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| Site Integration Test Report for Personnel Safety Systems 0 |
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# Introduction

## Purpose of the document

This report describes the Site Integration Test (SIT) for the Personnel Safety System 0 (PSS0) and is part of the verification and validation plan for PSS0 [1]. SIT is an integration test, which verifies that the installed hardware and software work together properly, ensuring that their combination is serving the purpose of PSS0’s safety functions and procedures.

All of the checklists in this document shall be filled in and the SIT certificate needs to be signed before the SIT can be approved.

Note: To reduce the risk of damaging the Equipment Under Control (EUC) due to repeated tests, the EUC will be disconnected from PSS0 during PSS0 SIT. The SIT is performed on site [1].

Before starting the SIT, make sure all entry criteria are fulfilled [1]:

* Hardware SAT complete.
* Software pre-FAT complete.
* Test descriptions and test report templates shall be available and reviewed before the SIT tests commence.
* Software uploaded to PSS0 PLCs.
* PSS0 network communication equipment configured.

## System

For information about PSS0 purpose, scope, and equipment, please refer to the PSS0 Concept of Operations [2].

## Strategy

Hardware (HW) and software (SW) integration tests will be carried out according to SS-EN 62381 [3] and IEC 61511 [4]. The different applicable standards are described in the verification and validation plan [1].

## Requirements

For more information about the safety requirements of the Safety Instrumented Functions (SIF) associated with PSS0 see the safety requirement specification document [5]. The SIFs described in the safety requirement specification [5] and procedures and alarms defined in [6] are fully tested during SIT.

## Deviations

Failed or incomplete tests shall be recorded and categorized in the punch list (Table 3) provided in the appendix of this document, and treated as agreed in configuration management [7].

## Traceability

The safety requirement specification (SRS) [5] defines the safety requirements for each SIF. It includes specifications of both the functional and safety integrity requirements for the system.

Traceability is established from the requirements that are defined in the SRS document. These requirements will be tested and verified using checklists which can be found in the section named SIT checklist in this document. The completed checklist shall be uploaded to CHESS. For deviation traceability please see [7] for more information.

# Tests

This section describes procedures to test the PSS0 functionality in detail with all related interlocks, alarms, feedbacks and displays on PSS0 Human Machine Interfaces (HMI) in the Front End Building (FEB). These tests will be performed during the SIT and the results shall be noted down in the SIT checklist (Table 1) attached to this document. According to [2], PSS0 includes four main operating procedures, which need to be tested during SIT. There should be both positive and negative tests. Positive tests are the tests where the test personnel perform the operating procedures as described in [2], and negative tests are tests in which the test personnel perform operating procedures in an unexpected order or in a way which is incorrect.

Operating procedures for PSS0:

* Formalised search
* Procedure for issuing PSS0 permit in order to energise the ISrc HV PS
* Procedure for removing PSS0 permit in order to de-energise the ISrc HV PS
* Procedure for removing PSS0 permit in order to de-energise the ISrc HV PS in case of emergency

The test cases will have the following content:

* **Description:**

A small description of what is tested.

The safety instrumented function that mitigates the hazard.

* **Entry criteria:**

Any activity that needs to be done before execution of a test case.

Entry criteria includes:

* + List of documents, checklist templates, tools, etc. required during the test.
  + Set up of any equipment associated with the test.
  + Requirements on personnel, i.e. to be familiar with a procedure for carrying out the test correctly and safely and to have appropriate training(s) enabling them to work in the area where the test is carried out.
* **Test steps:**

A numbered list of the tasks to be performed/verified in the test.

* **Acceptance criteria:**

Explanation on what is needed for the test to be accepted.

## Formalised search procedure

### Description

Test the procedure for formalised search (positive test).

### Entry criteria

* The personnel who carry out the test shall be authorized to work in the test area, and shall also be familiar with the test procedures.
* Test report template, with checklist and punch list.
* The person conducting the search has the safety key in possession.
* The person conducting the search has a timer.
* Requires a minimum of three persons:
  + Person 1: carrying out the search;
  + Person 2: standing outside the Access door;
  + Person 3: standing next to PSS HMIs.

