2025 ESF Template description

Society of Automotive Engineers of Japan, Inc.（JSAE）

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Introduction

- This document is an instruction manual for the ESF (Electric Systems Form) for the EV class of Formula SAE Japan (FSAEJ) organized by JSAE.

- The ESF is called a template in the FSAE Rules.
  In FSAEJ, it is customary to refer to it as "form“, "format" etc., but both are synonymous with “template” in the SAE Rules.

- This document is an explanation of how to write an ESF and is NOT about rule interpretation or design method.

Contents

- What is ESF
- How to wright the ESF in general
- How to wright each sheets
- Summary

Contents

What is Electric Systems Form (ESF)

The ESF clearly describes the entire electrical system of the EV.
"ESF approval" is NOT the same as "EV inspection qualification".

EV.2.1 Electrical System Form – ESF

EV.2.1.1 Each team must submit an Electrical System Form (ESF) with a clearly structured documentation of the entire vehicle electrical system (including control and Tractive System). Submission and approval of the ESF does not mean that the vehicle will automatically pass Electrical Technical Inspection with the described items / parts.

EV.2.1.2 The ESF may provide guidance or more details than the Formula SAE Rules.

EV.2.1.3 Use the format provided and submit the ESF as given in section DR - Document Requirements

"ESF approval" will have the advantage of the EV inspection.

Participation Rules 2025, Article 16 Submission of EV-ESF

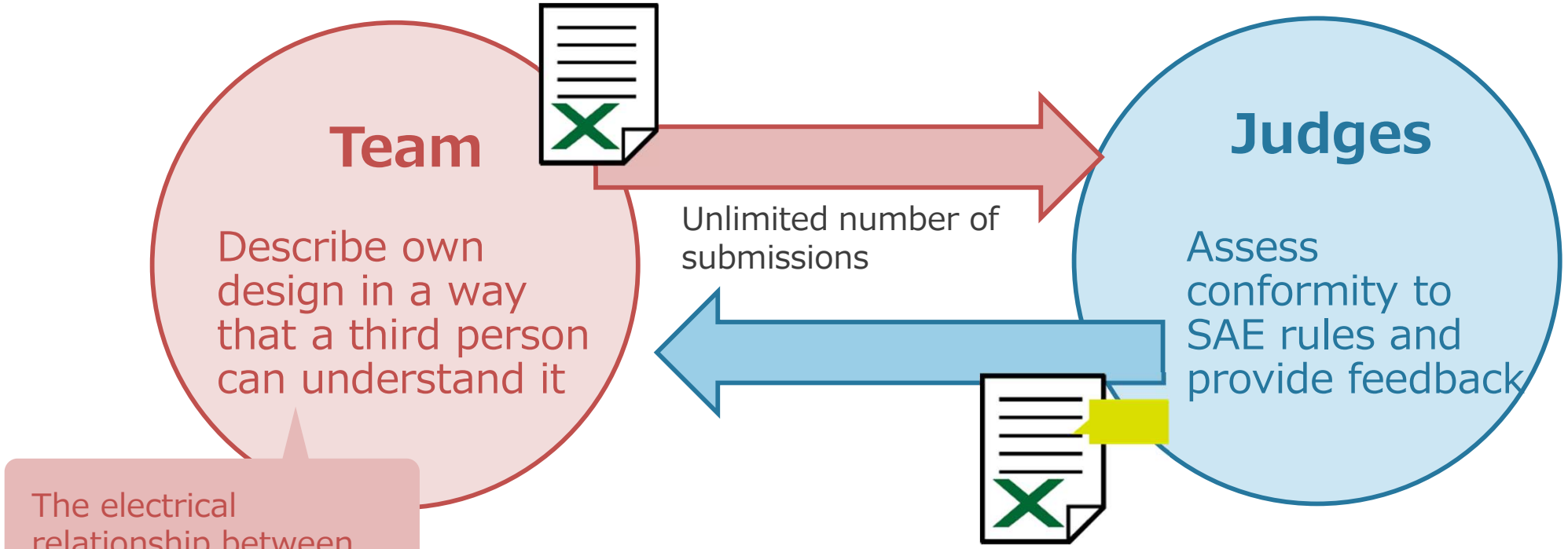
1. Aim of submission

The screening of electrical system design documents is emphasized as the most effective means of ensuring the safety of EV design, and enabling to proceed to Dynamic Events.

Basic procedure between team and judges

For the team, the ESF is the electrical design document for the entire vehicle system.

The ESF is used by the auditors themselves to check the compliance status of the electrical system rules.



Role as a design document in ESF

■ Get an objective view of your design

- Clarify design specifications and use the ESF as a blueprint
- Use it to debug the vehicle and validate its operation
- Update the ESF if the information in the ESF does not match the information in the vehicle.

■ Each person who reads the ESF **understands the design details** and **shares information and knowledge**.

■ Transfer vehicle technology to younger members

- The younger members understand the design concept/structure and make the design better.

