



GTR No. 20 EV Safety

IWG #23 – Thermal Propagation Documentation Sub-Group – Status

March 2022

Thermal Propagation - Phase 1 Summary

- ***Why was a documentation approach pursued in Phase 1?***
 - Test procedure was not fully developed
 - Rapid evolution of EV technology
- ***What are the issues with the Phase 1 Thermal Propagation Documentation Requirements?***
 - 1) Unclear who/what we are protecting
 - 2) Contain ambiguous conditions (e.g. operation modes are not specified)
 - 3) Do not address the safety need (e.g. parked mode, etc.)
 - 4) Performance criteria are not relevant to the operating modes under consideration in Phase 2
 - 5) Only pertains to REESSs containing flammable electrolyte
 - *5.4.12: “For the vehicles equipped with a REESS containing **flammable electrolyte**, the vehicle occupants shall not be exposed to any hazardous environment caused by thermal propagation which is triggered by an internal short circuit leading to a single cell thermal runaway.”*

Need to strengthen the details of the documentation approach to improve uniformity and enforceability

Summary of First Sub-Group Meeting: January 20th, 2022

Sub-Group Documentation — Brainstorming Activity #1 (25 mins):

- Why do we need a documentation approach to address the risk of thermal propagation from an internal short-circuit in a cell of a REESS?
 - Brainstorming prompts:
 - a) Do the proposed Phase 2 TP test methods meet the following requirements? If so, how are the requirements met? If not, why?
 - 1) Tests are reasonable and practicable (addresses safety need taking into consideration cost, available technology, and stringency)
 - 2) Objective (unambiguous, repeatable, and reproducible)
 - 3) Not design restrictive.
 - 4) Appropriate for each vehicle type (or REESS)
 - 5) Address the safety problem?
 - 6) Enforceable (even though they may be intrusive)

Sub-Group Documentation — Brainstorming Activity #2 (25 mins):

- What are the challenges to the documentation approach (from a regulatory perspective)?
 - Brainstorming prompts:
 - 1) Enforceability
 - 2) Intellectual Property
 - 3) Any others?

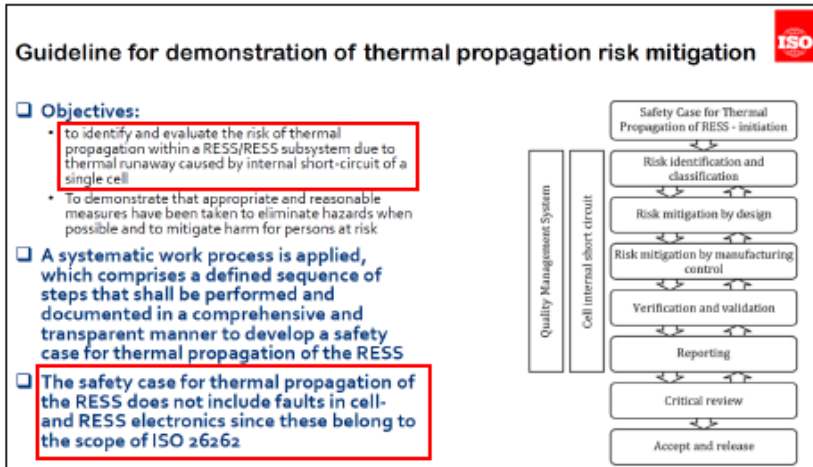
Sub-Group Documentation — Brainstorming Activity #3 (5 mins):

- Ideas for a path forward for the documentation approach?
 - Brainstorming prompts:
 - 1) ISO-26262, ISO-6469, and any others?

- First Sub-Group Meeting was part of Thermal Propagation (TP) Task Force (TF)
 - TF convened on January 19th & 20th
- **Three Brainstorming Activities were discussed (left)**
 - Round-table: CA, OICA, EU, CN, JPN, US, etc.
- **Decisions/Next Steps:**
 - De-coupled sub-group meetings from TP-TF meetings to focus on development of the documentation approach details
 - Establish monthly meeting cadence to discuss the details of the documentation framework
 - **Discuss “What type of information would be provided?”**
 - **Collectively decided to develop both the test method and the documentation approach in parallel**

Summary of Second Sub-Group Meeting: February 24th, 2022 (1/4)

Review of ISO-6469* and ISO-26262 & Identification of Possible Requirements which could be extracted/incorporated into GTR Documentation Approach (2/4)



*Source: TC22 SC37 WG3 Liaison Report for EVS-GTR Thermal Propagation Work Item, October 2021, slide 8.

