



GTR No. 20 EV Safety

IWG #24 – Thermal Propagation Documentation Sub-Group – Status

June 2022

Summary of Third Sub-Group Meeting: April 6th, 2022

Review of Comments from February Sub-Group Meeting (1/5)

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

Guideline for demonstration of thermal propagation risk mitigation

Objectives:

- to identify and evaluate the risk of thermal propagation within a REESS subsystem due to thermal runaway caused by internal short-circuit of a single cell
- To demonstrate that appropriate and reasonable measures have been taken to eliminate hazards when possible and to mitigate harm for persons at risk
- A systematic work process is applied, which comprises a defined sequence of steps that shall be performed and documented in a comprehensive and transparent manner to develop a safety case for thermal propagation of the RESS
- The safety case for thermal propagation of the RESS does not include faults in cell- and RESS electronics since these belong to the scope of ISO 26262



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?

*Source: TC22 SC37 WG3 Liaison Report for EVS-GTR Thermal Propagation Work Item, October 2021, slide 6

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Sub-Group Member Round-Table Discussion Order:

- US, UK, JPN, CN, CA, OICA, IN, EU, KOR

Consensus during the Meeting:

- Vehicle Level
- Battery Technology Agnostic
 - Generally, agree to formulate requirement using GTR “REESS”

Summary of General Comments Received:

- Additional discussion needed on who/what we are protecting
 - Discussed further at TP-TF Meeting on 4/26/2022 – see separate status report
- Additional discussion needed on whether the scope/goal should be the same between the test method and the documentation approach

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Summary of Third Sub-Group Meeting: April 6th, 2022

Review of Comments from February Sub-Group Meeting (2/5)

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 REESS

- **Description of the lithium-ion REESS**
- **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 during the Meeting:**
 - “Description of REESS” instead of “Description of Lithium-ion RESS”
- **Summary of General Comments Received:**
 - Majority of sub-group members agree to include data sources & quality requirements
 - Some Sub-Group Members requested additional details of requirements/examples
 - Location of Data Sources and quality requirements – TBD

Summary of Third Sub-Group Meeting: April 6th, 2022

Review of Comments from February Sub-Group Meeting (3/5)

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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)

*Source: TC22 SC37 WG3 Liaison Report for EVS-GTR Thermal Propagation Work Item, October 2021, slide 10.
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- **Was*:** "Limitations of Analysis"
- **Proposed/Now*:**
 - "Scope of the Safety Case Analysis" – meaning the scope of the safety case analysis will be on normal use conditions i.e. the conditions (SOC, voltage, current, temperature range, etc.) under which the RESS was designed to operate; abuse conditions are outside of the scope of the analysis.
- (7) Can we agree on the proposed meaning above?
 - (a) Are there any additional suggestions?
- **Was*:** "Identify risks → FMEA"
- **Proposed/Now*:** Expand to include known methodology standards for risk assessment presently in GTR 20 ("IEC 61508, MIL-STD 882E, ISO 26262, AIAG DFMEA, fault analysis as in SAE J2929, or similar").
- (8) Can we agree on the proposal above?
 - (a) Are there any additional/other standards that we wish to specifically include?
- * Please Note: The proposals above pertain to the GTR No. 20 documentation framework (not to ISO-6469-1:2019/DAM 1).

Consensus during the Meeting:

- "Scope of Safety Case Analysis" – General Consensus with Concept
 - Update phrasing to focus on spontaneous Single-Cell Thermal Runaway and Propagation due to an Internal Short-Circuit
- Consensus on expanding "FMEA" to include known methodologies already captured in GTR No. 20

Summary of General Comments Received:

- Will the different risk assessment methodologies that are permitted impact enforceability?

Summary of Third Sub-Group Meeting: April 6th, 2022

Review of Comments from February Sub-Group Meeting (4/5)

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
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 - 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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- **Was:** "Risk Mitigation by Manufacturing Control"
- **Proposed during February meeting*:**
 - Move "Risk Mitigation by Manufacturing Control" under the "Risk Mitigation by Other Means" category.
- (9) Should the Risk Mitigation by Manufacturing Control be moved?
 - (a) Are there any additional suggestions?
- **Part III – very important to all Sub-Group members**
 - Main discussion topic of today's meeting after review of comments
- * Please Note: The proposals above pertain to the GTR No. 20 documentation framework (not to ISO-6469-1:2019/DAM 1).