### Test steps

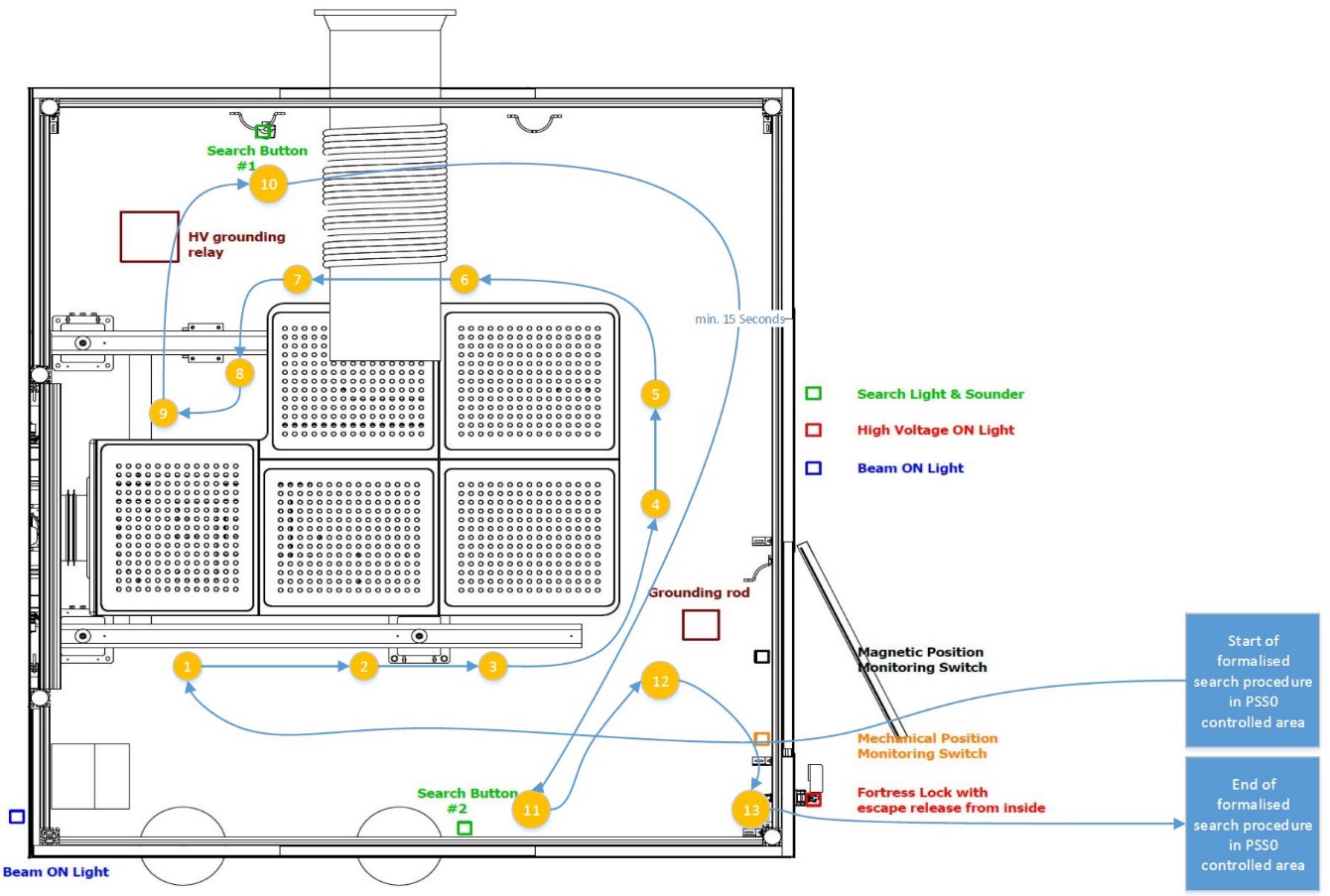


Figure 1: Formalised search

1. Person 3: verify that the system is in Access mode by visually checking the HMIs.
2. Person 1: enter the PSS0 controlled area and verify that there is nobody inside the HV platform, and that all nine steel doors of the ISrc HV platform can be closed.
3. Person 1: verify that search button #1 is flashing green and that search button #2 is off.
4. Person 1: press the search button #1 to start the search and verify that after pressing, the button turns solid green.
5. Person 2: verify that the green search light (next to access door) is flashing and that the pulsing sounder turns on when search process starts.

Person 3: verify that the system is in Search mode by visually checking the HMIs.  
Person 1: verify that the sounder tone can be heard from inside the PSS0 controlled area.