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- **Can we all agree on the proposed scope & goal of the GTR Phase 2 documentation approach?**
- **Proposed Scope:** holistic risk assessment & management/mitigation approach from vehicle system level (including ISO-26262)
- **Phase 2 Documentation Approach Goal** – Flexible/Adaptable to stand the test of time as battery technologies continue to rapidly evolve
 - Should the GTR Documentation approach be battery technology agnostic?

Round-Table:

- US, JPN, OICA, (KOR*), CA, CN, (EU**), IN, UK

Consensus during the Meeting:

- Proposed Scope & Goal (see General comment below)
- Battery Technology Agnostic

Summary of General Comments Received:

- ISO-6469-1:2019/DAM 1
- Define “vehicle system level” or use “vehicle level”
- Define “battery technology agnostic”
- Define who/what we are protecting
- General comment: define scope & goal of the GTR Phase 2 approach to TRP.


*KOR not present.

**EU participated as observers and provided written input.

Summary of Second Sub-Group Meeting: February 24th, 2022 (2/4)

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Review of ISO-6469* and ISO-26262 & Identification of Requirements which could be extracted/incorporated into GTR Documentation Approach (3/4)

Contents of safety case for thermal propagation of the RESS 

- Description of the lithium-ion RESS**
- Operational description of functional units**
 - functional operation of relevant systems and components and their inter-relationships shall be provided
 - an explanation shall be included regarding which functions and unit processes are included in the thermal propagation safety demonstration
- Allocation procedure**
 - conditions that may result in internal short-circuit and thermal runaway of a single cell shall be identified and allocated to appropriate components or functional units within the system
 - the associated preventive and/or mitigating functions and/or actions adopted by the RESS and/or vehicle to manage thermal propagation should also be identified
- Data sources and quality requirements**
 - the relevance and appropriateness of the data shall be described and justified
 - Different types of data that can be used
 - Major uncertainty factors
 - Quality of data:
precision – completeness – representativeness – consistency – reproducibility - sources

- *Can we all agree the boxes in red (left) should be elements included in the documentation approach?*
- *Can we all agree the following proposed requirements should be added to the GTR Phase 2 Documentation Approach?*
 - Description of any system/component relevant to single-cell thermal runaway & propagation due to ISC
 - (e.g. BMS, thermal management system, sensors used to monitor, etc.)?
 - Battery technology agnostic → If single-cell TR&P due to ISC is not a risk to the innovative/alternative design, require a description addressing how/why this risk is not present?
 - Description of operational modes, advanced warning indication (including operating logic)
 - (Part I – System Analysis of Report)
- *Anything else that should be added?*

*Source: TC22 SC37 WG3 Liaison Report for EVS-GTR Thermal Propagation Work Item, October 2021, slide 9.


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- **Consensus on:**
 - Incorporating red boxes from ISO-6469-1:2019/DAM 1 (left)
 - Incorporating additional black text (right)
- **Summary of General Comments Received:**
 - Expand “Description of the lithium-ion REESS” for GTR documentation requirement to “Description of REESS”
 - Propose to include data sources and quality requirements*.
 - *Written input submission.

Summary of Second Sub-Group Meeting: February 24th, 2022 (3/4)

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Review of ISO-6469* and ISO-26262 & Identification of Requirements which could be extracted/incorporated into GTR Documentation Approach (4/4)

Contents of safety case for thermal propagation of the RESS 

- Assumptions
- Limitations of analysis
- Risk identification and classification
 - to identify the hazard and determine the likelihood and severity of the occurrence
 - an appropriate recognized industry standard method or equivalent, shall be used to identify and evaluate risks and hazards levels to produce the risk assessment inventory
- Risk mitigation by design
- Risk mitigation by manufacturing control
- Verification and validation of data
 - Documentation of different test/verification methods and different types of data
 - Completeness check
 - Sensitivity check
 - Consistency check
- Reporting
- Critical review
- Supportive templates (Annex C and D)

