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| **Distribution list**  | <<Name>> | <<Role/ Title>> |

Report of the Installation Readiness Review for the Ion Source and LEBT

September 26, 2017

N. Gazis, H. Novella, D. Phan, M. Skafar, K. Wigren, D. de Wit, J. G. Weisend II (Chair)

# INTRODUCTION

The Installation Readiness Review (IRR) of the Ion Source and LEBT (IS-LEBT) was held in Lund on September 15, 2017. The charge and committee for this review are given in Attachment 1.

The IS-LEBT are the first beam line components to be installed in the accelerator tunnel. They are completed provided by in-kind partners (INFN-LNS, Catania and CEA, Saclay). The work by INFN – LNS and CEA on the design, construction and testing of the Ion Source and LEBT is very impressive. The equipment has already been assembled and tested at nominal ESS beam conditions at INFN-LNS. The Factory Acceptance Test results for the Ion Source and LEBT at Catania indicate that the system will likely meet ESS requirements and is ready for installation. Additional measurements will be made during the commissioning in the tunnel.

INFN has developed a detailed list of deliverable documentation and started to populate it with drawings, interface descriptions, operating procedures, cable lists. This is seen as quite good and a subset of this information, to be agreed upon between ESS and INFN, will be needed for the Safety Readiness Review (SRR) and test stand licensing in early 2018.

There is an on-going effort to move the IS-LEBT information into CHESS as final controlled documents.

A safety cage has been designed that will protect people from both electrical and radiation hazards. ESS will develop an access procedure that will be reviewed by the ACCSYS safety group and/or ESS ESH.

INFN has developed a Non-Conformity reporting system. A number of Non-conformities have been identified to date but none are seen to be technical showstoppers. Additional analysis by ESS on some of these may be needed.

ESS will not be ready to install the IS-LEBT until December 1. This is only an estimated date. A more definite readiness date will be known on October 20.

Activities by C101/Skanska during installation will follow the same ACCSYS coordination and safety processes as all other contractors and workers in the ACCSYS areas.

The control system was tested at INFN and accepted. There are some non-conformities that won’t stop the installation but will need to be fixed during the commissioning.

The migration by ICS to the Micro TCA crates on the beam instrumentation associated with the IS-LEBT will not occur prior to the arrival of the IS-LEBT at ESS. This affects the plans of the beam instrumentation team.

A detailed and reasonable installation plan has been developed and there is good coordination between INFN and ESS. Some additional details including step-by-step instructions should be added.

Good installation coordination is seen between INFN, ACCSYS, Survey and Alignment teams.

# DECISION

The IS-LEBT is complete and ready to be installed at ESS. The earliest date at which ESS will be ready to install the IS-LEBT is December 1 due to the installation of remaining technical systems. Once, however, these ESS systems are installed, the committee believes the IS-LEBT installation should start. Installation planning, including safety planning is well advanced. Some additional documentation will need to be developed prior to the SRR and licensing.

# ANSWERS TO CHARGE QUESTIONS

1. Will the Ion Source & LEBT system meet its technical specifications? Do we know how to verify this?

*Yes, The testing done by INFN constitutes the FAT and all results indicate that the IS-LEBT will likely meet ESS requirements. The final verification will take place during the commissioning in the tunnel.*

2. Are the interfaces between the various components and subsystems that compose this system completed defined in terms of: a) physical connection – location and type of mating flanges, location and type of power and cable connections, support stands etc. and b) physical parameters (flows, pressure, temperatures, current, voltage, data acquisition formats and rates etc.)

*Yes. The components have all been connected together during the testing at INFN. The majority of the documents exist and the remainder should be completed on time.*

3. Have all interfaces between this system and other systems been completely defined and agreed. Are all the connections on the ESS site in place? This applies to physical connections, physical parameters (flows, pressure, temperatures, current, voltage, UPS requirements) and data exchange.

