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LIST OF ABBREVIATIONS

ADC.....Analogue to Digital Converter
AIP.....Advanced Instrumentation Programme
AIV.....Assembly Integration and Verification
API.....Application Program Interface
APM.....Astrometric Performance Metric
AUS.....Australia
CDR.....Critical Design Review
CISPR .....Comité International Spécial des Perturbations Radioélectriques
CPU.....Central Processor Unit
CSP .....Central Signal Processing
DAA .....Dense Aperture Array
DDBH .....Digital Data Backhaul
DDE.....Direction Dependent Effects
DOI .....Document Object Identifier
DRM .....Design Reference Mission
DSH.....Dish
ECSS.....European Committee on Space Standardisation
EIA.....Environmental Impact Assessment
EMC .....Electromagnetic Compatibility
EMI .....Electromagnetic Interference
EPA .....Environmental Protection Agency
EPBC.....Environment Protection and Biodiversity Conservation
ESD .....Electrostatic Discharge
ESOH .....Environmental Safety and Occupational Health
EVLA .....Expanded Very Large Array
EWP .....Elevating Work Platform
FLD.....Folder (i.e. not a requirement)
FLOPS.....Floating Point Operations
FMEA .....Failure Mode and Effects Analysis
GASS .....General Assembly and Scientific Symposium
GHQ .....Global Head Quarters
GPS.....Global Positioning System
GSM .....Global System for Mobile Communications
HMG .....Her Majesty's Government
HPBW.....Half Power Bandwidth
HPC.....High Performance Computing
ICD .....Interface Control Document

IEC .....International Electrotechnical Commission
IEEE .....Institute of Electrical and Electronics Engineers
IPR .....Intellectual Property Rights
IPS.....Ionospheric Prediction Service
ISO .....International Standards Organisation
IVOA.....International Virtual Observatory Alliance
IXR .....Intrinsic cross polarisation ratio
LFAA .....Low Frequency Aperture Array
LNA .....Low Noise Amplifier
LOFAR .....Low Frequency Array
LRU .....Line Replaceable Unit
MHZ.....Mega Hertz
MIL .....Military
MRO.....Murchison Radio Observatory
MTBF.....Mean Time Before Failure
MTBM.....Mean Time Between Maintenance
MTTR .....Mean Time to Repair
NEMA.....National Environmental Management Act
NOHSC .....National Occupational Health and Safety Commission
NZS .....New Zealand Standard
OHS.....Occupational Health and Safety
PAF .....Phased Array Feed
PDR.....Preliminary Design Review
PPM.....Photometric Performance Metric
PSF .....Point Spread Function
RAM .....Reliability, Availability, Maintainability
RFI.....Radio Frequency Interference
RPM .....Radiometric Performance Metric
SADT.....Signal and Data Transport (includes Synchronisation and Timing)
SANS.....South African National Standard
SDP .....Science Data Processor
SIMBAD.....Set of Identifications, Measurements and Bibliography for Astronomical Data (Astronomical Database)
SKA .....Square Kilometre Array
SKADS .....Square Kilometre Array Design Study
SKAO .....Square Kilometre Array Organisation (or Office)
SMS.....Short Message Service
SPF .....Single Pixel Feed
SPM.....Spectrometric Performance Metric

SPO.....Office of the Square Kilometre Array Organisation
SSHA.....Subsystem Hazard Analysis
TAT.....Turnaround Time
TBC .....To Be Confirmed
TBD .....To be Determined
TBJ.....To Be Justified
TEC .....Total Electron Content
TOO.....Target of Opportunity
URSI.....l'Union Radio-Scientifique Internationale
UTC .....Universal Time Co-ordinated
VLBI.....Very Long Baseline Interferometry
WBSPF.....Wideband Single Pixel Feed

1 Introduction

1.1 Purpose of the Document

This document serves as a vehicle to communicate the high-level quantitative and qualitative characteristics of the SKA Phase 1 Observatory in the form of formal requirements that are to be allocated to each of its constituent elements.

Intentionally blank: New diagram to be inserted in future revision of this document

Figure 1 SKA Phase 1 System Requirements Specification Context

Figure 1 provides an initial simplified context assumed for this document in relation to other SKA documentation. There may be changes to the figure as the system engineering process progresses.

This figure should be studied carefully since the SKA development process may not be as expected. In particular, the root document is not the Level 0 requirements;

There are no security, intellectual property, or privacy considerations attached to the use or distribution of this document.

1.1.1 Approach

This document will reside within a requirements capture tool (Jama Contour) and for each requirement statement will include relational links back to the following source documents:

- Baseline Design + SKA-BD-17-13a and SKA-BD-17-13c rebase-lining documents presented to the SKA board.
- Science Priority Outcome
- Operations Concept Guidance

This document is a living document that will converge on the requirements for the SKA1 system. The convergence process is an iterative one between the SKA Office and the consortia involved with the Element design work.

At present, some requirement statements have no traceability link available back to higher level source documents. These will usually be identified as TBJ (to be justified). However, if no link is identified then it is to be assumed that this is the case. If the requirement cannot be justified it will be removed.

Each requirement identified within this document will have a unique four digit identifier preceded by a short hand prefix of "SYS_REQ_". The identifier is a truncation of the "SKA1-SYS_REQ_" that is generated be generated by the requirements capture tool. It provides a useful reference tag and indicates where in the system hierarchy the requirement resides.

Each requirement will identify the type of verification method.

The status of each requirement will be identified.

The allocation of requirements to Elements is provided in Appendix C of this document

The latest issued document will take precedence over the contents of the requirements capture tool. However, an issued Level 1 Requirement document represents a requirements capture tool baseline. The data-base baseline identifier will be referenced in the document history.

Amendments to the document will be via change control. If accepted, amendments will be via the requirements capture tool. Up 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.

1.1.3 For but not with

"For but not with" in a requirement denotes that provision is to be made for a sub-assembly in the design but that such a sub-assembly is not necessarily to be delivered. An example would be mount positions for feeds at the focal plane of an antenna that are not necessarily all to be immediately filled with feeds.

1.1.4 Parent Requirements

Parent Requirements: The Parent Requirement field denotes the source of information providing justification. The allowed values or types of value are:

- "Root": No further justification is considered to be necessary. Rarely used.
- "Established Precedent": There is a known precedent such as an existing computing centre at a given location.
- Other requirement: Another requirement acts as justification.
- Baselined SKA document: for example ConOps or Baseline design.
- SKA document in preparation
- Publically available document with established naming conventions such as standard, academic papers, DOIs.

Within this definition, we will provide a parent requirement for all requirements.

1.2 Scope of the Document

The Square Kilometre Array Phase 1 (SKA1) Level 1 Requirements Specification ultimately aims to provide:

- A complete set of traceable level 1 requirements for the SKA1 Observatory allocated to each Element at the next level down in the observatory hierarchy.
- Identify the verification method for each requirement presented
- Allocate each requirement to the appropriate Element in the next level of the Observatory hierarchy

1.2.1 Identification

The SKA Observatory is assumed to include all of the associated equipment, facilities, material, software, hardware, policy, technical documentation, services, and personnel required for its operation.

2 References

2.1 Applicable documents

In the event of conflict between the contents of the applicable documents and this SKA1 System Requirement Specification (SRS) document, the applicable documents shall take precedence;

[1] SKA1 System Baseline Design SKA-TEL-SKO-DD-001 Rev 1

[2] Concept of Operations for the SKA Observatory SKA.TEL.SE.OPS-SKO-COO-001-0-A

[3] Operational Concepts [in prep]

[4] SKA EMI/EMC standards SKA EMI/EMC Standards and Procedures SKA-TEL-SKO-0000202-AG-RFI-ST-01

[5] SKA1_Low Configuration Coordinates (*in preparation*)

[6] SKA1_Mid Configuration Coordinates (*in preparation*)

[7] SKA1 Rebaselining outcome summary (*in preparation*)

2.2 Reference documents

The following documents are referenced in this document. In the event of conflict between the contents of the referenced documents and this document, this document shall take precedence.

[8]SKA Memo 130: '*SKA Phase 1: Preliminary System Description'*, P.E. Dewdney et al, dated November 2010.

[9]Logistics Engineering and Management B.S. Blanchard Sixth Edition Prentice Hall

[10] Reliability-Centred Maintenance John Moubray Second Edition Butterworth-Heinemann

[11] Practical Reliability Engineering Patrick D.T. O'Connor Fourth Edition Wiley

[12] System Engineering Management B.S Blanchard Third Edition Wiley

[13] The Basics of FMEA R.E. McDermott, R.J. Mikulak

[14] M.R. Beauregard Second Edition CRC Press

[15] RFI Protection and Threshold Levels for the SKA SKA.TEL.OFF.PAQA.RFI-SK0-TN-001 (available T0 + 12 weeks)

[16] Rau, U., Bhatnagar, S., Voronkov, M.A., and Cornwell, T.J., "Advances in Calibration and Imaging Techniques in Radio Interferometry", Proc IEEEE, 97, 1472-1481, (2008)

[17] U. Rau and T. J. Cornwell, A multi-scale multi-frequency deconvolution algorithm for synthesis imaging in radio interferometry A&A 532, A71 (2011)

[18] S.J. Wijnholds, J.D. Bregman and A.van Ardenne, Calibratability and its inmpact on configuration design for LOFAR and SKA phased array radio telescopes, Radio Science, vol. 46, No. RS0F07, 8 November 2011

[19] C.J. Lonsdale, D. Oberoi, A.J Coster and P.J Erickson, The Effects of Variable Ionospheric and Plasmaspheric Faraday Rotation on Low Frequency Radio Arrays, Proceedings of the XXXth General Assembly and Scientific Symposium of the Interation Union of Radio Science (URSI GASS), Istanbul (Turkey), 13 - 20 August 2011

[21] A. Schutte SKA1 Power Budget SKA-SE-POW-TN-001 Rev2

2.3 Reference Standards

[22] IEEE Systems and Software engineering – System life cycle processes ISO/IEC 15288-2008

[23] IEEE Guide for Developing Systems Specifications IEEE Std 1233 1998 Edition

[24] MIL-HDBK-520A Specification Practices

[25] Occupational Health and Safety [OHS] Act, No. 181 1993 (General Machinery regulations 1988, Construction regulation 2003)

[26] National Environmental Management Act [NEMA] Act No. 107 1998

[27] Occupational Health and Safety (Commonwealth Employment) Act 1991

[28] Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems IEC 61508

[29] Safety of machinery. Electrical equipment of machines general requirements BS EN 60204-1

[30] Low voltage switchgear and controller gear BS EN 60947-5-5

[31] Safety of machinary. Safety-related parts of control systems general principles for design BS EN ISO 13849-1

[32] Generic Requirements for Network Equipment in the Outside Plant (OSP) GR-3108-Core Iss 3.

[33] Equipment Engineering Environmental conditions and environmental tests for telecommunications equipment Part 1-2: Classification of environmental conditions Transportation ETS 300 019-1-2

3 Observatory structure

3.1 Observatory functions

The Observatory functions have been described by the Board[1]. Here we show the allocation of these functions to the top level components of the adopted Observatory model .

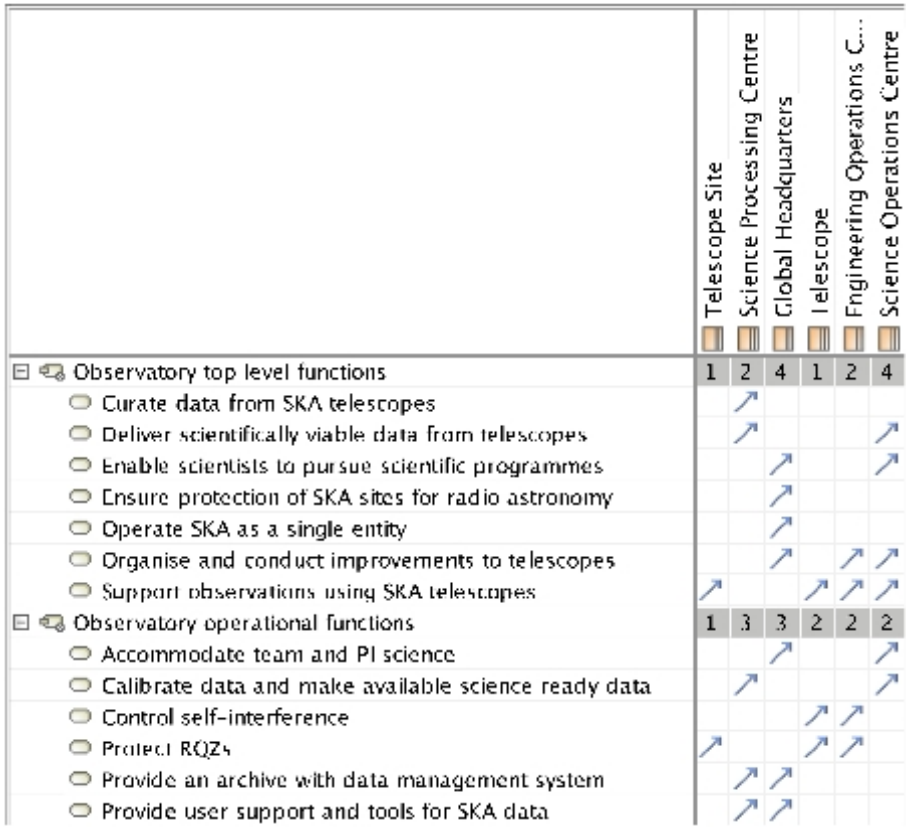

Figure 2 Observatory Functions

3.2 Global Headquarters

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2113	**Global Headquarters** The SKA Global Headquarters (GHQ) will have overall responsibility for the SKA Observatory.	Accepted	Concept of Operations for the SKA Observatory : SKA.TEL.SE.OPS-SKO-COO-001-0-A Rev B	Inspection

3.3 Site location

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2114	**Site location.** The SKA1 Antenna systems and digital signal chain shall be located within radio quiet zones provided by the Host Countries of South Africa and Australia.	Accepted	Concept of Operations for the SKA Observatory : SKA.TEL.SE.OPS-SKO-COO-001-0-A Rev B	Inspection

3.4 Distribution and deployment

3.4.1 Australia

3.4.1.1 SKA1_low array

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2124	**SKA1_low array.** The SKA1_low array shall be located within the legal boundary of the Boolardy station.	Accepted	Baseline design section 2.1 last sentence	Inspection

3.4.1.2 SKA1_low central frequency reference

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2713	**SKA1_low central frequency reference.** The SKA1_low central frequency reference shall be located in the SKA1_low Central Signal Processing facility	Accepted	SKA-TEL.SKO-DD-002	Inspection

3.4.1.3 SKA1_low CSP Facility

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2654	**SKA1_low CSP facility.** The facility housing the station beamformers for the inner area of the SKA1_Low and the central signal processing for SKA1_Low shall be at a distance of 2 km South West of the centre of the SKA1_Low array.	Accepted	Baseline Design	Inspection

3.4.1.4 Australian Science Operations Centre

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2120	**Australian Science operations centre.** The Australian Science Operations Centre shall be in Perth.	Accepted	Baseline design section 2.1 para 4 and section 2.3 para 6	Inspection

3.4.1.5 Australian Engineering Operations Centre

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2121	**Australian Engineering Operations Centre** The Australian Engineering Operations Centre shall be in in Geraldton.	Accepted	Existing Precedent	Inspection

3.4.1.6 Australian Science Processing Centre

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2123	**Australian Science processing centre** The Australian Science Processing Centre shall make use of floor space, power, cooling, and other infrastructure at the Pawsey centre in Perth.	Accepted	SKA-TEL.SKO-DD-002	Inspection

3.4.2 South Africa

3.4.2.1 SKA1_mid array

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2119	**SKA1_Mid array.** The SKA1_Mid dish array shall be located in the Karoo Central Astronomy Advantage Area.	Accepted	Baseline design section 1.3.1 first bullet point	Inspection

3.4.2.2 SKA1_mid CSP Facility

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2656	**SKA1_mid CSP facility.** The CSP facility for SKA1_mid shall be located in the Karoo Array Processor Building.	Accepted	SKA-TEL.SKO-DD-002	Inspection

3.4.2.3 SKA1_mid central frequency reference

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2714	**SKA1_mid central frequency reference.** The SKA1_mid central frequency reference shall be located in the SKA1_mid Central Signal Processing facility	Accepted	SKA-TEL.SKO-DD-002	Inspection

3.4.2.4 South African Science Operations Centre

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2115	**South African Science Operations.** The South African Science Operations Centre shall be located in Cape Town.	Accepted	Concept of Operations for the SKA Observatory : SKA.TEL.SE.OPS-SKO-COO-001-0-A RevB	Inspection

3.4.2.5 South African Science Processing Centre

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2118	**South African Science Processing Centre** The South African Science Processing centre shall be located in Cape Town	Accepted	Baseline design section 2 first para	Inspection

3.4.2.6 South African Engineering operations Centre

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2116	**South African Engineering Operations Centre.** The South African Engineering Operations Centre shall be located at Klerefontein.	Accepted	Existing Precedent	Inspection

4 Telescopes

4.1 SKA1_Low

4.1.1 SKA1_Low Configuration and Performance

4.1.1.1 Receptor type

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2671	**Receptor type.** The SKA1_Low shall utilise dual, orthogonal, polarization log-periodic antennas.	Accepted	Baseline design section 6.6	Analysis

4.1.1.2 Array resolution

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2673	**Array resolution (core).** The SKA1_Low shall have an array resolution of better than 5 arc minutes at 100 MHz (centre of the EoR frequency range).	Accepted	Baseline design section 6.2 bullet 4	Analysis

