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## Official IEC61508 Scope Document for Accelerator personnel Safety System

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## EXECUTIVE SUMMARY

This document provides a scope for the European Spallation Source (ESS) Ion Source test stand Personnel Safety System 0 (PSS0) for the ESS project in Lund, Sweden. The Ion Source test stand comprises of the Ion Source (ISrc) and the Low Energy Beam Transport (LEBT). Parts of PSS0 will have an interface with the Accelerator personnel safety system PSS.

### 1. INTRODUCTION

#### 1.1. Scope

The scope of this document is limited to the PSS0 for the ISrc test stand. This document addresses the requirements of IEC61508 safety lifecycle phase 2 and the scope of this document is in compliance with (but not limited to): IEC61508: 2010 Part 1 section 7.3 Overall scope definition.

#### 1.2. Objectives

The objective of this document is to determine the boundary of the PSS0 controlled area and the Equipment Under Control (EUC), which will have an interface with PSS0. This document will specify the scope of the hazard and risk analysis in accordance with IEC61508:2010, detail the systems physical environment, the likely hazards, hazardous events arising from operation of the ISrc test stand and its accompanying equipment, as well as the safety regulations that apply and any relevant details of interactions with other systems.

The ISrc test stand will be approximately the first 8m of the Accelerator from the ion source through to, and including the faraday cup at the end of the LEBT and a maximum energy of 75keV.

### 2. ABBREVIATIONS

|        |  |
|--------|--|
| ALARA  | As Low As Reasonably Achievable                                      |
| BIS    | Beam Interlock System  |
| E/E/PE | Electrical/Electronic/Programmable Electronic safety related systems |
| ES&H   | Environmental, Safety & Health                                       |
| ESS    | European Spallation Source   |
| EUC    | Equipment Under Control  |
| HV     | High Voltage   |
| LEBT   | Low Energy Beam Transport  |
| LINAC  | Linear Accelerator   |
| PSS    | Personnel Safety System  |
| PSS0   | Personnel Safety System 0  |
| QRA    | Quantitative Risk Analysis   |
| RF     | Radio Frequency  |

SIF Safety Instrumented Function  
SIL Safety Integrity Level

### 3. PSSO SCOPE

#### 3.1. Boundary of the PSSO controlled area.

Figure 1 defines the PSSO controlled area. The PSSO will prevent access of workers into the PSSO controlled area when any electrical hazard is present. The Access gate will have a key lock system to allow authorised workers to gain entry into the PSSO controlled area after the high voltage power supply has been de-energised and the area is safe. Note all safety training and authorisation for workers will be carried out and fully documented by the Environmental, Safety and Health (ES&H) Division.

There is one access point to the PSSO controlled area, and a High voltage safety fence mark the boundary of the PSSO controlled area. The access gate will be will be monitored by the PSSO system.

Operation of the ISrc can continue whilst installation work is carried out in the remaining areas of the G01 tunnel outside of the PSSO controlled area.

All personnel will be excluded from the PSSO controlled area when the ISrc test stand is in operation and when PSSO interfaced EUC are energised. A formalised search will be carried out before operation of the ISrc test stand is permitted.

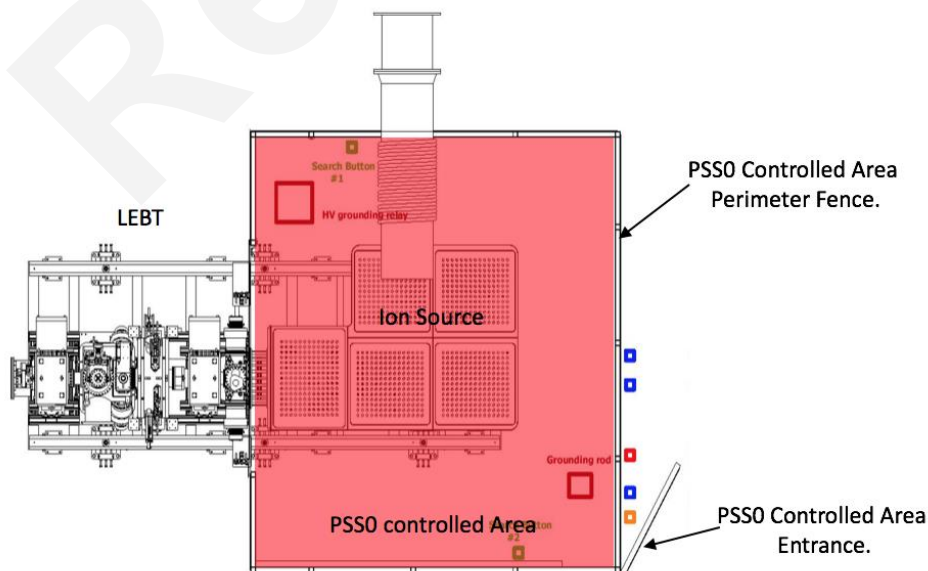


Figure 1: PSSO Controlled area.