*Generally, yes. There is some additional documentation that should be provided.*

4. Has an integrated control system (both hardware and software) been developed and tested that permits control of the system, collection of data and integration of this system into accelerator operations?

*Yes, as a test stand but additional work will be needed for accelerator operations*

5. 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 INFN-LNS, no outstanding safety issues or showstoppers were identified during the Ion source & LEBT IRR. However, ESS and INFN-LNS shall give high priority to the following safety matters before the beam commissioning starts:*

* *Prepare the necessary safety documentation (access procedure to HV cage, procedure for grounding, etc.) for the submission of the licensing application to SSM.*
* *Find a technical solution that can guarantee a dry environment around the HV cage in order to avoid exposure to electrical shocks.*
* *Verify that the current location of the H2 bottles as per design, does not represent an explosive hazard.*

 *ESS shall verify that the design meets Swedish high voltage regulations together with INFN-LNS..*

 *A Safety Readiness Review (SRR) will be held prior to start of commissioning.*

6. What standards (European Directives or other) were used in the design?

*The design was based many years of professional experience in the construction of Ion sources and LEBTs in the EU. All commercial components were CE marked.*

7. Is there sufficient information available for ESS to issue a Declaration of Conformity and if not what is missing?

*ESS has to develop clear guidelines on what is required from the IK Partners for the issuance of the Declaration of Conformity. The documentation shown so far is a good start towards a Declaration of Conformity. The role of the in-kind partner in this work needs to be finalized.*

8. Is the planned document delivery in accordance to the In-Kind Agreement in terms of format and scope?

*Mostly yes, but additional documentation will be needed prior to licensing and the SRR.*

9. Will the system fit within its allocated space and can be transported there within the give transport path (height of doors, pass by other equipment) with the available transport means? Are the alignment requirements agreed upon and can the system components be aligned within these requirements?

*Yes.*

10. Is the installation plan for the system adequate? Have all tools, including cranes, movement devices, stands, alignment fixtures etc. been defined. Has the staff for this work been identified? Is the installation sequence consistent with the overall installation plan?

*Yes, but additional detailed steps are needed.*

11. Has the reliability and maintainability of the system been optimized? Have all the spare parts required from the first day of operation been identified and procured?

*The spare parts are determined but are limited. No real information on reliability and maintainability were presented.*

12. Have all inspections and permits required prior to installation been carried out? Have the inspections and permits required between installation and the Accelerator Readiness Review been identified?

*This work is well under way and has been captured in the Work Safety Coordination Plan. Required inspections associated with the 10 Bar Cooling system must be determined and carried out.*

13. Have all recommendations from component design reviews been addressed?

*Mostly yes.*

# RECOMMENDATIONS

1. 1. INFN and ESS shall agree upon a set of documentation to be delivered in time for the Safety Readiness Review and Test Stand licensing scheduled for 2018.
2. Test the insulating cone to 100 kV
3. ESS should review the non-conformities to ensure that they do not have any broader implications on the machine performance beyond the IS-LEBT.
4. ESS and INFN should come to an agreement on when best to deliver the IS-LEBT based on the new dates for readiness of the ESS infrastructure. INFN will check with the transport company on the effect of this change. The impact on beam Instrumentation work also should be considered.
5. CF, AD and ESH shall work together to address the issue of connecting technical systems to the switch gears and providing power to the switch gears.
6. “The main three phase power and the control circuit power of the ion source high voltage power supply (FUG) should be separated so that the controls are not switched off by the PSS system when the cage door is opened.
7. Optimize the migration to the micro TCA systems in order to minimize the impact on the beam instrumentation team.
8. The proper staff for making electrical power connections associated with this work needs to be identified by ESS.
9. Consider adding step by step instructions into the INFN installation plan.
10. ESS to prepare the necessary safety documentation (access procedure to HV cage, procedure for grounding, etc.) for the submission of the licensing application to SSM.
11. ESS AD installation team to find a technical solution that can guarantee a dry environment around the HV cage in order to avoid exposure to electrical shocks.
12. ESS AD safety group to verify that the current location of the H2 bottles as per design, does not represent an explosive hazard.
13. INFN-LNS to identify, via the WSCP, the types of intervention that do not require the full set of PPE.
14. The FEB installation team should develop quality checks to ensure that installed equipment such as racks, cables, water systems will function as desired.
15. Document all specifics and details that appear during installation, start up and commissioning (especially hardware commissioning). Make a special effort on documentation during that phase (assign some people following the technicians during installation and taking notes).
16. ESS has to develop clear guidelines on what is required from the IK Partners for the issuance of the Declaration of Conformity. This must be done in cooperation with the In-kind partner and the role of the In-kind partner in this work must be formalized.