4.1.1.3 Electromagnetic frequency range

Note the baseline design Rev1 states the upper operating frequency as both 300 and 350 MHz. An rfp clarification confirms the figure is 350 MHz. This is corrected in the catch-all addendum to the baseline design.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2134	**Electromagnetic frequency range.** SKA1_Low shall be able to measure electromagnetic radiation in a frequency range from 50 MHz to 350 MHz.	Accepted	Baseline Design Section 2.1 and Table 2 Rows 2 & 3. See also catch-all addendum to the baseline design.	Test

4.1.1.4 Spectral stability

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2621	**Spectral stability:** The spectral stability, on a time scale of 600 sec.,of the station beam bandpass, post station calibration and RFI-mitigation, shall be within 1.3 %, 0.4 %, 0.6 % and 1.1 % at 50 MHz, 100 MHz, 160 MHz, and 220 MHz respectively compared to the full polarization, parameterized beam model.	Accepted	Derived from science requirements	Test

4.1.1.5 SKA1_Low array sensitivity at 50 MHz

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2135	**SKA1_Low array sensitivity at 50MHz**. The SKA1_Low array shall have sensitivity per polarization at zenith greater than 72 m^2K^{-1} at 50MHz when assuming a sky noise temperature following the law 60.lamda$^{2.}$	Accepted	Baseline Design Table 3 Row 20	Test

4.1.1.6 SKA1_Low array sensitivity at 100 MHz

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2136	**SKA1_Low array sensitivity at 110MHz**. The SKA1_Low array shall have a sensitivity per polarization at zenith greater than 380 m^2K^{-1} at 100 MHz when assuming a sky noise temperature following the law 60.lambda^2.55	Accepted	Baseline Design Table 3 Row 21	Test

4.1.1.7 SKA1_Low array sensitivity at 160 MHz

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2137	**SKA1_Low array sensitivity at 160MHz**. The SKA1_Low array shall have a sensitivity per polarization at zenith of greater than 535 m^2K^{-1} at 160 MHz when assuming a sky noise temperature following the law 60.lambda^2.55	Accepted	Baseline Design Table 3 Row 22	Test

4.1.1.8 SKA1_Low array sensitivity at 220 MHz

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2138	**SKA1_Low array sensitivity at 220MHz**. The SKA1_Low array shall have a sensitivity per polarization at zenith of greater than 530 m^2K^{-1} at 220 MHz when assuming a sky noise temperature following the law 60.lambda^2.55.	Accepted	Baseline Design Table 3 Row 23	Test

4.1.1.9 SKA1_Low array sensitivity at 280MHz.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2814	**SKA1_Low array sensitivity per polarization at 280 MHz.** The SKA1_Low array shall have a sensitivity per polarization at zenith greater than 500 m^2/K at 280 MHz when assuming a sky noise temperature following the law 60.lambda^2.55	Accepted	Baseline Design, Chapter 6	Test

4.1.1.10 SKA1_Low array sensitivity at 340MHz.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2815	**SKA1_Low array sensitivity per polarization at 340 MHz.** The SKA1_Low array shall have a sensitivity per polarization at zenith greater than 453 m^2/K at 340 MHz when assuming a sky noise temperature following the law 60.lambda^2.55	Accepted	Baseline Design, Chapter 6	Test

4.1.1.11 Sensitivity for off zenith angles

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2622	**Sensitivity for off zenith angles.** The SKA1_low receptor has an off-zenith beam response defined by the receptor, a log-periodic dipole antenna,in the Baseline Design.	Accepted	Baseline Design section 6.1 item 6	Test

4.1.1.12 SKA1_Low antennas per station

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2139	**SKA1_Low antennas per station.** The SKA1_Low shall comprise of stations each containing 256 antennas.	Accepted	Baseline Design Table 2 Row 4 + addendum	Inspection

4.1.1.13 SKA1_Low station diameter

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2140	**SKA1_Low station diameter.** The station diameter will be 35 metres, which is consistent with being able to provide a single, circularly symmetric, beam of 5 degrees at the half-power points at 100 MHz (centre of the EoR frequency range) while meeting the sensitivity requirements with 256 antennas per station evenly distributed in an irregular-random configuration.	Accepted	Baseline Design Table 2 Row 10	Inspection

4.1.1.14 SKA1_Low number of stations

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2142	**SKA1_Low number of stations.** The SKA1_Low shall comprise of 512 stations.	Accepted	Baseline Design Table 2 Row 11 + addendum	Inspection

4.1.1.15 SKA1_Low configuration

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2143	**SKA1_Low configuration.** The SKA1_Low shall have a configuration as specified in TBD.	Accepted	Baseline Design Table 2 Row 12	Inspection

4.1.1.16 SKA1_Low maximum baseline length between stations

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2817	**SKA1_Low maximum baseline length between stations.** The maximum distance between station centres shall be approximately 80 km	Accepted	Baseline Design, section 6.2	Inspection

4.1.1.17 SKA1_Low Instantaneous Bandwidth

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2147	**Instantaneous bandwidth.** The SKA1_Low shall be capable of simultaneously processing 300 MHz of bandwidth.	Accepted	Baseline Design Table 2 Row 18 + addendum	Test

4.1.1.18 SKA1_Low separation

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2652	**SKA1_Low separation.** The SKA1_Low core shall be located at a minimum distance of 10km from the ASKAP core.	Accepted	Baseline design section 6.9 para. 1	Measurement

4.1.1.19 Digitisation

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2674	**Digitisation.** Digitisation of SKA1_antenna (SKA1_Low only) signals shall be to at least 8 bits.	Accepted	Baseline Design	Demonstration

4.1.1.20 Clipping

Clipping occurs when the range of the input signal voltages to the ADC is larger than the ADC voltage range.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2639	**Clipping.** The amplitude dynamic range of the SKA1_Low ADC's shall be such that no clipping will occur for 95% of the time	Accepted	Operational requirement to meet availability	Test

4.1.1.21 Clipped data flagging

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2640	**Clipped data flagging.** Clipped data shall be flagged accordingly within the data stream.	Accepted	Operational requirement to meet availability	Demonstration

4.1.1.22 Linearity

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2653	**Linearity.** At the finest frequency resolution in the processing chain, the level of spurious signals due to non-linearity shall be less than the noise level when no external input signal is present.	Accepted	Related to Signal Chain dynamic range	Test

4.1.1.23 Absolute flux scale

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2824	**Absolute flux scale**: The absolute flux scale shall be accurate to 5%	Accepted	Established Precedent	Test

4.1.2 SKA1_Low beamformer

4.1.2.1 Dynamic range

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2676	**Dynamic range.** The SKA1_Low beams shall have a dynamic range of better than 40 dB	Accepted	Signal chain performance document in preparation	Test

4.1.2.2 SKA1_Low station beams

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2146	**SKA1_Low station beams** The antennas within each station shall be coherently beam-formed to provide one pair of station beams,one beam for each orthogonal polarization,for primary science.	Accepted	Baseline Design Table 2 Row 17	Demonstration

4.1.2.3 Control of station beam properties

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2779	**Control of station beam properties:** It shall be possible to control specific properties of the station beam by setting the station beam weights appropriately.	Accepted	Control of LFAA Station Properties [doc, in prep]	Test

4.1.2.4 Station beam stability

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2629	**Station beam stability.** The difference between the parameterized station beam model and the actual station beam shall remain smaller than 1.3 %, 0.4 %, 0.6 % and 1.1 % relative to the main beam peak power, after calibration, at 50 MHz, 100 MHz, 160 MHZ and 220 MHz respectively	Accepted	Derived from Science Requirements	Test

4.1.2.5 Calibration update rate

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2634	**Calibration update rate.** Calibration measurements shall be necessary at a rate of no more than 10seconds.	Accepted	References [16], [17]	Demonstration

4.1.2.6 Real time calibration

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2635	**Real-time calibration.** The LFAA reception system at station level shall provide on-line instrumental calibration functions with an update rate of 10 minutes	Accepted	Derived from DRM	Demonstration

4.1.2.7 Beam products

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2636	**Beam products.** The SKA1_Low shall be capable of outputting beam products as voltage time series.	Accepted	Baseline design Table 2 row 17 and 18	Demonstration

4.1.3 SKA1_Low Correlator

4.1.3.1 SKA1_Low correlator sub-array support

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2773	**SKA1_Low correlator sub-array support**. The SKA1_Low correlator shall be able to correlate SKA1_low station beams from one to sixteen sub-arrays independently and concurrently.	Accepted	SYS_REQ-2127, Baseline design section 5	Test

4.1.3.2 SKA1_Low channelisation

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2148	**SKA1_Low channelisation.** The SKA1_Low channelisation for each sub array shall provide up to 65,536 linearly spaced frequency channels across the available frequency range of each band.	Accepted	Baseline Design Table 2 Row 28, SYS_REQ-2127	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2149	**SKA1_Low channeliser maximum leakage power for adjacent frequency channels.** The SKA1_Low channeliser for each sub-array shall have a maximum noise leakage power from immediately adjacent frequency channels of < -30 dB.	Accepted	Signal chain performance document in preparation	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2810	**SKA1_Low channeliser maximum leakage power for non-adjacent frequency channels.** The SKA1_Low channeliser for each sub-array shall have a maximum noise leakage power from non adjacent frequency channels better than -60 dB.	Accepted	Signal chain performance document in preparation	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2811	**SKA1_Low fine frequency channel amplitude variation.** The fine frequency channels for the SKA1_Low channeliser shall have a total amplitude variation as a function of frequency of less than 0.01 dB.	Accepted	Signal chain performance document in preparation	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2812	**SKA1_Low fine frequency channel band edge**. The fine frequency cells for the SKA1_Low channeliser shall have a -3dB transition band amplitude at the channel band edge.	Accepted	Signal chain performance document in preparation	Test

4.1.3.3 SKA1_Low Correlator signal to noise

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2678	**SKA1_Low correlatation signal to noise**. SKA1_Low correlation, for each sub array, shall not degrade the Signal to Noise ratio by more than 2 % compared to ideal analogue correlation.	Accepted	Signal chain performance document to be issued, SYS_REQ-2127	Analysis

4.1.3.4 SKA1_Low correlator integration time

The correlator dump time is derived from the level of acceptable image smearing. This is nominally identified as < 2% in the base line design. However this isn't sufficient information as the field of view this is applicable to needs to be specified. The baseline designs a factor of 2 over and above the half power beam width though this isn't explicitly stated.

The base line design suggests two separate ranges of baselines with associated dump rates. This is problematic for Imaging processing and not included in the SKA1 requirements

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2150	**SKA1_Low correlator Integration rate. T**he SKA1_Low correlator for each sub array shall have independently configurable visibility integration periods in the range 9s to 0.9s.	Accepted	Baseline Design Table 4 Row 9	Test

4.2 Reflector Antennas

4.2.1 Diameter

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2153	**Diameter**. SKA1 dishes shall have a projected diameter of larger than 15m and smaller than 16.5m.	Accepted	Baseline Design Table 5 Row 1	Inspection

4.2.2 Aperture efficiency

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2155	**Aperture Efficiency**. Aperture efficiency shall be within +/- 5 % of: • 60% at 350MHz with gradual degradation from 400 to 350 MHz • 65% at 400MHz • 78% from 600MHz to 8000MHz • 70% from 8 to 15 GHz • 65% from 15 to 20 GHz	Accepted	Baseline Design Table 6 Rows 4 to 8	Test

4.2.3 Precision pointing repeatability

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2158	**Pointing repeatability.** The pointing repeatability shall be better than 10 arc seconds rms for winds < 7 m/s at night time.	Accepted	Baseline Design Table 5 Rows 15 and 17	Test

4.2.4 Standard pointing repeatability

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2159	**Pointing repeatability**. The pointing repeatability shall be better than 17 arc seconds rms for an average wind speed of < 7 m/s in the day time	Accepted	Baseline Design Table 5 Rows 15 and 18	Test

4.2.5 Degraded pointing repeatability

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2160	**Pointing repeatability.** The pointing repeatability shall be better than 180 arc seconds rms for an average wind speed between 7 and 20 m/s	Accepted	Baseline Design Table 5 Rows 15 and 19	Test

4.2.6 Number of receivers

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2162	**Number of feeds**. There shall be space at the Gregorian focus of SKA1 dishes for five single pixel feeds (SPF) or three Phased Array Feeds (PAF)	Accepted	Baseline Design Table 5 Row 12	Inspection

4.2.7 Polarisation purity

The polarisation purity of reflector antenna shall be expressed by using the intrinsic polarisation ratio (IXR). It will give coordinate system independent FoM of the polarisation purity and quantify the polarimetric performances even after the calibration.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2165	**Polarisation Purity.** The IXR shall be better than 15 dB over the whole observing bandwidth within the HPBW	Accepted	Baseline Design Table 5 Row 10 SCI-T_REQ-0440	Test

4.2.8 Elevation limit

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2170	**Elevation limit.** Reflector antennas shall be capable of operating at all elevations greater than 15 degrees	Accepted	Baseline Design Table 5 Rows 13	Demonstration

4.2.9 Azimuth range

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2171	**Azimuth range.** The Dish shall have a continuous useable azimuth observation range from -270° to +270°, inclusive measured relative to true North defined as 0° and with East defined as +90°	Accepted	Baseline Design Table 5 Row 14	Demonstration

4.3 SKA1_Mid

4.3.1 SKA1_Mid configuration and performance

4.3.1.1 Inclusion of MeerKAT

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2833	**SKA1_Mid inclusion of MeerKAT.** The SKA1_Mid shall incorporate the 64 antennas in both monitor and control and data collection functions.	Accepted	Baseline Design section 9.5.1 para 2 bullets 2 and 3	Demonstration

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2173	**MeerKAT array.** The monitor and control functions of MeerKAT shall be made available to SKA1_Mid via a Foreign Telescope interface consisting of a Local Monitor and Control system connected to the SKA1_Mid Telescope Manager.	Accepted	Baseline Design section 8.4.2 para 2 bullet 1	Demonstration

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2834	**SKA1_Mid-MeerKAT infrastructure reuse.** Where economically practicable, the existing MeerKAT infrastructure will be reused	Accepted	Baseline Design section 9.5.1 para 2 bullets 2 and 3	Analysis

4.3.1.2 Absolute flux scale

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2825	**Absolute flux scale:** The absolute flux scale shall be accurate to 5% rms.	Accepted	Established Precedent	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2826	**Absolute flux scale:** The absolute flux scale shall be accurate to 3% rms.	Accepted	Established Precedent	Test

4.3.1.3 SKA1_Mid configuration

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2174	**Combined SKA1 Mid Configuration.** The SKA1_Mid shall have the configuration defined in the TBD	Accepted	Array Configurations Document [ ]	Inspection

4.3.2 SKA1_Mid antenna

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2712	**SKA1_Mid antenna.** The SKA1_Mid array shall consist of 133 antennas centred in the same location as the MeerKAT array	Accepted	Baseline design Table 6 row 1	Inspection

4.3.3 Antenna RF system

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2179	**Antenna RF system.** The Dish Element shall make available only a single frequency band at any one time.	Accepted	Baseline Design Table 8 Row 14	Inspection

4.3.3.1 RF system frequency range band 1

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2180	**RF system frequency range band 1** The array of SKA1_Mid dishes, when the band 1 capability is selected, shall operate over a frequency range from 0.35 to 1.050 GHz for each polarisation.	Accepted	Baseline Design Table 6 Row 17	Test

4.3.3.2 RF system frequency range band 2

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2181	**RF system frequency range band 2.** The SKA1_Mid dishes, when the band 2 capability is selected, shall operate over a frequency range from 0.95 to 1.76 GHz for each polarisation.	Accepted	Baseline Design Table 6 Row 18	Test

4.3.3.3 RF system frequency range band 3

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2182	RF system frequency range band 3. The SKA1_Mid dishes, when the band 3 capability is selected, shall operate over a frequency range from 1.65 to 3.05 GHz for each polarisation	Accepted	Baseline Design Table 6 Row 19	Test

4.3.3.4 RF system frequency range band 4

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2183	**RF system frequency range band 4.** The SKA1_Mid dishes, when the band 4 capability is selected, shall operate over a frequency range from 2.80 to 5.18 GHz for each polarisation	Accepted	Baseline Design Table 6 Row 20	Test

4.3.3.5 RF system frequency range band 5

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2184	**RF system frequency range band 5.** The SKA1_Mid dishes, when the band 5 capability is selected, shall operate over a frequency range from 4.6 to 13.8 GHz for each polarisation.	Accepted	Baseline Design Table 6 Row 21	Test

4.3.3.6 RF system sampled bandwidth band 1

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2185	**RF system sampled bandwidth band 1.** The instantaneous bandwidth for band 1 will be 700MHz and shall be sampled to at least 2.0 G samples per second for each polarisation.	Accepted	Baseline Design Table 6 Row 17	Test

4.3.3.7 RF system sampled bandwidth band 2

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2186	**RF system sampled bandwidth band 2.** The instantaneous bandwidth for band 2 will be 810 MHz and shall be sampled to at least 2.0 G sample per second for each polarisation.	Accepted	Baseline Design Table 6 Row 18	Test

4.3.3.8 RF system sampled bandwidth band 3

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2187	**RF system sampled bandwidth band 3** The instantaneous bandwidth for band 3 will be 1,403 MHz and shall be sampled to at least 5.0 G samples per second for each polarisation	Accepted	Baseline Design Table 6 Row 19	Test

4.3.3.9 RF system sampled bandwidth band 4

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2188	**RF system sampled bandwidth band 4** The instantaneous bandwidth for band 4 will be 2,380 MHz and shall be sampled at at least 5.0 G samples per second for each polarisation.	Accepted	Baseline Design Table 6 Row 20	Test

