

SKA1 LFAA SPS SUB-ELEMENT REQUIREMENTS SPECIFICATION

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LIST OF ACRONYMS AND ABBREVIATIONS

AADC	Aperture Array Design and construction Consortium
AAVS	Aperture Array Verification System
ADC	Analog to Digital converter
Ad-n	nth document in the list of Applicable Documents
AIV	Assembly Integration and Verification
ASIC	Application Specific Integrated Circuit
CAD	Computer Aided Design
CCB	Configuration Control Board
CDR	Critical Design Review
CI	Configuration Item
COTS	Commercial Off the Shelf
CPF	Central Processing Facility
CM	Configuration Manager
CW	Continuous Wave
DMS	Document/Data Management System
ECP	Engineering Change Proposal
EMI	Electro Magnetic Interference
FoV	Field of View
FPGA	Field Programmable Gate Array
FTR	Full Text Retrieval
HW	Hardware
ICD	Interface Control Document
INFRAAUS	Infrastructure Australia
ISO	International Organisation for Standardisation
LFAA	Low Frequency Aperture Array
LFAA-DN	Low Frequency Aperture Array – Data Network
LNA	Low Noise Amplifier
LMC	Local monitoring and Control
LOFAR	Low Frequency Aperture Array
MBSE	Model Based Systems Engineering
MCCS	Monitor, Control and Calibration servers
MOM	Minutes of Meeting
MPO	Multi-Purpose Optic (connector)
MRI	Master Record Index
MRO	Murchison Radio-astronomy Observatory
MWA	Murchison Widefield array
NRE	Non-Recurring Engineering
OCR	Optical Character Recognition
PA	Product Assurance
PDF	Portable Document Format
PDR	Preliminary Design Review
PC	Project Controller
PO	Project Officer
QA	Quality Assurance
RBS	Re-Baselining Submission
RD-N	nth document in the list of Reference Documents
RF	Radio Frequency
RFI	Radio Frequency Interference
RFoF	Radio Frequency signal over Fibre
RPF	Remote Processing Facility

SaDT	Signal and Data Transport
SDP	Signal Data Processing
SEMP	System Engineering Management Plan
SFDR	Spurious Free Dynamic Range
SKA	Square Kilometre Array
SKA-LOW	SKA low frequency part of the full telescope
SKAO	SKA Office
S/N	Signal to noise
SOW	Statement of Work
SW	Software
TCP-IP	Transmission Control Protocol – Internet Protocol
TBC	To Be Confirmed
TBD	To Be Decided
TBS	To Be Supplied
TM	Telescope Management
TPM	Tile Processor Module
TRB	Test Review Board
WBS	Work Breakdown Structure
WDM	Wavelength Division Multiplexing
WP	Work Package

1 Introduction

1.1 Purpose of Document

1.1.1 Approach

This document resides within a requirements capture tool (Jama Contour) and for each requirement statement includes relational links back to the Level 2 Requirements.
This document is a living document that will converge on the requirements for the SPS Sub-element. The convergence process is an iterative one between the SKA Office and the consortia involved with the Element design work.
Each requirement within this document has an abbreviated form of the requirement data base's prefix which is shortened from "SKA1-LFAA-SPS_REQ-" to "SPS_REQ" and is appended to a unique four digit identifier. The identifier is generated by the requirements capture tool. It provides a useful reference tag and indicates where in the system hierarchy the requirement resides.
Each requirement identifies the type of verification method.
The latest issued document takes precedence over the contents of the requirements capture tool. However, an issued Level 3 Requirement document represents a requirements capture tool baseline. The data-base baseline identifier is referenced in the document history.
Amendments to the document will be via change control. If accepted, amendments will be via the requirements capture tool. Re-issue of this document will require a new baseline and export from the requirements tool and subsequent submission and approval via the Document Management System.

1.1.2 Verb Convention

"Shall" is used whenever a statement expresses a convention that is binding. The verbs "should" and "may" express non-mandatory provisions. "Will" is used to express a declaration of purpose on the part of the design activity.

1.2 Scope of Document

1.2.1 Identification

The LFAA_SPS Sub-element is assumed to include all of the associated equipment, facilities, material, software, hardware, policy, technical documentation, services, and personnel required for its operation. This requirement specification does not cover policy, technical documentation, services, or personnel required for its operation.
This document covers the LFAA_SPS aspects of the SKA1 Low Telescope and as such specifies the following product:

- LFAA_SPS 163-000000

1.2.2 Intended Use of Document

This specification:

1. Forms part of the SKA LFAA systems engineering baseline, as defined in the SKA1 LFAA SEMP [AD9].
2. Defines functional, performance, interface, environmental, physical, safety, logistic support, regulatory (legal) and special design requirements which are an input to the engineering and development of the item.
3. Is the specification against which the LFAA_SPS Sub-element will be sold-off (proven to be compliant to requirements).
4. Identifies the methods that will be used to verify that these requirements have been met when the item is submitted for acceptance.

This document is expected to be used by the LFAA Element and LFAA_SPS Sub-element Engineering Team and the SKAO System Engineering Teams. This document will also be used as part of the Construction Procurement Package.

1.3 SPS Description, Context and Deployment

1.3.1 SPS Overview

The context of the LFAA_SPS Sub-element is captured within the SKA1 LFAA Architectural Design Document [RD3].

1.3.2 External Interfaces

The external interfaces to the LFAA_SPS are covered in the applicable Interface Control Documents and are further elaborated in the SKA1 LFAA Architectural Design Document [RD3].

1.3.3 Functional Breakdown

SPS performs the following basic functions:

- Signal pre-conditioning
- Digitisation
- Tile beamforming
- Station beamforming including sub-station configuration
- RFI Detection and Flagging
- Spectrometer
- Calibration sample generation
- Support for Transient capture of either antenna or beam signals

The SPS delivers 384 full-polarisation station beam channels per station with each channel being configurable for one of up to up to eight pointings co-ordinated by the Telescope Manager, TM, across the Low telescope. It is also possible for TM to partition individual 40 metre diameter stations into 4 or 6 substations on nominal diameter of 10 metres such that either 1024 or 2048 substations are deployed across the Low telescope as a whole. This utilises a trade-off of bandwidth for beams such that the cross-correlation processing load does not increase.

1.4 Operational Modes

The definition of the terms “States” and “Modes” is very diverse in the SE and software communities and it is generally accepted that States and Modes can be used interchangeably, and that there is no clearly defined difference. The strict definition of States and Modes is therefore considered to be not important in this document, and the terms are used quite loosely.
However, they are generally used in the following sense:

- Modes: refer to sets of behaviour or functionality that are needed to control an item.
- States: refer to sets of characteristics that are needed for reporting of an item’s condition.

SPS implementation of states and modes is aligned with the document “SKA1 Control System Guidelines” [RD4].