Attachment 1

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| **Installation Readiness Review for the Ion Source and LEBT****September 15, 2017** |
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| **Charge for the IRR** |
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**Purpose of this IRR**

 The IRR is meant to be the final technical review of the system prior to the start of installation. As such, it examines the final technical design of the integrated system with an emphasis on interfaces between components and subsystems, controls integration and a detailed look at the plans, staff and tooling required for the installation work itself.

 This IRR is for the Ion Source and LEBT. It covers in detail the installation of all Ion Source and LEBT equipment in the accelerator tunnel and FEB Level 90.

**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, presented through the material presented and discussions, at the IRR. Note that the presentations themselves are means of communication only, and it is the 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 IRR, a clear recommendation to ESS about the readiness of the Ion Source and LEBT and its associated systems to be installed at the ESS site and the readiness of the ESS site to receive such an installation.

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 IRR, it is of essence that the actions/comments requested are very precise in their formulation and that the fulfilment decision is transferred to INFN-LNS and ESS, all this due to time constraints in the manufacturing schedule and sequence).

4. REPORT: The Review Committee is to document in a short report to be delivered as soon as possible after the IRR, 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 IRR 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 scope for the review includes:

* All the components of the Ion Source and LEBT that will be installed at the ESS site in Lund in November-December
* Installation plans including: required permits, tooling, cranes, personnel requirements, training, schedule, alignment issues, material transport, laydown area requirements
* Readiness of supporting utilities (water, electrical power, instrument air). This will be provided by ESS staff.
* Quality Assurance and Quality Control Organisation and activities.
* Safety aspects
* Reliability

**Deliverables for IRR - Information to be reviewed**

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

INFN-LNS is requested to deliver to the IRR 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 Fifteen (15) working days prior to the IRR.

1. Relevant standards and European Directives applied in the system design
2. Technical file:
	1. Update of all related engineering documentation
	2. Mechanical design documentation at a sufficient detail to answer interface, performance, alignment and installation questions below.
	3. Applicable Electrical design including single line drawings, instrumentation lists, cable designs and connector pin outs, calibrations etc.
	4. Integrated controls system design and documentation sufficient to answer charge questions.
3. Results of relevant component and subsystem testing
	1. Factory Acceptance Tests of subsystems (where applicable)
	2. Summary of testing and commissioning in Catania
	3. Leak tests
	4. Non-Conformity Reports
4. Hazard analysis and residual risks for component and installation work.
5. A strategy for System Verification except beam commissioning
6. Installation schedule
	1. Detailed Installation plan including alignment strategy
	2. List of needed spares for installation
7. Work & Safety Coordination Plan including all its Annexes (Area Hazard Analysis, Job Hazard Analysis, System Deliverables, Equipment List etc.)
8. First draft of Operation manuals of all delivered equipment in English
9. Maintenance manuals of all delivered equipment in English
10. Transport and delivery plan including package sizes, weights, identification and handling instructions.