4.3.3.10 RF system sampled bandwidth band 5

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2189	**RF system sampled bandwidth band 5** The SKA_Mid, for band 5, shall digitise two separate 2.5 GHz bands for each polarisation.	Accepted	Baseline Design Table 6 Row 21	Test

4.3.3.11 RF digitisation

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2190	**RF digitisation.** Digitisation for each polarisation shall be: • band 1 8 bits • band 2 8 bits • band 3 6 bits • band 4 at least 4 bits • band 5 at least 2 streams of 3 bits	Accepted	Baseline Design Table 6 Row 36 to 40	Demonstration

4.3.4 SKA1_Mid Correlator

4.3.4.1 SKA1_Mid correlator sub-array support

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2774	**SKA1_Mid correlation sub-array support.** The SKA1_Mid shall be able to correlate SKA1_mid dishes as multiple sub-arrays independently and concurrently..	Accepted	Baseline design paragraph 5 bullet 6	Demonstration

4.3.4.2 SKA1_Mid channelisation

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2195	**SKA1_Mid channelisation.** The SKA1_Mid channelisation for each sub array shall provide up to 65,536 linearly spaced frequency channels across the sampled bandwidth of each band.	Accepted	Baseline Design Table 10 Row 3	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2196	**SKA1_Mid channelisation maximum leakage power for adjacent channels.** The SKA1_Mid for each sub-array shall have a maximum noise leakage power from immediately adjacent frequency channels of < -30 dB	Accepted	Signal chain performance document to be issued	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2803	**SKA1_Mid maximum leakage power for non-adjacent frequency channels.** The SKA1_Mid, for each sub-array, shall have a maximum noise leakage power from non adjacent frequency channels better than -60 dB.	Accepted	Signal processing chain performance document in preparation	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2805	**SKA1_Mid fine frequency channel amplitude variation.** The fine frequency channels for the SKA1_Mid channeliser shall have a total amplitude variation as a function of frequency of less than 0.01 dB after bandpass calibration	Accepted	Signal processing chain performance document in preparation	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2804	**SKA1_Mid fine frequency channel band edge**. The fine frequency cells for the SKA1_Mid channeliser shall have a -3dB transition band amplitude at the channel band edge.	Accepted	Signal processing chain performance document in preparation	Test

4.3.4.3 SKA1_Mid correlation signal to noise

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2679	**SKA1_Mid correlation signal to noise.** The SKA1_Mid correlation, for the same sub-array, shall not degrade the Signal to Noise ratio by more than 2% compared to ideal analogue correlation.	Accepted	Signal chain performance document in preparation	Analysis

4.3.4.4 SKA1_Mid correlation integration time

The base line design suggests two separate ranges of baselines with associated dump rates. This is problematic for Imaging processing and not included in the SKA1 requirements

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2197	**SKA1_Mid correlation integration period.** The SKA1_Mid shall have independently configurable visibility integration period from a maximum integration time of 1.4s to a minimum of 0.14s for each subarray.	Accepted	Baseline Design Table 10 Row 14	Demonstration

4.3.4.5 SKA1_Mid correlator Pulsar binning

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2616	**SKA1_Mid Pulsar phase binning.** The SKA1_Mid, for each subarray, shall allow for pulse phase-resolved observations supporting the product of the number of phase bins, channel and polarisation products up to 262,144 (i.e. 4 x 65,536).	Accepted	Baseline design section 8.6.1.6 para 3	Demonstration

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2830	**SKA1_Mid Pulsar phase bin width.** The SKA1_Mid shall be capable of providing pulsar phase bin widths with a time resolution of better than 10us.	Accepted	Baseline design section 8.6.1.6 para 3	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2831	**SKA1_Mid Pulsar phase bin synchronisation.** The SKA1_Mid shall be capable of synchronising phase bins to the ephemeris to limit drift to less than 10% of the selected bin width within the selected correlator integration period.	Accepted	Baseline design section 8.6.1.6 para 3	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2835	**SKA1_Mid Phase bin averaging time.** The SKA1_Mid phase bin averaging time shall be constrained to limit the output data rate to at most the single bin configuration output data rate.	Accepted		Demonstration

4.3.4.6 Inclusion of MeerKAT into SKA1_Mid Correlator

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2740	**Inclusion of MeerKAT into SKA1_mid correlator.** The SKA1_Mid correlator shall be capable of forming real time cross correlation products from all antenna within the SKA1_Mid combined array including those MeerKAT.	Accepted	Baseline design section 8.6.1 para 2, table 10 row 20, table 11 row 2	Demonstration

4.3.5 SKA1_Mid Central Beam-former

4.3.5.1 Beam-former sub-array support

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2201	**Beam-former sub-array support.** The SKA1_Mid central beam-former shall be able to form beams or more beams for one to sixteen sub-arrays independently and concurrently.	Accepted	SYS_REQ-2127, Baseline design section 5 bullet 6	Demonstration

4.3.5.2 Pulsar search and timing within sub-arrays

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2751	**Pulsar search and timing within sub-arrays.** SKA1_Mid shall be capable of Pulsar search and timing processing within individual sub-arrays.	Accepted	Baseline design section 5 bullet 3, section 8.6.3.1, section 8.6.3.2	Demonstration

4.3.5.3 Pulsar search array diameter

The baseline design suggests a diameter of ~ 1000m based on the figure of merit (Ndish Adish/Ddish)^2 for the current baseline design configuration. The normal operation of Pulsar search will be at the array optimised figure of merit. However, allowing sub-array to optionally extend to 20km diameter allows small area observations at higher sensitivity.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2202	**Pulsar search array diameter.** The central beam-former for pulsar search shall be capable of forming beams independently across all dishes (SKA1_Mid and MeerKAT) within each of the SKA1_Mid sub-arrays up to a distance of up to 10,000 metres from sub-array centres.	Accepted	Baseline Design Table 11 Row 4	Demonstration

4.3.5.4 Pulsar search beamformer centre frequency

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2755	**Pulsar search beamformer centre frequency**. The Pulsar search beamformer shall form beams for each of the search sub arrays with an independently selectable centre frequency for the sub-array in the range from the lowest frequency of SKA1_Mid band 1 through to the highest frequency of band 5.	Accepted	Baseline design Table 12	Demonstration

4.3.5.5 Pulsar search beamformer bandwidth

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2756	**Pulsar search beamforming bandwidth.** The SKA1_Mid Pulsar search shall have a contiguous processing bandwidth for beamforming of up to 300 MHz.	Accepted	Baseline design Table 13 line 12	Demonstration

4.3.5.6 Number of beams: Pulsar survey

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2203	**Number of beams: Pulsar search.** SKA1_Mid, when performing the Pulsar Search function, shall simultaneously form up to a total of 1111 beams per observation across all sub arrays.	Accepted	Baseline Design Table 13 row 17	Demonstration

4.3.5.7 Beam-former S/N: Pulsar survey

The signal to noise, S/N, performance includes all losses including but limited to coherence, quantisation, scalloping but not RFI

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2205	**Beamformer S/N pulsar search.** The SKA1_Mid central beam-forming for each sub array shall have a Signal to Noise ratio greater or equal to 98% of ideal analogue beam forming for the same sub array:	Accepted	Signal chain performance document in preparation	Analysis

4.3.5.8 Pulsar search beamformer output

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2753	**Pulsar search beamformer output.** For each SKA1_Mid Pulsar search sub-array the output shall be the power of summed polarisation beams.	Accepted	Baseline design Table 13 row 18	Demonstration

4.3.5.9 Pulsar search beamformer output frequency resolution

Pulsar search beamformer output frequency resolution. The frequency resolution for each Pulsar search sub-array shall be independently configurable in frequency resolution with values in the range of 20kHz to 75kHz

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2752	**Pulsar search beamforming output frequency resolution.** The frequency resolution for SKA1_Mid Pulsar search shall be independently configurable in frequency resolution with values in the 20 kHz and 75 kHz	Accepted	Baseline design Table 13 row 13, Table 12 column 7	Demonstration

4.3.5.10 Pulsar search beamformer output time resolution

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2754	**Pulsar search beamforming output time resolution:** SKA1_Mid Pulsar search output beams shall have a minimum time resolution of 50us.	Accepted	Baseline design Table 11 Row 4	Demonstration

4.3.5.11 Pulsar timing array diameter

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2206	**Pulsar timing array radius.** The central beam-former for pulsar timing shall be capable of forming beams across all dishes within the SKA1_Mid sub-arrays to a distance of up to 10,000 metres from their centres.	Accepted	Baseline Design Table 11 Row 4	Demonstration

4.3.5.12 Pulsar timing beamformer centre frequency

This requirement supports the baseline design timing scenario but has been expressed in a form that isn't scenario specific which provisionally includes all available SKA1_mid frequency bands.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2757	**Pulsar timing beamformer centre frequency.** The Pulsar timing beamformer shall form beams for each of the timing sub-arrays with a selectable centre frequency for the sub-array in the range from the lowest frequency of SKA1_Mid band 1 through to the highest frequency of band 5.	Accepted	Baseline design Table 8 rows 15 through 35	Demonstration

4.3.5.13 Pulsar timing beamformer bandwidth

This requirement supports the baseline design timing scenario but has been expressed in a form that isn't scenario specific which provisionally includes all available SKA1_mid frequency bands.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2758	**Pulsar timing beamformer bandwidth.** The SKA1_Mid Pulsar timing beamformer for each timing sub-array shall have a contiguous processing bandwidth up to the full bandwidth of the selected band up to a bandwidth of 2.5 GHz.	Accepted	Baseline design Table 8 rows 16 through 35, Table 14 rows 11 through 15	Test

4.3.5.14 Number of beams: Pulsar timing

The maximum number of simultaneous beams has been increased from "up to 10" in the baseline design to "up to 16" to support simultaneous Pulsar timing in each of up to 16 sub arrays

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2207	**Number of beams: Pulsar timing.** The SKA1_Mid central beam-former for Pulsar timing shall be capable of forming up to 16 dual polarisation coherent beams in total across all timing sub-arrays.	Accepted	Baseline Design Table 14 Row 17, section 5 bullet point 6.	Demonstration

4.3.5.15 Beamformer S/N performance: Pulsar timing

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2208	**Beamforming S/N ratio: Pulsar timing.** The SKA1_Mid for Pulsar timing shall have a Signal to Noise ratio greater or equal to 98% of an ideal analogue beam former.	Accepted	Signal chain performance document in preparation	Analysis

4.3.5.16 SKA1_mid VLBI

The VLBI community indicate there should be at least 4 beams generated for VLBI usage: one for target and three for calibrators to establish calibration plane.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2689	**SKA1_Mid VLBI beam number.** SKA1_Mid shall be capable of producing up to four VLBI beams	Accepted	ConOps 8.6, Baseline design section 5 bullet 6.	Analysis

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2759	**SKA1_Mid VLBI array diameter.** SKA1_Mid shall be able to generate VLBI beams from sub-arrays with receptors separated by up to 100km.	Accepted	Baselime Design Table 8 row 9	Analysis

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2760	**SKA1_Mid VLBI centre frequency.** SKA1_Mid shall be able to form a VLBI beam with a 0.01MHz step selectable centre frequency within the boundaries of the defined frequency bands for SKA1_Mid.	Accepted	Con Ops 8.6, Baseline design Table 8 rows 17 to 30	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2761	**SKA1_Mid VLBI beam bandwidth.** SKA1_Mid VLBI beamforming shall have a contiguous processing bandwidth up to the full bandwidth of the selected band	Accepted	Con Ops 8.6. Baseline design Table 8 row 27	Analysis

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2762	**SKA1_Mid VLBI beamformer S/N performance**. SKA1_Mid VLBI beamforming shall have the Signal to Noise ratio by more than 98% compared to an ideal analogue beam former.	Accepted	Signal chain performance document to be issued	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2847	**SKA1_Mid VLBI store the time-dependent antenna weights.** SKA1_Mid shall be able to store the time-dependent antenna weights used for each tied-array beam sum	Accepted	Baseline Design	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2848	**SKA1_Mid VLBI timestamp accuracy.** SKA1_Mid shall be able to generate data from the VLBI beams with samples traceable to a timestamp with an accuracy of 1 nsec or better.	Accepted	Baseline Design	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2849	**SKA1_Mid VLBI beams sampling rate.** SKA1_Mid shall be able to output VLBI beams with a sampling rate selectable between Nyquist and oversampled rates for the selected bandwidth.	Accepted	Baseline Design	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2850	**SKA1_Mid VLBI beamforming**. SKA1_Mid shall be able to allocate antennas to be included in, or excluded from, individual tied-array beams.	Accepted	Baseline Design	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2851	**SKA1_Mid VLBI relative sensitivity and coherence losses.** The SKA1_Mid beamformer shall be able to weight the antenna inputs into the tied-array sums based on relative sensitivity and coherence losses.	Accepted	Baseline Design	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2852	**SKA1_Mid VLBI configurability.** SKA1_Mid shall be able to change the pointing, centre frequency, and bandwidth of the individual tied-array beams within a single observing schedule.	Accepted	Baseline Design	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2853	**SKA1_Mid VLBI configurability.** SKA1_Mid shall be capable of selecting, through configuration, 1, 2, 3, or 4 separate VLBI specific beams, each with independently selectable centre frequency, bandwidth, frequency resolution and pointing.	Accepted	Baseline Design	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2854	**SKA1_Mid VLBI configurability.** SKA1_Mid shall be capable of reconfiguring the centre frequency, frequency band, and bandwidth for each tied-array beam, in less than 30 seconds.	Accepted	Baseline Design	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2855	**SKA1_Mid VLBI spectral resolution.** SKA1_Mid shall be able to generate VLBI beams with a spectral resolutions different from the spectral resolution used for imaging within the same VLBI sub-array	Accepted	Baseline Design	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2856	**SKA1_Mid VLBI channel width**. SKA1_Mid shall be able to generate VLBI beam data with a selectable channel width of: 512MHz, 256 MHz, 128MHz, 64MHz, 32MHz, 16MHz, 4MHz or 1MHz.	Accepted	Baseline Design	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2857	**SKA1_Mid VLBI imaging and beamforming** SKA1_Mid shall be able to simultaneously generate imaging data using all antennas in a VLBI sub-array, as well as generating the VLBI beams.	Accepted	Baseline Design	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2859	**SKA1_Mid VLBI spectral line and time domain observation** SKA1_Mid shall be able to generate VLBI beams optimised for either spectral line observations (to mitigate spectral leakage) or time domain observations (to mitigate time smearing)	Accepted	Baseline Design	Demonstration

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2860	**SKA1_Mid VLBI beams and sub-arrays.** SKA1_Mid shall be able to allocate individual VLBI beams to different sub-arrays.	Accepted	Baseline Design	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2861	**SKA1_Mid VLBI array diameter.** SKA1_Mid shall be able to generate VLBI beams from sub-arrays with receptors separated by up to 20km.	Accepted	Baseline Design	Demonstration

4.3.6 SKA1_Mid Pulsar Search

4.3.6.1 Pulsar search sub-array support

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2765	**Pulsar search sub-array support**. The SKA1_Mid Pulsar search shall be able to independently process a total of up to 1111 beams from one to sixteen sub-arrays independently and concurrently.	Accepted	SYS_REQ-2127, Baseline design section 5	Demonstration

4.3.6.2 Pulsar search processing bandwidth

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2767	**Pulsar search processing bandwidth**. The Pulsar search processing shall have a contiguous processing bandwidth up to 300 MHz for each search sub array.	Accepted	Baseline design section 5 bullet 6, section 8.6.3.1 para 3.	Test

4.3.6.3 Dispersion measure

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2212	**Dispersion Measure.** SKA1_Mid for pulsar search shall provide, for each sub array, trial dispersion corrections across the observation frequency range for dispersion measures from 0 up to 3000 pc cm^{-3}.	Accepted	Baseline Design Table 12 Row 2	Demonstration

4.3.6.4 Time resolution

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2216	**Time resolution.** The time resolution of the SKA1_Mid pulsar search processing for each sub-array shall be equivalent to the temporal smearing due to dispersion at the observation frequency and bandwidth of the observation with a quantisation of value in powers of 2 from 50 μs to 800 us	Accepted	Baseline Design Table 13 Row 9	Analysis

4.3.6.5 Pulsar search observation time

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2218	**Pulsar search observation time.** For each Pulsar search sub-array, the processing shall provide independently configurable observation times up to 1800 seconds duration.	Accepted	Baseline Design Table 13 Row 6	Demonstration

4.3.6.6 Single pulse searches

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2219	**Single pulse searches**. For each search sub-array within SKA1_Mid Pulsar search, the processing shall be capable of searching for single dispersed pulses over dispersion measure range up to 3000 pc cm^{-3} commensally with searches for periodic pulses with a S/N performance better than 7	Accepted	Baseline Design 1.3.2 para 4, section 2.2 para 1, section 2.2 para 6, Table 12 row 2 column 2.	Analysis

4.3.6.7 Binary search

The baseline design identifies the number of trial accelerations up to 120 in the representative sizing of Appendix B. The requirement states 350 trial accelerations based on known systems presented at the Pulsar science workshop.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2220	**Binary search.** For each Pulsar search sub-array within SKA1_Mid the processing shall be capable of searching for binary systems with accelerations due to their orbital motion of up to 350 ms^{-2}.	Accepted	Baseline design Table 24 line 35	Analysis

4.3.7 SKA1_Mid Pulsar Timing

4.3.7.1 Pulsar timing sub-array support

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2763	**Pulsar timing sub-array support**. The SKA1_Mid Pulsar timing processing shall be able to independently process a total of up to 16 beams from one to sixteen sub-arrays independently and concurrently.	Accepted	Baseline design section 5 bullet 8	Demonstration

