INAF

ISTITUTO NAZIONALE DI ASTROFISICA
NATIONAL INSTITUTE FOR ASTROPHYSICS

Non Functional Requirements

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1 Reference documents

1.1 Project documentation

[PD1] LFAA Signal Processing System Detailed Design Document, SKA-TEL-LFAA-0500035, Issue 1
[PD2] LFAA Signal Processing System Prototype Test Report, SKA-TEL-LFAA-0500047, Rev. 01
[PD3] SKA LFAA SPS Cabinet Specification Document, Issue, 1 04/04/2018, Sanitas EG
[PD4] SKA LFAA conceptual sub-rack design, Issue 1.2, 14/02/2018, Sanitas EG
[PD5] SKA Management Board Description, Issue 1.1, 24/20/2019, Sanitas EG
[PD6] Cabinet Monitor and Control Points, Issue 1, 15/11/2018, Sanitas EG
[PD7] Design of performance improvements and industrial process of SKA-LFAA receiver , LEONARDO
[PD8] SKA iTPM-ADU V1.6 Board User Manual, Issue 1.1, 20/02/2020, Sanitas EG
[PD9] SKA System Budget-Low System Timing Budget_u1, SKA-TEL-SKO-0000637-03
[PD10] Clock Distribution Analysis, Issue 1, 15/11/2018, Sanitas EG
[PD11] Detailed Thermal Study Cooling Solution for SKA, Rev. 12, AAVID Themalloy
[PD12] SKA Backplane Board, Issue 1.1, 23/09/2019, Sanitas EG
[PD13] R. Chiello, iTPM Firmware Architecture, Issue 2.2, 18/05/2020, University of Oxford
[PD14] G. Comoretto, C. Belli: LFAA Tile Beamformer Signal processing, INAF
[PD15] G. Comoretto, LFAA SPS Network, Rev 2.2, 30/01/2020, INAF
[PD16] LFAA to INFRA AUS Interface Control Document, 100-000000-003, Rev. 04
[PD17] SKA1 Power Quality Standard Specification, SKA-TEL-SKO-00000293
[PD18] Safety Management Plan, SKA-TEL-SKO-0000740
[PD19] SKA EMI/EMC Standards, Related Procedures & Guidelines, SKA-TEL-SKO-0000202
[PD20] C.Taljaard: SKA RAM allocation, SKA-TEL-SKO-0000102

1.2 Public regulations, standards and data sheet

[PS1] PET1300-12-054xA AC-DC Front-End Power Supply, Bel Power Solution and Protection, datasheet, https://www.belfuse.com/resources/datasheets/powersolutions/ds-bps-pet1300-series.pdf
[PS2] Australian Work Health and Safety Act 2011, https://www.legislation.gov.au/Details/C2018C00293
[PS3] IEC AN AS/NZS 60950.1:2015, Information technology equipment - Safety - Part 1: General requirements.
[PS4] Restriction of Hazardous Substances Directive (RoHS 2) http://www.conformance.co.uk/adirectives/doku.php?id=rohs Directive2011/65/EU
[PS5] ETSI EN 300 019-1-1, Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-1: Classification of environmental conditions; Storage 2014



http://www.etsi.org/deliver/etsi_en/300001_300099/3000190101/02.02.01_60/en_3000190101v020201p.pdf

[PS6] ETSI EN 300 019-1-2, Equipment Engineering Environmental conditions and environmental tests for telecommunications equipment Part 1-2: Classification of environmental conditions Transportation http://www.etsi.org/deliver/etsi_en/300001_300099/3000190102/02.01.07_20/en_3000190102v020107a.pdf

[PS7] ETSI EN 300 019-1-3, Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-3: Classification of environmental conditions; Stationary use at weather-protected locations https://www.etsi.org/deliver/etsi_en/300001_300099/3000190103/02.03.02_60/en_30000190103v020302p.pdf

[PS8] IEC 60721-3-1, Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 1: Storage 1997.

[PS9] IEC 60721-3-2 Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 2: Transportation 1997.