Attribute	Range	Description and comments
adminMode		Set by an outside authority (operations via TM).
(read-write)	ONLINE	The tile can be used for scientific observing.
	MAINTENANCE	The tile is not to be used for scientific observing but can be used for testing and commissioning. The LFAA is not aware of the higher observation goals and does not enforce this restriction; the LFAA executes commands received from TM. However, some test modes may be available only when the tile is set to MAINTENANCE mode.
	OFFLINE	The tile is not to be used at all; when adminMode=OFFLINE, the operational state=DISABLE.
	NOT-FITTED	Set by operations to suppress alarm generation.
opState (read-only)		*LFAA rolls-up the operational state of all components used by the tile and reports the overall operational state for the tile.*
	OFF	The tile is powered off
	INIT	The tile has been switched on and is initialising (TANGO device does a of POST test to check that device is operating properly)
	STANDBY	The Tile is in low power mode (I don't know if low power mode has been formally specified for the Tile yet)
	ON	Tile is on (ready to be configured, or in observation)
	DISABLE	The tile is administratively disabled (adminMode=OFFLINE, NOT_FITTED, or RESERVE); basic monitor and control functionality is available, but beam-forming capabilities are not available.
	ALARM	The Quality Factor for at least one attribute is outside the pre-defined ALARM limits. Some or all functionality may not

		be available
	FAULT	An unrecoverable fault has been detected. The tile is not available for use; maintainer/operator intervention is required .
	UNKNOWN	The tile is unresponsive, *e.g.*, due to loss of communication
healthState (read-only)	OK DEGRADED FAILED	*The LFAA rolls-up attribute quality factors, states, and other indicators for all components used by the tile and reports the overall tile healthState.*
obsState (read-only)		*The server Observing State indicates status related to scan configuration and execution.*
	IDLE	The tile is not processing input data and is not generating output products.
	CONFIGURING	Transient state entered when a command to re-configure the tile is received. The tile leaves this state when re-configuration is completed.
	READY	The tile enters READY when (re-)configuration has been completed; scan configuration is complete; the tile is ready to generate output data products. The parameters that require updates during the scan are being updated.
	SCANNING	The tile is generating tile beam output products.
	PAUSED	When the command 'pause scan' is received, the tile transitions to obsState=PAUSED, but tile beams continue to be produced and sent to the Station. The tile configuration remains as-is. The command 'resume scan' causes the tile to transition to SCANNING.
	ABORTED	The tile transitions to this state when a command 'abort scan' is received. In this state re-configuration, and any other on-going processing functions are stopped.
	FAULT	An unrecoverable error that requires operator intervention has been detected.

Table 1-1 SPS Sub-element States and Modes

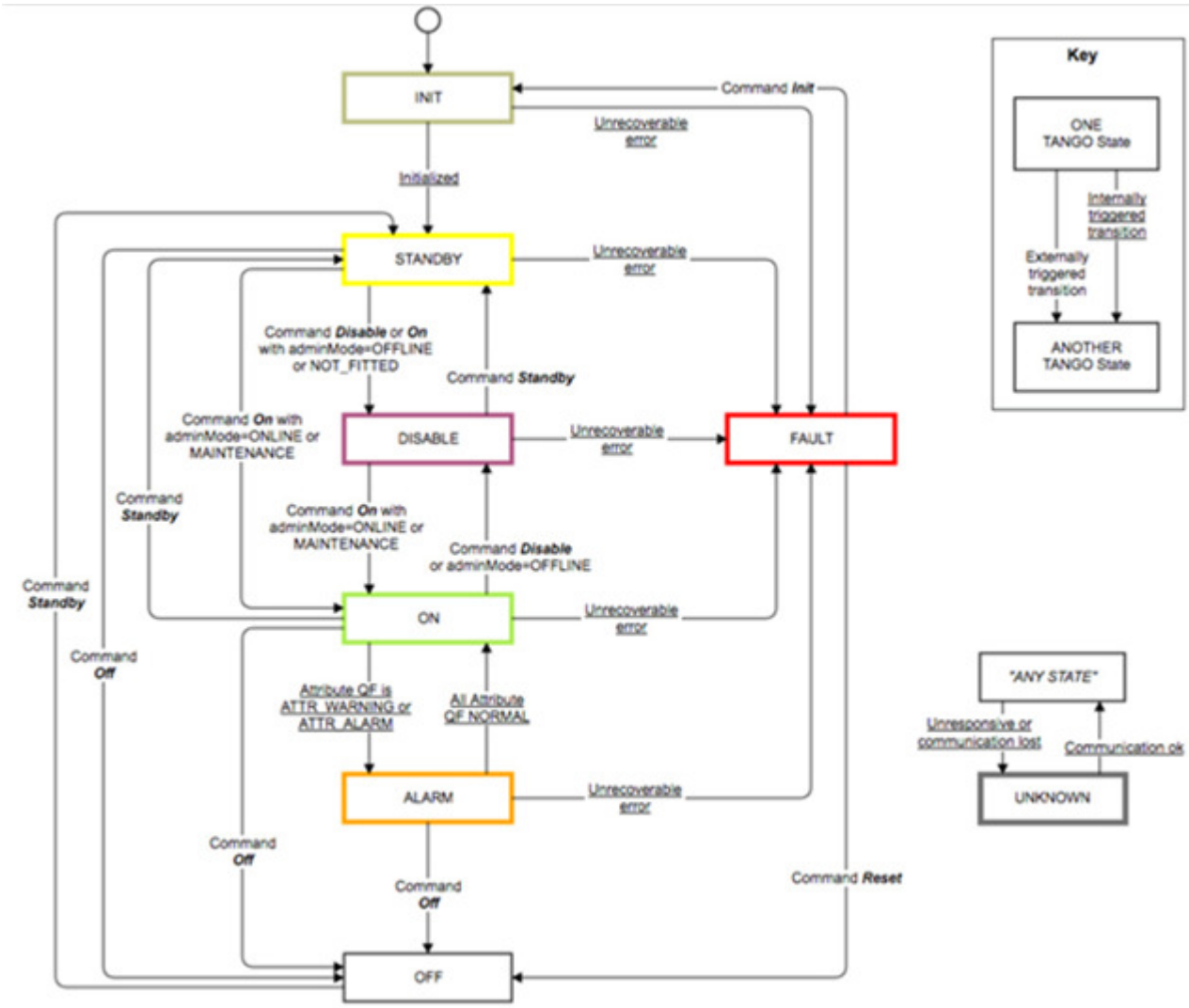


Figure 1-1 SPS Operational States

2 Applicable and Referenced Documents

2.1 Applicable Documents

The following documents at their indicated revision form part of this document to the extent specified herein. In the event of conflict between the contents of the applicable documents and this SKA1 LFAA Signal Processing System Requirements Specification document, the applicable documents shall take precedence.

Ref No	Document/Drawing Number	Document Title	Issue Number
AD1	A. Sutinjo & F Schlagenhaufer 13th March 2013	AAVS0.5: RFI Measurements and Updates	Draft
AD2	SKA-TEL-SKO-0000557	SKA1 Low Configuration-Constraints & Performance Analysis	01
AD3	SKA-TEL-LFAA-0200030	LFAA Internal ICD Document	01
AD4	100-000000-004	SKA1 Low LFAA to CSP Interface Control Document	03
AD5	100-000000-026	SKA1 Low SaDT to LFAA Interface Control Document	04
AD6	100-000000-003	SKA1 Low LFAA to Infrastructure Australia Interface Control Document	03
AD7	SKA-TEL-SKO-0000740	Safety Management Plan	01
AD8	SKA-TEL-SKO-0000202	SKA EMI/EMC Standards and Procedures	03
AD9	AADC-TEL-LFAA-SE-MGT-AADC-PL-001	LFAA System Engineering Management Plan	01
AD10	SKA-TEL-SKAO-0000104	SKA1 Integrated Logistic Support Plan	01
AD11	SKA-TEL-SKO-0000035	SKA Power Budget	05
AD12	SKA-TEL-SKO-0000102	SKA1 RAM Allocation	03
AD13	SKA-TEL-SKO-0000293	SKA Power Quality Standard	03

Table 2-1 Applicable Documents

2.2 Referenced Documents

The following documents provide useful reference information associated with this document. These documents are to be used for information only. Changes to the date and/or revision number do not make this document out of date. In the event of conflict between the contents of the referenced documents and this document, this document shall take precedence.