4.3.7.2 Pulsar timing processing bandwidth

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2768	**Pulsar timing processing bandwidth.** The Pulsar timing engine shall have a contiguous processing bandwidth up to the full bandwidth of the selected band up to a bandwidth of 2.5 GHz for each timing sub-array	Accepted	Baseline design Table 8 row 27	Test

4.3.7.3 Frequency agility

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2224	**Frequency agility.** The SKA1_Mid system shall, for each timing sub-array, be able to change from observing in any frequency band, to observing in any other frequency band in less than or equal to 30 seconds.	Accepted	Baseline design section 8.4.2 third para main bullet point 9	Demonstration

4.3.7.4 Pulsar timing observation time

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2766	**Pulsar timing observation time.** The observation period for each observation for each timing sub-array shall be independently configurable between 3 minutes and 300 minutes.	Accepted	Baseline design Table 14 rows 6, 7, 9 and 10	Demonstration

4.3.7.5 Time stamping

Time stamping is required to facilitate multiple temporally separate timings over a period of up to 10 years.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2764	**Time stamping.** For each individual Pulsar timing observation within a sub-array, each data sample shall be traceable to a time stamp derived from a clock accurate to 10ns on a time scale of 10 years referenced to a common delay centre at the centre of the SKA1_Mid array.	Accepted	Baseline design Table 14 row 16, section 11.1 para 5, REQ_2274	Demonstration

4.3.7.6 Multiple simultaneous timings

The number of simultaneous timings is 16 as opposed to 10 given in table 14 of the baseline design. This is to facilitate timing in up to 16 sub-arrays.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2230	**Multiple timings.** The SKA Phase 1 shall be capable of timing up to 16 pulsars simultaneously in total across all timing sub arrays .	Accepted	Baseline design section 5 bullet 6, Table 14 row 18.	Demonstration

4.3.7.7 Dispersion Measure

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2231	**Pulsar timing Dispersion Measure.** The SKA1_Mid shall be capable of timing pulsars with dispersion measures between 0 to 3000 pc cm^{-3} such that residual dispersive smearing is less than 500 ns.	Accepted	Baseline Design Table 14 Row 20	Analysis

5 Observing

5.1 Operational Modes

5.1.1 Normal observing

5.1.1.1 Continuum and Spectral Imaging Mode

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2128	**Continuum and spectral line imaging mode.** Both SKA1 telescopes shall be capable of operating in a Continuum and Spectral-line imaging mode concurrently.	Accepted	ConOps[2]	Demonstration

5.1.1.2 Pulsar Search Mode

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2129	**Pulsar Search Mode.** The SKA1_mid telescope shall be capable of operating in a Pulsar search mode, concurrently with Continuum imaging mode.	Accepted	ConOps[2]	Demonstration

5.1.1.3 Pulsar Timing Mode

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2130	**Pulsar Timing Mode.** The SKA1_mid telescope shall be capable of operating in a Pulsar timing mode, concurrently with continuum imaging mode.	Accepted	ConOps[2]	Demonstration

5.1.1.4 Simultaneous operation

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2126	**Simultaneous operation of telescopes.** Both SKA1 telescopes shall be capable of operating concurrently and independently.	Accepted	BD section 5	Demonstration

5.1.1.5 Mode transition

Requirement will enable the ability of the system to observe targets of opportunity.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2133	**Mode transition.** The switching time between telescope operating modes shall take less than 30 seconds (not including antenna slewing time)	Accepted	Operations Requirements document	Test

5.1.2 Observations on a fixed schedule

5.1.2.1 Specific epoch observations

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2681	**Specific epoch observations.** The observatory shall have the capability of scheduling observations at a specific epoch for time dependent phenomena.	Accepted	Concept of operations section 8.2	Demonstration

5.1.3 Time-critical overrides

5.1.3.1 Overriding normal processes

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2682	**Overriding normal processes.** There shall be a mechanism for requesting observing time outside the normal observing time allocation process for unpredicted phenomena or in cases of high current scientific interest.	Accepted	Concept of operations section 8.3	Inspection

5.1.3.2 Overriding allocated time

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2683	**Overriding allocated time.** The Director-General or his/her delegate shall have the power to override allocation of time to other projects.	Accepted	Concept of operations section 8.3	Inspection

5.1.4 Commensal observing

5.1.4.1 Data access rights

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2688	**Commensal Observing Data access rights.** There shall be a documented data access rights policy for commensal observing for data sets shared across projects.	Accepted	Concept of operations section 8.5	Inspection

5.1.5 Sub arrays

5.1.5.1 Sub arraying

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2127	**Sub-Arraying.** Both of the SKA1 telescopes shall be capable of operating independently with one to sixteen sub-arrays (i.e. collecting area is split and allocated to separate, concurrently observing programmes).	Accepted	BD section 5	Demonstration

5.2 Telescope Manager

5.2.1 General

5.2.1.1 Authentication and Authorisation

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2736	**Authentication and Authorisation**. All SKA users shall require to be registered and authenticated for the purposes of proposal and project submission.	Accepted	ConOps 4.6	Demonstration

5.2.1.2 Scheduled Maintenance Logs

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2278	**Scheduled maintenance logs**. A maintenance database shall be established that logs all the scheduled maintenance and unexpected repairs.	Accepted	Operational Concepts[3]	Demonstration

5.2.1.3 System error logs

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2279	**System error logs.** A failure database shall be established, which logs the errors of the system and its subsystems, including the corrective actions taken.	Accepted	Operational Concepts[3]	Demonstration

5.2.1.4 System status

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2280	**System status.** The system shall extract information about the current condition of the system from the science and calibration data streams, and log this information along with other relevant system and environmental status information. Based on this information, it shall be possible to monitor, save, and analyse the technical performance of the system.	Accepted	ConOps 5.2	Demonstration

5.2.1.5 Central location for data bases

The telescope must control the information used by Elements.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2282	**Central location for data bases.** External sources of information used by the Elements shall be cached by Telescope Manager. No sources other than those cached by TM shall be used.	Accepted	ConOps 5.2	Demonstration

5.2.1.6 Target of opportunity

Certain classes of astronomical transient events occur at frequent and unpredictable intervals (e.g. gamma ray bursts). Principal Investigators wishing to study such events as a class are required to submit proposals at the time of regular proposal submission. Such an object is designated as a Target of Opportunity. In circumstances meeting the proposed conditions, observations of the TOO will be triggered.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2283	**Target of opportunity.** TOO observing shall be via Scheduling Blocks.	Accepted	ConOps 4.2	Test

5.2.1.7 Latency of TOO scheduling block initiation

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2285	**Latency of TOO scheduling block initiation**. Scheduling intervention on TOO triggers shall be initiated within 1s of receiving the trigger.	Accepted	SKA-SYS_REQ-2283	Test

5.2.1.8 Discard previous scheduling block.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2286	**Discard previous scheduling block.** At the launching of a TOO Scheduling Block, the results from any active Scheduling Blocks shall be discarded.	Accepted	ConOps 4.3	Test

5.2.2 Proposal submission

5.2.2.1 Proposal submission

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2289	**Proposal submission.** Program submission, assessment, and time allocation shall governed by an official policy document	Accepted	ConOps 4.1	Inspection

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2723	**Proposal submission tool.** There shall be a tool to facilitate the assessment, review and ranking of proposals, guided by official SKA Policies.	Accepted	ConOps 4.1	Test

5.2.3 Tool for proposal submission

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2647	**Tool for proposal submission.** There shall be a tool, either web or client, for the construction and submission of proposals, as necessary facilitating access to relevant sources of information such as Telescope characteristics, previous observations, SIMBAD, templates.	Accepted	SKA1-SYS-REQ-2647	Test

5.2.4 Telescope Scheduling

Scheduling Blocks are the indivisible executable units of a project and contain all the information necessary to execute a single observation, including configuration, and scripts to be executed.

5.2.4.1 Pre and post conditions

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2290	**Pre and post conditions.** Scheduling Blocks shall have computable pre- and post-conditions.	Accepted	SYS_REQ-2290	Demonstration

5.2.4.2 Semester Queue (of duration related to the proposal cycle)

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2291	**Semester queue**. A Semester Queue (SQ) shall be constructed by Operations following acceptance of proposals.	Accepted	ConOps 4.2	Demonstration

5.2.4.3 Operations responsible for Short Term Schedule

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2292	**Operations: Operations** shall be responsible for constructing an executable schedule and Scheduling Blocks and submitting for execution.	Accepted	ConOps 4.1	Inspection

5.2.4.4 Short term schedule construction tool

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2293	**Short term schedule construction tool.** There shall be an interactive tool to aid the proposer in constructing Scheduling Blocks and an executable schedule.	Accepted	ConOps 4.2	Demonstration

5.2.4.5 API for construction of schedule

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2646	**API for construction of schedule.** There shall be a API or APIs for the construction of scheduling blocks from Python and Java.	Accepted	ConOps 4.2	Test

5.2.4.6 Simulated execution of scheduling blocks.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2294	**Simulated execution of scheduling blocks.** The scheduling tool shall offer the option to simulate execution of Scheduling Blocks in order to verify correctness and scientific performance at some limited level of accuracy.	Accepted	ConOps 4.2	Demonstration

5.2.4.7 Operator control

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2735	**Operator control.** It shall be possible for the operator to take manual control of the telescope.	Accepted	Operational Concepts[3]	Test

5.2.5 Response to internal detections of transients

5.2.5.1 Response policy

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2295	**Response policy.** The nature of the response to a transient event shall be controlled by policy administered by Telescope Manager.	Accepted	ConOps 8.3	Inspection

5.2.5.2 Responses to transients

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2296	**Responses to transients** Responses shall be one of the following (a) invoking a special mode on the telescope of origin, (b) issuing an VOEvent, (c) issuing a TOO announcement to SKA Telescopes, (d) no action.	Accepted	ConOps 8.3	Demonstration

5.2.5.3 Observing mode latency

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2297	**Observing mode latency** The maximum allowed latency between event and detection shall be allowed to be Observing Mode dependent.	Accepted	ConOps 8.3	Demonstrate

5.2.5.4 Rules for issuing VOEvents.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2298	**Rules for issuing VOEvents** Proposals to search for transients shall include rules for issuing VOEvents.	Accepted	ConOps 8.3	Demonstration

5.2.5.5 Latency of initiating response

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2299	**Latency of initiating a response.** Response to an event shall be initiated within 1 second of notification.	Accepted	ConOps 8.3	Test

5.2.6 Response to external detections of transients

5.2.6.1 TOO VOStreams

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2300	**TOO VOStreams**. TOO proposals shall include specified VOEvent streams to be monitored.	Accepted	ConOps 8.3	Test

5.2.6.2 VOEvent issue latency

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2301	**VOEvent issue latency**. A qualifying VOEvent shall lead to initiation of a response by the Telescope Manager within 1 second.	Accepted	ConOps 8.3	Test

5.2.7 Telescope model

The telescope model is shared across the entire Telescope. It describes the telescope via:

- Structural and behavioural models
- Specific equations, such as geodetic, geometric, antennas, pointing
- Configuration parameters such as frequency setups, pointing, sky direction,
- Labelling information such as names and ids

5.2.7.1 Telescope Model

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2645	**Telescope model.** A dynamic computational model of the Telescope shall be used to answer all queries about the state of the Telescope. The telescope model shall consist of configuration information, numerical models, empirical parameters, and conventions.	Accepted	ConOps 5.2	Demonstration

5.2.7.2 Single geodetic model

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2302	**Single geodetic model (Telescopes).** There shall be a single geodetic model for all telescopes, published as part of the Telescope Model.	Accepted	SYS_REQ-2645	Demonstration

5.2.7.3 Single geometric model

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2303	**Single geometric model.** There shall be a single geometric model for all receptor types, published by TM.	Accepted	SYS_REQ-2645	Demonstration

5.2.7.4 Dish pointing model

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2304	**Dish pointing model.** The dish receptor system shall include a model for pointing including structural model, thermal model, reference pointing model, and refraction model, published by TM.	Accepted	SYS_REQ-2321	Demonstration

5.2.7.5 AA element and station beam model

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2305	**AA element and station beam model.** The AA receptor system shall include a model for element and station beams as a function of azimuth and zenith angle, frequency, and polarisation, published by TM.	Accepted	SYS_REQ-2321	Demonstration

5.2.8 Forensic analysis of telescope behaviour

5.2.8.1 Forensic tool for telescope behaviour

This will draw upon the monitor data archive, the System Configuration database, Alarm Log, Calibration data, and other related sources of information.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2306	**Forensic tool for telescope behaviour** There shall be an interactive forensic tool for evaluating and understanding the state and behaviour of the system at any one time.	Accepted	ConOps 5.1	Demonstration

5.2.8.2 Interfaces

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2307	**Interfaces.** The interactive forensic tool shall have an Internet interface with availability on a range of platforms including desktop and mobile devices.	Accepted	SYS_REQ_2306	Demonstration

5.2.8.3 Replay of sequences

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2308	**Replay of sequences**. The interactive forensic tool shall allow replay of selected sequences.	Accepted	SYS_REQ_2306	Demonstration

5.2.9 Alarms

5.2.9.1 Active alarms

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2309	**Active alarms.** Alarm notification shall be active (via SMS, email, etc.) rather than passive (requiring an Operator query)	Accepted	SYS_REQ_2306	Demonstration

5.2.9.2 Alarm filtering

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2310	**Alarm filtering**. It shall be possible to filter alarms individually or by group.	Accepted	Operational Concepts[3]	Demonstration

5.2.9.3 Alarm latency

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2312	**Alarm latency.** Latency from event to alarm shall be no more than 5 seconds.	Accepted	Operational Concepts[3]	Test

5.2.10 Data bases

5.2.10.1 Access to historical data

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2313	**Access to historical data.** All current and historic Site monitor data shall be as examinable as that from any telescope component.	Accepted	ConOps 5.2	Demonstration

5.2.10.2 Total Electron Content

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2314	**Total electron content.** The SKA Phase 1 TM shall retrieve, persist and publish data on Total Electron Content (TEC) from dual frequency GPS as part of the Telescope Model.	Accepted	SYS_REQ-2645	Inspection

5.2.10.3 Ionospheric Activity

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2315	**Ionospheric activity.** There shall be timely access to information from other relevant sources e.g. IPS concerning unusual ionospheric activity or alerts.	Accepted	SYS_REQ-2645	Demonstration

5.2.10.4 Weather Station

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2316	**Weather station**. There shall be a data base for site weather station data.	Accepted	SYS_REQ-2645	Demonstration

5.2.10.5 Satellites

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2317	**Satellites.** There shall be a database of relevant satellite trajectories, including orbit	Accepted	SYS_REQ-2645	Demonstration

	information, emission characteristics and owner.			

5.2.10.6 Commercial flights

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2318	**Commercial flights.** There shall be a data base of commercial flights in the neighbourhood of the site.	Accepted	SYS_REQ-2645	Demonstration

5.2.10.7 RFI

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2734	**RFI database.** There shall be a database holding information about RFI.	Accepted	ConOps 4.3	Demonstration

5.3 Science Data processor

5.3.1 Calibration and imaging formalism

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2729	**Calibration and imaging formalism.** The Calibration and Imaging formalism shall be based upon the Rau framework [14].	Accepted	Reference [1]	Demonstration

5.3.2 Calibration model

5.3.2.1 Closed loop calibration

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2319	**Closed loop calibration.** The telescope calibration shall be solved by comparison of observed with GSM predictions with a time scale appropriate to the component and physical effect being calibrated and fed back to the telescope.	Accepted	ConOps 4.3	Demonstration

5.3.3 Imaging model

5.3.3.1 Global Sky Model

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2322	**Global sky model.** Calibration and continuum subtraction shall use a Local Sky Model, derived from a Global Sky Model or previous Local Sky Model.	Accepted	ConOps 9.8	Demonstration

5.3.3.2 Multi-frequency synthesis imaging

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2324	**Multi-frequency synthesis imaging**. All imaging shall construct and make use of frequency dependent image models over the entire observed bandwidth.	Accepted	Reference [2]	Demonstration

5.3.3.3 Deconvolution of single channels

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2325	**Deconvolution of single channels** Scale sensitive two-dimensional (i.e. on the tangent plane) deconvolution shall be available.	Accepted	Reference [1]	Demonstration

5.3.3.4 Solution for pointing errors

Pointing self-calibration has been demonstrated on EVLA data.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2328	**Solution for pointing errors.** It shall be possible to solve for and correct time- and station-dependent pointing errors with accuracy and timescale limited by signal to noise ratio.	Accepted	Reference [1]	Demonstration

5.3.3.5 Peeling

Peeling is defined as the solution for and subtraction of both source model and calibration parameters for a relatively compact source.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2330	**Peeling.** Peeling of bright sources (strength limited by signal to noise ratio) from the visibility data shall be possible.	Accepted	ConOps 9.8	Demonstration

5.3.4 Direction dependent effects

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2321	**Direction dependent effects.** Self-calibration and image reconstruction algorithms shall be capable of dealing with direction dependent effects.	Accepted	Baseline Design 8.7	Demonstration

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2724	**Aperture Array DDE**. There shall be a direction dependent model for the aperture array primary beam to be used in calibration and imaging.	Accepted	SYS_REQ-2321	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2727	**Dish DDE.** There shall be a direction dependent model for the dish primary beam to be used in calibration and imaging.	Accepted	SYS_REQ-2321	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2725	**Faraday rotation DDE.** There shall be a direction dependent Faraday Rotation model for use in calibration and imaging.	Accepted	SYS_REQ-2321	Test

5.3.5 Image processing model

5.3.5.1 Continuum source finding

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2333	**Continuum source finding.** Where appropriate, continuum source finding shall be conducted on images generated by the Continuum Imaging pipeline. Polarization shall be fitted if available.	Accepted	ConOps 4.3	Test