Don’t modify provided ESF excel form

■ Formula SAE Rules 2025

DR.2.2.3 Do Not alter the format of any provided template files

DR.2.2.4 Each submission must be one single file in the specified format (PDF - Portable Document File, XLSX - Microsoft Excel Worksheet File)

■ 2025 FSAEJ Participation Rules

Article 16 Submission of EV-ESF,

2. Regarding ESF Format

The ESF must use FSAEJ templates that can be downloaded from team page at the end of February 2025 and maintain the original format.
Do not edit or save the file using any software other than Microsoft Excel.
The ESF Templates that can be downloaded from February 2025 must be used, and maintain the Original format.
The file protection settings must not be removed.
Do not edit or save the file using any software other than Microsoft Excel. Other compatible software poses a risk of file corruption. (e.g., Google Spreadsheets)

Important Note:
Even if unintentional, modification of the format may be considered as non-submission.

Submission of ESF (Participation Rules 2025, Article 16)

(3) Initial Submission

・The submission will be treated as non-submission,
- if roughly one-third or more of the document items are not completed at the initial submission,
- or if the designated form is not used.

・If the judge finds that the contents have been improved, the submission will be treated as an initial submission.

・It is recommended to submit the documents well in advance of the deadline.

(4) Re-submission and Final Submission

・If the initial submission is not accepted, the team will be required re-submission of ESF.

・The second submission after the initial submission must be done by "Second Submission Deadline".

・Re-submission is possible after receiving feedback from the judge and can be resubmitted any number of times without waiting for the deadline.
(Note that the method of feedback is different from that of SES submission in Article 14.)

・To pass ESF as soon as possible, it is recommended to resubmit without waiting for the respective submission deadlines.

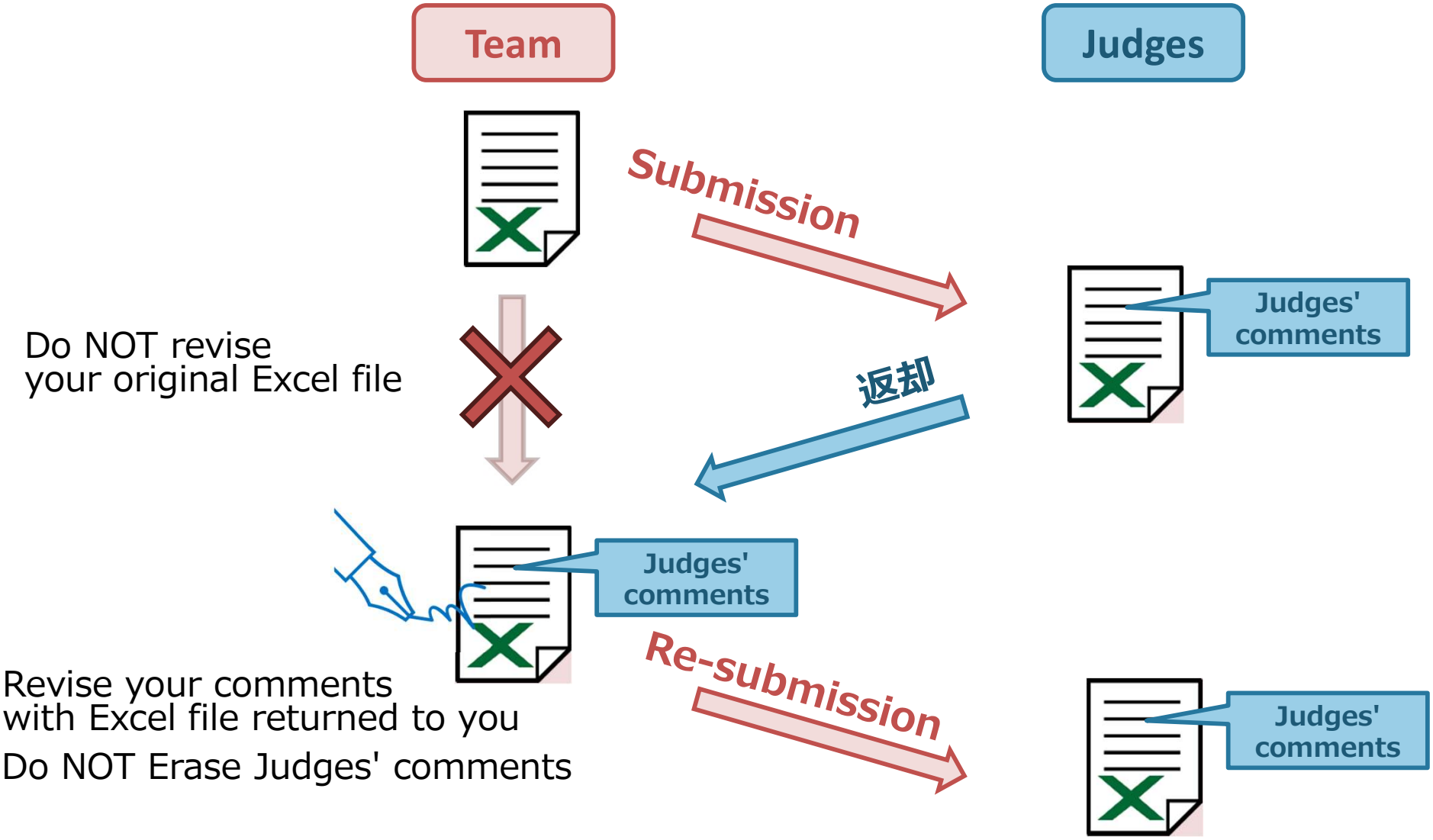
・**Feedback from the judges may take up to 2 weeks**.