1. Person 1: verify that search button #2 starts flashing fifteen seconds after pressing the search button #1.
2. Person 1: press the search button #2 and verify that after pressing, the button turns solid green.
3. Person 1: verify that it is possible to remove the grounding rod from the ISrc HV platform and place the grounding rod in its rest place across the Access door.
4. Person 1: leave the PSS0 controlled area and verify that the Access door can be closed after putting grounding rod in place.
5. Person1: verify that putting the grounding rod in its rest place and closing the door can be done within 10 seconds.

Person 2: verify that the Z0 sounder is sounding a long pulse for 5 seconds when the search is done (both search button lights solid green, Access door closed and grounding rod in place) and the green search light turned solid green.  
Person 3: verify that area searched feedback is on and that the system is in Transition mode by visually checking HMIs.

1. Person 2: verify that the time between putting the grounding rod in place and search finish (Access door closed, search light on) is exactly 10 seconds.
2. Person1: try to remove the Access key without inserting the Safety key and verify that it is not possible to remove the Access key. Verify that the Access key can be removed only when the Safety key is inserted in slot #3.
3. Person 1: remove the Access key from slot #2 on the proLok and verify that the green LED on the proLok is turned off (door mechanically locked).
4. Person 1: try to open the Access door when the Access key is out and verify that the Access door cannot be opened.

### Acceptance criteria

* The sounder pulsed tone shall be on during the search and shall be heard from inside the PSS0 controlled area.
* The search light shall be flashing during the search.
* The HMIs shall display that the system is in Search mode after pressing search button #1.
* The illuminated search buttons shall go from flashing to solid green after being pressed.
* The search button #2 shall not start flashing within fifteen seconds after the search button #1 has been pressed.
* It shall be possible to put the grounding rod in its rest place without problems.
* It shall not be possible to remove either the Access or Safety key if one of them is not inserted in the proLok.
* After the search is completed, the search light shall turn solid green, the sounder shall sound a 5 seconds long pulse and the PSS HMIs shall display that the area is searched.

## Formalised search procedure broken by exceeding time limit

### Description

Test that if the formalised search duration exceeds the prescribed time, the search is broken and the system goes back to Access mode (negative test).

### Entry criteria

See chapter 2.1.2.

### Test steps

1. Start a new search procedure and verify that exceeding sixty seconds before pressing the search button #2 will break the search.

Person 1: verify that it is not possible to continue the search by pressing the search button #2 and that search button #1 started flashing again.  
Person 3: verify that the system transitioned back to Access mode on the HMIs.

1. Start a new search procedure and verify that if exceeding the sixty seconds before putting the grounding rod in its rest place across the Access door will break the search.

Person 1: verify that it is not possible to continue the search by putting the grounding rod in its rest place across the Access door sixty seconds after search has started and that search button #1 starts flashing again only when the grounding rod is removed from its rest place.  
Person 3: verify that the system transitioned back to Access mode on the HMIs.

1. Start a new search procedure and verify that exceeding the sixty seconds before closing the Access door will break the search.

Person 1: verify that it is not possible to finish the search if the Access door is not closed sixty seconds after the process has started. Verify that search button #1 starts flashing again only when the grounding rod is removed from its rest place.  
Person 3: verify that the system transitioned back to Access mode on the HMIs.

### Acceptance criteria

* It shall not be possible to finish the formalised search procedure if it takes more than sixty seconds.

## Unexpected order in formalised search procedure

### Description

Test that it is not possible to perform the formalised search procedure in a wrong order.

### Entry criteria

See chapter 2.1.2.

### Test steps

1. Verify that a search procedure cannot be started if pressing of search button #1 is skipped (i.e. by pressing the search button #2).
2. Verify that a search procedure cannot be started if the grounding rod is in its rest place across the Access door.
3. Start a new search procedure and verify that a successful formalised search cannot be finished if pressing of the search button #2 is skipped.
4. Start a new search procedure and verify that a successful formalised search cannot be completed in less than fifteen seconds.
5. Start a new search procedure and verify that a successful formalised search cannot be finished if putting the grounding rod in its rest place across the Access door is skipped.
6. Start a new search procedure and verify that a successful formalised search cannot be finished if the Access door is not closed within then seconds after putting the grounding rod in its rest place across the Access door.

### Acceptance criteria

* It shall not be possible to bypass the order of formalised search procedure.

## Procedure for issuing PSS0 permit in order to energise the ISrc HV PS and testing the SIF04

### Description

Test the procedure for issuing a permit to energise the ISrc HV PS and SIF04 (positive test).

* SIF04: If the Access key is in slot #1 position ON, lock the Access door [6].

