Report of the Particle Free

Vacuum Assembly System Review

December 4, 2017

H. Danared, D. Phan, R. Geng, L. Lilje,

M. Lindroos, P. Pierini, J. G. Weisend II (Chair)

**Introduction**

The System Review on Particle Free Vacuum Assembly in the ESS Linac was held November 29th in Lund. The charge and committee for the review is given in Attachment 1.

ESS and STFC have developed detailed vacuum and cleanroom processing procedures. The procedures and plans are based on current best practices and should minimize the risk of particle contamination to the SRF cavities. Some additional optimization of the procedures still needs to be done. No critical issues were found but recommendations including the placement of the High Energy Differential Pumping (HEDP), the size of the RATS cleanroom and the development of a mock-up for installation testing should be carefully considered.

STFC would have preferred to particle count each individual component and flange of the LWU but ESS has required an integrated particle count at STFC based on cost and schedule requirements. STFC has highlighted this as a risk.

The summary assembly and test data from STFC will be entered in to CHESS in the FBS structure. There is additional test and inspection information from each component maintained at STFC in addition to the summary report sent to ESS.

There is sufficient planned staff to enable 3 LWU installations simultaneously.

The current fixed clean room in the RATS appears to be too small for easy use and assembly. Additionally, a mock-up should be built around one of the portable cleanrooms in the RATS denoting the walls of the adjacent cryomodules and other obstructions so that procedures and schedules can be developed and tested in a realistic environment.

Recent changes in delivery schedules mean that there is an increased presence of warm beam line between the last cryomodule and the HEDP unit. This may result in significant hydrogen gas being cryopumped on SRF cavities.

No significant safety or quality issues were identified in this review. Installation safety requirements such as training and Work Safety Coordination Plans will be addressed at a future LWU Installation Readiness Review.

**Decision**

The committee agrees that an impressive amount of attention is being paid to the issue of particle free assembly by ESS and STFC and that the plans for this assembly are suitable. Additional work needs to be done on the details and optimization of these plans and the recommendations below should be seriously considered.

**Answers to Charge Questions**

Is the design, cleaning process and installation procedure for the LWU beam tube vacuum sufficient to result in a particle free environment that will protect SRF cavity performance?

*Generally, yes. The effort and attention that has been made to date is impressive. The recommendations below should be considered carefully.*

Is the time allotted for this installation appropriate?

*This should be tested during mock – up work. The general opinion is that 7 days should be considered a minimum time.*

Have all safety issues been defined and dealt with? Are additional separate safety reviews or inspections required?

*Based on the presentations and documentation provided by STFC and ESS, no outstanding safety issues or showstoppers were identified during the system review of the Particle Free LWUs installation. WSCP, detailed installation plan, safety and organisational aspects (transport & logistics, lay down area, equipment) will be evaluated at the next Installation Readiness Review.*

Have all QA/QC plans been defined and implemented?

*Yes, This seems to be in good shape.*

Has a suitable strategy been developed for the collection and dissemination of documentation resulting from this installation process? Is this approach consistent with ESS Wide standards?

*Yes, A traveller containing assembly and inspection data will come with each LWU and these in addition to documentation and test results from ESS will be entered into the CHESS FBS structure consistent with ESS standards.*

**Recommendations**

1. Move the HEDP upstream directly behind the last cryomodule to block hydrogen outgassed by the warm particle free portion of the linac from reaching the cold cavites in the last cryomodule.
2. Develop an accurate mock up of the tunnel environment (showing the limits of the wall, cryogenic distribution system and ends of cryomodules) in the RATS facility so that the LWU installation process can be verified and practiced and the needed assembly time estimated.
3. Flush the LWU system with nitrogen while removing flanges and making connections.
4. Optimize the installation sequence to take into account the fact that the linac will not be cooled down until all the LWUs are installed and to avoid the possibility of the cryomodule cryopumping the LWU.
5. Cover the floor under the portable clean room with a suitable material during tunnel installation to avoid particle contamination.
6. ESS shall develop an operational procedure for the closure of the cryomodules' gate valves during maintenance phases
7. The use of ionized nitrogen for particle cleaning should be applied project wide.
8. Develop a test process to qualify the in-situ blowing of nitrogen in the LWU clean out. Can this also include ionization?
9. Based on the revised schedule, investigate the possibility of assembling more of the Beam Instruments into the LWU at STFC.
10. The clean room facility in the RATS should be enlarged to allow easier handling and mounting of equipment.