・The ESF feedback may not be provided to teams that are unable to participate in the EV and Technical Inspections.

Please understand that judges need to balance their time between their normal work and the ESF review.

Use the Returned Excel file for re-submission

Once the ESF is returned, make additions to the returned.
Do NOT delete Judges' comments for saving history.

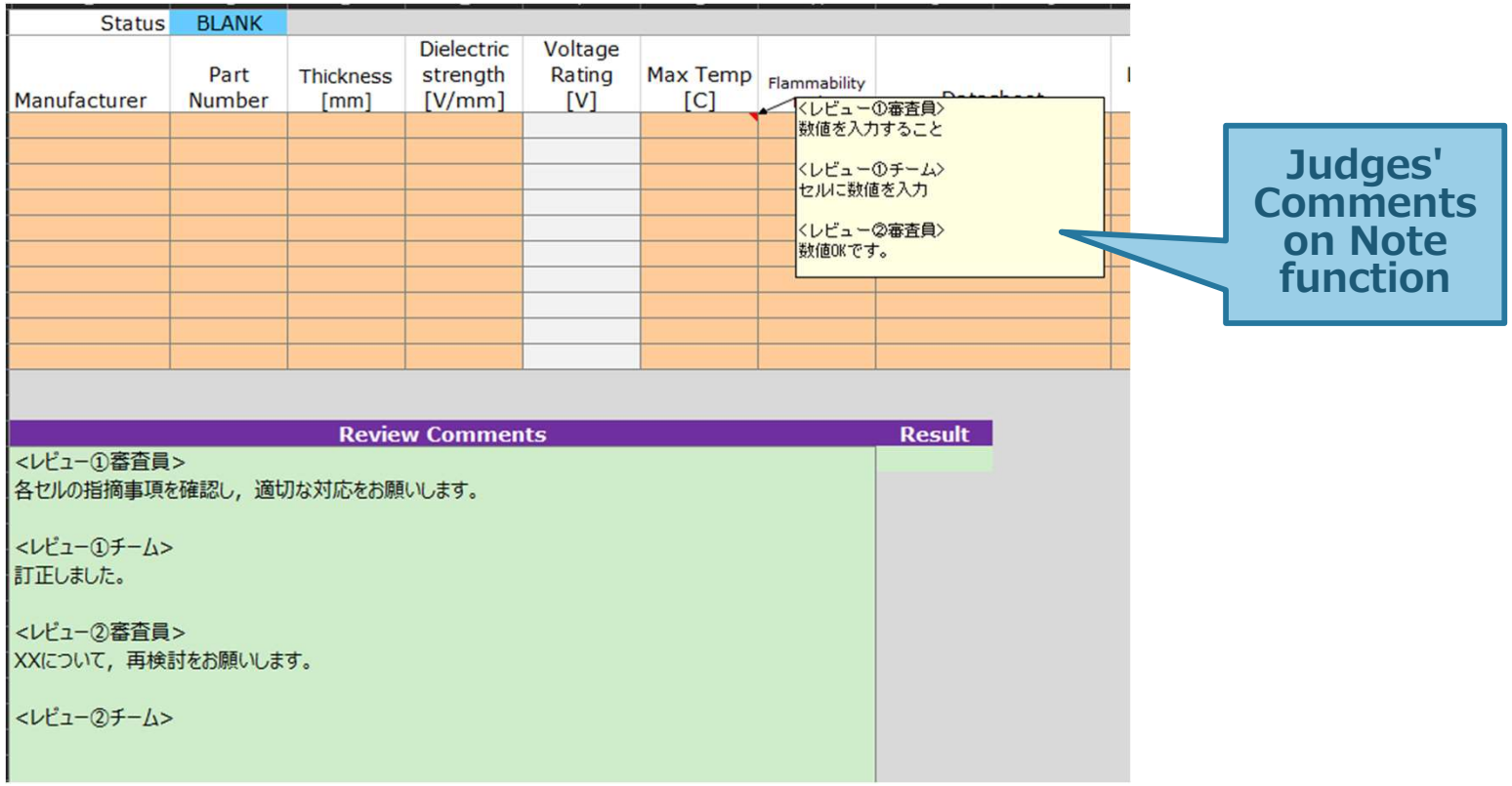


Do NOT Erase Judges' comments

Judges are commented on using Excel's note function (or comments function prior to Office365).
When the team re-submits, the comments written by the judges must be kept.(unless the judges tell the team to delete them)

- The judges enter the remarks in the cell and Review Comments with the letters "<Review (times) judge >" as below.
  To keep the history of past reviews and to prevent backtracking, do NOT delete the Notes (Comments) function and Review Comments.
- The team's response to the Judges' comments should also include the letters "<Review (times) Team>" .