### Entry criteria

* The personnel who carry out the test shall be authorized to work in the test area, and shall also be familiar with the test procedures.
* Test report template, with checklist and punch list.
* PSS0 area searched.
* The person conducting the test has the Access key in possession.
* Requires a minimum of three persons:
  + Person 1: carrying out the test;
  + Person 2: Remains inside the PSS0 controlled area to check the grounding relay status;
  + Person 3: standing next to PSS0 HMIs.

### Test steps

1. Verify that the system is in Transition mode and Area search feedback is active on the HMIs.
2. Open the Access key box, insert the Access key in slot #1 and turn the key to ON position.
3. Verify that the system has transitioned to HV ON mode, by checking the HMIs.
4. Check the screen with actuator feedbacks on both HMIs and verify that all actuators are in the expected state.
5. Verify that the HMIs show that the PSS0 permit to the ISrc HV PS is enabled
6. Verify that the HV grounding relay is disconnected, by visual inspection.
7. Verify that the PSS0 contactors interfacing the main input power to the HV PS are enabled (i.e. closed), using visual inspection.
8. Verify that the solenoid of the Access door lock (proLok) is de-energised (both LEDs turned off), and the door is locked. (**SIF04**).
9. Verify that the PSS0 permit to the interlock PLC is enabled (i.e. the respective relay is closed), by using visual inspection.
10. Verify that the “High Voltage ON” light panel and the “Beam ON” light panels are on.

### Acceptance criteria

* After inserting the Access key in slot #1 and turning it to ON, the following shall be fulfilled:
  + The contactors interfacing the mains input power to HV PS shall be enabled,
  + The HV grounding relay shall be disconnected (i.e. open),
  + The PSS0 permit to the interlock PLC shall be enabled,
  + The PSS0 HMIs shall display HV ON mode,
  + The proLok LED lights shall be off.

## Unexpected order in procedure for issuing PSS0 permit in order to energise the ISrc HV PS

### Description

Test that it is not possible to perform the procedure in a wrong order or to bypass necessary steps in the procedure (negative test).

### Entry criteria

See chapter 2.4.2.

### Test steps

1. Initiate the issuing of a PSS0 permit by putting the Access key in slot #1 position ON when the PSS0 controlled area is not searched. Verify that a permit to energise the HV PS cannot be issued if the PSS0 controlled area is not searched.

Verify on the HMIs that the system goes to Alarm mode if issuing the permit is requested when PSS0 controlled area is not searched.

1. Verify that it is possible to transition to HV ON mode (i.e. issue a permit to energise the HV PS) only if the system (both red and blue PLCs) are in Transition mode.
2. Carry out search so that both red and blue systems are in Transition mode. Switch off the blue PLC and initiate the issuing of a permit by putting the Access key in slot #1 position ON. Verify that a permit to energise the HV PS cannot be issued if a blue PLC is not functional.
3. Carry out search so that both red and blue systems are in Transition mode. Cause an alarm in a blue PLC by removing one of the fail-safe I/O modules and initiate the issuing of a permit by putting the Access key in slot #1 position ON. Verify that a permit to energise the HV PS cannot be issued if there is an active alarm in blue PLC.
4. Repeat steps 3 and 4 with a red PLC.

### Acceptance criteria

* It shall not be possible to issue a permit to energise the HV PS if the PSS0 controlled area is not searched.
* It shall not be possible to issue a permit to energise the HV PS if the system was not previously in Transition mode.
* It shall not be possible to issue a permit to energise the HV PS if there is a failure or active alarm in any of the PLCs.

## Misusing of the PSS keys

### Description

Test that it is not possible to bypass the mechanical sequence of trapped-key exchange system (negative test).

### Entry criteria

* The personnel who carry out the test shall be authorized to work in the test area, and shall also be familiar with the test procedures.
* Test report template, with checklist and punch list.
* This test can be done by one person.

### Test steps

1. Verify that the Safety key cannot be removed from slot #3 if the Access key is not in slot #2.
2. Verify that the Access key can be removed from slot #2 only if the Safety key is in slot #3 and if the Access door is closed.
3. Verify that the Safety key cannot be used as the Access key to initiate issuing of the permit to energise the HV PS.

### Acceptance criteria

* It shall not be possible to remove the Safety key from the proLok before inserting the Access key.
* It shall not be possible to remove the Access key from the proLok before returning the Safety key and closing the Access door.
* It shall not be possible to use the Safety key in slot #1 as the Access key.

## Procedure for removing PSS0 permit in order to de-energise the ISrc HV PS and testing the SIF03

### Description

Test the procedure for removing the PSS0 permit in order to de-energise the ISrc HV PS and test SIF03 (positive test).