[PS10] IEEE 519-1992, IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems https://standards.ieee.org/standard/519-1992.html

[PS11] IEC 62040-3, Uninterruptible power systems (UPS) - Part 3: Method of specifying the performance and test requirements

[PS12] IEC 61000-3-3, Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤16 A per phase and not subject to conditional connection

[PS13] IEC 61000-4-2, Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test

[PS14] IEC 61000-4-3, Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test

[PS15] IEC 61000-4-4, Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test

[PS16] IEC 61000-4-5, Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test

[PS17] IEC 61000-4-6, Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields

[PS18] IEC 61000-4-8, Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test

[PS19] IEC 61000-4-11, Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current up to 16 A per phase

[PS20] AS/NZS 3000:2007, Electrical installations (known as the Australian/New Zealand Wiring Rules) https://www.standards.org.au/standards-catalogue/others/sa-slash-snz/as-slash-nzs--3000-2007

[PS21] RoHS Directive 2011/65/EU (RoHS 2), Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous



substances in electrical and electronic equipment (recast) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32011L0065

[PS22] IEC 61000-6-4, Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments

[PS23] IEC 61000-6-2, Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments

[PS24] ISO 61310_2, Safety Of Machinery - Indication, Marking and Actuation - Part 2: Requirements for Marking



2 SPS subrack requirements

2.1 Environment & Safety

Title	**Subrack safety legislation and regulations**
Description	Subrack equipment and operations shall comply with all applicable Australian Occupational Health and Safety legislation and regulations [PS2] in accordance with the latest approved version of the LFAA to INFRA ICD [PD16].
Parent	SKA1-LFAA_SPS_REQ-168
Verification	Test & Inspection

Title	**Subrack safety certification**
Description	Subrack and LRU equipment shall be safety certified to AS/NZS 60950.11:2015 [PS3]or equivalent in accordance with the latest approved version of the LFAA to INFRA ICD [PD16].
Parent	SKA1-LFAA_SPS_REQ-169
Verification	Test & Analysis

Title	**Subrack environmental certification**
Description	Subrack and LRU equipment shall be RoHS 2 (2011/65/EU) certified [PS21]in accordance with the latest approved version of the LFAA to INFRA ICD [PD16].
Parent	SKA1-LFAA_SPS_REQ-210
Verification	Analysis

Title	**Subrack acoustic noise emission**
Description	Subrack acoustic noise emission sound pressure level shall be less than 80 dBA at a distance of 1m from the equipment.
Parent	SKA1-LFAA_SPS_REQ-211, SKA1-CSP_INFRA_REQ-31
Verification	Test&Analysis
Rationale	The complete rack shall have an acoustic emission of less than 85 dB at a distance of 1m. Some attenuation due to rack enclosure is assumed. As 85 dBA is the threshold level for prolonged exposure causing ear damages, a margin is useful.

Title	**Subrack equipment shutdown on failure**
Description	Subrack shall autonomously detect and shut-down affected equipment in accordance with the latest approved version of the LFAA to INFRA ICD [PD16], when any of the following conditions occur: 1. an over-current condition occurs in an element; 2. an over-temperature condition occurs in an element.
Parent	SKA1-LFAA_SPS_REQ-172
Verification	Test&Analysis



Title	**SPS Storage of Equipment**
Description	SPS equipment, while in its storage packaging, shall withstand, and shall operate to specification as defined herein after exposure to, the storage environmental conditions as defined in "Class 1.1: Weather protected, partly temperature-controlled storage locations" of the ETSI EN 300 019-1-1 standard [PS5] and defined in BS EN IEC 60721-3-1 [PS8]. 1. Climatic Conditions 1K3 2. Biological Conditions 1B2 3. Chemical conditions 1C2 4. Dust and Sand conditions 1S2 5. 5. Shock & Vibration Conditions 1M2
Parent	SKA1-LFAA_SPS_REQ-134
Verification	Test

Title	**SPS Transportation Environment**
Description	All components and spares of the SPS, in their transport packaging, shall be safe from damage while, and shall perform to specification as defined herein, after being transported under conditions as defined in "Class 2.2: careful transportation" of the ETSI EN 300 019-1-2 standard [PS6] and defined in BS EN IEC 60721-3-2 [PS9]: • Climatic conditions 2K5H • Biological conditions 2B3 • Chemical conditions 2C1 • Dust and Sand conditions 2S3 • Shock & Vibration conditions 2M3
Parent	SKA1-LFAA_SPS_REQ-135
Verification	Test

Title	**SPS COTS operating environment**
Description	The SPS "off-the-shelf" equipment shall perform to specification as defined herein during operation under the environmental conditions as defined in the ETSI EN 300 019-1-3 standard for "Class 3.6: Telecommunication control room locations" or equivalent [PS7].
Parent	SKA1-LFAA_SPS_REQ-136
Verification	Test

Title	**SPS Seismic Resilience**
Description	SPS racks and equipment shall survive and be fully operational after seismic events resulting in a maximum peak ground acceleration of 1 m/s2 when mounted (4 units per cabinet) in a standard 19" 42U cabinet.
Parent	SKA1-LFAA_SPS_REQ-137
Verification	Analysis