Ref No	Document/Drawing Number	Document Title	Issue Number
RD1	SKA-TEL-SKO-0000661	Hardware software standards	02
RD2	SKA1-TEL-LFAA-0200028	LFAA Architectural Design Document	01
RD3	000-000000-010	SKA Control System Guidelines	01

RD4	SKA-TEL-SKO-0000661	Fundamental SKA Software and Hardware Description Language Standards Rev2	01
RD5	RFC 5905	Network Time Protocol version 4 standard	
RD6	IEC 61000-3	EMC product family standards: emission	
RD7	IEC 61000-3-2	Harmonic Current Emissions	
RD8	IEC 61000-3-3	Voltage Fluctuations and Flicker Emissions	
RD9	IEC 61000-4-2	Electrostatic Discharge Immunity Test	
RD10	IEC 61000-4-3	Radiated, radio-frequency, electromagnetic field immunity test	
RD11	IEC 61000-4-4	Electrical Fast Transient / Burst Immunity Test	
RD12	IEC 61000-4-5	Testing and Measurement techniques - Surge Immunity Test	
RD13	IEC 61000-4-6	Immunity to Conducted Disturbances, Induced by Radio Frequency Fields	
RD14	IEC 61000-4-8	Electromagnetic Compatibility (EMC) - Part 4-8: Testing and Measurement Techniques - Power Frequency Magnetic Field Immunity Test	
RD15	IEC 61000-4-11	Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests	
RD16	IEC 61000-6-2	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments	
RD17	IEC 61000-6-4	Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments	
RD18	IEC 60950-1	Information Technology Equipment - Safety Part 1 General Requirements	
RD19	ISO 45001	Occupational health and safety	
RD20	AS/NZS 3000:2007	Electrical installations (known as the Australian/New Zealand Wiring Rules)	
RD21		Reserved	
RD22	ISO 61310_2	Safety of machinery. Indication, marking and actuation. Requirements for marking	
RD23	ISO 7010	Graphical symbols -- Safety colours and safety signs -- Registered safety signs	
RD24		National Environmental Management Act, 1998 ("NEMA")	
RD25		National Water Act, 1998	
RD26	27315	National Environmental Management: Air Quality Act, 2004	
RD27	32000	National Environmental Management Waste Act, 2008	
RD28		National Environmental Management: Biodiversity	

		Act, 2004	
RD29		National Heritage Resources Act, 1999	
RD30	11927	Environment Conservation Act, 1989	
RD31		National Heritage Resources Act, 1999	
RD32		Hazardous Substances Act, 1973	
RD33		Health Act, 1977	
RD34		Nuclear Energy Act, 1999	
RD35		National Nuclear Regulatory Act, 1999	
RD36		National Environmental Management: Protected Areas Act, 2003	
RD37		Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947	
RD38		Marine Living Resources Act, 1998	
RD39		National Environmental Management: Integrated Coastal Management Act, 2008	
RD40		Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act 1999	
RD41		Western Australian Environmental Protection Act 1986	
RD42		Western Australian Land Administration Act 1997	
RD43		Western Australia Mining Act 1978	
RD44		Heritage of Western Australia Act 1990	
RD45		Western Australian Aboriginal Heritage Act 1972	
RD46		MRO Indigenous Land Use Agreement 2009	
RD47	RoHS Directive 2011/65/EU (RoHS 2)	What Manufacturers Need To Know And Do	
RD48	CISPR-22	EN 55022 EMC Standard	
RD49	CISPR-24	Information technology equipment - Immunity characteristics - Limits and methods of measurement	
RD50	CISPR-32	New International Standard on Electromagnetic Emissions from Multimedia Equipment	
RD51	ETSI EN 300 019-1-1	Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-1: Classification of environmental conditions; Storage	
RD52	BS EN IEC 60721-3-1	CLASSIFICATION OF ENVIRONMENTAL CONDITIONS - PART 3: CLASSIFICATION OF GROUPS OF ENVIRONMENTAL PARAMETERS AND THEIR SEVERITIES - SECTION 1: STORAGE	
RD53	ETSI EN 300 019-1-2 standard [37]	Classification of environmental conditions: Part 1-2: Transportation. V2.1.4 (2003-04)	
RD54	BS EN IEC 60721-3-2	Classification of environmental conditions. Classification of groups of environmental	

		parameters and their severities. Transportation.	
RD55	EN 50600-2-5	Data centre facilities and infrastructures, Part 2-5. Security systems.	

Table 2-2 Reference Documents

3 Requirements

3.1 Array Attributes

SKA1-LFAA_SPS_REQ-184	**SPS number of SKA1_Low stations** When commanded, SPS shall accept and process inputs for both polarisations from all 256 antenna within up to 512 Field Nodes in the SKA1_Low array, each with an identical interface defined in the SPS to Field Node ICD
Parent	SKA1-LFAA-118, SKA1-LFAA-115, SKA1-LFAA-103, SKA1-LFAA-204
Verification	Test & Inspection

SKA1-LFAA_SPS_REQ-185	**SPS maximum array extent** SPS shall process data from Field Nodes with separations as large as 65 km.
Parent	SKA1-LFAA-119
Verification	Test

3.2 Signal Processing

3.2.1 Digitisation

SKA1-LFAA_SPS_REQ-174	**Digitisation** Digitisation of LFAA antenna signals shall be to at least 7.8 ENOB (equivalent number of bits).
Parent	SKA1-LFAA-124
Verification	Test

SKA1-LFAA_SPS_REQ-175	**SPS dynamic range** The amplitude dynamic range of the SPS signal chain shall be such that for the SKAO supplied RFI uses Cases the signal level is within the linear region as per linearity requirements 95% of the time.
Parent	SKA1-LFAA-125
Verification	Analysis

SKA1-LFAA_SPS_REQ-227	**SPS coherence loss** The SPS signal and clock distribution chain shall cause a maximum differential variation of no more than 0.2 deg phase or 1.4 ps time in the signal and clock distribution chains for periods of 1 second to 1 minute
Parent	SKA1-LFAA-100, SKA-LFAA-101, SKA1-LFAA-106
Verification	Test

3.2.2 Signal Processing Chain

SKA1-LFAA_SPS_REQ-203	**Linearity** The level of spurious products generated by SPS, in the presence of signals representative of the expected RFI [AD1] environment shall maintain the degradation of expected thermal noise floor within 10% over an integration period of 1000 hours.
Parent	SKA1-LFAA-127, SKA1-LFAA-128
Verification	Analysis

SKA1-LFAA_SPS_REQ-207	**SPS signal processing signal to noise** LFAA.SPS shall keep the degradation of its Signal to Noise ratio to less than 2 % compared to ideal processing for the same inputs.
Parent	SKA1-LFAA-111, SKA1-LFAA-112
Verification	Test

3.2.2.1 *Processed Bandwidth*

SKA1-LFAA_SPS_REQ-173	**SPS Instantaneous bandwidth** LFAA.SPS when commanded by the MCCS, shall process up to and including 300 MHz of aggregate bandwidth per polarisation, as discrete coarse channels individually assigned to sub-stations and/or beams, for a given observation period or until commanded to stop.
Parent	SKA1-LFAA-123, SKA1-LFAA-204
Verification	Demonstration

3.2.2.2 *RFI Flagging*

SKA1-LFAA_SPS_REQ-198	**SPS RFI detection and flagging** When commanded, SPS shall automatically detect RFI in the processed bandwidth and, when detected, flag data to prevent corruption of any downstream data products. Conformance to this requirement is determined by testing of all SKAO-mandated RFI use cases such that, in each case, prescribed acceptable performance is obtained.
Parent	SKA1-LFAA-172
Verification	Test

SKA1-LFAA_SPS_REQ-199	**SPS RFI masking** LFAA.SPS shall flag beamformed data corrupted by RFI using a mask provided by TM via MCCS, with a time resolution of the integration unit and a frequency resolution of one coarse channel.
Parent	SKA1-LFAA-172, SKA1-LFAA-204
Verification	Test

SKA1-LFAA_SPS_REQ-200	**Saturated Data Flagging** LFAA.SPS shall flag individual pre-channelised samples within the data stream exceeding a MCCS supplied value representing the boundary of acceptable saturation.
Parent	SKA1-LFAA-126, SKA1-LFAA-204
Verification	Demonstration

3.2.2.3 *Channelisation*

SKA1-LFAA_SPS_REQ-221	**SPS spectral channels** For each polarisation of each antenna, SPS shall form a fixed number of least 350 and no more than 512, dependent on implementation, linearly spaced frequency channels across the frequency band
Parent	SKA1_LFAA-192
Verification	Analysis