* SIF03: If the Access key is removed from slot #1 position ON, de-energise the HV PS by removing its supplied power. Additionally, the HV grounding relay shall be closed to remove any residual stored energy from the power supply and its output cable [5].

### Entry criteria

* The personnel who carry out the test shall be authorized to work in the test area, and shall also be familiar with the test procedures.
* Test report template, with checklist and punch list.
* Requires a minimum of three persons:
  + Person 1: carrying out the test;
  + Person 2: Remains inside the PSS0 controlled area to check the grounding relay status.
  + Person 3: standing next to PSS0 HMIs.

### Test steps

1. Verify that the system is in HV ON mode, by visually checking the HMIs.
2. Turn the Access key into OFF position and remove it from slot #1. Verify that the contactors interfacing the mains input power to the ISrc HV PS are open and that the HV grounding relay is closed upon turning the Access key (**SIF03**), by visual inspection.
3. Verify that the system is in Transition mode on the HMIs.
4. Verify that the HMIs show that the PSS0 permit to the ISrc HV PS is disabled.
5. Verify that the “High Voltage ON” and “Beam ON” light panels turn off by visual inspection.
6. Verify that the signal to the proLok solenoid is enabled by using visual inspection.
7. Take the Access key to the Access door, insert the Access key in slot #2 on the proLok and verify that the Access door is still mechanically locked (cannot be open).
8. Remove the Safety key from slot #3 on the proLok and verify that the Access door is unlocked (can be opened).
9. Verify that the search light turns off.
10. Verify on HMIs that the area searched feedback is not active and the system is in Access mode.
11. Remove the grounding rod from its rest place and place it on the ISrc HV platform. Verify that the grounding rod can be easily placed on the HV platform.

### Acceptance criteria

* The contactors interfacing the mains input power to the ISrc HV PS shall open, the HV grounding relay shall close and the system shall be in Transition mode if the Access key is removed from slot #1 position ON.
* The Access door is unlocked if the Safety key is removed.
* The search shall be broken upon opening of the Access door and the system shall be in Access mode.

## Removing PSS0 permit in order to de-energise the ISrc HV PS in case of unexpected PSS0 hardware errors

### Description

Test that the permit to energise the ISrc HV PS will be removed in case of serious PSS0 hardware errors/faults while the HV PS is in operation (negative test).

### Entry criteria

* The personnel who carry out the test shall be authorized to work in the test area, and shall also be familiar with the test procedures.
* Test report template, with checklist and punch list.
* Requires a minimum of three persons:
  + Person 1: carrying out the test;
  + Person 2: Remains inside the PSS0 controlled area to check the grounding relay status.
  + Person 3: standing next to PSS0 HMIs.
* The system is in HV ON mode and the Access key is in slot #1 position ON.

### Test steps

1. Disconnect the signal from the Access key switch in the red system.

Verify that the HMIs show that the PSS0 permit to the ISrc HV PS is disabled.

Verify that the contactors interfacing the mains input power to the ISrc HV PS are open and that the HV grounding relay is closed, by visual inspection.

1. Disconnect the signal from the Access key switch in the blue system.

Verify that the HMIs show that the PSS0 permit to the ISrc HV PS is disabled.

Verify that the contactors interfacing the mains input power to the ISrc HV PS are open and that the HV grounding relay is closed, by visual inspection.

1. Disconnect the wire between PSS0 red PLC DQ module and contactor relay 1. Verify as described in step 1.
2. Disconnect the wire between PSS0 blue PLC DQ module and contactor relay 2. Verify as described in step 2.

### Acceptance criteria

* The PSS0 permit to energise the ISrc HV PS shall be removed if an error in monitoring the Access key position or contactors is detected by any of red or blue systems.

## Procedure for removing PSS0 permit in order to de-energise the ISrc HV PS in case of pressing the HV OFF button and testing the SIF01

### Description

Test the functionality of the ISrc HV OFF button and SIF01.

* SIF01: If the ISrc HV OFF button is pressed, de-energise the HV PS by removing its supplied power [5].

### Entry criteria

See chapter 2.8.2.

### Test steps

1. Press the ISrc HV OFF button in the vicinity of the PSS0 controlled area when the system is in HV ON mode (permit issued).
2. Verify that the HMIs show that the system is in Alarm mode and that the permit to the ISrc HV PS is removed.
3. Verify that the PSS0 contactors interfacing the mains input power to the ISrc HV PS are disabled (i.e. open) and that the HV grounding relay is closed, using visual inspection.