Example：



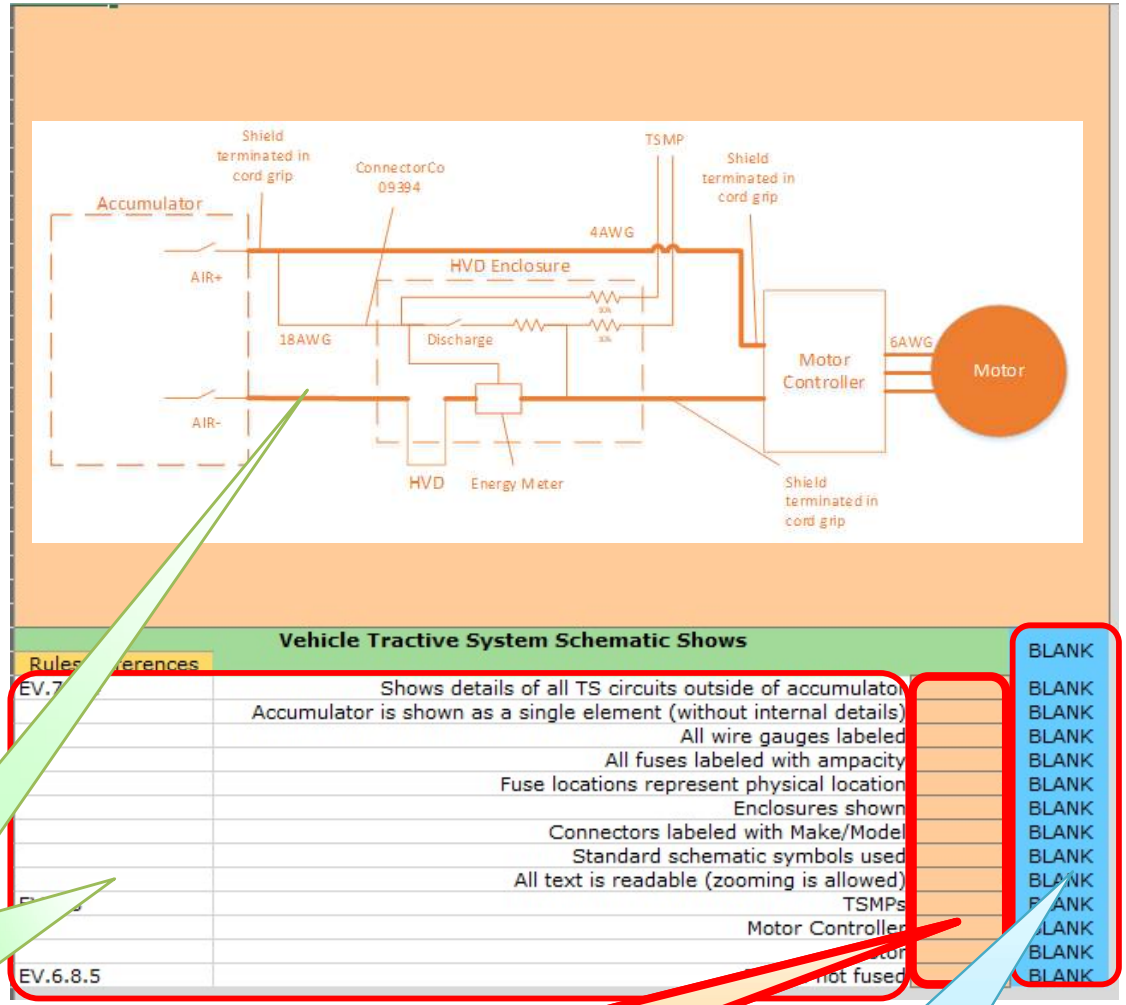
Contents

Cell entry and auto-judgment by Excel

As shown in the figure on the right, Team inputs in orange cells, and an auto-judgment is displayed in blue cells.

In the example on the right, if the orange cells are selected in TRUE, the blue cells will be OK.

The final decision is made by the Judge, who determines TRUE from the schematic. (Automatic-judgement is for reference only.)



The diagram above should be filled with components on the list below at least.