- Can we all agree the boxes in red (left) should be elements included in the documentation approach?
- Can we all agree the following proposed requirements should be added to the GTR Phase 2 Documentation Approach?
- Proposed Structure & Additional Requirements for GTR Phase 2 Documentation Approach:
 - Part II – Risk Identification & Mitigation
 - Identify risks → FMEA
 - Classify Risks as:
 - Risk Mitigation by Design
 - Risk Mitigation by Manufacturing Control
 - Risk Mitigation by Other Means?
 - Example: Functionality testing of components relevant to SC TR&P due to ISC, cell coupon testing of heat input required to induce TR, and TP testing IAW ISO-6469, statistical trends based on field data, etc.
 - Intent is not to prescribe design-restrictive tests, but leverage and document the risk identification and management process implemented by the OEM
 - Part III – Risk Mitigation Effectiveness – Validation & Verification
 - Part IV – Conclusion

*Source: TC22 SC37 WG3 Liaison Report for EVS-GTR Thermal Propagation Work Item, October 2021, slide 10.

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Consensus on:

- Incorporating red boxes from ISO-6469-1:2019/DAM 1 (left)
- Incorporating additional black text (right)

Summary of General Comments Received:

- Define “Limitations of Analysis”
- Expand “FMEA” to include other industry standards
- Move Risk Mitigation by Manufacturing Control under Risk Mitigation by Other Means?
- What does Part III include in detail?
 - ***Important to all CPs***

Summary of Second Sub-Group Meeting: February 24th, 2022 (4/4)

Summary of Proposed High-Level Requirements for GTR Documentation Approach

- **Scope:** Holistic risk identification & management approach from vehicle system level for all operational modes (usual parking, temporary parking, external charging, active drive possible mode) to mitigate single-cell TR & P risks due to an ISC
 - Elements of the report may be tailored to address/leverage REES/subsystem engineering analyses/tests; but the approach is a top-down, systematic, and holistic risk identification and management approach from the vehicle system level
- **Battery technology agnostic** – forward-looking approach that can stand the test of time and adapt as battery technologies rapidly evolve
 - non-Li-ion will need to comply with documentation approach and address why/not SC TR&P due to ISC is/not an issue as well as use the methodology to address other known risks the innovative technology may have
- **Thermal Propagation Report Structure:**
 - **Part I – System Analysis**
 - Descriptions of systems/components relevant to SC TR&P due to ISC; interoperability (including but not limited to REESS, sensors, Thermal Mgmt. System, BMS, etc.)
 - Description of Operational modes (Active drive possible, parking, and external charging modes)
 - Description of Advanced Warning Indication & operating logic
 - Functional Analyses – identified the conditions leading to ISC and allocating them to the corresponding components/functional units/subsystem, etc.
 - **Part II – Risk Identification & Mitigation**
 - Identify risks → FMEA
 - Risk Mitigation by Design
 - Risk Mitigation by Manufacturing Control
 - Risk Mitigation by Other Means – including rationale
 - **Part III – Risk Mitigation Effectiveness – Validation & Verification**
 - **Part IV – Conclusion**

Can we all agree on these foundational elements for the GTR No. 20 Phase 2 documentation approach?

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- **Consensus on:**
 - For the documentation approach, continue the use of a risk-based approach from Phase 1 from the Vehicle Level for all operational modes
 - General Report Structure (Part I-IV)
- **Summary of General Comments Received:**
 - What is the requirement for the “scope”?
 - Define Operational Modes
 - **What does Part III entail?**

Decisions & Next Steps

- ***Decisions made at the Sub-Group:***
 - Develop ***both*** the documentation approach and test method in ***parallel***
 - Documentation Framework should be battery technology agnostic
 - Mitigate risks in all operational modes
 - Agreed to the proposed report structure (4 parts) and basic elements Part I & II will contain
- ***Next Steps – To be discussed at next Sub-Group Meeting:***
 - Discuss options to address comments received (including written input provided by additional Sub-Group Members)
 - Discuss the proposed details of Part III of report