5.3.5.2 Spectral line source finding

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2334	**Spectral line source finding.** Where appropriate, spectral line source finding shall be conducted on image cube generated by the Spectral Line pipeline.	Accepted	ConOps 4.3	Test

5.3.5.3 Stacking

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2335	**Stacking.** Where appropriate, spectral line stacking shall be conducted on image cubes generated by the pipelines using *a priori* known source lists.	Accepted	ConOps 4.3	Test

5.3.6 Pipelines

5.3.6.1 Standard pipeline products

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2336	**Standard pipeline products.** All pipelines shall include as data products the pipeline processing log, and Quality Assessment log.	Accepted	ConOps 4.5	Test

5.3.6.2 Calibration pipeline

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2338	**Calibration pipeline.** There shall be a Calibration pipeline that derives current telescope parameters using a recent observation and a Global Sky Model, either a known GSM or the most recent GSM.	Accepted	ConOps 4.4	Test

5.3.6.3 Continuum imaging pipeline

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2339	**Continuum imaging pipeline.** There shall be a Continuum Imaging pipeline that shall have the goal of constructing noise-limited wide-band images for observations up to 1000h integration time. Polarisation shall be available if requested or necessary for calibration or quality assurance.	Accepted	SYS_REQ-2128	Test

5.3.6.4 Continuum imaging data products

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2340	**Continuum imaging data products.** The Data Products shall include the first n moment images for multi-frequency synthesis, corresponding residual images (if deconvolved), sensitivity image and representative PSF image, where n is set by signal to noise ratio.	Accepted	SYS_REQ-2128	Test

5.3.6.5 Spectral line emission pipeline

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2341	**Spectral line emission pipeline.** There shall be a Spectral Line Emission pipeline that is optimised for constructing noise-limited (up to 1000h integration) channel cubes of spectral line emission either with continuum emission remaining or with continuum emission removed.	Accepted	SYS_REQ-2128	Test

5.3.6.6 Spectral line emission data products

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2342	**Spectral line emission data products.** The data products shall include spectral line cube image, continuum model images, sensitivity image, and representative point spread function.	Accepted	SYS_REQ-2128	Test

5.3.6.7 Spectral line absorption pipeline

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2343	**Spectral line absorption pipeline.** There shall be a Spectral Line Absorption pipeline that is optimised for constructing noise-limited channel cubes of spectral line absorption with continuum sources removed.	Accepted	SYS_REQ-2128	Test

5.3.6.8 Spectral line absorption data products

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2344	**Spectral line absorption data products.** The data products shall include spectral line cube image, continuum model images, sensitivity image, and representative point spread function.	Accepted	SYS_REQ-2128	Test

5.3.6.9 Slow transient pipeline

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2345	**Slow transient pipeline.** There shall be a Slow Transient imaging pipeline that shall be capable of constructing a continuum image after a GSM has been subtracted for every correlator integration time or slower, searching for transient sources, and producing a time-ordered catalogue.	Accepted	SYS_REQ-2131	Test

5.3.6.10 Slow transient data products

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2346	**Slow transient data products.** The data products shall include a catalogue of found sources, a sensitivity image, and representative PSF image.	Accepted	SYS_REQ-2131	Test

5.3.6.11 Automated Quality Assessment

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2347	**Automated Quality Assessment.** All pipelines shall perform standardised, automated Quality Assessment of Images along the axes of astrometry, photometry, radiometry, polarimetry, and spectrometry.	Accepted	ConOps Section 2.1	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2742	**Performance assessment:** Performance assessment shall be based on multi-valued functions of an observed Image and optionally a template Image.	Accepted	ConOps Section 2.1	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2743	**Performance Goals:** Performance goals shall be based on multi-valued functions of an observed Image and optionally a template Image.	Accepted	ConOps Section 2.1	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2744	**Quality assessment:** Quality assessment shall be based on the comparison of a Performance Assessment and a Performance Goal.	Accepted	ConOps Section 2.1	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2745	**Astrometric performance metric:** The Astrometric performance metric (APM) shall measure deviation (rms, average offset, and med) of source positions from known standards.	Accepted	ConOps Section 2.1	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2746	**Photometric performance metric:** The Photometric performance metric (PPM) shall measure deviation (rms, average offset, and med) of source fluxes from known standards.	Accepted	ConOps Section 2.1	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2747	**Radiometric performance metric:** The Radiometric performance metric (RPM) shall measure noise fluctuations (rms, average offset, and med) in an Image.	Accepted	ConOps Section 2.1	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2748	**Polarimetric performance metric:** The Polarimetric performance metric (OPM) shall measure deviation (rms, average offset, and med) of source polarisations (polarisation degree and angle) from known standards.	Accepted	ConOps Section 2.1	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2749	**Spectrometric performance metric:** The Spectrometric performance metric (SPM) shall measure deviation (rms, average offset, and med) of source spectral lines from known standards.	Accepted	ConOps Section 2.1	Test

5.3.7 Data Products

5.3.7.1 Archive

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2821	**Archive.** There shall be an archive for each telescope, located in the Science Processing Centre, for storing selected science data products for subsequent access by users according to science data access policy.	Accepted	ConOps	Demonstration

5.3.7.2 Role of science processing centres

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2348	**Role of science processing centres.** The science-processing centre will convert the output data from the CSP into science data products to be stored in the science data archive.	Accepted	ConOps 4	Test

5.3.7.3 Mirror sites

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2350	**Mirror sites.** All data within Science Archives shall have a secondary copy located offsite in a secure location.	Accepted	ConOps 4.5	Test

5.3.7.4 Web interface

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2352	**Web interface.** The science data archives shall be accessible from the internet via a standardised web interface.	Accepted	ConOps 4.5	Demonstration

5.3.7.5 VO interface

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2353	**Virtual Observatory interface.** The science data archives shall be accessible via a set of recommended IVOA services chosen to allow access to all approved data products.	Accepted	ConOps 4.5	Test

5.3.7.6 Archive API

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2354	**Archive API.** The science data archives shall publish a user accessible, open API in a small number of complementary languages such as Python, C++, and Java.	Accepted	ConOps 4.5	Test

5.3.7.7 Data product provenance

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2355	**Data product provenance.** An official data product shall have known, documented provenance, and shall have been produced via SKA observations and processing.	Accepted	ConOps 4.5	Definition

5.3.7.8 QA annotation

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2357	**QA annotation.** The telescope shall facilitate the addition of QA annotations by Users.	Accepted	ConOps 4.6	Test

5.3.7.9 Third party data products

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2358	**Third party data products.** Third party data products shall not be admitted to the archive.	Accepted	ConOps 4.5	Inspection

5.3.7.10 Operations DP archive policy

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2360	**Science data product archive policy.** There shall be a policy, developed and administered by Operations, governing which types and sizes of data products will be retained in the archive and for how long.	Accepted	ConOps 4.5	Inspection

5.3.7.11 Archive Access

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2361	**Archive access.** A telescope archive will be nominally open for access 24/7/365, with no more than 24 hrs planned downtime per year. Unplanned downtime shall be consistent with availability budget.	Accepted	ConOps 4.5	Test

5.3.7.12 Archive lifetime

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2363	**Archive lifetime.** The science data archives shall be designed to provide an archived data lifetime of not less than 50 years from the start of archived observations.	Accepted	ConOps 4.5	Inspection

5.3.7.13 Data migration design

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2728	**Data migration design.** The archive design shall support and facilitate migration from one medium to another.	Accepted	ConOps 4.5	Demonstration

5.3.7.14 Data migration plan

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2364	**Data migration plan.** Operations shall maintain at all times and update yearly a current data migration plan covering the contingency of moving from one archive platform to another.	Accepted	ConOps 4.6	Inspection

5.3.7.15 Distribution of data products

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2366	**Distribution of data products.** As limited by resource constraints, it will be possible to deliver science data products to approved off-site facilities, which may be globally distributed.	Accepted	ConOps 4.5	Test

5.3.7.16 Backup archive retrieval

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2660	**Backup archive retrieval**. Backup archive items shall be retrievable to the full archive from an alternate source within 24 hours	Accepted	ConOps 4.5	Demonstration

5.3.7.17 Backup archive user access conversion

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2661	**Backup archive user access conversion.** Users shall have access to the data of the entire archive within one week following an incident.	Accepted	ConOps 4.5	Demonstration

5.3.7.18 Levels of access

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2739	**Levels of access**. Access to the archive shall be either anonymous with correspondingly limited capabilities or via SKA authentication and authorisation.	Accepted	ConOps 4.6	Test

5.3.8 Early Science

5.3.8.1 Processing

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2657	**Processing capability.** SDP processing per telescope at Early Science shall support processing rates 10% of that required for Full Observing (decimation being in any or all of time, frequency, field of view)	Accepted	Root	Test

6 Synchronisation and Timing

6.1 Synchronisation

6.1.1 Coherence losses: 1s

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2268	**Coherence losses 1s.** The SKA frequency reference system shall provide a 2% maximum coherence loss , equivalent to 0.2 radians, within a maximum integration period of 1s.	Accepted	Baseline Design addendum SKA-TEL.SKO-DD-003	Demonstration

6.1.2 Coherence loss : 1 min.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2692	**Coherence loss 1min**. The SKA frequency reference system shall provide a 2% maximum coherence loss , equivalent to 0.2 radians, within a maximum solution interval for in-beam calibration of 1 minute.	Accepted	Baseline Design Addendum SKA-TEL-SKO-DD-003	Demonstration

6.1.3 Frequency reference linear phase drift

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2693	**Frequency reference phase drift.** The SKA Frequency Reference System shall have a phase drift of less than 1 radian, over calibration intervals of up to 10 minutes, when using out of beam calibration sources.	Accepted	Baseline design addendum SKA-TEL.SKO-DD-003	Demonstration

6.1.4 Pulse per Second precision

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2269	**Pulse per Second precision.** The SKA synchronisation and timing system shall provide a 1 pps heartbeat signal, precise to the sampling clock (the pulse-to-pulse scatter is less than one sampling time), derived from the distributed frequency reference.	Accepted	Baseline design addendum SKA-TEL.SKO-DD-003	Test

6.1.5 Pulse per second phase relative to UTC

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2695	**Pulse per second phase relative to UTC.** The SKA synchronisation and timing system shall provide a 1PPS heartbeat signal with phase relative to UTC that over a 10 minute calibration interval shall survive synchronisation loss.	Accepted	Baseline design addendum SKA-TEL-SKO-DD-003	Demonstration

6.2 Timing

6.2.1 UTC accuracy

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2274	**UTC accuracy**. The SKA1 timescale shall be connected to UTC with an accuracy of 10 ns, on a timescale of 10 years.	Accepted	Baseline design addendum SKA-TEL-SKO-DD-003	Analysis

6.2.2 Central frequency reference

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2275	**Central frequency reference.** In order to avoid large offsets, the central frequency reference shall be steered to UTC to within at least 1 microsecond, with a frequency drift of less than 10 ns/day.	Accepted	Baseline design addendum SKA-TEL-SKO-DD-003	Demonstration

6.2.3 SKA1 UTC offsets

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2276	**SKA1 UTC offsets.** The solution period for the calculation of offsets between SKA1 timescale and UTC shall be less than 1 day	Accepted	Baseline design addendum SKA-TEL-SKO-DD-001	Demonstration

7 Infrastructure

7.1 Site Monitoring

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2370	**Weather Monitoring**. Weather monitoring stations (2 No at each core and 2 No within each spiral arm) shall be provided as part of the infrastructure - wind, temperature and humidity.	Accepted	Operations Concept Plan. Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and Codes of Practice (as adopted)	Inspection

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2371	**Visual monitoring.** The infrastructure shall provide day and night time capability for the operator(s) to visually monitor all antennas: for Dish antennas this shall be at every dish, for LFAA this shall be located at each station and also around the perimeter of the core area. Monitoring to deliver images at least one per minute for purposes of security and general telescope visual monitoring and shall be able to detect personnel at each dish and within each LFAA station.	Accepted	Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and Codes of Practice (as adopted).	Inspection

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2730	**RFI Monitoring.** Permanent stations and mobile RFI monitoring units shall be provided as part of infrastructure.	Accepted	Concept of Operations [2] 5.3	Inspection

7.2 Tropospheric Monitoring

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2372	**Tropospheric Monitoring**. Existing Tropospheric monitoring stations shall be expanded as part of the SKA1 infrastructure to provide at least 3 No sensor units in each of the Australia and South Africa locations.	Accepted	Baseline Design 1.3.1 and 8.3	Inspection

7.3 Power

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2373	**Low RFI power delivery.** The power delivery infrastructure shall comply with the SKA1 RFI levels documentation.	Accepted	SYS_REQ-2462	Test

7.4 Access

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2374	**Site Access**. Roads and track-ways (including drainage) for the safe, secure and economic construction and operation of the SKA1 shall be provided.	Accepted	Baseline Design 15.1.4 and 16.1.4	Analysis and Inspection

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2375	**Air-strip**. There shall be access to an air strip on site.	Accepted	Baseline Design 15.1.5 and 16.1.5	Inspection

7.5 Water and Sanitation

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2376	**Construction.** Potable and non-potable water shall be available at SKA1 construction camps including foundation concrete plants.	Accepted	Baseline Design 15.1.5 and 16.1.5	Inspection

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2377	**Steady state.** Sufficient water shall be continually available at SKA1 facilities in support of equipment cooling for each telescope.	Accepted	Baseline Design 15.1.5 and 16.1.5	Inspection

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2378	**Standards and Regulations.** The delivery and disposal of water and all construction activity shall be compliant with local and national standards and regulations.	Accepted	Regulatory	Analysis

7.6 Buildings

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2382	**Central Processing Facility RFI shielding**. Each Central Processing Facility shall provide RFI shielding greater than that derived from zoning specifications given in the SKA RFI levels documentation (to be published by T0 + 12w).	Accepted	Baseline Design 14 and SYS_REQ-2462	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2383	**Central Processing Facility RFI penetrations**. The Central Processing Facility shall provide RFI compliant penetrations for signal and power cables entering the facility and also for all other penetrations.	Accepted	Baseline Design 14 and SYS_REQ-2462	Inspection

7.7 Antenna earthing and bonding

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2397	**Dish Antenna earthing**. For lightning protection of each dish antenna the earthing system shall conform to the requirements of IEC 62305 and also to national standards SANS 10142 and 10313. National standards shall take precedence.	Accepted	Established precedent	Test

7.8 Telephone network

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2398	**Telephone Network**. All populated facilities shall provide connectivity to the public telephone network.	Accepted	Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and Codes of Practice (as adopted).	Test

7.9 Vehicles

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2400	**Communication.** All vehicles used on site shall be equipped with long range communication devices.	Accepted	Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and Codes of Practice (as adopted)	Demonstration

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2401	**Training.** All drivers on or to the sites shall have appropriate awareness training.	Accepted	Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and Codes of Practice (as adopted)	Inspection

8 External Interfaces

8.1 Power

8.1.1 Site steady state power budget Africa

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2402	**Site steady state power budget Africa.** The total steady state power budget for the African site shall be within the limits specified in SKA Power Budget SKA-SE-POW-TN-001 [21].	Accepted	SKA Power Budget SKA-SE-POW-TN-001 [21]	Test

8.1.2 Site steady state power budget Australia

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2404	**Site steady state power budget Australia**. The total steady state power budget for the Australian site shall be within the limits specified in SKA Power Budget SKA-SE-POW-TN-001 Revision 1 [21].	Accepted	SKA Power Budget SKA-SE-POW-TN-001 Revision 1 [21]	Test

8.2 Time Reference

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2769	**Time Reference:** SKA1 shall use a time reference derived from Global Positioning System (GPS).	Accepted	Baseline Design	Inspection

8.3 VLBI

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2838	**VLBI data sources.** The SKA1_Mid telescope shall be a data source for VLBI data acquisition system. The interface between the SAK1_Mid telescope and the external VLBI data acquisition system shall be compliant with the ICD SKA-TEL-SKO-0000116	Accepted	Baseline Design	Demonstration

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2839	**Provision of equipment for recording**. Provision of equipment for recording or capturing VLBI data is outside the scope of SKA1	Accepted	Baseline Design	Demonstration

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2840	**VLBI equipment and eVLBI connectivity.** VLBI equipment and eVLBI connectivity beyond the interface boundary described in the ICD SKA-TEL-SKO-0000116 is outside the scope of supply of the SKA1 project.	Accepted	Baseline Design	Demonstration

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2841	**Infrastructure for VLBI equipment:.** The following infrastructure shall be provided to allow eventual outfitting of SKA1_Mid with VLBI equipment: 1. Adequate access for the potential fitment of VLBI equipment 2. Equipment space 3. Power 4. Cooling 5. Cable trays	Accepted	Baseline Design	Demonstration

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2842	**Provision for VLBI terminal**. Provision for VLBI terminals or equivalent equipment shall be made in the Science Processing Centres for the associated telescopes.	Accepted	Baseline Design	Demonstration

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2843	**Compatibility with existing VLBI terminal.** SKA1 shall be able to output VLBI beam data with each individual stream limited to 512 MHz of signal bandwidth to ensure compatibility with existing VLBI terminal capability	Accepted	Baseline Design	Demonstration

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2844	**VLBI Processing**. VLBI processing, with the exception of beam-forming and SKA1 imaging in support of VLBI. is outside the scope of the SKA1	Accepted	Baseline Design	Demonstration

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2845	**VLBI beam output data.** SKA1 shall be able to produce VLBI beam output data with either dual or single polarization	Accepted	Baseline Design	Test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2846	**Word length of VLBI beam output data**. SKA1 shall be able to output VLBI beam data with configurable word formats, the allowed values being 2, 4, 8, and 16-bit integer.	Accepted	Baseline Design	Test