Title	**Subrack size**
Description	Subrack size shall fit in a 19” 6U standard rack size, with maximum protrusion form the front panel plane of xxx mm in the front direction and xxx mm in the rear direction, (not) including connectors.
Parent	SKA1-LFAA_SPS_REQ-193
Verification	Inspection

Title	**SPS Subrack weight**
Description	The mass of fully populated SPS subracks shall not exceed 40 kg (25 kg desired) in accordance with the latest approved version of the LFAA to INFRA ICD [PD16].
Parent	SKA1-LFAA_SPS_REQ-194
Verification	Test&Analysis
Rationale	Main requirement is that the subrack shall be installed by at most two operators, without the aid of a mechanical lift. Mounting guides in the cabinet shall be used to facilitate subrack insertion and removal. Total weight of full populated cabinet is limited to 620 kg. Considering weight of other components and of the rack itself, this does not constitute a limit.

2.2 Electrical

Title	**Subrack Low power state**
Description	SPS shall have a low power mode that reduces the power consumption to less than 5% of the nominal power requirement.
Parent	SKA1-LFAA_SPS_REQ-31

Title	**Low power mode on power application**
Description	SPS shall enter the "low power" mode on start-up and remain in Low Power mode until commanded otherwise
Parent	SKA1-LFAA_SPS_REQ-32

Title	**SPS Low Power Mode capabilities**
Description	SPS shall continue to communicate with MCCS, monitor, report status and execute received commands while in the Low Power Mode
Parent	SKA1-LFAA_SPS_REQ-88

Title	**SPS power interruption survivability**
Description	SPS racks shall survive a main power interruption at any time, without requiring a repair activity to restore it once power is restored.
Parent	SKA1-LFAA_SPS_REQ-97



Title	**Subrack power interface**
Description	Subrack element shall connect to two rack power outlets, on the same or different phases, using power cables with IEC_60320 C13 connectors (C14 inlet on the subrack).
Parent	SKA1-LFAA_SPS_REQ-175

Title	**Subrack power wiring code**
Description	Subrack element shall use cables coloured using standard Australian colour coding for phase, neutral and protective Earth.
Note	Australian code has recently changed to align with international standard.

Title	**Subrack power quality**
Description	Subrack shall operate in compliance with the SKA1 Power Quality Standard Specification [PD17] in accordance with the latest approved version of the LFAA to INFRA ICD [PD16].
Parent	SKA1-LFAA_SPS_REQ-149
Verification	Test&Analysis
Note	SKA1 Power Quality Standard Specification [PD17] specifies a long set of requirements. The principal ones are reported in the following requirements, for clarity

Title	**Subrack power factor**
Description	For 20% to 100% loading Subrack equipment shall have a power factor between 0.9 lagging to 0.95 leading in accordance with the latest approved version of the LFAA to INFRA ICD [PD16].
Parent	SKA1-LFAA_SPS_REQ-151
Verification	Test&Analysis

Title	**Subrack average power consumption**
Description	Subrack average power consumption shall not exceed 1000 W
Parent	SKA1-LFAA_SPS_REQ-152
Verification	Test&Analysis
Rationale	Cabinet power is limited to 5 kW. Assumed 200W each for two network switches, 50W for the cabinet management board, and 350 W for liquid-to-air heat exchanger and cabinet fans.

Title	**Subrack peak power draw**
Description	Subrack shall have a peak power draw of less than 1.1 kW, excluding initial inrush.
Parent	SKA1-LFAA_SPS_REQ-155

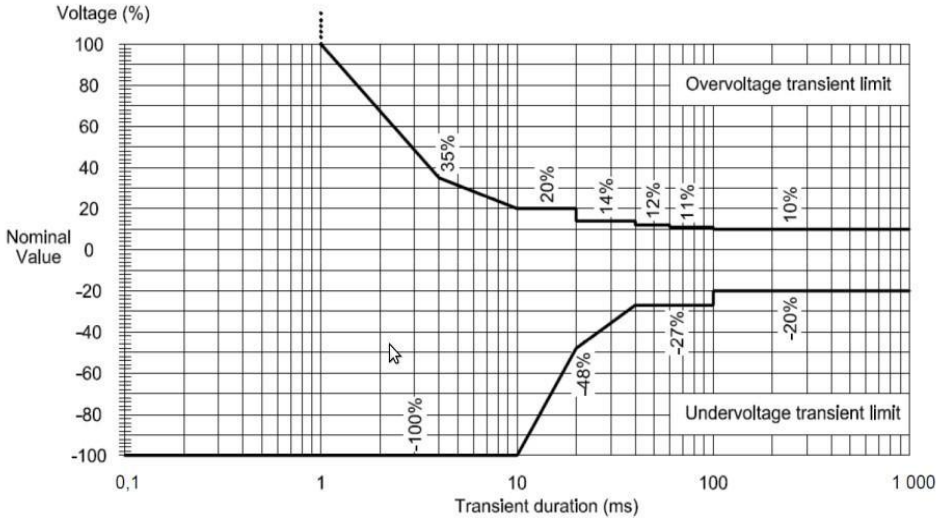
Title	**Subrack safety earth connection**
Description	SPS shall have a safety earth connection point with a connection resistance of less than 0.1 Ohm as per the latest approved version of the LFAA to INFRA ICD [PD16]
Parent	SKA1-LFAA_SPS_REQ-157