### 3.2. Boundary of the ISrc equipment under control

As part of the IEC 61508 safety lifecycle all equipment that is installed on the ISrc and LEBT test stand will undergo hazard and risk analysis, and from this analysis the PSS team determine the Equipment Under Control (EUC) that the PSSO system will interface. Some of the systems within the PSSO controlled area are powered/controlled by systems which are installed outside of this area.

### 3.3. Equipment Under Control (EUC)

The PSSO will only interface with equipment that has been identified as a source of hazard as a result of the hazard identification and risk analysis. This document will not detail all ISrc/LEBT components, but will just detail components that the PSSO will have an interface with. If other EUC components are identified during the continuous hazard identification process, then the EUC interface will be detailed as an addendum to this document.

Typically, PSSO will interface with the mains incoming power of the PSSO EUC in the ISrc test stand.

Initial hazards have been identified and it is expected that the PSSO will interface with the following equipment in the ISrc and LEBT test stand:

#### 3.3.1. The Ion Source High Voltage Extraction system

The 2.50 m-long H<sup>+</sup> ion source is a compact microwave discharge ion source installed on a compact High Voltage (HV) platform enclosed in a Faraday cage located in the PSSO controlled area. The ion source shall deliver 74mA beam pulses at 75keV and 14Hz repetition rate to the LEBT. Figure 1 shows images of the Ion Source and LEBT.

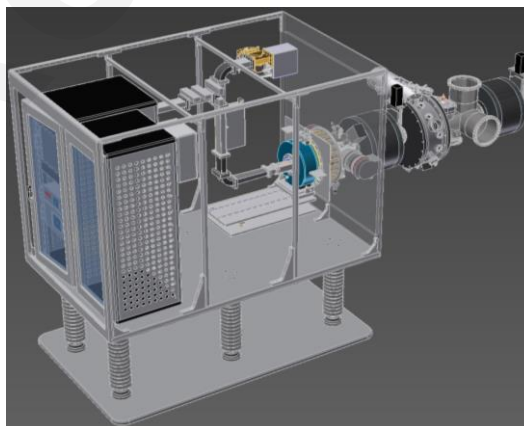


Figure 2: Ion Source and LEBT.

PSSO will interface with the ISrc HV power supply to mitigate against the following hazard:

- Electrical hazard within the PSSO controlled area.

The equipment in the ion source that the PSSO will interface with is:

- Ion source High Voltage Power Supply (part of the Ion Source extraction system). PSSO will interface with the mains incoming power of the FuG Elektronik GmbH HV power supply unit. See figure 3 below.



Figure 3: Ion Source High Voltage Power Supply.

### 3.4. Interface with the ISrc HV safety fence

Whilst the ISrc HV safety fence is not an EUC, PSSO equipment will be installed on various parts of ISrc HV safety fence and access gate, as detailed below:

#### 3.4.1. PSSO equipment on ISrc HV safety fence

On the inside of the HV safety fence search buttons on the inner side of HV safety fence. PSSO lights and sounder on the outside of HV safety fence:

#### 3.4.2. PSSO equipment ISrc HV safety fence access gate

There is only one access gate to the PSSO controlled area, and PSSO will monitor the position of the access gate, using safety switches.

### 3.5. Hazard and Risk Analysis

The primary role of PSSO is to prevent personnel from being harmed by exposure to electrical hazards generated by the ion source high voltage power supply (which is part of the extraction system). The PSSO is a safety related system and will prevent workers from accidental exposure to high voltage by controlling access to the PSSO controlled area with a key exchange system.

#### 3.5.1. Initiating Events that cause hazardous events

All hazards will be identified and will be documented in the PSSO hazard register. All initiating events will be considered for Electrical hazard and will then go through the required hazard analysis. The initiating events will take into account, but not be limited to the following:

- Accident progression
- System failure
- Component failure
- Human actions

#### 4. REFERENCES

- [1] IEC 61508:2010 Part 0 – Part 7. Functional Safety of electrical/electronic/programmable electronic safety-related systems. CENELEC Ref. No EN 61508-1:2010E
- [2] Swedish Work Environment Act (AML). As detailed by the Swedish Work Environment Authority: <http://www.av.se/inenglish/> .

#### DOCUMENT REVISION HISTORY

| Revision | Reason for and description of change | Author       | Date       |
|----------|--------------------------------------|--------------|------------|
| 1        | First issue                          | Stuart Birch | 2017-08-10 |

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