9 Internal Interfaces

9.1 AIV

9.1.1 MeerKAT to SKA1_mid CSP interface

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2410	**MeerKAT to SKA1_mid CSP interface**. The interface between MeerKAT and SKA1_mid CSP shall be compliant with SKA-TEL.AIV.SE-TEL.CSP.SE-ICD-001 Interface Control Document	Accepted	SKA-TEL.SE.INTERF-SKO-MP-001 section 3.2.3	Test

9.1.2 MeerKAT to SKA1_Mid SADT

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2412	**MeerKAT to SKA1_mid SADT interface**. The interface between MeerKAT and SKA1_mid SADT shall be compliant with SKA-TEL.AIV.SE-TEL.SADT.SE-ICD-001 Interface Control Document	Accepted	SKA-TEL.SE.INTERF-SKO-MP-001 section 3.2.3	Test

9.1.3 MeerKAT to SKA1_Mid TM

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2414	**MeerKAT to SKA1_mid SADT interface**. The interface between MeerKAT and SKA1_mid SADT shall be compliant with SKA-TEL.AIV.SE-TEL.TM.SE-ICD-001 Interface Control Document.	Accepted	SKA-TEL.SE.INTERF-SKO-MP-001 section 3.2.3	Test

9.1.4 MeerKat to SKA1_INFRA

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2775	**MeerKAT to SKA1_INFRA interface.** The interface between MeerKAT and SKA1_INFRA shall be compliant with SKA-TEL.AIV.SE-TEL.INFRA.SE-ICD-001 Interface Control Document.	Accepted	SKA-TEL.SE.INTERF-SKO-MP-001 section 3.2.3	Test

9.2 Central Signal Processor

9.2.1 CSP to Infra

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2416	**CSP to Infra interface**. The interface between CSP and Infra shall be compliant with the SKA-TEL.CSP.SE-TEL.INFRA.SE-ICD-001 Interface Control Document.	Accepted	SKA-TEL.SE.INTERF-SKO-MP-001 section 3.2.3	Test

9.2.2 CSP to SDP

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2738	**CSP to SDP interface**. The interface between CSP and SDP shall be compliant with the SKA-TEL.SDP.SE-TEL.CSP.SE-ICD-001 Interface Control Document	Accepted	SKA.TEL.SE.INTERF-SKO-MP-001 section 3.2.3	Test

9.3 Dish

9.3.1 Dish to CSP

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2418	**Dish to CSP interface**. The interface between CSP and Dish shall be compliant with the SKA-TEL.DSH.SE-TEL.CSP.SE-ICD-001 Interface Control Document.	Accepted	SKA-TEL.SE.INTERF-SKO-MP-001 section 3.2.3	Test

9.3.2 DSH to Infra

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2419	**Dish to Infra interface**. The interface between Dish and Infra shall be compliant with the SKA-TEL.DSH.SE-TEL.INFRA.SE-ICD-001 Interface Control Document.	Accepted	SKA-TEL.SE.INTERF-SKO-MP-001 section 3.2.3	Test

9.4 Low Frequency Aperture Array

9.4.1 LFAA to CSP

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2420	**LFAA to CSP interface**. The interface between LFAA and CSP shall be compliant with the SKA-TEL.LFAA.SE-TEL.CSP.SE-ICD-001 Interface Control Document.	Accepted	SKA-TEL.SE.INTERF-SKO-MP-001 section 3.2.3	Test

9.4.2 LFAA to Infra

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2421	**LFAA to Infra interface**. The interface between LFAA and INFRA shall be compliant with the SKA-TEL.LFAA.SE-TEL.INFRA AUS.SE-ICD-001Interface Control Document.	Accepted	SKA-TEL.SE.INTERF-SKO-MP-001 section 3.2.3	Test

9.5 SADT

9.5.1 SADT to DSH

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2422	**SADT to DSH interface**. The interface between SADT and DSH shall be compliant with the SKA-TEL.SADT.SE-TEL.DSH.SE-ICD-001 Interface Control Document.	Accepted	SKA-TEL.SE.INTERF-SKO-MP-001 section 3.2.3	Test

9.5.2 SADT to LFAA

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2423	**SADT to LFAA interface**. The interface between SADT and LFAA shall be compliant with the SKA-TEL.SADT.SE-TEL.LFAA.SE-ICD-001 Interface Control Document.	Accepted	SKA-TEL.SE.INTERF-SKO-MP-001 section 3.2.3	Test

9.5.3 SADT to CSP

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2424	**SADT to CSP interface**. The interface between SADT and CSP shall be compliant with the SKA-TEL.SADT.SE-TEL.CSP.SE-ICD-001 Interface Control Document.	Accepted	SKA-TEL.SE.INTERF-SKO-MP-001 section 3.2.3	Test

9.5.4 SADT to SDP

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2425	**SADT to SDP interface**. The interface between SADT and SDP shall be compliant with the SKA-TEL.SADT.SE-TEL.SDP.SE-ICD-001 Interface Control Document.	Accepted	SKA-TEL.SE.INTERF-SKO-MP-001 section 3.2.3	Test

9.5.5 SADT to Infra

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2426	**SADT to Infra interface**. The interface between SADT and Infra shall be compliant with the SKA.TEL.SADT.SE-TEL.INFRA.SE-ICD-001 Interface Control Document.	Accepted	SKA-TEL.SE.INTERF-SKO-MP-001 section 3.2.3	Test

9.6 Telescope Manager

9.6.1 TM to DISH

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2427	**TM to Dish interface**. The interface between TM and Dish shall be compliant with the SKA-TEL.TM.SE-TEL.DSH.SE-ICD-001. Interface Control Document.	Accepted	SKA-TEL.SE.INTERF-SKO-MP-001 section 3.2.3	Test

9.6.2 TM to LFAA

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2428	**TM to LFAA interface**. The interface between TM and LFAA shall be compliant with the SKA-TEL.TM.SE-TEL.LFAA.SE-ICD-001 Interface Control Document.	Accepted	SKA-TEL.SE.INTERF-SKO-MP-001 section 3.2.3	Test

9.6.3 TM to SADT

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2429	**TM to SADT interface**. The interface between TM and SADT shall be compliant with the SKA-TEL.TM.SE-TEL.SADT.SE-ICD-001 Interface Control Document.	Accepted	SKA-TEL.SE.INTERF-SKO-MP-001 section 3.2.3	Test

9.6.4 TM to CSP

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2430	**TM to CSP interface**. The interface between CSP and TM shall be compliant with the SKA-TEL.CSP.SE-TEL.TM.SE-ICD-001. Interface Control Document.	Accepted	SKA-TEL.SE.INTERF-SKO-MP-001 section 3.2.3	Test

9.6.5 TM to INFRA

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2737	**TM to INFRA Interface.** The interface between TM and INFRA shall be compliant with the SKA.TEL.TM.SE-TEL.INFRA.SE-ICD-001 Interface Control Document.	Accepted	SKA.TEL.SE.INTERF-SKO-MP-001	Test

9.7 Science Data Processor

9.7.1 SDP to TM

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2431	**SDP to TM interface**. The interface between SDP and TM shall be compliant with the SKA-TEL.SDP.SE-TEL.TM.SE-ICD-001 Interface Control Document.	Accepted	SKA-TEL.SE.INTERF-SKO-MP-001 section 3.2.3	Test

9.7.2 SDP to INFRA

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2432	**SDP to INFRA interface**. The interface between SDP and Infra shall be compliant with the SKA.TEL.SDP.SE-TEL.INFRA.SE-ICD-001 Interface Control Document.	Accepted	SKA-TEL.SE.INTERF-SKO-MP-001 section 3.2.3	Test

10 RFI and EMC

10.1 Electromagnetic Radiation

The levels and the verification procedures are described in the RFI/EMI Protection and Threshold Levels for the SKA document, which is part of the Level 1 Requirements, to be published in its final form by T0+12w

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2462	**Electromagnetic Radiation.** Any component of the observatory shall not emit electromagnetic radiation, in any of the stated frequency intervals for broad band and narrow band cases, that exceeds the SKA RFI/EMI Threshold Levels[4]	Accepted	EMI/EMC Standards[4]	Test

10.2 Self-induced RFI

The levels and testing and acceptance procedures are described in the RFI/EMI Protection and Threshold Levels for the SKA document, which will be an Applicable Document of the Level 1 Requirements, to be published in its final form by T0+12 weeks.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2463	**Self-induced RFI.** The SKA1 Telescope shall generate less self-induced RFI, within the Telescope's operating frequency bands, than the SKA RFI/EMI Protection Levels, for both broad band and narrow band cases, as specified in the "RFI/EMI Protection and Threshold Levels for the SKA" document. The SKA RFI/EMI Protection Levels are defined at the respective receiver input, and measured at the respective Telescope time series output	Accepted	EMI/EMC Standards[4]	Test

10.3 Electromagnetic Compatibility Standards

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2464	**Electromagnetic Compatibility Standards.** The SKA1 Telescopes shall be compliant with one or more of the following standards for emissions and one or more for susceptibility/immunity: *BS EN 61000-6-2. Electromagnetic compatibility (EMC). Generic standards. Immunity standard for industrial environments. *BS EN 61000-6-4 AMD2. Electromagnetic compatibility (EMC). Part 6-4. Generic standards. Emission standard for industrial environments. *BS CISPR 14-1. Electromagnetic compatibility. Requirements for household appliances, electric tools and similar apparatus. Part 1. Emission. *MIL-STD-464C	Accepted	Root	Inspection

10.4 Electricity network Electromagnetic Compatibility

The levels and verification procedures are described in the RFI/EMI Protection and Threshold Levels for the SKA document, which is part of the Level 1 Requirements, to be published in its final form by T0+12 weeks.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2465	**Electricity network Electromagnetic Compatibility.** The SKA1 telescopes shall follow the TBD code of practice for the application of Electromagnetic Compatibility (EMC) standards and guidelines in electricity utility networks.	Accepted	EMI/EMC Standards[4]	Analysis

10.5 EMC Compatibility Marking

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2466	**EMC compatibility marking.** All "off-the-shelf" equipment shall possess as a minimum the host country EMC marking.	Accepted	EMI/EMC Standards[4]	Inspection

10.6 Electromagnetic Susceptibility

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2467	**Electromagnetic susceptibility.** The observatory shall not be susceptible to terrestrial electromagnetic radiation at any frequency that significantly interferes with its normal operation.	Accepted	EMI/EMC Standards[4]	Test

10.7 Receiver linearity - space borne RFI

The levels and testing and acceptance procedures are described in the RFI/EMI Protection and Threshold Levels for the SKA document, which is part of the Level 1 Requirements, to be published in its final form by T0+12w

10.8 Receiver linearity airborne RFI

The levels and testing and acceptance procedures are described in the RFI/EMI Protection and Threshold Levels for the SKA document, which is part of the Level 1 Requirements, to be published in its final form by T0+12w

10.9 RFI flagging

An RFI mask identifies individual frequency data to the resolution of one channel and time data to the integration unit that is likely to be corrupted by RFI

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2472	**RFI flagging.** The SKA1 telescopes shall automatically flag frequency data with a resolution of one channel and time data to the resolution of the integration unit if the data is corrupted by RFI.	Accepted	EMI/EMC Standards[4]	Test

10.10 RFI excision

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2473	**RFI excision.** The SKA1 Telescopes shall automatically excise data that is corrupted by RFI.	Accepted	EMI/EMC Standards[4]	Test

10.11 RFI masking

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2474	**RFI masking.** The SKA1 Telescopes shall flag data according to a pre-selected RFI Mask.	Accepted	EMI/EMC Standards[4]	Demonstration

10.12 RFI zones of avoidance

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2475	**RFI zones of avoidance**. The SKA1 telescopes shall allow spatial zones of avoidance to be defined.	Accepted	EMI/EMC Standards[4]	Demonstration

11 Extensibility

11.1 Design for SKA2 extensibility

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2433	**Design for Extensibility**.Design trade studies for SKA1 shall include scenarios where design features are included which will allow 1. Increases in the number of receptors for SKA2 over SKA1 by a factor of 10 whilst re-using more than 90% of SKA1 hardware 2. The introduction of AIP technologies at SKA2 scales whilst re-using more than 90% of SKA1 hardware Such trade studies shall yield the incremental cost of such scenarios over those which do not include such design features.	Accepted	Baseline Design	Inspection

12 Environmental, Safety and Occupational Health (ESOH)

12.1 Environmental Protection

NOTE: This section states requirements for the protection of the environment from the impacts of SKA activities and facilities. A separate section of requirements provide details of the environmental conditions that could impact the SKA systems.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2484	**Environmental legislation and regulations.** The observatory shall be compliant with all local, State and national environmental protection legislation and regulations. NOTE: Legislation takes precedence over project/contract documentation and requirements. Omission of a law from this requirement does not affect its enforceability. Legislation is also subject to amendment and so the Environmental Laws identified during the Request for Information (copied below) may be modified by the Hosting Agreements and subsequent Acts and Amendments. Legislation and regulations identified during the response to Request for Information include: South Africa: National Environmental Management Act, 1998 ("NEMA"); National Water Act, 1998; National Environmental Management: Air Quality Act, 2004; National Environmental Management Waste Act, 2008; National Environment Management: Biodiversity Act, 2004; National Heritage Resources Act, 1999.*	Accepted	Legislation. SA - NEMA. Australia EPBC, WA EPA et al.	Analysis

	Australia: The Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act 1999. The Western Australian Environmental Protection Act 1986 The Western Australian Land Administration Act 1997 In addition, approvals will be required under the Western Australia Mining Act 1978, Heritage of Western Australia Act 1990, the Western Australian Aboriginal Heritage Act 1972 and the MRO Indigenous Land Use Agreement 2009. * Other South African environmental statutes include the Environment Conservation Act, 1989, various air pollution statutes, the National Heritage Resources Act, 1999, the Hazardous Substances Act, 1973, the Health Act, 1977, the Nuclear Energy Act, 1999, the National Nuclear Regulatory Act, 1999, the National Environmental Management: Protected Areas Act, 2003, the Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947, the Marine Living Resources Act, 1998, and the National Environmental Management: Integrated Coastal Management Act, 2008.			

12.1.1 Environmental Impact Assessment

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2790	**Environmental Impact Assessment**. The Observatory shall undertake an Environmental Impact Assessment (EIA) in accordance with the local and national environmental legislation. NOTE: the EIA shall be undertaken in accordance with: South Africa - the National Environmental Management Act (NEMA); Australia - Western Australian EPA and Commonwealth EPBC.	Accepted	SYS_REQ-2484	Inspection

12.1.2 Environment protection plan

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2483	**Environment protection plan**. An Environmental protection plan shall be developed and maintained. This shall include the management of Environmental Impact Assessments (EIA) in accordance with SA NEMA, WA EPA and Commonwealth EPBC.	Accepted	SYS_REQ-2484	Inspection

12.1.2.1 Material environmental rule compliance

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2572	**Material environmental rule compliance.** All materials used in the SKA1 design shall be fully compliant to all environmental rules applicable to the SKA1 core and remote sites.	Accepted	SYS_REQ-2484	Inspection

12.2 Safety

The safety priorities of the system shall be:

i. protection of persons,
ii. guarding the technical integrity of the observatory and other equipment potentially affected by the operation of the observatory, and
iii. protection of scientific data, in this order.

SKA Observatory hazard analysis and safety practices will be governed by an order of precedence as follows:

1. Design for Minimum Risk: The primary means for mitigation of risk shall be to eliminate the hazard through design.
2. Incorporate Safety Devices: Fixed, automatic or other protective devices shall be used in conjunction with the design features to attain an acceptable level of risk. Provisions shall be made for periodic functional checks as applicable.
3. Provide Warning Devices: When neither design nor safety items can effectively eliminate or reduce hazards, devices shall be used to detect the condition, and to produce an adequate warning to alert personnel of a hazard. Devices may include audible or visual alarms, permanent signs or movable placards.

Procedures and Training: Where it is impractical to substantially eliminate or reduce the hazard or where the condition of the hazard indicates additional emphasis, special operating procedures and training shall be used.