SKA1-LFAA_SPS_REQ-208	**Oversampling** SPS frequency channels shall have a sampling frequency equal to the channel separation (nominal channel bandwidth) multiplied by an oversampling factor not larger than 1.20.
Parent	SKA1-LFAA-188
Verification	Analysis

SKA1-LFAA_SPS_REQ-181	**SPS channelisation transition band for adjacent frequency channels** The transition band between the SPS coarse frequency channels shall be monotonically decreasing starting from the coarse channel edge plus 1/128 of its bandwidth, to -60 dB or better at the nominal coarse channel edge as aliased in the oversampled channelizer.
Parent	SKA1-LFAA-139
Verification	Test

SKA1-LFAA_SPS_REQ-182	**SPS channelisation maximum leakage for non-adjacent frequency channels** The upper envelope of the power of noise leaking for non-adjacent visibility spectra coarse frequency channels shall fall off as 1/f or better as a function of frequency offset from the centre of a given frequency channel , for frequency offsets up to half the input bandwidth.
Parent	SKA1-LFAA-140
Verification	Demonstration

SKA1-LFAA_SPS_REQ-183	**SPS channelisation frequency channel amplitude response** The amplitude response of the LFAA SPS channeliser shall have a spectral slope of less than 0.003 dB per imaging zoom frequency channel across each LFAA channel passband. If the response covers more than one imaging zoom channel (overlapping region) the requirement applies to the sum of the power

	responses of the overlapping channels.
Parent	SKA1-LFAA-141
Verification	Analysis

SKA1-LFAA_SPS_REQ-202	**Total noise leakage power** The maximum total noise leaked from all channels into each LFAA channel, excluding the two adjacent channels on each side, shall be less than 60 dB.
Parent	SKA1-LFAA-144
Verification	Test

SKA1-LFAA_SPS_REQ-209	**SPS Spectral Purity** The spectral distortion of SPS beams compared to an ideal beamformer provided with the same inputs, shall be less than -60 dB in amplitude and 0.001 radians in phase.
Parent	SKA1-LFAA-193, SKA1-LFAA-185
Verification	Analysis

3.2.2.4 *Auto-correlation Spectra*

SKA1-LFAA_SPS_REQ-180	**SPS Autocorrelation spectra** LFAA.SPS shall compute autocorrelation spectra for individual antennas over the whole observing band (one antenna at each time), or for station beams over the beamformed spectral regions, with resolution of one coarse channel and time resolution of better than a LFAA calibration cycle.
Parent	SKA1-LFAA-50
Verification	Demonstration

3.2.2.5 *Beamforming*

SKA1-LFAA_SPS_REQ-178	**Beam steering** SPS shall, when commanded, track delays on individual antennas with an accuracy of better than 1.70 ps given delay and delay rate values from MCCS.
Parent	SKA1-LFAA-135, SKA1-LFAA-204
Verification	Demonstration

SKA1-LFAA_SPS_REQ-177	**SPS Multi-beam capability** LFAA.SPS shall, when commanded, generate up to eight beams per station or substation with independent pointings such that the sum of bandwidths over these beams is less than or equal to the available bandwidth. For Stations the available bandwidth is 300MHz, for 1024 substations across the telescope 150 MHz and 2048 substations across the telescope 75MHz.
Parent	SKA1-LFAA-134
Verification	Demonstration

SKA1-LFAA_SPS_REQ-201	**Multiple beam widths** LFAA.SPS shall, when commanded, form multiple station beams. Each beam will have divergent pointing, and is formed by an independent channel selection (where independence allows identical, overlapping or non-overlapping). Each selection is composed of a multiple of 8 channels, starting at an even channel number.
Parent	SKA1-LFAA-136
Verification	Demonstration

SKA1-LFAA_SPS_REQ-225	**Support for sub-stations** The SPS shall be configurable for the control and monitoring of up to 2048 sub-stations, configured within the limits set out in section 5.7.1 of [AD2]. Representative cases include but are not limited to the following (see document for further explanation): a. 1024 sub-stations randomly distributed within field nodes. i. Stations are populated with 4 randomly-located sub-stations in the core and 4 randomly-located sub-stations in one of the 6 field nodes at each cluster location. ii. 75 MHz of bandwidth is available. b. 1024 sub-stations regularly distributed within field nodes. i. Stations are populated with 6 sub-stations in the core and 4 sub-stations in one of the 6 field nodes at each cluster location. ii. 75 MHz of bandwidth is available c. 2048 sub-stations randomly distributed within field nodes i. Stations are populated with 4 randomly located sub-stations in all of the 512 field nodes. ii. 19 MHz of bandwidth is available. d. 2048 sub-stations regularly distributed within field nodes. i. Stations are populated with 6 sub-stations in the core and 6 sub-stations in 3 of the 6 field nodes at each cluster location ii. 19 MHz of bandwidth is available.
Parent	SKA1-LFAA-210
Verification	Demonstration

SKA1-LFAA_SPS_REQ-226	**SPS processing latency** The SPS shall have latency of at most 10 ms from the time that a signal arrives from the Field Node to the time when the beamformed signal is forwarded to CSP.
Parent	SKA1-LFAA-151
Verification	Demonstration

SKA1-LFAA_SPS_REQ-228	**SPS polarisation isolation** The SPS shall have an isolation between any individual polarisation pairs for individual antennas of greater than 30dB in total across the processing chain
Parent	SKA1-LFAA-110
Verification	Test

SKA1-LFAA_SPS_REQ-229	**SPS relative gain tolerance** The station beam accuracy for the SPS, over a 10-minute interval shall have a relative gain tolerance of better than 0.2%, across the LFAA frequency range.
Parent	SKA1-LFAA-111, SKA1-LFAA-133, SKA1-LFAA-228, SKA1-LFAA-106
Verification	Test

3.2.3 Transient Capture

SKA1-LFAA_SPS_REQ-213	**Data forwarding for transient capture** The SPS, when commanded, shall forward streamed station beam data at its native time and frequency resolution to MCCS for fast transient capture configured by MCCS for: 1. channel selection of up to a total of 150 MHz which may differ between beams 2. a selected station beam set. 3. a data width of 2, 4 8 bits
Parent	SKA1-LFAA-150, SKA1-LFAA-204
Verification	Test

3.3 Synchronisation and Timing

SKA1-LFAA_SPS_REQ-179	**Synchronous Time Stamping** Each station beam shall provide to the correlator-beamformer data block time stamps, synchronous with and locked to the sample clock and deterministically related to 1PPS, within an accuracy of 1.5ns (1σ) of the 1PPS distribution.
Parent	SKA1-LFAA-137
Verification	Test

SKA1-LFAA_SPS_REQ-222	**Network Time Protocol** All SPS client devices and applications that require synchronised telescope network time shall comply with the Network Time Protocol version 4 standard, RFC 5905
Parent	SKA1_LFAA-102
Verification	Inspection

3.4 Operation

SKA1-LFAA_SPS_REQ-	**SPS status** When commanded, SPS shall provide the following status information to

186	MCCS: (a) internal temperature; (b) voltage; (c) power; (d) cooling mechanism status; (e) communication path status; (f) device configuration status;.
Parent	SKA1-LFAA-205, SKA1-LFAA-204
Verification	Test

SKA1-LFAA_SPS_REQ-187	**SPS alarm latency** SPS shall indicate an alarm within 0.6 seconds from the time a measurement crosses an alarm set-point.
Parent	SKA1-LFAA-168
Verification	Test

SKA1-LFAA_SPS_REQ-188	**SPS processing resource configuration or reconfiguration time** When commanded, unless otherwise required, SPS shall complete any signal processing configuration or reconfiguration, within 24 seconds TBC from the specified configuration or re-configuration start time.
Parent	SKA1-LFAA-154, SKA1-LFAA-165
Verification	Test