Title	**Subrack voltage fluctuations and flicker emissions**
Description	Subrack equipment connected to the CPF and RPF electrical network shall be compliant with the IEC 61000-3-3 [PS12] standard or equivalent for Voltage Fluctuations and Flicker Emissions under standard test conditions and setups in accordance with the latest approved version of the LFAA to INFRA ICD [PD16].
Parent	SKA1-LFAA_SPS_REQ-159

Title	**Subrack Radiate power**
Description	SPS subrack shall radiate EMI at levels at or below CISPR 22/32 or equivalent standard in the SKA Low and SKA survey telescope frequency range (50 MHz to 1.5 GHz).
Parent	SKA1-LFAA_SPS_REQ-160
Verification	Test

Title	**Subrack radiated, radio-frequency, electromagnetic field immunity**
Description	Subrack equipment shall be compliant with the IEC 61000-4-3 [PS14] standard or equivalent for radiated, radiofrequency, electromagnetic field immunity under standard test conditions and setups in accordance with the latest approved version of the LFAA to INFRA ICD [PD16].
Parent	SKA1-LFAA_SPS_REQ-162

Title	**Subrack electrical fast transient/burst immunity**
Description	Subrack equipment shall be compliant with the IEC 61000-4-4 [PS15] standard or equivalent for electrical fast transient/burst immunity under standard test conditions and setups in accordance with the latest approved version of the LFAA to INFRA ICD [PD16].
Parent	SKA1-LFAA_SPS_REQ-163

Title	**Subrack surge immunity**
Description	Subrack equipment connected to the CPF and RPF electrical network shall be compliant with the IEC 61000-4-5 [PS16] standard or equivalent for Surge immunity under standard test conditions and setups in accordance with the latest approved version of the LFAA to INFRA ICD [PD16].
Parent	SKA1-LFAA_SPS_REQ-164
Note	In section 4.5.1 of SKA-TEL-SKO-00000293 [PD17] it is assumed that equipment shall be compliant to IEC 62040-3 [PS11], classification 3. Surge amplitude shall remain within the bounds in figure. 

Title	**Subrack immunity to conducted disturbances induced by radio-frequency fields**
Description	Subrack equipment connected to the CPF and RPF electrical network shall be compliant with the IEC 61000-4-6 [PS17] standard or equivalent for immunity to conducted disturbances, induced by radio-frequency fields under standard test conditions and setups in accordance with the latest approved version of the LFAA to INFRA ICD [PD16].
Parent	SKA1-LFAA_SPS_REQ-165

Title	**Subrack power frequency magnetic field immunity**
Description	Subrack equipment connected to the CPF and RPF electrical network shall be compliant with the IEC 61000-4-8 [PS18] standard or equivalent for power frequency magnetic field immunity under standard test conditions and setups in accordance with the latest approved version of the LFAA to INFRA ICD [PD16].
Parent	SKA1-LFAA_SPS_REQ-166



Title	**Subrack voltage dips, short interruptions and voltage variations immunity**
Description	Subrack LRU equipment connected to the CPF and RPF electrical network shall be compliant with the IEC 61000-4-11 [PS19] standard or equivalent for voltage dips, short interruptions and voltage variations immunity under standard test conditions and setups in accordance with the latest approved version of the LFAA to INFRA ICD [PD16].
Parent	SKA1-LFAA_SPS_REQ-167

Title	**Subrack ESD immunity**
Description	Subrack equipment susceptible to ESD shall be compliant with the IEC 61000-4-2 [PS13] standard or equivalent standard for ESD immunity under standard test conditions and setups in accordance with the latest approved version of the LFAA to INFRA ICD [PD16].
Parent	SKA1-LFAA_SPS_REQ-187

Title	**Subrack inrush current**
Description	The SPS Subrack shall have an inrush current of less than three times the average current draw at the point of connection at any point of time, and should reach the steady state current value within one second after switch on.
Parent	SKA1-LFAA_SPS_REQ-215