Select TRUE/FALSE

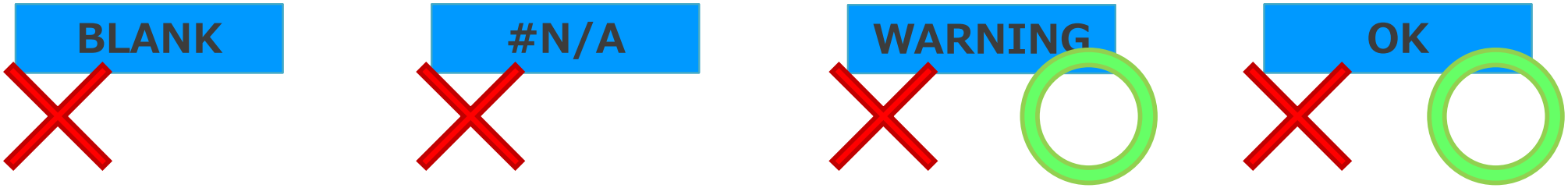
Excel judges automatically

How to use “Additional Comments”

Auto-judgment **“WARNING” ≠ “Failure of input to the cell”**

- If a blue cell is marked "WARNING", the "Additional Comments" section should be filled in to describe the foreseeable reason for the "WARNING" and the basis for the design, etc.

- If the design is reasonable and meets the rules, this section may be qualified.
- If the blue cell is marked "BLANK" or "#N/A", the entry is missing and should be reviewed.



- To help the judges understand, use Additional Comments aggressively for the team's innovations, explanations of diagrams, etc.

-Additional Comments sections are provided throughout for documentation of things which the team feels are not adequately documented in the provided fields. These are optional and do not need to be completed.

Fill in “2_Datasheets”

If “2_Datasheets” is left blank, some cells cannot be entered in other sheets.

- Some cells in “Resistors” or “Contactors/Relays” will create a pull-down list for other sheets If no entry is made, the drop-down list will be blank.

2_Datasheets

Resistors								OK
Manufacturer	Part Number	Voltage [V]	Resistance [Ω]	Power [W]	Power for 15 sec [W]	Heatsink [°C/W] (Enter "None" if no heatsink)	Datasheet	Location Used	
Tigers	100	600	500	5	15	None	test	TSMP	OK

5_PrechargeDischarge

TSMP		BLANK
Resistor		BLANK
# parallel	Tigers 100	BLANK
# series		BLANK
Resistance		#N/A
Cont power		#N/A
Voltage		#N/A

! Caution !
If you change the contents of 2_Datasheets after selecting it in the drop-down list, you must select it again from the drop-down list.

Cells that have been previously dropped down will not automatically reflect the changes.

How to improve drawing and photo

Point of attention must be clearly indicated

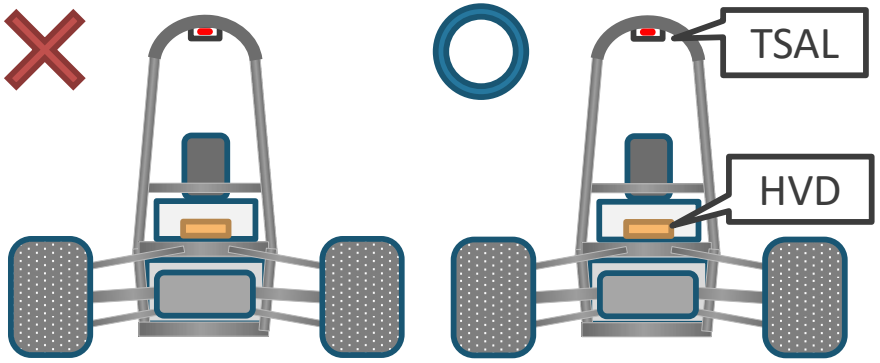
Don't just insert a drawing and/or picture
Clearly indicate what you want the judges to see for better understanding

Colors and dimensions related to the rules can be clearly indicated

Location and visibility descriptions should include color, height/length, etc., in addition to diagrams and figures.

e.g. : TSAL and HVD location

Be labeled with text for understanding objectively



e.g. : Diagram

Be labeled with text for more focus

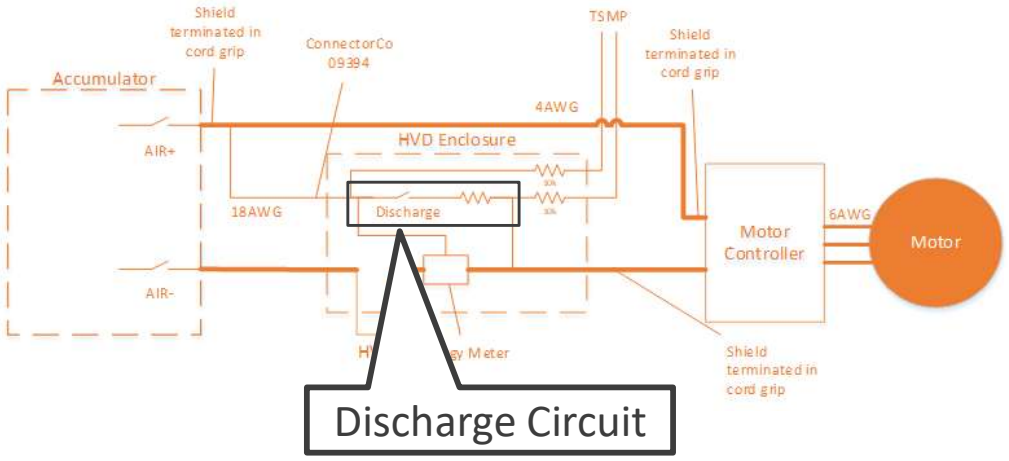


Diagram and drawing should be readable

Judges will enlarge ESF drawings for detailed review.