Verify that the “High Voltage ON” and “Beam ON” light panels are off.

1. Verify that PSS0 controlled area search is broken.

### Acceptance criteria

* If the ISrc HV OFF button is pressed in any mode, the following shall happen:
  + The PSS contactors interfacing the main input power to the ISrc HV PS shall be disabled.
  + The HV grounding relay shall be closed (connected to earth).
  + The system shall be in Alarm mode and the PSS0 permit to the ISrc HV PS shall be removed.

## Removing PSS0 permit in order to de-energise the ISrc HV PS in case of intrusion into PSS0 controlled area and testing the SIF02

### Description

Test the system’s reaction upon intrusion into PSS0 controlled area and SIF02.

* SIF02: If the Access door is detected in open position during operations, de-energise the HV PS by removing its supplied power [5].

### Entry criteria

See chapter 2.8.2.

### Test steps

1. Simulate an intrusion into the PSS0 controlled area by carrying out the following tests cases:
   1. Apply force from the outside to open the Access door.
   2. Disconnect the signal from the magnetic safety switch in the red system
   3. Disconnect the signal from the mechanical safety switch in the red system
   4. Disconnect the signal from the magnetic safety switch in the blue system
   5. Disconnect the signal from the mechanical safety switch in the blue system
   6. Open the Access door from inside the PSS0 controlled area by using the escape release button
2. Verify that the system is in Alarm mode on the HMIs and that the PSS permit to the ISrc HV PS is disabled.

Verify that the contactors interfacing the mains input power to the ISrc HV PS are open and that HV grounding relay is closed, by visual inspection (**SIF02**).

1. Verify that the “High Voltage ON” and “Beam ON” light panels are off.

### Acceptance criteria

During the HV ON, if the Access door is detected in open position or if there is a fault in any of the safety position monitoring switches, the PSS0 permit to energise the ISrc HV PS shall be removed.

## Exiting the PSS0 controlled area in case of emergency

### Description

Test that it is possible to escape the PSS0 controlled area for a person trapped inside (the Access door is locked) during operations.

### Entry criteria

* The personnel who carry out the test shall be authorized to work in the test area, and shall also be familiar with the test procedures.
* Test report template, with checklist and punch list.
* The system is in HV ON or Transition mode and the PSS0 controlled area is searched.
* This test can be done by one person.

### Test steps

1. Verify that it is possible to unlock the Access door by using the escape release button and escape from the PSS0 controlled area if the system is in HV ON or Transition mode.
2. Verify that the Access door cannot be locked before the escape release button is reset.

### Acceptance criteria

* It shall be possible to leave the PSS0 controlled area after the area is searched.
* It shall not be possible to lock the Access door before the escape release button is reset.

## Timing between actuating the ISrc HV PS contactors and HV grounding relay during de-energising the HV PS

### Description

Test the timing of actuating the ISrc HV PS contactors and the HV grounding relay during de-energisation of the HV PS, as described in [2]. It should be noted that the delay time between actuation of sensor, power contactors and grounding relay is to protect EUC, and it has no personnel safety implications.

### Entry criteria

* The personnel who carry out the test shall be authorized to work in the test area, and shall also be familiar with the test procedures.
* Test report template, with checklist and punch list.
* The system is in HV ON mode and the PSS0 controlled area is searched.
* An oscilloscope is required to capture the times of sending commands to the actuators.
* This test requires a minimum of two persons.

### Test steps

1. PSS0 is in HV ON mode.
2. Test the time between “PSS0 permit to HV PS through interlock PLC removed” and “Contactors on the mains power to HV PS open”:
   1. Connect channel 1 of oscilloscope to the NO (Normally Open) of the relay in PSS0 rack sending “HV PS permit” to interlock PLC.
   2. Connect channel 2 of oscilloscope to the NC (Normally Closed) auxiliary contact of one of the power contactors.
   3. Verify that the ISrc HV PS contactors are open 500 milliseconds (as minimum time) after PSS0 “HV PS permit” is removed.
3. Test the time between “Contactors on the mains power to HV PS open” and “The grounding relay closed”:
   1. Connect channel 1 of oscilloscope to the NC auxiliary contact of one of the power contactors.
   2. Connect channel 2 of oscilloscope to the NC auxiliary contact of the grounding relay.
   3. Verify that the HV grounding relay is closed 1 second after removing Access key or PSS0 transitioning to Alarm mode.
4. Carry out tests mentioned in steps 2 and 3 by moving the Access key in slot #1 to OFF position. Note the measured times in table 1.
5. Carry out tests mentioned in steps 2 and 3 by pressing ISrc HV PS OFF button. Note the measured times in table 1.