12.2.1 Safe Design

12.2.1.1 Safety of machinery risk assessment

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2819	**Safety of machinery risk assessment**. A risk assessment shall be conducted for each item of machinery in accordance with BS EN ISO 12100.	Accepted	Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and Codes of Practice (as adopted)	Inspection

12.2.1.2 Safety information for use

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2450	**Safety information for use.** Where risks remain despite inherently safe design measures, safeguarding and the adoption of complementary protective measures, the residual risks shall be identified in the information for use in accordance with BS EN ISO 12100 (section 6). The information for use shall include, but not be limited to, the following: □ operating procedures for the use of the machinery consistent with the expected ability of personnel who use the machinery or other persons who can be exposed to the hazards associated with the machinery; □ the recommended safe working practices for the use of the machinery and the related training requirements adequately described; □ sufficient information, including warning of residual risks for the different phases of the life of the machinery; □ the description of any recommended personal protective equipment, including detail as to its need as well as to training needed for its use. Information for use shall not be a substitute for the correct application of inherently safe design measures, safeguarding or complementary protective measures.	Accepted	Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and Codes of Practice (as adopted)	Inspection

12.2.1.3 Ergonomics and Human Factors

This section specifies the requirements with the ease with which the system can be used. Other potential standards:

ISO9241 Ergonomic requirements for office work with visual display terminals

ISO11064 Ergonomic design of control centres

ISO 12407 Human-centred design processes for interactive systems (1999)

ISO DTR 16982 Usability methods supporting human centred design

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2554	**Ergonomics.** The ergonomic design shall be compliant with ISO 6385.	Accepted	Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and Codes of Practice (as adopted)	Inspection

12.2.1.4 Safety of equipment < 600V

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2820	**Safety of equipment with rated voltage not exceeding 600V**. Equipment shall comply with the safety requirements of BS EN IEC 60950. NOTE: This includes electric shock, energy related hazards, fire, heat related hazards, mechanical hazards, radiation and chemical hazards.	Accepted	Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and Codes of Practice (as adopted)	Inspection

12.2.1.5 Hazard analysis

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2437	**Design for hazard elimination.** Designs shall demonstrate the elimination, or mitigation to a risk level practically achievable, of all hazards by means of a subsystem hazard analysis (SSHA) report as described in EN 14738 and tailored by SKA Product Assurance and Safety Plan SKA-OFF.PAQA-SKO-QP-001.	Accepted	Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and Codes of Practice (as adopted)	Analysis

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2435	**Hazard analysis**. A hazard analysis shall be performed at the system and element level in accordance with BS IEC 61882 and, where applicable, shall include a FMEA in accordance with EN 60812.	Accepted	Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and Codes of Practice (as adopted)	Inspection

12.2.1.6 Hazardous Materials List

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2567	**Hazardous Materials list.** Each Element supplier shall provide a list of hazardous materials used for all items intended for use in the SKA1 detailing suggested handling precautions, disposal instructions and contra-indications.	Accepted	Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and Codes of Practice (as adopted)	Inspection

12.2.1.7 Hazard warning marking

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2579	**Hazard warning marking.** All items that present a potential hazard shall be labelled in accordance with BS EN ISO 7010.	Accepted	Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and Codes of Practice (as adopted)	Inspection

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2818	**Marking of machinery - safety.** In accordance with ISO 61310_2, machinery shall bear all markings which are necessary – for its unambiguous identification; – for its safe use; and supplementary information shall be given, as appropriate: – permanently on the machinery; – in accompanying documents such as instruction handbooks; – on the packaging	Accepted	SYS_REQ-2579	Demonstration

12.2.1.8 Fail-Safe Design

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2438	**Fail safe design.** Components and Equipment shall be designed to be locally fail-safe and not rely on external safety devices or measures to operate safely.	Accepted	SYS_REQ-2437	Analysis

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2788	**Non-propagation of failures**. The equipment shall be designed such that hardware failures and software errors should not create a hazardous situation to interfacing systems.	Accepted	SYS_REQ-2437	Demonstration

12.2.1.9 Emergency stop

Emergency stop buttons are to be provided as a backup for use in emergency only. They need to be robust, dependable and available at all positions where it might be necessary to operate them.

As guidance BS EN 60204-1 standard defines the categories of operation and BS EN 60947-5-5 the characteristics of the emergency stop switches.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2439	**Emergency stop.** The SKA1 Elements shall have emergency stop switches or brakes for all electro-mechanical or mechanical systems that have been identified by safety analyses (required under SYS_REQ-2435) to pose a hazard.	Accepted	SYS_REQ-2437	Demonstration

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2733	**Location of Emergency stop**. Emergency stop switches shall be located in such a way to minimize the risk of injury. (Verified by Analysis as 'minimisation' is unverifiable any other way.)	Accepted	SYS_REQ-2437	Analysis

12.2.1.10 Safety documentation file

The pre-construction safety plan should take into account the applicable pre-cursor safety plan.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2786	**Safety documentation file**. Elements shall provide procedures for maintainers to recover from an unplanned shut-down, including safety checks to be conducted prior to start-up, as specified in SKA PRODUCT ASSURANCE & SAFETY PLAN SKA-OFF.PAQA-SKO-QP-001.	Accepted	SYS_REQ-2436	Inspection

12.2.1.11 Sharp Metal edges

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2447	**Sharp metal edges.** If they cannot be eliminated from design, sharp edges, access openings and corners shall be protected with covers or coatings.	Accepted	Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and Codes of Practice (as adopted)	Inspection

12.2.2 Electrical safety

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2446	**Electrical safety.** Electrical risks and hazards shall be controlled in accordance with local, State and national legislation and Codes of Practice. NOTE: In South Africa, SANS 10142-1 and SANS 10142-2 shall apply. NOTE: In Australia, in addition to legislation, the following Codes of Practice shall be applied: AS/NZ 3000 Safe Work Australia 'Managing Electrical Risks at the Workplace'; Western Australia Director of Energy Safety 'Safe Low Voltage Work Practices by Electricians'	Accepted	Legislation	Inspection

12.2.2.1 Protection from high voltages

Safety equipment used by electrical workers includes insulated rubber gloves and mats. These protect the user from electric shock. Safety equipment is tested regularly to ensure it is still protecting the user. Test regulations vary according to country. Testing companies can test at up 300,000V and offer services from glove testing to Elevated Working Platform or EWP Truck testing.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2443	**Protection from high voltages.** High voltage cages or enclosures shall be used to protect personnel from inadvertent access to high voltages in accordance with AS/NZS3000 (Australia) and SANS10142 (South Africa).	Accepted	National Standards AS/NZS3000 & SANS10142	Inspection

12.2.2.2 Safety grounding and bonding

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2444	**Safety grounding and bonding.** External conductive parts shall be grounded in compliance to: South Africa: National Building Regulations and Building Standards Act, 1977 Occupational Health and Safety act, 1993 SANS 10313 Australia: AS/NZ 3000, AS/NZ 1768	Accepted	Legislation	Test

12.2.2.3 Electrical circuit interlocks

Guidance to safeguarding and complementary protective measures are provided in BS EN 12100-2 clause 5.

Monitoring of safety signals is available in BS EN ISO 13849-1.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2445	**Electrical circuit interlocks.** Electrical circuit inter-locks shall be provided to prevent personnel coming into contact with hazards that cannot otherwise be eliminated from design.	Accepted	Legislation: AS/NZ 3000; SANS 10142	Inspection

12.2.3 Emergency Communications

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2481	**Emergency communication.** The observatory shall provide an independent system to communicate with outside locations in emergencies.	Accepted	Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and	Demonstration

			Codes of Practice (as adopted).	

12.2.3.1 Safety preparation for construction and operations

12.2.3.1.1 Construction & AIV Safety Plan

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2449	**Construction and AIV Safety Plan.** A comprehensive safety plan, tailored to construction and AIV activities, shall be established and implemented before the construction starts at the observatory site.	Accepted	Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and Codes of Practice (as adopted).	Inspection

12.2.3.1.2 Safety incident recovery plan

A plan detailing the actions and corrective actions required in the eventuality of a safety incident. This is generated in conjunction with or part of the Hazard analysis. Not all hazards can be completely eliminated from the system

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2436	**Safety incident recovery plan.** A safety incident recovery plan shall be produced in accordance with SKA PRODUCT ASSURANCE & SAFETY PLAN SKA-OFF.PAQA-SKO-QP-001.	Accepted	Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and Codes of Practice (as adopted)	Inspection

12.2.3.1.3 Safety training

Training for first aid, fire fighting and other safety related skills

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2451	**Safety training**. All personnel shall be provided with appropriate Health and Safety training in compliance with local regulations.	Accepted	Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and Codes of Practice (as adopted)	Test

12.2.3.1.4 Fire fighting equipment

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2454	**Fire fighting equipment.** Fire fighting equipment shall be made available at all SKA premises and facilities.	Accepted	SYS_REQ-2477	Inspection

12.2.3.1.5 First aid stations

The location and capability for first aid stations is to be determined in association with the hazard analysis.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2453	**First aid stations.** First aid stations shall be provisioned.	Accepted	Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and Codes of Practice (as adopted)	Inspection

12.2.3.1.6 Protective Clothing

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2452	**Protective clothing.** Protective Clothing for areas where environments detrimental to human safety shall be worn.	Accepted	Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and Codes of Practice (as adopted)	Inspection

12.2.3.1.7 Travel Safety

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2795	**Travel safety.** Personnel shall adhere to local safety procedures for travelling in remote areas. NOTE: Safety procedures should include the training and equipment required, such as driving instruction, vehicles appropriate for the environment and radio equipment.	Accepted	SYS_REQ-2791	Inspection

12.3 Occupational Health

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2460	**Occupational health legislation and regulations.** The observatory shall comply with all applicable local, State and national occupational health regulations and standards in force at the time. Regulations include, but are not limited to: South Africa: Occupational Health and Safety Act, 1993, and all its regulations. Australia: Commonwealth Occupational Health and Safety Act 1991; OHS (Safety Arrangements) Regulations 1991; OHS (Safety Standards) Regulations 1994; OHS Codes of Practice 2008. Western Australia: Occupational Safety and Health Act 1984; Harmonised OHS legislation (as enacted).	Accepted	Legislation. South African Occupational Health and Safety Act, 1993, and all its regulations. Australia - Occupational Safety and Health Act 1984; WA Harmonised OHS legislation, as approved by WA and Commonwealth Acts.	Analysis

12.3.1 Noise level dosage

UK guidelines suggest hearing protection is provided where average daily or weekly upper exposure is greater than 85dB (Noise at work a brief guide to controlling risks: Health and Safety Executive)

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2455	**Noise level dosage.** Personnel shall not be exposed to noise level dosages exceeding local health and safety guideline levels. The maximum noise levels shall not exceed an 8-hour average exposure of 85 decibels as specified in the Australian National Standard for Occupational Noise NOHSC: 1007(2000) and South African Noise-Induce Hearing Loss Regulations (No R.307 2003) of the Occupational Health and Safety Act, 1993 (Act No 85 of 1993). The desirable maximum noise level is 75 decibels. Note: The National Code of Practice for Noise Management and Protection of Hearing at Work [NOHSC:2009(2004)] provides practical guidance on how NOHSC:1007(2000) can be achieved.	Accepted	Legislation as listed. Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and Codes of Practice (as adopted)	Test

12.3.2 Transient noise level dosage

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2456	**Transient noise level.** Noise levels exceeding 85dB shall be controlled or mitigated in accordance with NOHSC National Standard for Occupational Noise [NOHSC: 1007].	Accepted	Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and	Test

			Codes of Practice (as adopted)	

12.3.3 Illumination

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2457	**Illumination.** Personnel shall be provided with a working illumination level which is compliant with local and national regulations including the current issue of SANS 10114-1 in South Africa and the AS/NZS 1680 series in Australia.	Accepted	SYS_REQ-2460	Test

12.3.4 Clean air

Dust is likely to be a principal but not limited to driver of this requirement. Where the air quality cannot be managed, protective masks may be required. This is covered by the protective clothing requirement

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2458	**Clean air.** Personnel shall be provided with air quality at least compliant with the current issue of SANS 10400-O (South Africa - The application of National Building Regulations Part O : Lighting and ventilation) and the AS 1668 series of codes (Australia - The use of mechanical ventilation and air conditioning in buildings).	Accepted	SYS_REQ-2460	Test

12.3.5 Humidity

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2649	**Humidity.** Working environments shall be designed, built and maintained to provide air quality that meets or exceeds the guidance provided in the Australian Code of Practice for Managing the Work Environment and Facilities, National Code of Australia and AS 1668. NOTE: Building humidity required for computing facilities is specified in Req 2367.	Accepted	Legislation - RSA No. 85 of 1993: Occupational Health and Safety Act, as amended, and related Regulations. Australian OH&S Act 1984, OH&S Regulations 1996. Western Australia WHS Regulations and Codes of Practice (as adopted)	Test

13 Security

The SKA will be a very attractive target for criminals, including theft of infrastructure and cyber attacks exploiting the HPC and networks. It will also be seen to be a 'soft' target with connections to the academic and research communities. The potential impacts include financial cost to replace equipment and to restore systems, loss of observing opportunities (telescopes could be rendered useless for weeks or months) and loss of reputation for the SKA and the host nations. The threats will exist from the outset and security will need to be established before physical installation starts (including security of information systems to deter trojan horses from being installed early in the development phase).

There is currently no ISO Standard for a Security Management System, although DPC: 13 / 30278101 DC included Draft BS ISO 34001 Security Management System which forms the basis of the Security requirements. In addition, the UK Cabinet Office HMG Security Policy Framework (Version 11.0) has been used to derive requirements.

The security risk management system shall include:
i.personnel security,
ii.physical security and counter terrorism, and
iii.security of information.

13.1 Security Management

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2791	**Security Management System**. The SKA shall provide a security management system that includes : i. personnel security, ii. physical security (asset) iii. security of information	Accepted	'BS EN 50600-2-5. Data centre facilities and infrastructures. Part 2-5. Security systems' and others	Inspection

13.2 Personnel security

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2793	**Personnel security training**. All personnel shall receive the security training identified in the Security Management System necessary for their location. Additional specialist pre-deployment training shall be given prior to working in remote environments.	Accepted	SYS_REQ-2791	Inspection

13.3 Physical security

SKA assets must be safeguarded against a range of physical threats, including crime (theft, criminal damage, assaults on staff etc), natural hazards (e.g. flooding), and security threats such as terrorism and exploitation by criminal and malicious groups (including hacktivists).

Physical security describes a range of controls that are intended to protect individuals from violence; prevent unauthorised access to sites and / and other valuable assets; and reduce the risk a range of physical threats and mitigate their impact to a levels that is acceptable to the organisation. Security must be incorporated into the initial stages of planning, selecting, designing or modifying any building or facility, using appropriate methodologies; putting in place integrated and proportionate control measures to prevent, deter, detect and/or delay attempted "physical attacks", and to trigger an appropriate response.

Host Country security organisations will need to be consulted to determine the terrorism threat to the SKA (currently negligible but may
vary in time).

This section on physical security requirements will expand as the use cases are developed and the need for perimeter, interior and inter-site security is better understood.

13.3.1 Equipment Security

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2478	**Equipment security.** The observatory shall provide a secure environment for equipment. This shall include protection of generators, fuel, solar cells and inter-station assets such as copper cables.	Accepted	SYS_REQ-2791	Analysis

13.3.2 Intrusion Detection

13.4 Information security

The Information Security Management System will be based upon the ISO 27000 series, tailored for the SKA project. Information security is important to the SKA project in order to protect: availability of telescopes being impacted by attacks and viruses; legal, regulatory and reputational damage should SKA systems be exploited by criminal and malicious organisations; protection of IPR; and protection of personal and financial information stored on SKA business systems. Assets that have vulnerabilities that are exploitable include hardware, software, network, personnel, site and organisation.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2822	**Information security risk assessment**. An information security risk assessment shall be conducted for each element in accordance with ISO/IEC 27005.	Accepted	SYS_REQ-2791	Inspection

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2823	**Information security management for inter-organizational communications.** Information transfer between organisations shall be controlled in accordance with ISO/IEC 27010 as tailored by SKA Organisation Security Policy.	Accepted	SYS_REQ-2791	Demonstration

13.4.1 Accessibility

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2482	**Accessibility.** It shall be possible to control on a per user basis which SKA1 facilities and resources (both hardware and software) may be accessed by the user.	Accepted	SYS_REQ-2791	Demonstration

13.4.2 Archive Security

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2479	**Archive security.** The observatory shall provide a secure environment for all its data archives.	Accepted	SYS_REQ-2478	Test

13.4.3 Security of communications bearers

14 System Environment

14.1 Non-weather protected locations - protection of equipment.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2798	**Protection of equipment in stationary use at non-weather protected locations**. Equipment in stationary use at non-weather protected locations shall be protected against environmental conditions 4K4H/ 4Z1/ 4Z5/ 4Z6/ 4B2/ 4C1/ 4S3/ 4M4 in accordance with BS EN IEC 60721-3-4. NOTE: 4Z5 refers to the survival, non-operational mode. The equipment shall be able to operate normally for air movement up to 11 m/s	Accepted	Concept of Operations Sect 5	Inspection

14.1.1 Allowable air temperature range

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2488	**Allowable air temperature range.** SKA1 equipment located at the dishes or aperture arrays or outside the central processing and operating facilities shall be able to withstand (non-operating if necessary) an outside air temperature within the range of -15 ºC to +60 ºC. Note this takes precedence over IEC 60721-3-4 4K4H of parent requirement.	Accepted	SYS_REQ-2798	Test

14.1.2 Air temperature operation range

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2489	**Air temperature operation range.** SKA1 equipment located at the dishes or aperture arrays or outside the central processing and operating facilities shall be able to operate within specification if the outside air temperature is within the range of -5 ºC to +50 ºC. Note this takes precidence over IEC60721-3-4 4K4H	Accepted	SYS_REQ-2798	Test

14.1.3 Wind velocities

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2490	**Wind velocities.** SKA1 equipment shall be able to survive wind velocities up to 160 km/hr, and shall operate within normal specification ranges for wind velocities up to 40 km/hr. Note: this takes precedence over IEC60721-3-4 4Z5	Accepted	SYS_REQ-2798	Test

14.2 Weather protected locations - protection of equipment

Specify and control noise, illumination, humidity and temperature in areas where personnel are required to perform operating and maintenance functions.