■ "Instructions" on "1_Overview" on the ESF

-For sections which require an image or schematic, The image should be pasted and located over the specified area. Images should be pasted at a high resolution and then resized. This allows the reader to zoom into the image if more resolution is required.

■ e.g. Cell input

All text is readable (zooming is allowed)	TRUE	OK

Use a diagram with an appropriate resolution that allows for legible (=readable) text and symbols.

How to describe “11_Appendix Datasheets”

- "Instructions" on "1_Overview" on the ESF
  -Where datasheets are requested, a hyperlink to the datasheet from the manufacturer must be provided. Only when a link to the outside does not exist, a hyperlink to the datasheet in the “11_Appendix Datasheets" must be provided.

- Hyperlink the Datasheet* field.
  Parts for which a Datasheet is being required should have a hyperlink to the information provided by the manufacturer.
  However, only when there is no external link, the necessary information must be pasted into "11_Appendix Datasheets" in the ESF, and a hyperlink (cell reference) should be set in the ESF Excel file.

  ※ Datasheet : Component specifications
  e.g. Specifications, instruction manuals, catalogs, and other documents

- All pages of the datasheet must be provided.

- Underlining is recommended as follows:
  1. Specific parts selected by the team among the many parts of the datasheet
  2. Important description that is related to ESF requirement

How to describe “9_Procedure” collectively

- Procedure is a necessary procedure during competitions, especially during vehicle inspections
  - Can you work safely?
  - What you need to check before operation?
  - What is safety dress code?
  - What should be checked first? ...etc.

- The procedures should be numbered. Flowchart is acceptable.

- Refer to examples of “charging” procedure on the textbook of “**ESO safety training for work on vehicles with high-voltage systems** Page.63”.

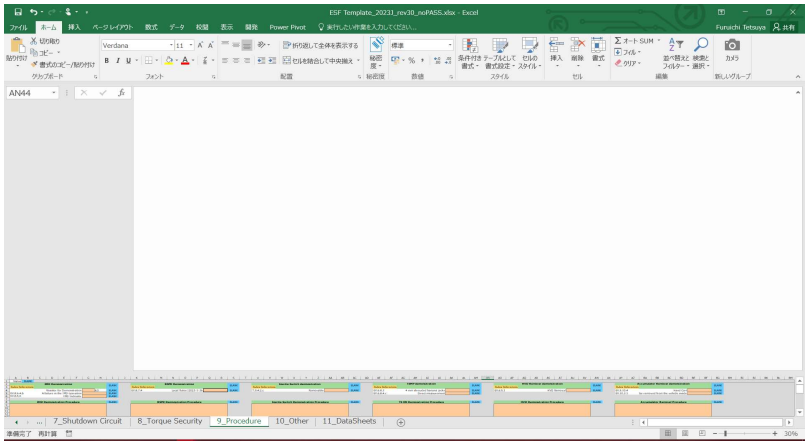
- The procedures are written so that a person unfamiliar with the vehicle (e.g., a new team member, judge, etc.) can work safely after reading the procedures.

- Improvement of vehicle design quality
  Prevent design changes just before the competition by obtaining detailed procedures in advance(e.g., adding or repositioning connectors, changing circuits, etc.)

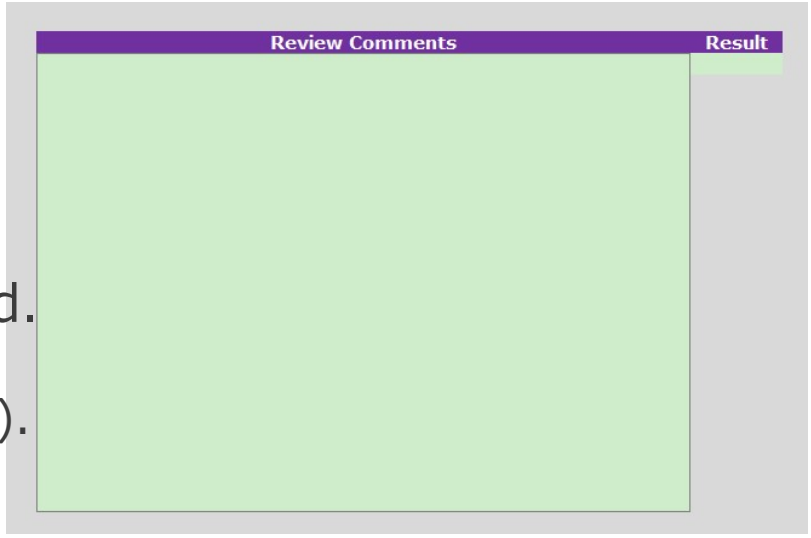
Other Notes

- **Input character type**
  Use single-byte alphanumeric characters. Incorrect input character types may result in incorrect calculations.
  Japanese (double-byte characters) may be used for sentences such as "Additional Comments.