SKA1-LFAA_SPS_REQ-189	**SPS station beam weighting** When commanded, SPS shall apply independent dynamic weights to each antenna contributing to each station beam, including the ability to exclude individual antennas. Note: weights will come from MCCS.
Parent	SKA1-LFAA-135, SKA1-LFAA-204
Verification	Test

SKA1-LFAA_SPS_REQ-190	**SPS processing status reporting** When commanded, SPS shall report at least the following processing status: 1. Configuration for any antenna's processing path, 2. Function Mode for any TPM, 3. Antenna inclusion in any processing operation and output data production and 4. any accumulated/stored exception or inconsistency-detection conditions.
Parent	SKA1-LFAA-205
Verification	Test

3.5 Internal Interfaces

3.5.1 SPS to Field Node

SKA1-LFAA_SPS_REQ-191	**SPS to Field Node General** The interface between SPS and Field Node shall be compliant with the SKA1 SPS to Field Node Sub-elements Interface Control Document [SKA-TEL-LFAA-0200030].
Parent	SKA1-LFAA-204
Verification	Test

3.5.2 MCCS to SPS

SKA1-LFAA_SPS_REQ-192	**MCCS to SPS General** The interface between SPS and MCCS shall be compliant with the SKA1 MCCS to SPS Sub-elements Interface Control Document [SKA-TEL-LFAA-0200030].
Parent	SKA1-LFAA-204, SKA1-LFAA-50
Verification	Test

3.5.3 MCCS to FN Data exchange

SKA1-LFAA_SPS_REQ-214	**MCCS to Field Node M&C message forwarding** The SPS shall forward all monitoring and control messages between the MCCS and Field Node in accordance with the MCCS to SPS and SPS to Field Node ICDs
Parent	SKA1-LFAA-204
Verification	Demonstration

3.6 External Interfaces

3.6.1 LFAA to CSP

SKA1-LFAA_SPS_REQ-145	**LFAA to CSP: General** The interface between LFAA and CSP shall be compliant with the SKA1 LFAA to CSP Interface Control Document [100-000000-004].
Parent	SKA1-LFAA-174
Verification	Test

SKA1-LFAA_SPS_REQ-	**Beam Identification** THE SPS shall uniquely identify beam data products with the beam and the

223	station they are associated with in accordance with the LFAA to CSP ICD.
Parent	LFAA-SPS-121
Verification	Demonstration

3.6.2 SaDT to LFAA

SKA1-LFAA_SPS_REQ-146	**SADT to LFAA: General** The interface between SADT and LFAA shall be compliant with the Low SADT to LFAA Interface Control Document [100-000000-026]
Parent	SKA1-LFAA-176
Verification	Inspection

3.6.3 LFAA to INFRA

SKA1-LFAA_SPS_REQ-147	**LFAA to Infra Interface** The interface between SPS and Infra AUS shall be in compliance with the latest approved version of the SKA1 LFAA to INFRA Interface Control Document [100-000000-003]
Parent	SKA1-LFAA-175
Verification	Test & Analysis

SKA1-LFAA_SPS_REQ-148	**SPS deployment location** SPS shall be located in the Central Processing Facility and Remote Processing Facilities in accordance with the latest approved version of the LFAA to INFRA ICD [100-000000-003]
Parent	SKA1-LFAA-175
Verification	Inspection

3.6.3.1 *Environmental and Safety*

SKA1-LFAA_SPS_REQ-168	**SPS safety legislation and regulations** SPS equipment and operations shall comply with all applicable Australian Occupational Health and Safety legislation and regulations in accordance with the latest approved version of the LFAA to INFRA ICD.
Parent	SKA1-LFAA-87
Verification	Test & Inspection

SKA1-LFAA_SPS_REQ-169	**SPS safety certification** SPS rack and LRU equipment shall be safety certified to AS/NZS 60950.11:2015 or equivalent in accordance with the latest approved version of the LFAA to INFRA ICD.

Parent	SKA1-LFAA-87
Verification	Test & Analysis

SKA1-LFAA_SPS_REQ-210	**[Useful] LFAA.SPS environmental certification** LFAA.SPS rack and LRU equipment shall be RoHS 2 (2011/65/EU) certified in accordance with the latest approved version of the LFAA to INFRA ICD.
Parent	SKA1-LFAA- 77
Verification	Analysis

SKA1-LFAA_SPS_REQ-170	**SPS rack side-to-side stability** SPS racks shall be attached to adjacent racks in the same row to provide lateral stability in accordance with the latest approved version of the LFAA to INFRA ICD.
Parent	SKA1-LFAA-87
Verification	Inspection

SKA1-LFAA_SPS_REQ-171	**SPS rack forward-backward stability** SPS racks shall have a Centre Of Gravity (CofG) that is less than 50% of the rack height in the upward direction in accordance with the latest approved version of the LFAA to INFRA ICD.
Parent	SKA1-LFAA-87
Verification	Analysis

SKA1-LFAA_SPS_REQ-211	**[Useful] LFAA.SPS acoustic noise emission** [Useful] LFAA.SPS acoustic noise emission sound pressure level shall be in accordance with the latest approved version of the LFAA to INFRA ICD.
Parent	SKA1-LFAA-195
Verification	Test & Analysis

SKA1-LFAA_SPS_REQ-172	**SPS equipment shutdown on failure** SPS shall autonomously detect and shut-down affected equipment in accordance with the latest approved version of the LFAA to INFRA ICD, when any of the following conditions occur: 1. an over-current condition occurs in a rack; 2. an over-temperature condition occurs in an LRU.
Parent	SKA1-LFAA-82
Verification	Test & Analysis

3.6.3.2 *Mechanical Interface*

SKA1-LFAA_SPS_REQ-193	**SPS rack size** SPS shall use racks with dimensions of less than or equal to 800mm wide x 1200mm deep x < 2000mm floor to top of cabinet in accordance with the latest approved version of the LFAA to INFRA ICD.

Parent	SKA1-SPS-175
Verification	Inspection

SKA1-LFAA_SPS_REQ-194	**SPS rack weight** The mass of fully populated SPS racks shall not exceed 620 kg in accordance with the latest approved version of the LFAA to INFRA ICD.
Parent	SKA1-LFAA-175
Verification	Test & Analysis

SKA1-LFAA_SPS_REQ-195	**SPS rack count** The SPS rack count shall not exceed 148 in the CPF and 3 in each of the 36 RPFs in accordance with the latest approved version of the LFAA to INFRA ICD.
Parent	SKA1-LFAA-175
Verification	Inspection

3.6.3.3 *Electrical Interface*

SKA1-LFAA_SPS_REQ-149	**SPS power quality** SPS shall operate in compliance with the SKA1 Power Quality Standard Specification [SKA-TEL-SKO-00000293] in accordance with the latest approved version of the LFAA to INFRA Interface Control Document [100-000000-003].
Parent	SKA1-LFAA-202
Verification	Test & Analysis

SKA1-LFAA_SPS_REQ-151	**SPS power factor** For 20% to 100% loading SPS rack 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.
Parent	SKA1-LFAA-202
Verification	Test

SKA1-LFAA_SPS_REQ-150	**SPS phase current balancing** The SPS electrical load shall be balanced such that the difference in currents between any two of the three phases will nominally be less than 5% and not exceed 10% for periods greater than 2 minutes when the sub-element is fully powered in accordance with the latest approved version of the LFAA to INFRA ICD.
Parent	SKA1-LFAA-202
Verification	Test & Analysis

SKA1-LFAA_SPS_REQ-152	**SPS average power consumption** SPS average power consumption shall not exceed 1226 kW in accordance with the latest approved version of the LFAA to INFRA ICD.
Parent	SKA1-LFAA-203
Verification	Test and Analysis

SKA1-LFAA_SPS_REQ-153	**SPS power draw rate of change** SPS power draw rate of change shall be less than 20% of the maximum power draw averaged over a one second interval (TBC) during start-up and mode transitions in accordance with the latest approved version of the LFAA to INFRA ICD.
Parent	SKA1-LFAA-202
Verification	Test & Analysis