Title	**Subrack operable frequency**
Description	The SPS Subrack shall be operable inside the following frequency deviation: 1. From Grid supply or Generator power (steady) +/- 2% (49Hz to 51Hz) 2. During switch from/to generator power +/- 5% (47.5 to 52.5 Hz)
Parent	SKA1-LFAA_SPS_REQ-217

Title	**Magnitude of supply voltage (steady state)**
Description	The SPS subrack shall operate with supply voltage within + 10% of nominal 230V (207-253V)
Parent	SKA1-LFAA_SPS_REQ-218

Title	**Supply voltage transients**
Description	The SPS subrack shall be withstand the transient limits defined in IEC 62040-3 [PS11] dynamic output performance classification 3
Parent	SKA1-LFAA_SPS_REQ-219



Title	**Subrack harmonic current limits**
Description	Subrack equipment connected to the CPF and RPF electrical network shall be compliant with the IEEE 519-1992 [PS10] part 11.5 standard as tailored for the low short circuit currents of the distribution network. Maximum harmonic current distortions at point of connection, averaged over the two connections, is reported in the following table as a function of the harmonic, for odd harmonics, expressed as percentage of maximum current drawn for individual harmonics and THD
Parent	SKA1-LFAA_SPS_REQ-220
Verification	Test
Rationale	See section 5.1.1. of SKA-TEL-SKO-00000293 [PD17] for details

Maximum Harmonic Current Distortion in Percent of I_L for odd harmonics					
<11	11≤ h <17	17 ≤ h < 23	23 ≤ h < 35	35 ≤ h	THD
4.0	2.0	1.5	0.6	0.3	5.0

2.3 Thermal

Title	**SPS Subrack thermal load**
Description	The thermal load of SPS subracks shall be less than (1.05) kW in accordance with the latest approved version of the LFAA to INFRA ICD [PD16].
Parent	SKA1-LFAA_SPS_REQ-197
Rationale	The total electric power is equal to the dissipated power within the Subrack

Title	**Airflow**
Description	The SPS subrack shall require an airflow of less to 80 l/s of air at nominal atmospheric pressure, (front to rear), with maximum inlet temperature of 40°C to guarantee proper heat dissipation

2.4 Software and Firmware Standards

Title	**SPS software and quality**
Description	SPS software and hardware description language related deliverables shall comply with the "Fundamental SKA Software and Hardware Description Language Standards"
Parent	SKA1-LFAA_SPS_REQ-61



2.5 Occupational Health and Safety

Title	**SPS hazard elimination**
Description	SPS subrack shall be safe to the operators, maintainers and own equipment, according to the SKA Project Safety Management Plan [PD18].
Parent	SKA1-LFAA_SPS_REQ-65

Title	**Subrack protruding obstacles**
Description	SPS equipment LRUs and racks shall eliminate or suitably protect obstacles that protrude and that may cause a safety hazard to personnel or equipment.
Parent	SKA1-LFAA_SPS_REQ-89

Title	**SPS sharp edges and corners**
Description	Exposed SPS shall have: 1. corners rounded to a radius not less than 13 millimetres or suitably protected with covers or coatings; 2. sharp edges rounded to a radius not less than 0.75 millimetres.
Parent	SKA1-LFAA_SPS_REQ-90

Title	**SPS heavy equipment handholds**
Description	SPS equipment weighing more than 23 kg shall have lifting provisions to allow team lifting and/or the use of moving equipment
Parent	SKA1-LFAA_SPS_REQ-91

Title	**SPS electrical installation**
Description	The electrical wiring of all SPS hardware shall comply with low voltage installation Standards (wiring of premises) AS/NZS 3000:2007 [PS20].
Parent	SKA1-LFAA_SPS_REQ-93

Title	**SPS electrical circuit interlock**
Description	The SPS subrack shall provide electrical circuit inter-locks to prevent personnel coming into contact with hazards that cannot otherwise be eliminated from design.
Parent	SKA1-LFAA_SPS_REQ-94

Title	**SPS fail-safe operation**
Description	SPS subrack shall operate in a locally fail-safe manner and not rely on external safety devices or measures to operate safely.
Parent	SKA1-LFAA_SPS_REQ-68



Title	**SPS non-propagation of failures**
Description	SPS equipment hardware failures and software errors shall be safe from creating hazardous conditions in interfacing elements and sub-elements.
Parent	SKA1-LFAA_SPS_REQ-69

Title	**SPS fail safe state**
Description	SPS equipment that would otherwise present a safety hazard when subjected to an unplanned loss of main electrical power or main control function, shall enter a designated fail safe state.
Parent	SKA1-LFAA_SPS_REQ-48