- **Number of characters to be entered**
  Fill in as many characters as necessary in a cell, even if the input box is too small to write in.
  If not all are shown in a cell,
  The judges will expand the input box to check.
  *Cell size cannot be changed.



- **Judges' Comments**
  This entry is for Judges' comments only.



- **Modification of the Excel form is not allowed.**
  Do not edit anything except orange cells (including "11_Appendix Datasheets" Worksheet).
  Do not change it.

In Case of Trouble

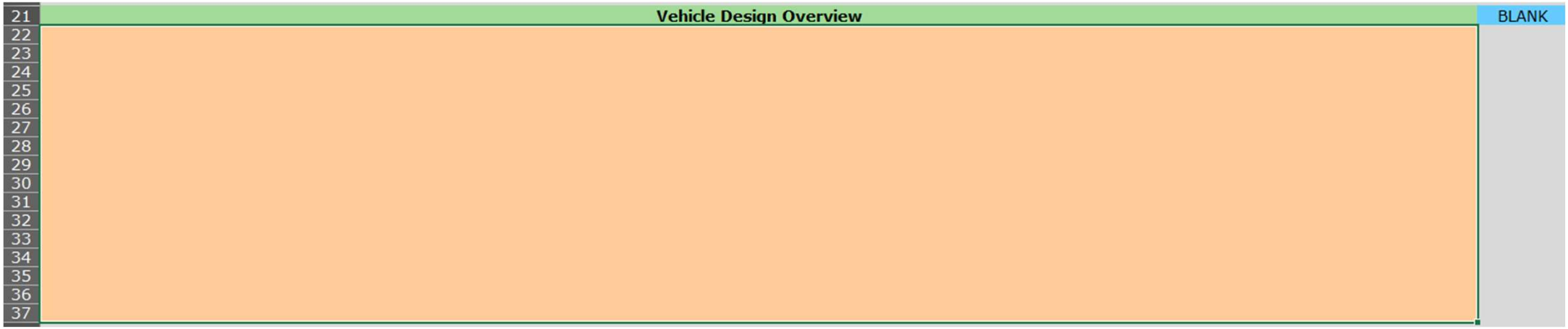
- Understand what is required by the "formula" of the cell to avoid mistakes.
  - The judgment formula automatically determines whether or not the input matches the specified conditions and whether or not there are any input errors.

- Understand all the Rules
  - Read the official JSAE rules (Formula SAE® Rules 2025, Local Rules, Participation Rule) and other documents (Q&A, Design Guides, etc.) carefully.

Contents

1_Overview

A22 ; Vehicle Design Overview



- This cell does not have judging criteria, but teams should actively introduce their Vehicle's electrical system.
- The following information should be simple enough for judges to understand
  - Battery configuration (voltage/capacity)
  - TS voltage (max/nominal/min)
  - TS current (max/rated)
  - Motor/Inverter output (max/rated)
  - The background for determining TS max current and TS rated current

2_Datasheets

D3:D15 ; Battery Cell

2	**Battery Cell**		BLANK
3	Make		
4	Model		
5	Nominal Capacity	Ahr	
6	Maximum Voltage	V	
7	Nominal Voltage	V	
8	Minimum Voltage	V	
9	Max output current	A	
10	Max continuous current	A	
11	Max Cell temp	C	
12	Cell Chemistry		
13	Datasheet		
14	SDS		
15	Additional Comments		

- The TS maximum voltage, etc. is automatically calculated by the value input to the cell, such as maximum voltage.
  Enter the values from the battery cell datasheet in the above cells.

- Add an explanation if you enter values different from those in the battery cell datasheet,
  Ex. If max cell voltage is 4.2V, TS max voltage is 4.2V x 96 cells = 403.2V exceeds the max. input voltage limit 400V of the inverter. As a result, max cell voltage should be 4.1V and max voltage should be 4.1V x 96 cells = 393.6V.
  The control method to prevent the cell voltage from exceeding 4.1V is ... ...

- SDS: (Safety Data Sheet)
  A document used to provide information on the physicochemical properties, hazards and toxicity, and handling of chemical substances and mixtures containing chemical substances to the party to whom the chemical substances are transferred or provided.