### Acceptance criteria

* During the procedure for removing the permit to energise, the contactors shall be open 500 ms after a permit is removed, and the HV grounding relay shall be closed 500 ms after the contactors are detected open.
* Upon alarm during HV ON mode, the contactors shall be open 500 ms after a permit is removed, and the HV grounding relay shall be closed 500 ms after the contactors are detected open.

## Opening Access door during PSS0 failure

### Description

Test that the Access door to the PSS0 controlled area can be opened using the Override key and the Access key during PSS0 failure.

### Entry criteria

* The personnel who carry out the test shall be authorized to work in the test area, and shall also be familiar with the test procedures.
* Test report template, with checklist and punch list.
* The solenoid cannot be energised, i.e. failure in PSS0.
* This test requires two persons.

### Test steps

1. Switch the PSS0 red PLC to stop mode so that the proLok solenoid cannot be energised.
2. Open the Access key box and turn the Access key into OFF position. Remove the key from slot #1.
3. Take the access key to the ISrc access door.
4. Insert the mechanical override key in the proLok.
5. Insert the access key in slot #2 on the proLok.
6. Remove safety key from slot #3 on the proLok.
7. Verify that the door is unlocked.

### Acceptance criteria

* The Access door to the PSS0 controlled area can be open using the Override key and the Access key during PSS0 failure.

# SIT check list

## Purpose

The purpose of the checklists is to be able to systematically verify each safety aspect and to evaluate the safety of the overall system [1].

## Checklist

The checklist in Table 1 has to be filled in before SIT is finalised. The test cases are described in the test section (Section 2).

Table 1: SIT checklist

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Test id** | **Test title** | **Acceptance criteria** | **Test result [Pass][Fail]** | **Remarks** |
| 1 | Formalised search procedure | See 2.1.4 | Pass  Fail | This test was successfully carried out on 2018-08-17. |
| 2 | Formalised search broken by exceeding time limit | See 2.2.4 | Pass  Fail | This test was successfully carried out on 2018-08-17. |
| 3 | Unexpected order for formalised search | See 2.3.4 | Pass  Fail | This test was successfully carried out on 2018-08-17. |
| 4 | Procedure for issuing PSS0 permit in order to energise the ISrc HV PS and testing the SIF04 | See 2.4.4 | Pass  Fail | This test was successfully carried out on 2018-08-17. |
| 5 | Unexpected order in procedure for issuing PSS0 permit in order to energise the ISrc HV PS | See 2.5.4 | Pass  Fail | This test was successfully carried out on 2018-08-17. However, a minor modification was required in regards to the information shown on the HMIs. The test was repeated with successful result on 2018-08-22. |
| 6 | Misusing of the PSS keys | See 2.6.4 | Pass  Fail | This test was successfully carried out on 2018-08-17. |
| 7 | Procedure for removing PSS0 permit in order to de-energise the ISrc HV PS and testing the SIF03 | See 2.7.4 | Pass  Fail | This test was successfully carried out on 2018-08-17. |
| 8 | Removing PSS0 permit in order to de-energise the ISrc HV PS in case of unexpected PSS0 hardware errors | See 2.8.4 | Pass  Fail | This test was successfully carried out on 2018-08-17. |
| 9 | Procedure for removing PSS0 permit in order to de-energise the ISrc HV PS in case of pressing the HV OFF button and testing the SIF01 | See 2.9.4 | Pass  Fail | This test was successfully carried out on 2018-08-17. |
| 10 | Removing PSS0 permit in order to de-energise the ISrc HV PS in case of intrusion into PSS0 controlled area and testing the SIF02 | See 2.10.4 | Pass  Fail | This test was successfully carried out on 2018-08-17. |
| 11 | Exiting the PSS0 controlled area in case of emergency | See 2.11.4 | Pass  Fail | This test was successfully carried out on 2018-08-17. |
| 12 | Timing between actuating the ISrc HV PS contactors and HV grounding relay during de-energising the HV PS | See 2.12.4 | Pass  Fail | This test was successfully carried out on 2018-08-22.  **Step 4:** (time for step 2: 660 ms, Time for step 3: 660 ms)    **Step 5:** (time for step 2: 600 ms, Time for step 3: 390 ms) |
| 13 | Opening Access door during PSS0 failure | See 2.13.4 | Pass  Fail | This test was successfully carried out on 2018-08-17. |
| Executed by | | | Morteza Mansouri, Denis Paulic, Stuart Birch, Alberto Toral Diez | |
|  | |
|  | |
| Execution date(s) | | | 2018-08-17 and 2018-08-22 | |

# F-collective signatures

The F-collective signatures for the safety program in the F-CPU shall be recorded when the SIT is performed. If changes have been made, those changes shall be recorded as well.