Title	**SPS fail safe warnings**
Description	Where transitioning to a designated fail safe state represents a hazard, components of the SPS subrack shall issue continued warnings for the duration of the transition.
Parent	SKA1-LFAA_SPS_REQ-49

Title	**SPS fail safe recovery**
Description	Once a transition to a designated fail-safe state is triggered, the SPS subrack shall complete the transition and remain in the designated fail-safe state until commanded otherwise.
Parent	SKA1-LFAA_SPS_REQ-50

Title	**SPS Thermal Overload Protection**
Description	All LRUs within SPS shall be equipped with thermal overload protection functionality to automatically power down the LRU when the SPS operating temperature exceeds the LRU's safe operating temperature.
Parent	SKA1-LFAA_SPS_REQ-95

Title	**SPS safety of equipment**
Description	SPS racks and equipment shall comply with IEC 60950-1 Information Technology Equipment - Safety Part 1 General Requirements [PS3] or equivalent standard.
Parent	SKA1-LFAA_SPS_REQ-96

Title	**SPS LRU electrostatic warning marking**
Description	SPS LRU equipment with electrostatic sensitive components shall be fitted with ESD warning labels.
Parent	SKA1-LFAA_SPS_REQ-94



2.6 Environmental protection

Title	**SPS environmental protection regulations**
Description	SPS shall be compliant with all local, State and national environmental protection legislation and regulations.
Parent	SKA1-LFAA_SPS_REQ-63

Title	**SPS recycling and decomposition.**
Description	SPS equipment shall be compliant with environmental, ecological, safety, political and social legislation with regard to recycling and decomposition.
Parent	SKA1-LFAA_SPS_REQ-103

Title	**SPS disposable equipment labelling**
Description	SPS disposable equipment should be labelled as such.
Parent	SKA1-LFAA_SPS_REQ-104

Title	**SPS restriction of hazardous substances**
Description	SPS shall be compliant with the RoHS Directive 2011/65/EU (RoHS 2) [PS21] or equivalent.
Parent	SKA1-LFAA_SPS_REQ-105

2.7 EMI and EMC

Title	**SPS EMI and EMC**
Description	SPS equipment shall be compliant with the emission and immunity standards in the SKA EMI/EMC Standards and Procedures document [PD19].
Parent	SKA1-LFAA_SPS_REQ-106

Title	**SPS essential conducted and radiated electromagnetic emissions**
Description	SPS LRU equipment that radiate electromagnetic emissions in the SKA1 frequency range and that aren't within a shielded enclosure of a higher level LRU, shall at a minimum be compliant with the IEC 61000-6-4 [PS22] standard or equivalent for conducted and radiated emissions under standard test conditions and setups in the SKA Low telescope frequency range as specified in the SKA EMI/EMC Standards and Procedures [PD19].
Parent	SKA1-LFAA_SPS_REQ-107



Title	**SPS electromagnetic susceptibility**
Description	SPS equipment shall be compliant with the IEC 61000-6-2 [PS23] standard or equivalent for susceptibility to conducted and radiated emissions under standard test conditions and setups.
Parent	SKA1-LFAA_SPS_REQ-108
Note	Only LRUs with electrical or electronic components that are susceptible to EMI and that aren't within a shielded enclosure of a higher level LRU need to be checked for compliance.

Title	**SPS essential off-the-shelf equipment EMC marking**
Description	SPS "off-the-shelf" LRU equipment shall as a minimum be CISPR 22 and 24 Class A or equivalent compliant over the SKA telescope frequency range.
Parent	SKA1-LFAA_SPS_REQ-109

2.8 Availability

Title	**SPS Inherent Availability**
Description	The complete SPS subrack (including preADU) shall have a MTBF greater than 5000 hours.
Parent	SKA1-LFAA_SPS_REQ-111

Title	**SPS Operationally Capable**
Description	SPS shall remain Operationally Capable when any one processing LRU (TPM or PSU) fails.
Parent	SKA1-LFAA_SPS_REQ-112

Title	**SPS maintenance hours**
Description	SPS subrack shall require less than 1 Direct Maintenance Hours (DMH) per year at the Organizational Level (O-Level)
Parent	SKA1-LFAA_SPS_REQ-113
Note	DMH/year = MTTR x number of equipment repair actions per year at the O-Level.