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

The IRR 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 WP 3 Leader, and
* 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  |
| Kent Wigren | ESS, ACCSYS QA Lead | Review Committee member |
| Mattias Skafar | ESS, Head of Quality Division | Review Committee member |
| Duy Phan | ESS, ACCSYS Safety Group  | Review Committee member |
| Nick Gazis | ESS, Installation Manager | Review Committee member |
| Daniel Piso/Hector Novella | ESS, Integrated Controls System | Review Committee member |
| Dennis de Wit | ESS, Area Supervisor, Tunnel | Review Committee member |
| Santo Gammino | INFN-LNS, WP3 Leader | Reviewer  |
| Håkan Danared | ESS, Linac Group Leader | Reviewer |
| Liviu Penescu | Consultant | Reviewer |
| Fabien Rey | ESS, Survey, Alignment & Metrology Group Leader | Reviewer |
| Simone Scolari | ESS, Vacuum Systems Engineer | Reviewer |
| Thomas Shea | ESS, Beam Instrumentation Section Leader | Reviewer |
| Frithiof Jensen | ESS, WP15 (Electrical Support) Leader | Presenter |
| Evangelia Vaena | ESS, WP15, Electrical Engineer | Presenter |
| Anton Lundmark | ESS, WP16 (Cooling Support) Leader | Presenter |
| William Ledda | ESS, ICS, Control System Integrator | Presenter |
| Nour Akel | ESS, ICS Installation Coordinator | Presenter |
| Edgar Sargsyan | ESS, WP3 Deputy Leader | Presenter |
| Øystein Midttun | ESS, ISRC & LEBT System Leader | Presenter |
| Jörgen Larsson | ESS, Warehouse & Logistics Group Leader | Presenter |
| Luigi Celona | INFN-LNS | Presenter |
| Lorenzo Neri | INFN-LNS | Presenter |
| Andrea Miraglia | INFN-LNS | Presenter |
| Ornella Leonardi | INFN-LNS | Presenter |
| Frank Hellström | ESS, WP3 Liaison  | Observer |
| Åsa Alström Johannesson  | ESS, CF/Skanska Senior Occupational Health & Safety Engineer  | Observer |
| Maria Romedahl | ESS, Integrated Controls System | Observer |

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| Appendix 3**IRR Charge Questions** |

1. Will the Ion Source & LEBT system meet its technical specifications? Do we know how to verify this?
2. Are the interfaces between the various components and subsystems that compose this system completed defined in terms of: a) physical connection – location and type of mating flanges, location and type of power and cable connections, support stands etc. and b) physical parameters (flows, pressure, temperatures, current, voltage, data acquisition formats and rates etc.)
3. Have all interfaces between this system and other systems been completely defined and agreed. Are all the connections on the ESS site in place? This applies to physical connections, physical parameters (flows, pressure, temperatures, current, voltage, UPS requirements) and data exchange.
4. Has an integrated control system (both hardware and software) been developed and tested that permits control of the system, collection of data and integration of this system into accelerator operations?
5. Have all safety issues been defined and dealt with? Are additional separate safety reviews or inspections required?
6. Have all QA/QC plans been defined and implemented?
7. What standards (European Directives or other) were used in the design?
8. Is there sufficient information available for ESS to issue a Declaration of Conformity and if not what is missing?
9. Is the planned document delivery in accordance to the In-Kind Agreement in terms of format and scope?
10. Will the system fit within its allocated space and can be transported there within the give transport path (height of doors, pass by other equipment) with the available transport means?
11. Are the alignment requirements agreed upon and can the system components be aligned within these requirements?
12. Is the installation plan for the system adequate? Have all tools, including cranes, movement devices, stands, alignment fixtures etc. been defined. Has the staff for this work been identified? Is the installation sequence consistent with the overall installation plan?
13. Has the reliability and maintainability of the system been optimized? Have all the spare parts required from the first day of operation been identified and procured?
14. Have all inspections and permits required prior to installation been carried out? Have the inspections and permits required between installation and the Accelerator Readiness Review been identified?
15. Have all recommendations from component design reviews been addressed?