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| 660 kVA SML Modulators for RFQ, DTL and MBeta Electrical Safety Review Charge Document |
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| Electrical Safety Review 660 kVA SML modulators for RFQ, DTL and MBeta |
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| **Charge for the Review**  |
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Purpose of this Review

 The objective and purpose of this review is to confirm that the design for the 660 KVA modulators is likely to meet all electrical safety requirements and will be safe to operate at ESS.

In general terms, the expected outputs of detailed design, which should be presented and reviewed in the CDR, are:

* Any specifications agreed as inputs for the conceptual design of the 660 kVA SML modulators.
* Design drawings and schematics of the detailed design;
* Testing results obtained with the reduced scale prototype;

The specific information, which should be reviewed in the review, is listed as Deliverables. See Appendix 1.

**Charge to the Committee**

 The Review Committee is composed of the Chairman and members as identified in Appendix 2. This list also shows reviewers, who provide comments and review but are not on the formal committee.

 The Review Committee is asked to:

1. REVIEW: Scrutinize and assess the deliverables listed in Appendix 1, presented through the material presented and discussions, at the review. Note that the presentations themselves are means of communication only, and it is the design and design documentation which must be reviewed.

2. ANSWER: Answer each question listed in Appendix 3.

3. DECIDE: The Review Committee is to elaborate and deliver at the conclusion of this review, a clear recommendation to ESS about the safety implications of the design and about continuing with the production of the modulators along with a list of recommendations.

Suggested forms for the decision are:

* Approved, without qualifying comments or further actions.
* Approved, but with recommended actions and or clarifications.
* Not approved, but with recommended actions, for further inputs and activities, and a proposal for a follow-on review.

(If the committee rules for “Approved with recommended actions” or “Not approved” of the CDR, it is of essence that the actions/comments requested are very precise in their formulation and that the fulfilment decision is transferred to WP17, all this due to time constraints in the schedule).

4. REPORT: The Review Committee is to document in a short report to be delivered as soon as possible after the CDR, its recommendation and any specific actions for WP17 Work Unit Power Converters, identifying any further design necessary and other guidance for assisting planning and future success of the Work Unit related to its scope and deliverables.

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| Appendix 1**Scope and Deliverables for Review** |
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Scope for Work Units 660kVA SML modulators for RFQ, DTL and MBeta

ACCSYS WBS 11.17.3 Work Unit (WU) Klystron Modulators for RFQ & DTL is led by Pedro Gonzalez, ESS Bilbao. ACCSYS WBS 11.17.5 Work Unit (WU) Klystron Modulators for Medium Beta is presently led by Carlos Martins, ESS.,. These WU’s are part of ACCSYS WBS 11. Work Package (WP) 17 Power Converters, led by Carlos A. Martins, ESS, is responsible for the delivery of all these systems to the ESS project.

The procurement of the modulators covered by WBS 11.17.3 (RFQ & DTL) and by WBS 11.17.5 (Medium Beta) were launched by ESS Bilbao and ESS ERIC, respectively. However, the outcome of both tender evaluations led to the award of both contracts to the same company (Jema Energy), which has the mandate of producing, testing and delivering 3+ 9 = 12 modulators. Since the design and technical specifications of both sets of modulators is identical,

The WU’s are responsible for the following scope that is relevant for this CDR

* Needed analysis e.g.
	+ Topology identification for the 660kVA SML modulator;
	+ The link from requirements to electrical schematics, 3D mechanical drawings and list of main components;
	+ The link from requirements to safety aspects and interfaces;
	+ The verification and validation of the design of the 660kVA SML modulators (simulation results, preliminary experimental results obtained with reduced scale prototype, etc);
* Final design
* Procurement as build-to-print for detailed design and prototyping
* The manufacturing, construction, assembly, testing and other verification of the 660kVA SML modulators.
* The needed QA process

Deliverables for Review - Information to be reviewed

The information identified below is to be described and communicated through presentation at the safety review, and the source information is to be available to reviewers for reference during the safety review.

ESS is requested to deliver to the safety review Secretary (John Weisend) for distribution to the Review Committee and other reviewers, an agreed subset of the following information for pre-review and comments no later than ten (7) working days prior to the safety review.

1. Topology description:

Reviewers shall assess the component design, the topology, simulations and experimental results, and their compliance with safety requirements and best engineering practices provided by ESS and validate the design choices on matters related to electrical safety.

2. Descriptions or other identification of systems and components – in General:

* Detailed electrical schematic;
* Simulation results;
* List of components impacting on safety;
* Mechanical layout of the 660kVA SML modulators;
* Information on the controller platform, internal signals list and interlocks/protection strategy;
* Contract follow-up aspects on a build-to-print basis, on matters related to safety. CE marking;
* Testing safety devices and apparatus;
* The results of internal reviews and quality assurance performed of the design (including PDR) and its results and requested corrective actions in matters related to safety
* Safety:- protection against direct contact; isolation from AC mains; short circuit protection; internal interlocks including fast power abort (emergency switch); energy discharge mechanisms and their activation principle, safety and EMC grounding, presence of oil and related hazard mitigation
* Preliminary risk analysis
* Maintenance, transportation and handling strategies

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| Appendix 2**Review Committee and other Reviewers, Presenters and Observers** |

The safety review Committee conducts this review with the authority of ACCSYS Project Leader, Mats Lindroos, and ESS Director General, John Womersley.

The Committee serves in an advisory capacity to:

* the Work Unit teams for Klystron Modulators both at ESS and ESS Bilbao,
* the ACCSYS WP 17 Leader, and
* the ACCSYS management team

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| Name | Organisation | Appointment for CDR |
| John Weisend II | ESS, ACCSYS Deputy Project Leader | Chairman of the Review Committee |
| David Nisbet | External Expert CERN | Review Committee member |
| David Anderson | External Expert SNS | Review Committee member |
| Michael Plagge | ESS, ES&H | Review Committee member |
| Fredrik Jörud | ESS, ES&H | Review Committee member |
| Kent Wigren | ESS, ACCSYS QA | Review Committee member |
| Niklas Arvidsson | ESS, ES&H | Review Committee member |
| Stuart Birch | ESS, ICS/PSS | Review Committee member |
| Anders Sunesson | ESS, ACCSYS RF group leader | Reviewer |
| Morten Jensen | ESS, RF Sources section | Reviewer |
| Frithiof Jensen | ESS, ACCSYS Conventional Power | Reviewer |
| Carlos Martins | ESS, ACCSYS Power Converters section leader | Presenter |
| Pedro Gonzalez | ESS Bilbao, IKC manager for RFQ&DTL modulators | Presenter |
| Jose Maria de la Fuente | Jema Energy, Project technical manager | Presenter |
| TBD | Jema Energy, Engineer | Assistant |

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| Appendix 3**Review Charge Questions**  |
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1. Have all safety risks been identified and eliminated or otherwise mitigated as appropriate in the detailed design?
2. Will the design meet the current electrical safety requirements of ESS?
3. How will CE Marking or a Certificate of Compliance be addressed?
4. Does the design provide for safe operation on the modulator at ESS? Are there sufficient interlocks, grounding etc. to allow for safe operation?
5. What quality assurance and quality control activities have been planned and how will these be conducted and documented or reported