Title	**SPS mean time to repair**
Description	SPS subracks shall have an Mean Time To Repair (MTTR) of less than 1 hour at the organizational level (O-Level).
Parent	SKA1-LFAA_SPS_REQ-114

Title	**SPS software maintenance down time**
Description	SPS subracks shall have a Maintenance Down Time (MDT) of less than 1 hour per year for software repairs (during steady state operation).
Parent	SKA1-LFAA_SPS_REQ-115



Note	Software MDT is defined as the time per year that SPS is unavailable as result of SPS software defect repairs and software maintenance activities during the telescope operational phase. SPS software defect repairs and maintenance that don't require SPS down-time are excluded from MDT. SPS softwre repairs are executed simultaneously on all cabinets.

2.9 Testability

Title	**SPS off-line built-in self-test capability**
Description	When commanded and with the SPS Administrative Mode set to OFFLINE, SPS subrack shall perform diagnostic tests to detect and isolate LRU and sub-element level faults.
Parent	SKA1-LFAA_SPS_REQ-116

Title	**SPS off-line fault detection performance**
Description	When commanded and the SPS Administrative Mode set to OFFLINE, SPSF built-in diagnostic self-test capability shall detect and report 99% of all critical sub-element failures.
Parent	SKA1-LFAA_SPS_REQ-117
Note	A Critical Failure is a failure that would prevent SPS being "Operationally Capable".

Title	**SPS off-line fault isolation performance**
Description	When commanded and with the SPS Administrative Mode set to OFFLINE, SPS cabinet shall isolate 95% of all failures down to a LRU level.
Parent	SKA1-LFAA_SPS_REQ-118
Note	The SPS maintainer functions as part of the fault isolation mechanism by removing and replacing suspect LRUs.

Title	**SPS off-line communications fault detection**
Description	When commanded and with the SPS Administrative Mode set to OFFLINE, SPS cabinet shall detect and report 99% of sub-element LRU to LRU and LRU to external interface communication path faults.
Parent	SKA1-LFAA_SPS_REQ-119

Title	**SPS off-line memory and calculation fault detection**
Description	When commanded and with the SPS Administrative Modes set to OFFLINE, SPS shall detect and report the following faults: 1. Stuck or incorrect memory cells, whether a direct fault or manifested as such, 2. Calculation faults that may lead to incorrect data products, whether a direct fault or manifested as such.
Parent	SKA1-LFAA_SPS_REQ-120



2.10 On-line Diagnostic Tests

Title	**SPS on-line built-in self-test capability**
Description	While the SPS Administrative Mode is set to ONLINE or MAINTENANCE, SPS shall perform diagnostic tests to detect and isolate LRU and sub-element faults.
Parent	SKA1-LFAA_SPS_REQ-121

Title	**SPS on-line fault detection performance**
Description	While the SPS Administrative Mode is set to ONLINE or MAINTENANCE, SPS shall detect and report 99% of all Critical Failures.
Parent	SKA1-LFAA_SPS_REQ-122
Note	A Critical Failure is a failure that would prevent the SPS of being "Operationally Capable".

Title	**SPS on-line fault isolation performance**
Description	While the SPS Administrative Mode is set to ONLINE or MAINTENANCE, the SPS shall isolate more than 95% of all failures down to a LRU level.
Parent	SKA1-LFAA_SPS_REQ-123
Note	SPS maintainer implements part of the fault isolation capability by removing and replacing suspected LRUs to isolate the faulty LRU.

Title	**SPS on-line communications fault detection**
Description	While the SPS Administrative Mode is set to ONLINE or MAINTENANCE, SPS shall detect all utilized sub-element LRU to LRU and LRU to external LRU communication path faults with a detection probability of at least 99%.
Parent	SKA1-LFAA_SPS_REQ-124

Title	**SPS monitor and report operational state**
Description	SPS shall monitor its operational state and make available the information upon request in line with the software standard.
Parent	SKA1-LFAA_SPS_REQ-125

Title	**Current and voltage monitor**
Description	SPS subrack shall measure voltages at input of the PSUs, current and power used by PSUs, current and voltage for individual TPMs, output voltage for all voltage regulators and current for regulators providing at least 90% of the total absorbed power.

Title	**Temperature monitor**
Description	SPS subrack shall measure temperature in all points which could reach dangerous temperatures in case of a fault, and in representative points in the cooling airflow

Title	**Airflow monitor**

Description	SPS subrack shall measure rotational speed of all cooling fans, and detect the presence of a cooling airflow

Title	**Critical Condition Reporting**
Description	SPS subrack shall report any temperature, voltage, airflow anomaly, and power down the affected LRUs if these values exceed their safety margins.