SKA1-LFAA_SPS_REQ-220	**SPS harmonic current limits** SPS equipment connected to the CPF and RPF electrical network shall be compliant with the IEEE 519-1992 part 11.5standard or equivalent for Harmonic Current Limits under standard test conditions and setups in accordance with the latest approved version of the LFAA to INFRA ICD.
Parent	SKA1-LFAA-202
Verification	Test

SKA1-LFAA_SPS_REQ-154	**SPS rack power interface** Each LFAA.SPS rack shall connect to two INFRA Element CPF electrical power outlets via two 3 phase power cables (length >=2 meters) that have IEC 60309 (6H) 3P+N+PE 32A RED Cable Mount Plugs (Part Number: 888-231-NS).
Parent	SKA1-LFAA-175
Verification	Demonstration

SKA1-LFAA_SPS_REQ-155	**SPS rack peak power draw** SPS racks shall have a peak power draw of less than 1226 kW in accordance with the latest approved version of the LFAA to INFRA ICD.
Parent	SKA1-LFAA-175
Verification	Test

SKA1-LFAA_SPS_REQ-156	**SPS rack short circuit current survivability** SPS rack electrical protection circuitry shall have a Interrupt Rating (IR) and Short-Circuit Current Rating of not less than 25 kA TBC in accordance with the latest approved version of the LFAA to INFRA ICD.
Parent	SKA1-LFAA-175
Verification	Inspection

SKA1-LFAA_SPS_REQ-157	**SPS rack safety earth connection** SPS racks 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
Parent	SKA1-LFAA-175
Verification	Test

SKA1-LFAA_SPS_REQ-	**SPS inrush current** The LFAA.SPS shall have an inrush current of less than three times the average

215	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-202
Verification	Test

SKA1-LFAA_SPS_REQ-216	**LFAA.SPS phase operability (voltage)** The LFAA.SPS shall be operable with supplied voltage phase with a variation of up to 2% of the nominal voltage and 3% during unusual network and load configurations.
Parent	SKA1-LFAA-202
Verification	Analyse

SKA1-LFAA_SPS_REQ-217	**SPS operable frequency** The LFAA.SPS shall be operable inside the following frequency deviation: 1. From Grid supply $\pm$ 2% (49Hz to 51Hz) 2. From Generating plant supply $\pm$ 5% (47.5 to 52.5 Hz)
Parent	SKA1-LFAA-202
Verification	Analysis

SKA1-LFAA_SPS_REQ-218	**Magnitude of supply voltage (steady state)** The LFAA.SPS shall operate with supply voltage within $\pm$ 10% (360V - 440V)
Parent	SKA1-LFAA-202
Verification	Analysis

SKA1-LFAA_SPS_REQ-219	**Supply voltage transients** The LFAA.SPS shall be withstand the transient limits defined in IEC 62040-3 dynamic output performance classification 3
Parent	SKA1-LFAA-202
Verification	Analysis

3.6.3.4 *Electromagnetic Interface*

3.6.3.4.1 Emissions

SKA1-LFAA_SPS_REQ-158	**SPS harmonic current emissions** SPS equipment connected to the CPF and RPF electrical network shall be compliant with the IEC 61000-3-2 standard or equivalent for Harmonic Current Emissions under standard test conditions and setups in accordance with the latest approved version of the LFAA to INFRA ICD.
Parent	SKA1-LFAA-53
Verification	Test

SKA1-LFAA_SPS_REQ-	**SPS voltage fluctuations and flicker emissions** SPS equipment connected to the CPF and RPF electrical network shall be

159	compliant with the IEC 61000-3-3 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.
Parent	SKA1-LFAA-53
Verification	Test

SKA1-LFAA_SPS_REQ-160	**SPS number of electromagnetic radiators** SPS shall contain at most 4500 LRUs in the CPF and 50 in the RPF that radiate EMI at levels up to CISPR 22/32 or equivalent standard in the SKA Low telescope frequency range. Note: Rack level LRUs must be configured as per the LFAA design during radiated emissions certification. In other words, rack level LRUs must be populated with all components that contribute radiated emissions. If some components aren't present during certification, these components must be separately certified and be accounted for in the emitter count as specified above.
Parent	SKA1-LFAA-53
Verification	Test & Analysis

3.6.3.4.2 Immunity

SKA1-LFAA_SPS_REQ-161	**SPS ESD immunity** SPS equipment susceptible to ESD shall be compliant with the IEC 61000-4-2 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.
Parent	SKA1-LFAA-187
Verification	Test

SKA1-LFAA_SPS_REQ-162	**SPS radiated, radio-frequency, electromagnetic field immunity** SPS equipment connected to the CPF and RPF electrical network shall be compliant with the IEC 61000-4-3 standard or equivalent for radiated, radio-frequency, electromagnetic field immunity under standard test conditions and setups in accordance with the latest approved version of the LFAA to INFRA ICD.
Parent	SKA1-LFAA-187
Verification	Test

SKA1-LFAA_SPS_REQ-163	**SPS electrical fast transient/burst immunity** SPS equipment connected to the CPF electrical network shall be compliant with the IEC 61000-4-4 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.
Parent	SKA1-LFAA-187

Verification	Test

SKA1-LFAA_SPS_REQ-164	**SPS surge immunity** SPS equipment connected to the CPF and RPF electrical network shall be compliant with the IEC 61000-4-5 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.
Parent	SKA1-LFAA-187
Verification	Test

SKA1-LFAA_SPS_REQ-165	**SPS immunity to conducted disturbances induced by radio-frequency fields** SPS equipment connected to the CPF and RPF electrical network shall be compliant with the IEC 61000-4-6 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.
Parent	SKA1-LFAA-187
Verification	Test

SKA1-LFAA_SPS_REQ-166	**SPS power frequency magnetic field immunity** SPS equipment connected to the CPF and RPF electrical network shall be compliant with the IEC 61000-4-8 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.
Parent	SKA1-LFAA-187
Verification	Test

SKA1-LFAA_SPS_REQ-167	**SPS voltage dips, short interruptions and voltage variations immunity** SPS LRU equipment connected to the CPF and RPF electrical network shall be compliant with the IEC 61000-4-11 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.
Parent	SKA1-LFAA-187
Verification	Test

3.6.3.5 *Cooling Interface*

SKA1-LFAA_SPS_REQ-196	**SPS sub-element thermal load** The SPS total thermal load shall not exceed 1636 kW in accordance with the latest approved version of the LFAA to INFRA ICD.
Parent	SKA1-LFAA-175
Verification	Test & Analysis

SKA1-	**SPS rack thermal load**

LFAA_SPS_REQ-197	The thermal load of SPS racks shall be less than 5 kW in accordance with the latest approved version of the LFAA to INFRA ICD.
Parent	SKA1-LFAA-175
Verification	Test

3.7 Non-Functional Requirements

3.7.1 Software and Firmware Standards

SKA1-LFAA_SPS_REQ-61	**SPS software and quality** SPS software and hardware description language related deliverables shall comply with the "Fundamental SKA Software and Hardware Description Language Standards" [RD1]
Parent	SKA1-LFAA-181
Verification	Inspection

3.7.2 Power Management

SKA1-LFAA_SPS_REQ-31	**SPS Low power state** SPS shall have a low power mode that reduces the power consumption to less than 5% of the nominal power requirement.
Parent	SKA1-LFAA-97
Verification	Test & Analysis

SKA1-LFAA_SPS_REQ-32	**Low power mode on power application** SPS shall enter the "low power" mode on start-up and remain in Low Power mode until commanded otherwise
Parent	SKA1-LFAA-98
Verification	Test

SKA1-LFAA_SPS_REQ-88	**SPS Low Power Mode capabilities** SPS shall continue to communicate with MCCS, monitor, report status and execute received commands while in the Low Power Mode
Parent	SKA1-LFAA-97, SKA1-LFAA-204
Verification	Test