Ministry of Health, Labor and Welfare ：SDS[Safety and Health Keywords] in Japanese

4_Accumulator

G3 ; Segment-to-Segment Connection

Segment-to-Segment Connection	Series	
Maximum TS Voltage	756	V
Nominal TS Voltage	0	V
Total Cells	360	

Segment Data

Cell Connection Order: Parallel then Series

Segment	Parallel cells	Series cells	Temp Sensors	Accumulator Number	Max V
1	2	18	4	1	
2	2	18	4	1	
3	2	18	4	1	
4	2	18	4	1	
5	2	18	4	1	
6	2	18	4	1	
7	2	18	4	1	
8	2	18	4	1	
9	2	18	4	1	
10	2	18	4	1	

- Select “Series”, if the segments are connected in series.
- Enter 1 in the “Accumulator Number” field.

Segment-to-Segment Connection	Parallel	
Maximum TS Voltage	378	V
Nominal TS Voltage	0	V
Total Cells	360	

Segment Data

Cell Connection Order: Parallel then Series

Segment	Parallel cells	Series cells	Temp Sensors	Accumulator Number	Ma
1	2	18	4	1	
2	2	18	4	1	
3	2	18	4	2	
4	2	18	4	2	
5	2	18	4	3	
6	2	18	4	3	
7	2	18	4	4	
8	2	18	4	4	
9	2	18	4	5	
10	2	18	4	5	

- Select “Parallel”, if the segments are connected in parallel.
- Enter the same value in the “Accumulator Number” fields for the parallel segments.
- The table above shows an example of 5 series and 2 parallel connections.

4_Accumulator

Q27 ; Cells sensed per sensor

Temperature Sensors			
Temp Sensor Location			BLANK
Distance to cell terminal		mm	BLANK
Cells sensed per sensor		cells	BLANK
Thermal Contact material used			
Thermal contact material datasheet			
Thermal contact material conductivity		W/(m·K)	

- In the “Cells sensed per sensor” field, enter the number of battery cells that one temperature sensor measures.
- The “Cells sensed per sensor” field may be more than 2 in the case of parallel connection of pouch cells.

6_Charging

A50, J50 ; Charging Procedure / Charging Abnormality Procedure

47	**Relaxation of Rules for EV Chargers**	BLANK
48	Local Rules J2025-EV-12	BLANK
49	**Charging Procedure**	
50		BLANK
51		
52		
53		
54		
55		
56		
57		
58		

- **Charging /Charging Abnormality Procedure is required for all teams**
  If Local Rule J2025-EV-12 is used, the procedure must be written in the ESF.
  The Competition Handbook will state “The ESO will conduct and supervise the Charging Procedure (Normal/Abnormality) during charging”.
  All teams are required to prepare a written procedure for the competition site.

- **TSMPs are used to measure the TS voltage.**
  When the Charging shutdown circuit is opened, the TS voltage must be Low Voltage T.9.1.2 or less within 5 seconds. (EV.8.4.2.b)
  Checking the TS voltage with a multimeter on the TSMPs is mandatory for the procedure.

Contents

Requests from judges

The judges are not familiar with your vehicle

The judges receives information about the vehicle only from the ESF.
Teams should use “Additional Comments” to supplement the explanation so that judges understand that the vehicle meets the rules and other requirements below.

The judges knows the SAE Rules

It is not necessary to explain the content of the rule. Just quote the SAE Rule number.

Be aware of the judges' point of view

The judges will check the ESF in order of priority: (1) Compliance with the rules, (2) safety, and (3) ability to perform dynamic judging.
There have been instances where additional explanation is needed, especially for (2) and (3).
A good ESF is one that is described by judges and objective viewpoints without being pointed out.

The ESF should be passed.

If the ESF is not passed, the number of items to be judged will be extremely large.
Due to time constraints, it is very difficult to pass the vehicle inspection during the competition period.

Judges will help teams pass the ESF.

The judges support your team. Do your best to get a pass!

Known ESF Template (Ver. 2.5) bugs

5_PrechargeDischarge
The formula for “R10:R16” field is incorrect.

Vehicle TSMP			BLANK	Rules References
Resistor			BLANK	EV.5.8.4
# parallel			BLANK	
# series			BLANK	
Resistance	#N/A	Ohms	#N/A	
Cont power	#N/A	W	#N/A	
Voltage	#N/A	V	#N/A	

Charger TSMP			OK	Rules References
Resistor				EV.5.8.4
# parallel				
# series				
Resistance	#N/A	Ohms		
Cont power	#N/A	W		
Voltage	#N/A	V		

- **Judgment is OK regardless of the entries in the fields**
- **Use uploaded revised version (Ver2.6)**
  The ESF Template Revision History is on the bottom of “1_Overview” sheet.

Template Revision History		
Version	**Date**	**Comment**
2.6	3/13/25	Multiple updates and bug fixes.
2.5	2/21/25	Updated for FSAE Japan 2025 season.
2.4	2/26/24	Updated for FSAE Japan 2024 season.
2.3	10/29/23	Updated for 2024 season.
2.2	11/3/22	Updated for 2023 season.
2.1	10/22/21	Updated for 2022 season.
2.0	11/27/20	Multiple updates and bug fixes.