2.11 Design for Maintainability

Title	**SPS in-system programmability**
Description	SPS programmable devices shall be in-system programmable in cases where the safety of personnel and equipment are not affected.
Parent	SKA1-LFAA_SPS_REQ-126

Title	**SPS software updates**
Description	SPS equipment shall facilitate major software updates within the LFAA maintenance time allocations.
Parent	SKA1-LFAA_SPS_REQ-127
Note	Software maintenance down time (MDT) is defined as the time per year that LFAA is unavailable as result of a LFAA software defect repairs and general software maintenance activities during the telescope operational phase. It's assumed that all major LFAA software defects are removed during construction and the first year of warranty. LFAA software defect repairs and maintenance that don't require LFAA down-time are excluded from MDT.

Title	**SPS maintenance provisions**
Description	SPS repairable items shall have maintenance provisions such as test points, accessibility, and plug-in components.
Parent	SKA1-LFAA_SPS_REQ-128

Title	**SPS LRU removal**
Description	SPS LRUs shall be mounted such that removal of any single LRU does not require the removal of other LRUs.
Parent	SKA1-LFAA_SPS_REQ-129

Title	**SPS mounting preclusion**
Description	SPS shall include provisions to preclude incorrect assembly to eliminate the possibility of equipment damage or mis-operation. These include key pins, different connector shape, or other mechanical preclusion. It shall be impossible to insert a LRU in a location where it could be damaged by improper connections. Equivalent LRUs (TPMs, power supplies) can be inserted in any position (i.e. they are not mechanically keyed to one specific location)



Parent	SKA1-LFAA_SPS_REQ-130

Title	**SPS stand-offs and handles**
Description	SPS shall provide equipment handles and stand-offs to facilitate the installation and handling and to mitigate damage of the equipment during out-of-system repair.
Parent	SKA1-LFAA_SPS_REQ-131

Title	**SPS mounting guides**
Description	Where applicable, SPS shall provide mounting guides and location pins on equipment to facilitate maintenance.
Parent	SKA1-LFAA_SPS_REQ-132

Title	**SPS mechanical keying for LRU**
Description	It shall be impossible to insert a LRU in a location where it could be damaged by improper connections. Equivalent LRUs (TPMs, power supplies) can be inserted in any position (i.e. they are not mechanically keyed to one specific location)

Title	**SPS geographic addressing**
Description	Equivalent LRUs which require addressing receive their address from their physical location in the subrack.

2.12 Equipment Configuration Identification

Title	**SPS equipment identification and safety markings**
Description	SPS equipment shall in accordance with ISO 61310_2 [PS24] or equivalent bear all markings necessary: • for its unambiguous identification; • for its safe use; and supplementary information given, as appropriate: • permanently on the machinery; • in accompanying documents such as instruction handbooks; • on the packaging.
Parent	SKA1-LFAA_SPS_REQ-99

Title	**SPS label robustness**
Description	SPS labels shall be affixed for at least 50 years or the lifetime of the equipment, whichever is the smaller, and unlikely to come off during maintenance or as a result of the environment.
Parent	SKA1-LFAA_SPS_REQ-102

Title	**SPS serial and part numbers**



Description	SPS equipment items identified in the SKA Logistics Analysis and Configuration Item Plan as needing individual characterisation shall be marked with a label displaying a unique Serial Number and Part Number. The label should normally be in an easily visible location but may also include embedded identification for items such as embedded firmware/software.
Parent	SKA1-LFAA_SPS_REQ-138

Title	**SPS marking method**
Description	Where items used in SPS require labelling, the method of marking shall be compliant with the SKA Logistic Analysis Plan. The nature of the item, its environment and its use will determine the method. Where items used in SPS require labelling, the method of marking shall be compliant with the SKA Logistic Analysis Plan. The nature of the item, its environment and its use will determine the method.
Parent	SKA1-LFAA_SPS_REQ-139

Title	**SPS electronically readable or scannable ID**
Description	Items used within the SPS shall be marked with a unique Electronically readable or scannable ID, in accordance with the SKA Logistic Analysis Plan and Configuration Plan. The ID may be serial number or part number or both or in some cases this may not be needed.
Parent	SKA1-LFAA_SPS_REQ-140

Title	**SPS package marking**
Description	All packaging of items used in SPS shall be marked to uniquely identify the contents in accordance with the SKA Logistics Analysis Plan. The identification is by part number and serial number.
Parent	SKA1-LFAA_SPS_REQ-141

Title	**SPS cable identification**
Description	Each SPS cable end shall carry an identifier that uniquely defines the connector it needs to connect to.
Parent	SKA1-LFAA_SPS_REQ-142

Title	**SPS connector plate identification**
Description	All SPS connector plates shall carry identification labels for connectors.
Parent	SKA1-LFAA_SPS_REQ-143