3.7.3 Occupational Health and Safety

SKA1-LFAA_SPS_REQ-	**SPS occupational health and safety** SPS shall comply with all local occupational health and safety regulations

73	applicable to the Australian observatory and its operations.
Parent	SKA1-LFAA-195
Verification	Analysis

SKA1-LFAA_SPS_REQ-65	**SPS hazard elimination** SPS shall be safe to the operators, maintainers and own equipment with categorization exceeding the acceptable levels defined in the SKA Project Safety Management Plan [AD7].
Parent	SKA1-LFAA-79
Verification	Analysis

3.7.3.1 *Fail Safe Design*

SKA1-LFAA_SPS_REQ-68	**SPS fail-safe operation** SPS equipment shall operate in a locally fail-safe manner and not rely on external safety devices or measures to operate safely.
Parent	SKA1-LFAA-63
Verification	Analysis

SKA1-LFAA_SPS_REQ-69	**SPS non-propagation of failures** SPS equipment hardware failures and software errors shall be safe from creating hazardous conditions in interfacing elements and sub-elements.
Parent	SKA1-LFAA-83
Verification	Analysis

SKA1-LFAA_SPS_REQ-48	**SPS fail safe state** 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-64
Verification	Test

SKA1-LFAA_SPS_REQ-49	**SPS fail safe warnings** Where transitioning to a designated fail safe state represents a hazard, components of the SPS shall issue continued warnings for the duration of the transition.
Parent	SKA1-LFAA-65
Verification	Test

SKA1-LFAA_SPS_REQ-50	**SPS fail safe recovery** Once a transition to a designated fail-safe state is triggered, the SPS shall complete the transition and remain in the designated fail-safe state until commanded otherwise.
Parent	SKA1-LFAA-66

Verification	Test

3.7.3.2 *Mechanical Safety*

SKA1-LFAA_SPS_REQ-89	**SPS protruding obstacles** 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-79
Verification	Inspection

SKA1-LFAA_SPS_REQ-90	**SPS sharp edges and corners** 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-79
Verification	Inspection

SKA1-LFAA_SPS_REQ-91	**SPS heavy equipment handholds** 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-80
Verification	Test & Inspection

SKA1-LFAA_SPS_REQ-92	**SPS heavy equipment lifting arrangement** SPS equipment with a weight of more than 40 kg shall have an integral lifting arrangement to allow mechanical assisted lifting.
Parent	SKA1-LFAA-195
Verification	Test & Inspection

3.7.3.3 *Electrical Safety*

SKA1-LFAA_SPS_REQ-93	**SPS electrical installation** The electrical wiring of all SPS hardware shall comply with low voltage installation Standards (wiring of premises) AS/NZS 3000:2007.
Parent	SKA1-LFAA-84
Verification	Inspection

SKA1-LFAA_SPS_REQ-94	**SPS electrical circuit interlock** The SPS shall provide electrical circuit inter-locks to prevent personnel coming into contact with hazards that cannot otherwise be eliminated from design.
Parent	SKA1-LFAA-86, SKA1-LFAA-84
Verification	Inspection

3.7.3.4 *Equipment Safety*

SKA1-LFAA_SPS_REQ-95	**SPS Thermal Overload Protection** 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-199
Verification	Test

SKA1-LFAA_SPS_REQ-96	**SPS safety of equipment** SPS racks and equipment shall comply with IEC 60950-1 Information Technology Equipment - Safety Part 1 General Requirements or equivalent standard.
Parent	SKA1-LFAA-78
Verification	Test

SKA1-LFAA_SPS_REQ-97	**SPS power interruption survivability** 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-99
Verification	Test

SKA1-LFAA_SPS_REQ-98	**SPS LRU electrostatic warning marking** SPS LRU equipment with electrostatic sensitive components shall be fitted with ESD warning labels.
Parent	SKA1-LFAA-94
Verification	Inspection

3.7.3.5 *Equipment Marking*

SKA1-LFAA_SPS_REQ-99	**SPS equipment identification and safety markings** SPS equipment shall in accordance with ISO 61310_2 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-81
Verification	Inspection

SKA1-LFAA_SPS_REQ-100	**SPS heavy equipment weight warning** SPS LRUs weighing more than 23 kg shall have a Weight Warning label.
Parent	SKA1-LFAA-80, SKA1-LFAA-81
Verification	Test & Inspection

SKA1-LFAA_SPS_REQ-101	**SPS hazard warning marking** SPS equipment that presents a potential hazard shall display a label in accordance with ISO 7010 or equivalent.
Parent	SKA1-LFAA-80
Verification	Inspection

SKA1-LFAA_SPS_REQ-102	**SPS label robustness** 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-74
Verification	Inspection

3.7.4 Environmental Protection

SKA1-LFAA_SPS_REQ-63	**SPS environmental protection regulations** SPS shall be compliant with all local, State and national environmental protection legislation and regulations.
Parent	SKA1-LFAA-77
Verification	Analysis

SKA1-LFAA_SPS_REQ-103	**SPS recycling and decomposition.** SPS equipment shall be compliant with environmental, ecological, safety, political and social legislation with regard to recycling and decomposition.
Parent	SKA1-LFAA-77
Verification	Inspection

SKA1-LFAA_SPS_REQ-104	**SPS disposable equipment labelling** SPS disposable equipment should be labelled as such.
Parent	SKA1-LFAA-75
Verification	Inspection

SKA1-LFAA_SPS_REQ-105	**SPS restriction of hazardous substances** SPS shall be compliant with the RoHS Directive 2011/65/EU (RoHS 2) or equivalent.
Parent	SKA-LFAA-79
Verification	Analysis

3.7.5 EMI and EMC

SKA1-LFAA_SPS_REQ-106	**SPS EMI and EMC** SPS equipment shall be compliant with the emission and immunity standards in the SKA EMI/EMC Standards and Procedures [SKA-TEL-SKO-0000202] document.
Parent	SKA1-LFAA-53, SKA1-LFAA-187
Verification	Test & Analysis

SKA1-LFAA_SPS_REQ-107	**SPS essential conducted and radiated electromagnetic emissions** 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 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 [AD8].
Parent	SKA1-LFAA-53
Verification	Test & Inspection

SKA1-LFAA_SPS_REQ-108	**SPS electromagnetic susceptibility** SPS equipment shall be compliant with the IEC 61000-6-2 standard or equivalent for susceptibility to conducted and radiated emissions under standard test conditions and setups. 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.
Parent	SKA1-LFAA-187
Verification	Test

SKA1-LFAA_SPS_REQ-109	**SPS essential off-the-shelf equipment EMC marking** 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-55
Verification	Inspection

3.7.5.1 *Electrical Network Electromagnetic Compatibility*

SKA1-LFAA_SPS_REQ-110	**SPS electricity network electromagnetic compatibility** SPS equipment shall follow the code of practice for the application of Electromagnetic Compatibility (EMC) standards and guidelines in electricity utility networks.
Parent	SKA1-LFAA-54

Verification	Analysis

3.7.6 Availability, Maintainability and Reliability

3.7.6.1 *Availability*

SKA1-LFAA_SPS_REQ-111	**SPS Inherent Availability** SPS shall have an Inherent Availability (Ai) of at least 99.99% while operationally capable.
Parent	SKA1-LFAA-184
Verification	Analysis

SKA1-LFAA_SPS_REQ-112	**SPS Operationally Capable** SPS shall remain Operationally Capable when any one processing LRU fails.
Parent	SKA1-LFAA-184
Verification	Analysis

3.7.6.2 *Maintainability*

SKA1-LFAA_SPS_REQ-113	**SPS maintenance hours** SPS shall require less than 113 Direct Maintenance Hours (DMH) per month at the Organizational Level (O-Level). Note: DMH/month = MTTR x number of equipment repair actions per month at the O-Level.
Parent	SKA1-LFAA-67
Verification	Analysis