**Attachment 1**

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| System Review of the Particle Free LWU Installation  November 29, 2017 |
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| **Charge for the System Review** |
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Purpose of this review

The system review will examine plans for the particle free installation of the LWUs in the ESS Linac. It examines design, cleaning and installation steps for the beam tube vacuum of the LWUs in the linac. The review will also examine the schedule for this work. It is not meant as a detailed design review of the LWUs as that was dealt with during the LWU PDR and CDR.

**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 and presenters.

The Review Committee is asked to:

1. REVIEW: Scrutinize and assess the deliverables listed in Appendix 1 and the presentations given during the Review.

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 suitability of the plans for the particle free installation of the LWU vacuum chambers in the ESS linac.

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.

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

If the System Review is “Approved but with recommended actions”, there shall be a summary list of requested actions defined .

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| Appendix 1  **Scope and Deliverables for Review** |
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Scope

The review will examine the basic design, cleaning processes and installation plans for the LWU beam vacuum in the ESS linac.

Deliverables for System Review - Information to be reviewed

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

The associated work packages should deliver to the Review Chairman for distribution to the Review Committee and other reviewers, an agreed subset of the following information for pre-review and comments no later than Five (5) working days prior to the Review.

1. Detailed design of the LWUs sufficient to answer the charge questions.
2. Cleaning and handling procedures for the LWU Beam Tubes.
3. Installation Procedures for the LWUs and their beam vacuum into the ESS linac.
4. Description LWU beam pumping cart.
5. Description of local clean rooms.
6. Installation schedule.

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

The System Committee conducts this review of design with the authority of ACCSYS Project Leader, Mats Lindroos, and ESS Chief Executive Officer, John Womersley.

The Committee serves in an advisory capacity to:

* the ACCSYS WP12 Work Package Leaders
* the ACCSYS management team

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| Name | Organisation | Appointment for IRR |
| John Weisend II | ESS, ACCSYS Deputy Project Leader | Chairman of the Review Committee |
| Mats Lindroos | ESS, ACCSYS Project Leader | Review Committee member |
| Hakan Danared | ESS, Linac Group Leader | Review Committee member |
| Duy Phan | ESS, ACCSYS Safety Group | Review Committee member |
| Paolo Pierini | ESS, SCRF Section | Review Committee member |
| Rongli Geng | Jefferson Laboratory | Review Committee member |
| Lutz Lilje | DESY Laboratory | Review Committee member |
| Marcelo Ferreira | ESS, WP12 Work Package Manager | Presenter |
| Paul Aden | STFC Daresbury | Presenter |
| Fabio Ravelli | ESS, Vacuum Section | Presenter |
| Christophe Jarrige | ESS, Vacuum Section | Presenter |
| TBD | CEA Saclay | Reviewer |
| TBD | IPNO | Reviewer |
| Christine Darve | ESS, WP 4/5 Deputy WP Manager | Reviewer |
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| Appendix 3  **Cryomodule Testing System Review Charge Questions** |

1. Is the design, cleaning process and installation procedure for the LWU beam tube vacuum sufficient to result in a particle free environment that will protect SRF cavity performance?
2. Is the time allotted for this installation appropriate?
3. Have all safety issues been defined and dealt with? Are additional separate safety reviews or inspections required?
4. Have all QA/QC plans been defined and implemented?
5. Has a suitable strategy been developed for the collection and dissemination of documentation resulting from this installation process? Is this approach consistent with ESS Wide standards?