Table 2: F-collective signatures during SIT

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Red System** | | | **Blue System** | | |
| **Date of compilation** | **F-collective signature** | **Remarks / changes** | **Date of compilation** | **F-collective signature** | **Remarks / changes** |
| 2018-08-16 | E460AFED | Initial software version for SIT | 2018-08-16 | 2A4535BE | Initial software version for SIT |
| 2018-08-20 | 820462F6 | Changes after initial SIT:  -Inverted logic for status exchange signals between two trains. Instead of “alarm ON” in blue, red system reads “blue PLC OK” to be able to recognise also if the blue system is off. It also writes to “red PLC OK” instead of sending the alarm status to blue system.  -Discrepancy time for Access door switches increased to 600 ms. | 2018-08-20 | 6957557 | Changes after initial SIT:  -Inverted logic for status exchange signals between two trains. Instead of “alarm ON” in red, blue system reads “red PLC OK” to be able to recognise also if the red system is off. It also writes to “blue PLC OK” instead of sending the alarm status to red system.  -Discrepancy time for Access door switches increased to 600 ms. |

# ABBREVIATIONS

CHESS Collaboration Home ESS

ESS European Spallation Source

FAT Factory Acceptance Test

HW Hardware

ICS Integrated Control System

I/O Input/Output

PSS Personnel Safety Systems

PSS0 Accelerator Personnel Safety System 0

SIF Safety Instrumented Function

SIL Safety Integrity Level

SIT Site Integration Test

SRS Safety Requirement Specification

# References

|  |  |
| --- | --- |
| [1] | PSS0 Verification and Validation Plan (ESS-0233615), 2018. |
| [2] | Concept of Operations For the Accelerator Personnel Safety System 0 (ESS-0134492), 2018. |
| [3] | Automation systems in the process industry – Factory acceptance test (FAT), site acceptance test (SAT), and site integration test (SIT) (SS-EN 62381), 2012. |
| [4] | Functional safety – Safety instrumented systems for the process industry sector (IEC 61511), 2016. |
| [5] | Safety Requirements Specification Document for PSS0 (ESS-0238059), 2018. |
| [6] | Overall Safety Requirements and their Allocation Document for PSS0 (ESS-0231390), 2018. |
| [7] | Configuration management plan for Personnel Safety Systems (ESS-0058389) \*, 2018. |

\* The Configuration management plan for Personnel Safety Systems (ESS-0058389) is under development.

# APPENDIX 1

## SIT punch list

Any incomplete work or non-conformances shall be recorded on the SIT punch list and categorized as follows [3]:

1. To be cleared on spot, SIT to continue after rectification.
2. Ongoing rectification during SIT.
3. SIT to be repeated.
4. Modification to be made after SIT.

See next page for punch list.

Table 3: SIT punch list.

|  |  |  |
| --- | --- | --- |
| **Test id** | **Category** | **Remarks** |
| 2.5 step 3 | 4 | ~~To be repeated due to the need to do a minor modification in the PLC software (2018-08-17).~~  This test was successfully done 2018-08-22. |
| 2.12 | 3 | ~~This test was not done on 2018-08-17. It will be done in week 34 (2018-08-17).~~  This test was successfully done 2018-08-22. |
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# APPENDIX 2

## SIT certificate

Before signing the SIT certificate, all checklists must be filled in and approved.

Table 4: SIT certificate.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Accepted** | X | **Not accepted** |  |  |
|  | | | | |
| **Project** | Accelerator Personnel Safety System 0 (PSS0) | | | |
| **Venue of SIT** | ESS Site, Building G01 (accelerator tunnel and FEB) | | | |
| **SIT finished on** | 2018-08-22 | | | |
|  | | **Name** | **Signature** | |
| **PSS representatives** | | Alberto Toral Diez |  | |
| Denis Paulic |  | |
| Morteza Mansouri |  | |
| Stuart Birch |  | |
| **-** | - | |
| **-** | - | |