SKA1-LFAA_SPS_REQ-114	**SPS mean time to repair** SPS shall have an Mean Time To Repair (MTTR) of less than 1 hour at the organizational level (O-Level).
Parent	SKA1-LFAA-196
Verification	Analysis

SKA1-LFAA_SPS_REQ-115	**SPS software maintenance down time** SPS shall have a Maintenance Down Time (MDT) of less than 1 hour per year for software repairs (during steady state operation). 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.
Parent	SKA1-LFAA-197

Verification	Analysis

3.7.6.3 *Testability*

3.7.6.3.1 Off-line Diagnostic Tests

SKA1-LFAA_SPS_REQ-116	**SPS off-line built-in self-test capability** When commanded and with the SPS Administrative Mode set to OFFLINE, SPS shall perform diagnostic tests to detect and isolate LRU and sub-element level faults.
Parent	SKA1-LFAA-198
Verification	Analysis

SKA1-LFAA_SPS_REQ-117	**SPS off-line fault detection performance** 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. Note: A Critical Failure is a failure that would prevent SPS being "Operationally Capable".
Parent	SKA1-LFAA-198
Verification	Analysis

SKA1-LFAA_SPS_REQ-118	**SPS off-line fault isolation performance** When commanded and with the SPS Administrative Mode set to OFFLINE, SPS shall isolate 95% of all failures down to a LRU level. Note: The SPS maintainer functions as part of the fault isolation mechanism by removing and replacing suspect LRUs.
Parent	SKA1-LFAA-198
Verification	Analysis

SKA1-LFAA_SPS_REQ-119	**SPS off-line communications fault detection** When commanded and with the SPS Administrative Mode set to OFFLINE, SPS shall detect and report 99% of sub-element LRU to LRU and LRU to external interface communication path faults.
Parent	SKA1-LFAA-198
Verification	Analysis

SKA1-LFAA_SPS_REQ-120	**SPS off-line memory and calculation fault detection** 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-198

Verification	Analysis

3.7.6.3.2 On-line Diagnostic Tests

SKA1-LFAA_SPS_REQ-121	**SPS on-line built-in self-test capability** 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-198
Verification	Analysis

SKA1-LFAA_SPS_REQ-122	**SPS on-line fault detection performance** While the SPS Administrative Mode is set to ONLINE or MAINTENANCE, SPS shall detect and report 99% of all Critical Failures. Note: A Critical Failure is a failure that would prevent the SPS of being "Operationally Capable".
Parent	SKA1-LFAA-198
Verification	Analysis

SKA1-LFAA_SPS_REQ-123	**SPS on-line fault isolation performance** 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. Note: SPS maintainer implements part of the fault isolation capability by removing and replacing suspected LRUs to isolate the faulty LRU.
Parent	SKA1-LFAA-198
Verification	Analysis

SKA1-LFAA_SPS_REQ-124	**SPS on-line communications fault detection** 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-198
Verification	Analysis

3.7.6.4 *Fault Reporting*

SKA1-LFAA_SPS_REQ-125	**SPS monitor and report operational state** SPS shall monitor its operational state and make available the information upon request in line with the software standard [RD5].
Parent	SKA1-LFAA-76
Verification	Test

3.7.6.5 *Design for Maintainability*

SKA1-LFAA_SPS_REQ-126	**SPS in-system programmability** SPS programmable devices shall be in-system programmable in cases where the safety of personnel and equipment are not affected.
Parent	SKA1-LFAA-68
Verification	Test & Analysis

SKA1-LFAA_SPS_REQ-127	**SPS software updates** SPS equipment shall facilitate major software updates within the LFAA maintenance time allocations. 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.
Parent	SKA1-LFAA-68
Verification	Analysis

SKA1-LFAA_SPS_REQ-128	**SPS maintenance provisions** SPS repairable items shall have maintenance provisions such as test points, accessibility, and plug-in components.
Parent	SKA1-LFAA-68
Verification	Inspection

SKA1-LFAA_SPS_REQ-129	**SPS LRU removal** SPS LRUs shall be mounted such that removal of any single LRU does not require the removal of other LRUs.
Parent	SKA1-LFAA-69
Verification	Inspection

SKA1-LFAA_SPS_REQ-130	**SPS mounting preclusion** SPS shall include provisions to preclude incorrect assembly to eliminate the possibility of equipment damage or mis-operation.
Parent	SKA1_LFAA-70
Verification	Inspection

SKA1-LFAA_SPS_REQ-131	**SPS stand-offs and handles** 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-71
Verification	Inspection

SKA1-LFAA_SPS_REQ-132	**SPS mounting guides** Where applicable, SPS shall provide mounting guides and location pins on equipment to facilitate maintenance.
Parent	SKA1-LFAA-72
Verification	Inspection

SKA1-LFAA_SPS_REQ-133	**SPS module labelling** SPS labelling of modules shall be in a conspicuous location, such that it is readable when the module is removed or installed in its intended operating environment, when such labelling doesn't impede functionality and/or performance.
Parent	SKA1-LFAA-73
Verification	Inspection

3.7.7 Equipment Environment

SKA1-LFAA_SPS_REQ-134	**SPS Storage of Equipment** 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 and defined in BS EN IEC 60721-3-1. 1. Climatic Conditions 1K3 2. Biological Conditions 1B2 3. Chemical conditions 1C2 4. Dust and Sand conditions 1S2 5. Shock & Vibration Conditions 1M2
Parent	SKA1-LFAA-59
Verification	Test

SKA1-LFAA_SPS_REQ-135	**SPS Transportation Environment** 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 [RD2] and defined in BS EN IEC 60721-3-2: - Climatic conditions 2K5H - Biological conditions 2B3 - Chemical conditions 2C1 - Dust and Sand conditions 2S3 - Shock & Vibration conditions 2M3
Parent	SKA1-LFAA-179
Verification	Test

SKA1-LFAA_SPS_REQ-136	**SPS COTS operating environment** 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.
Parent	SKA1-LFAA-175
Verification	Test

SKA1-LFAA_SPS_REQ-137	**SPS Seismic Resilience** SPS racks and equipment shall survive and be fully operational after seismic events resulting in a maximum peak ground acceleration of 1 m/s^2 . Note: Seismic events include underground collapses in addition to earthquakes.
Parent	SKA1-LFAA-60
Verification	Analysis

3.7.8 Equipment Configuration Identification

SKA1-LFAA_SPS_REQ-138	**SPS serial and part numbers** 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-90
Verification	Inspection

SKA1-LFAA_SPS_REQ-139	**SPS marking 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. 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-91
Verification	Inspection

SKA1-LFAA_SPS_REQ-140	**SPS electronically readable or scannable ID** 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-92

Verification	Demonstration

SKA1-LFAA_SPS_REQ-141	**SPS package marking** 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-93
Verification	Inspection

SKA1-LFAA_SPS_REQ-142	**SPS cable identification** Each SPS cable end shall carry an identifier that uniquely defines the connector it needs to connect to.
Parent	SKA1-LFAA-95
Verification	Inspection

SKA1-LFAA_SPS_REQ-143	**SPS connector plate identification** All SPS connector plates shall carry identification labels for connectors.
Parent	SKA1-LFAA-96
Verification	Inspection

3.7.9 Security and Access

SKA1-LFAA_SPS_REQ-144	**SPS user access control** SPS shall provide hardware and communication access to any authenticated user. Note: this means that user authentication for access to SPS is provided by MCCS with TM owning the user database.
Parent	SKA1-LFAA-89, SKA1-LFAA-204
Verification	Demonstration

4 Verification Provisions

We refer the reader to the SKA1 LFAA Signal Processing Subsystem Test Specification [RD3] which includes full details of the verification approach for LFAA Signal Processing Subsystem [163-000000].

5 Appendix A Intellectual Property Declaration

There is no claimed background or foreground Intellectual Property in this specification.