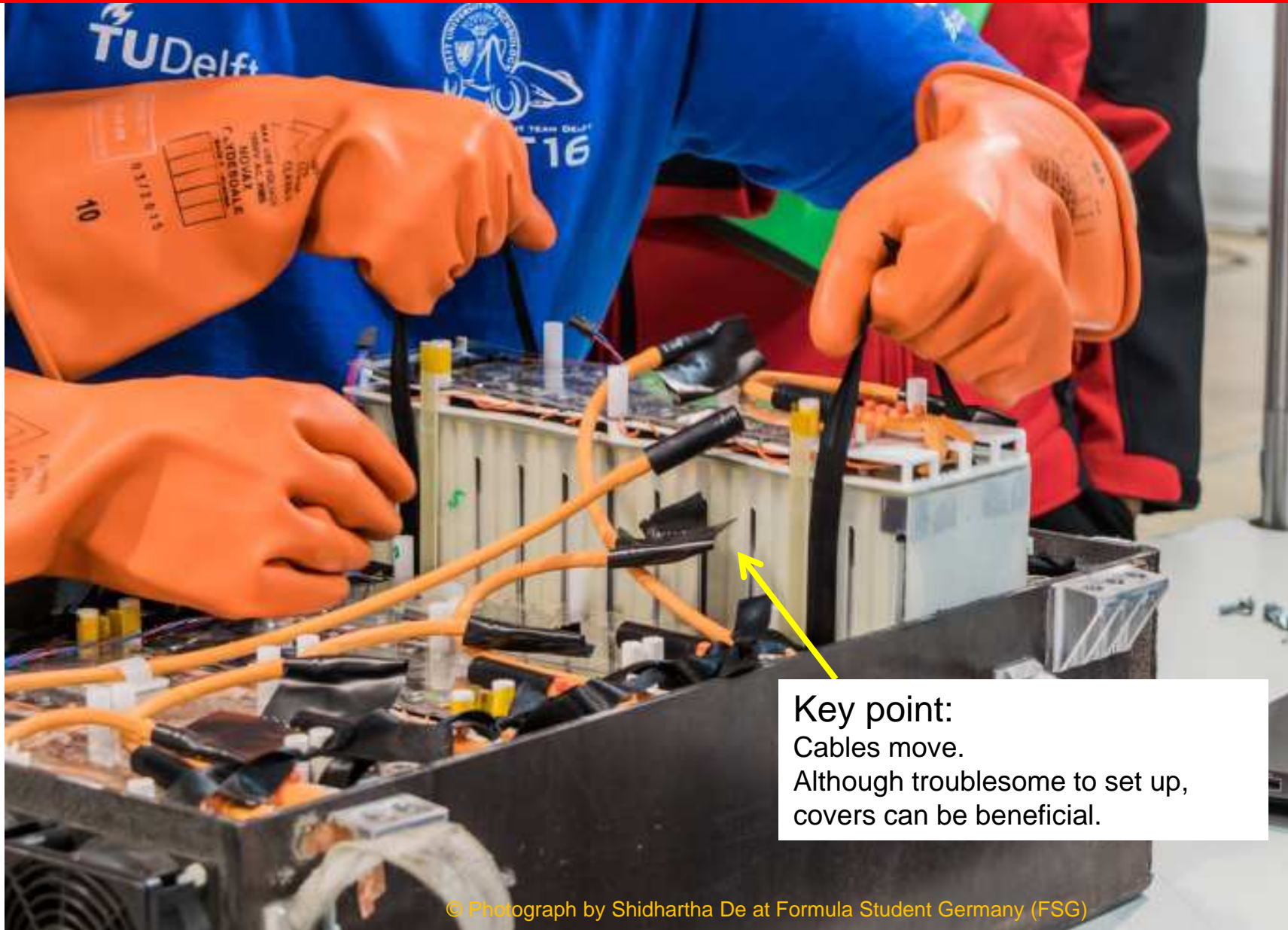
Short circuits caused by screws and the like can cause molten metal to jump out like fireworks.

Key point:

Only the connection operation area is uncovered.



Safety in Wiring inside the accumulator container



Key point:
Cables move.
Although troublesome to set up,
covers can be beneficial.