Summary of General Comments Received:

- Majority of Sub-Group Members support keeping Risk Mitigation by Manufacturing Control as a separate risk mitigation strategy category.
- Comment – Documentation requirement for Risk Mitigation by Manufacturing Control requires clarification.
- Comment – Reserving judgement on how its is implemented (regarding Question 9a).
- Comment – Not necessarily important how risk mitigation strategies are classified; rather it is important that the GTR No. 20 recognize and accept that there are various ways risks can be mitigated.

Summary of Third Sub-Group Meeting: April 6th, 2022

Review of Comments from February Sub-Group Meeting (5/5)

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 REESS/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-Lion will need to comply with documentation approach and address **why** hot 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 (or similar known risk assessment methodologies)
 - 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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- **Two comments on the first bullet (left):**
 - (1) **Scope** – What would be the requirement here?
 - (2) **Operational modes** – should be defined either in the Sub-Group or at Task Force/GTR Level
- **First Bullet Proposal:**
 - (1) No report requirement necessary. The intent of the “scope” bullet was to establish the methodology of the documentation framework i.e. confirm a holistic, risk-based approach as in Phase 1.
 - (2) For the documentation approach, overall evaluation of risks (for SC TR & P due to ISC) should be performed for **all** operational modes as the risk mitigation strategies may be different depending on the operational mode; **the specific vehicle’s operational modes are presented and described by the manufacturer in Part I.**
- (10) Can we agree on the proposal above? If not, shall we discuss the operational modes further at the TF/GTR Level?
 - (a) Are there any additional suggestions?
- (11) Is there any comment from February that was not addressed?

Consensus during the Meeting:

- Regarding Question 11, all comments were captured from February’s meeting.

Summary of General Comments Received:

- Majority of Sub-Group Members generally support the proposal (left).
- Additional discussion is needed on how the operational modes are defined in detail (relevant to both the test method and documentation approach).
- Comment – The details of the operational modes may be easier to discuss with a clearer goal (i.e., scope/goal). (To be discussed at TP-TF.)
- Comment – Operational modes should be the same as the test approach; additional discussion is needed.
- Comment – Agree with concept proposed; language may need to be edited for regulatory text requirements.
- Comment – Agree with scope; Need to revisit how the operational modes would be covered by the documentation approach; Strength of the documentation approach is that it gives an opportunity to cover all operational modes whereas the test method only covers one.
- Comment – Need specific examples in brackets for all operational modes.

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Summary of Third Sub-Group Meeting: April 6th, 2022

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Brainstorming Questions:

- Proposed Discussion Order:
 - **US, UK, JPN, CN, CA, OICA, IN, EU, KOR**
- (12) Can we all agree on the proposed details of Part II & III? Are there alternative proposals/details for Sub-Group Members to consider?
- (13) Is there anything else that should be added to Part II and/or III?
- (14) Are there any additional examples for evaluating the effectiveness of RM by Manufacturing Control?
- (15) Can we all agree on the proposed next steps below?
 - **Proposal:**
 - (1) Develop documentation approach details further (via sub-group discussions).
 - (2) After all details/elements of the documentation approach have been discussed in the sub-group, a small drafting team crafts the draft based on the agreed upon details from the Sub-Group meetings.
 - (3) Draft presented and collectively discussed at a Sub-Group meeting.

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- **Summary of General Comments Received:**
 - Majority of Sub-group Members generally agree with the presented Part II & III details.
 - There is interest in continuing discussions and seeing examples.
 - Comment – Concerned about inconsistencies in judgement of the same report. Would like to see examples of documentation approach to evaluate further.
 - Comment – Concerned about how to protect OEMs and their respective IP. Regarding comments to see examples, difficult to show an example without having agreed on the content.
 - Comment – Part II & III are reasonable; discuss enforceability further and flesh out details further.

Decisions & Next Steps

- ***Recent Decisions made at the Sub-Group:***
 - Established a Sub-Group Drafting Team – NEW!
 - US, CA, OICA
- ***Next Steps:***
 - Discussed who/what are we protecting, as well as the scope and goal of Phase II at the TP-TF meeting in April
 - Details & outcomes – see CN & CA's TP-TF Status Presentation
 - Paused sub-group discussions for now to avoid duplicate efforts/discussions
 - Will re-assess and resume Sub-Group discussions after TP-TF and 24th IWG meetings have convened