14.2.1 Protection of equipment in non-weather protected locations

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2799	**Protection of equipment in weather-protected locations.** Equipment in stationary use at weather protected locations shall be protected against environmental conditions 3K8H/ 3Z1/ 3Z11/ 3Z12/ 3B3/ 3C1R/ 3S3/ 3M4 in accordance with BS EN IEC 60721-3-3.	Accepted	Concept of Operations Section 5	Inspection

14.2.2 Storage and transport temperature

14.2.3 Operating humidity

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2500	**Operating Humidity.** The operating humidity shall be between 40% and 60%	Accepted	SYS_REQ-2799	Test

14.2.4 Storage and transport humidity

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2501	**Storage and transport Humidity.** The storage and transport humidity shall be between 40% and 95%.	Accepted	SYS_REQ-2799, ETSI ETS 300 0019-1-2 class 2.1 and 2.3	Analysis

14.2.5 Condensation

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2502	**Condensation.** Appropriate measures shall be taken to prevent the formation of condensation on operating electronic components.	Accepted	SYS_REQ-2799	Inspection

14.2.6 Pressure

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2503	**Pressure.** Components shipped by air shall be capable of surviving pressures down to 11 kPa (equivalent altitude ~ 50,000 feet).	Accepted	SYS_REQ-2799	Analysis

14.2.7 Facilities and equipment intrusion

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2504	**Facilities and Equipment Intrusion.** Where appropriate, SKA1 equipment facilities shall be adequately protected against intrusion by insect and "larger" wandering animals.	Accepted	SYS_REQ-2799	Inspection

14.2.8 Sand and Dust

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2505	**Sand and Dust.** SKA1 systems shall be adequately protected against sand and dust ingress.	Accepted	SYS_REQ-2799	Inspection

14.2.9 Fungus

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2506	**Fungus.** Equipment shall be protected against fungus growth.	Accepted	SYS_REQ-2799	Inspection

14.3 Storage of equipment

The maintenance plan will detail the level of protection provided to equipment when in storage. Protection may range from temperature-controlled buildings away from roads to non-weatherproofed areas exposed to sand and vibration from passing vehicles.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2801	**Storage of equipment**. Designs shall identify any requirements for equipment to be stored in environmental conditions less severe than 1K11/1B3/1C1/1S3/1M3 as specified inBS EN IEC 60721-3-1. Note: It may be assumed that equipment will be stored in its original packaging.	Accepted	Concept of Operations Section 5	Inspection

14.4 Transportation - protection of equipment

This section of requirements relates only to the movement of equipment by maintenance staff from an engineering site to a station by road. Note that this may be modified as the Concept of Maintenance is developed. It excludes air and sea transport of equipment to the engineering site which will be decided at Level 2.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2800	**Transportation of equipment**. Equipment shall be designed to withstand transportation from an engineering depot to a station exposed to environmental conditions 2K5H/2B3/2C1/2S3/2M3 as detailed in BS EN IEC 60721-3-2. NOTE: It may be assumed that the equipment will be transported in the original packaging that it was delivered to the engineering depot.	Accepted	Concept of Operations Sect 5	Inspection

14.5 Seismicity

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2491	**Safety.** SKA1 equipment and buildings shall be designed and built in compliance with national and State regulations including AS 1170.4 (Importance level 3, design life 50 years) and SANS 10160-4 for earthquakes of magnitude up to Richter 3.8.	Accepted	Legislation	Analysis

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2650	**Seismic resilience.** SKA1 structures and equipment shall survive and be fully operational after a seismic event of magnitude up to Richter 3.8. Note: Seismic event includes underground collapses in addition to earthquakes.	Accepted	Council for Geoscience Internal report no.: 2005-0121 Section 4	Analysis

15 Availability Reliability and Maintainability

High availability of the telescopes to conduct science will be a key user requirement in measuring the success of the SKA. In turn, availability is dependent upon both the reliability and maintainability of the telescopes. Both of these factors may have considerable impact on the whole life costs of the observatory. Therefore, although the Level 0 requirements should be targeting availability, the Level 1 requirements will need to allocate reliability and maintainability constraints on the elements.

BS 5760-0:1986 defines the following terms:
Availability - the ability of an item (under combined aspects of its reliability, maintainability and maintenance support) to perform its required function at a stated instant of time or over a stated period of time.
Reliability - the ability of an item to perform a required function under stated conditions for a stated period of time.
Maintainability - the ability of an item, under stated conditions of use, to be retained in, or restored to, a state in which it can perform its required functions, when maintenance is performed under stated conditions and using prescribed procedures and resources

15.1 Availability Reliability and Maintenance Plan

The availability, reliability and maintenance plan for the SKA1 telescopes will be developed concurrently so as to fit within the allocated capital and operating (maintenance) budgets. The plans and designs will be developed using the iterative method outlined in Appendix E.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2722	**Availability, reliability, and maintenance plans**. There shall be an availability, reliability and maintenance plan for each SKA1 telescope.	Accepted	ConOps 5.1	Inspection

15.2 Availability

The following applies to each of SKA1-low and SKA1-mid telescopes separately. In general available means that the telescope or a fraction thereof as defined below is available to an operator to be scheduled for science or other operations.

Availability is defined as A=MTBF' / (MTBF' + MTTR'), where MTBF' is the mean time between failures (based on the conditional probability of failure), given that regular inspection or preventative maintenance is done, and MTTR' is the total time spent on these two activities plus any repair time.

- Availability Fraction is defined as (N Ae) / (Nmax Ae_max), where N is the number of schedulable major modes and Ae is the effective area available; Nmax is the number of major modes in the full set of defined modes; Ae_max is the maximum effective area of the telescope.
- Major modes correspond to the main categories of observations that the telescope is designed to carry out. For each frequency band defined for the telescope they are:
    - Spectral line observations.
    - Pulsar search observations.
    - Pulsar timing observations.
    - Continuum observations.
    - Transient detection.

The telescope system will have three availability states:

1. Available: The availability fraction is 95%
2. Degraded: The availability fraction is between 50 and 95%.
3. Unavailable: The availability fraction is less than 50%.

In a running average over a year, the design requirement is:

- Unavailable for <5% of the time, corresponding to ~18 days per year.
- Degraded for <5% of the time, corresponding to ~18 days per year.
- Available >90% of the time, corresponding to ~329 days per year.

Natural disturbances of severity outside design boundaries are not counted against availability, unless the system does not behave according to design. The availability state depends only on the telescope, itself.

The operational state of all sub-systems shall be defined as 'failed', 'degraded' or 'available'. It shall be possible to sense and log the operational state (failed, degraded, or available) of every sub-system at the system level.

15.2.1 Telescope availability

Availability includes Available and Degraded availability states.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2716	**Average annual availability.** Each SKA1 telescope shall have an operational availability of 95%	Accepted	ConOps 5.1	Analysis

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2827	**System Availability**. System designs shall meet the system availability allocations specified in SKA-OFF.SE.ARC-SKAO-RAM-001.	Accepted	SYS_REQ-2716	Analysis

15.2.2 Availability budgets

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2718	**Availability budgets.** Availability budgets shall be allocated at the system decomposition level, and shall be consistent with the system level requirements for reliability and maintainability of the system.	Accepted	ConOps 5.1	Analysis

15.3 Reliability

15.3.1 Best practice

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2512	**Best practice.** Best available methods for reducing adverse effects of operational and maintenance environments on critical components shall be adopted.	Accepted	ConOps 5.1	Analysis

15.3.2 Critical-useful-life components

Critical-useful-life components are components with an expected life shorter than the planned life cycle of the system.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2513	**Critical-useful-life components.** Any critical-useful-life components shall be identified.	Accepted	ConOps 5.1	Inspection

15.3.3 Stress strength analysis

If stresses greater than those of normal conditions are imposed on components the reliability of the system may be affected. Over specifying is potentially expensive.

15.3.4 Component selection

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2515	**Component selection.** Parts and components shall be selected to meet reliability requirements.	Accepted	ConOps 5.1	Analysis

15.3.5 Matching parts

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2516	**Matching components.** Parts requiring select on test shall be eliminated by deign if possible.	Accepted	ConOps 5.1	Inspection

15.3.6 Known failure rate parts

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2517	**Known failure rate parts.** The failure rate of parts shall be known (e.g. through analysis or modelling) before inclusion in SKA design.	Accepted	ConOps 5.1	Inspection

15.3.7 High failure rate parts

ID	Requirement	Status	Parent Requirement	Verification

SYS_REQ-2518	**High failure rate parts.** Parts with excessive failure rates shall be identified.	Accepted	ConOps 5.1	Inspection

15.3.8 Reliability testing

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2519	**Reliability testing.** A testing and evaluation master plan shall be generated for high-risk reliability components.	Accepted	ConOps 5.1	Inspection

15.3.9 Spares and repair parts testing

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2520	**Spares and repair parts testing.** Critical spare and repair line replaceable units shall be tested before deployment.	Accepted	ConOps 5.1	Inspection

15.3.10 Component derating

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2521	**Component derating.** Safety factors and margins shall be applied in the selection of modules and components	Accepted	ConOps 5.1	Analysis

15.3.11 Shelf life and wear out characteristics

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2522	**Shelf life and wear out characteristics.** The shelf life and wear out characteristics of all components and parts shall be known before inclusion in SKA designs.	Accepted	ConOps 5.1	Inspection

15.3.12 Special procurement components

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2523	**Special procurement components.** Critical parts	Accepted	ConOps 5.1	Inspection

	requiring special procurement methods, testing and handling provisions shall be identified.			

15.3.13 Fail safe provisions

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2525	**Fail safe provisions.** Designs shall implement fail-safe provisions to prevent secondary failures.	Accepted	ConOps 5.1	Analysis

15.4 Maintainability

(Con Ops Section 5.1) There are SKA-specific factors beyond standard availability requirements that require particular attention and for which additional design effort and capital expenditure is justified. These are needed mainly to keep human occupancy on the sites to a minimum, as well as to enhance maintenance efficiency:

- Remote diagnostic and repair: In practice, this means that the monitor and control systems allow for a deep level of interrogation of sensor values and system state.
- Line-replaceable units: On-site repair will be particularly difficult and expensive at the remote sites. Systems should be designed to contain line replaceable units where feasible.
- Configuration Management System: Configuration management is a systems engineering process for managing the logistics of maintenance, tracking system documentation, and supplying real-time information to inform the system model. For this to work properly the system model must be tailored to SKA requirements.

Due to the geographically distributed nature of the SKA observatory there will be echelons or levels of maintenance for components of the observatory. Traditionally these have included:

- Site
- Operations centre
- Supplier

The maintenance functions for components at each level need to be defined along with their turnaround time (TAT) for repair.

The logistics pipeline time and Level of repair policies will be defined in an SKA1 Logistics Engineering Management Plan. This is assumed to include personnel quantities and skills at each level of maintenance.

15.4.1 Maintainability Budgets

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2526	**Maintainability budgets.** Maintainability budgets shall	Accepted	ConOps 5.1	Inspection

	be allocated at the system decomposition level, and shall be consistent with the system level requirements for reliability and maintainability of the system.			

15.4.2 Test and Repair Instructions

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2527	**Test and Repair Instructions.** Where end user repair is applicable Test and Repair Instructions shall be delivered with all equipment.	Accepted	ConOps 5.1	Inspection

15.4.3 Level of Maintenance

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2528	**Level of maintenance.** The level of maintenance shall be identified for each repairable item.	Accepted	ConOps 5.1	Inspection

15.4.4 Maintenance Test and Support Equipment

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2529	**Maintenance test and support equipment.** Equipment required for test and support shall be identified for each repairable item.	Accepted	ConOps 5.1	Inspection

15.4.5 Design for maintainability

Maintainability is that characteristic of design and installation that reflects the ease, accuracy, safety and economy of performing maintenance actions (B. S. Blanchard & W.J. Fabrycky 'Systems Engineering and Analysis' Pearson, 2011).

The purpose of maintainability analysis is to (ECSS-Q-ST-30):

- identify the possible corrective and preventive maintenance tasks,
- provide MTBF and MTTR for availability analysis,
- provide recommendations for improvement.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2802	**Design for maintainability**. Designs shall incorporate maintainability studies and analysis in accordance with BS EN IEC 60706-2 with emphasis on minimising the need for maintainers on sites. This activity should incorporate best practice such as described by B.S. Blanchard & W.J. Fabrycky 'Systems Engineering and Analysis', Pearson 2011.	Accepted	Concept of Operations Section 5	Inspection

15.4.5.1 Modular packaging

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2594	**Modular packaging.** The packaging of components shall be modular to limit maintenance to the removal of one module.	Accepted	SYS_REQ-2802	Inspection

15.4.5.2 Maintenance Provisions

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2595	**Maintenance provisions.** Repairable items shall be designed to include maintenance provisions such as test points, accessibility, and plug-in components.	Accepted	SYS_REQ-2802	Inspection

15.4.5.3 Discard at failure items

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2596	**Discard at failure items.** Discard at failure items shall be packed at low cost.	Accepted	SYS_REQ-2802	Inspection

15.4.5.4 Plug-in modules

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2597	**Plug-in modules.** The design shall implement plug-in modules to the maximum extent possible.	Accepted	SYS_REQ-2802	Inspection

15.4.5.5 Module access

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2598	**Module access.** Where applicable, access between modules shall be sufficient to facilitate hand grasping.	Accepted	SYS_REQ-2802	Inspection

15.4.5.6 Component removal

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2599	**Component removal.** Modules and components shall be mounted such that removal of any single item will not require the removal of other items (component stacking to be avoided where possible)	Accepted	SYS_REQ-2802	Inspection

15.4.5.7 Secure mounting of modules

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2600	**Secure mounting of modules.** Modules shall be securely mounted (in compliance with the shock and vibration requirements) with the minimum number of fasteners.	Accepted	SYS_REQ-2802	Inspection

15.4.5.8 Shock mounting provision

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2601	**Shock mounting provision.** Shock mounting provisions shall be made where applicable.	Accepted	SYS_REQ-2802	Inspection

15.4.5.9 Mounting preclusion

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2602	**Mounting preclusion.** Provisions for the preclusion of mounting the wrong module shall be provided (key coding of connectors etc.).	Accepted	SYS_REQ-2802	Inspection

15.4.5.10 Stand-offs and handles

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2448	**Stand-off and handles.** Stand-offs and handles shall be used to protect system components from damage during shop maintenance.	Accepted	SYS_REQ-2802	Inspection

15.4.5.11 Mounting guides

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2603	**Mounting guides.** Mounting guides and location pins shall be provided to facilitate module mounting.	Accepted	SYS_REQ-2802	Inspection

15.4.5.12 Module labelling

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2604	**Module labelling.** Where possible, labelling of modules shall be on the top or adjacent in plain sight.	Accepted	SYS_REQ-2802	Inspection

15.4.5.13 Label robustness

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2605	**Label robustness.** Labels shall be permanently affixed and unlikely to come off during maintenance or as a result of the environment.	Accepted	SYS_REQ-2802	Inspection

15.4.5.14 Disposable item labelling

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2606	**Disposable LRU labelling.** Disposable line replaceable units should be labelled as such.	Accepted	SYS_REQ-2802	Inspection

15.4.6 Component obsolescence plan

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2711	**Component obsolescence plan.** There shall be a plan for the management of component obsolescence.	Accepted	SYS_REQ-2722	Inspection

15.4.7 Long lead time items

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2571	**Long lead time items.** Long lead time items shall be identified to the project management.	Accepted	SYS_REQ-2722	Inspection

15.4.8 Parts availability

Life cycle includes tests, storage and mission.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2570	**Parts availability.** The estimated availability of the parts shall be compatible with the final system's life cycle.	Accepted	SYS_REQ-2722	Analysis

16 Quality Factors Requirements

16.1 Quality Control

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2806	**Product Assurance**. Product Assurance shall be managed following a process modelled on the SKA Product Assurance & Safety Plan SKA-OFF.PAQA-SKO-QP-001	Accepted	Concept of Operations	Inspection

16.2 Workmanship

Good workmanship expected for mechanical, electrical and software production. It refers to the physical characteristics relating to the level of quality introduced by the manufacturing and assembly activities.

16.2.1 Scope of Workmanship Standards

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2509	**Scope of workmanship standards.** SKA1 dedicated workmanship standards shall cover all phases of production, assembly and integration, testing, handling, and include clear requirements for acceptance/rejection criteria.	Accepted	SYS_REQ-2806	Inspection

16.3 Testability

Testability is an important feature in the operation and maintenance of a system or equipment and has a significant effect on its availability and maintainability. Diagnostic testing may be carried out manually or with test equipment which may contain various levels of automation. Optimum design for testability requires close cooperation between design, operation and maintenance organizations.

For a product to retain its functionality, the functional status of each sub-function should be known at any time while the product is in its operating condition. If a failure occurs, action should be taken to ensure that the fault is recognized and the faulty item localized. This requirement placed on the testability of a product might appear to be quite simple, but if it is not considered at the start of product development, subsequent realization will result in increased work and significantly increased cost. If all requirements are available at the start of development, the development engineer can specify the functional characteristic "testability" without much additional effort and therefore achieve considerable cost savings e.g. by minimizing the number
of test steps for verifying the development results. Experience has shown that the extra cost and effort in the development phase can be recovered for example in the production phase since available test

equipment can be used. Reliable fault recognition and low in-service maintenance costs increase the market value of a testable product considerably.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2816	**Design for testability.** Designs shall include an assessment of testability in accordance with BS EN IEC 60706-5	Accepted	SYS_REQ-2802	Inspection

16.3.1 Test and support equipment

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2538	**Test and support equipment** Test and support equipment shall be identified for each level of maintenance.	Accepted	SYS_REQ-2816	Inspection

16.3.2 Test and support equipment

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2539	**Test and support equipment standardisation.** Any test equipment not included in the standard test equipment list required for the integration, commissioning and maintenance of equipment shall be declared.	Accepted	SYS_REQ-2802	Inspection

16.3.3 Test and support equipment life cycle costs

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2540	**Test and support equipment lifecycle costs.** Life cycle costs shall be generated for all test and support equipment.	Accepted	SYS_REQ-2802	Inspection

16.3.4 Test equipment reliability

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2541	**Test equipment reliability** Test equipment reliability shall be sufficient to meet the maintainability requirements.	Accepted	SYS_REQ-2802	Analysis

16.3.5 Training Plan

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2542	**Training** A plan detailing the training required for maintenance, calibration and repair shall be generated.	Accepted	SYS_REQ-2802	Inspection

16.3.6 Direct fault indicators

Direct fault indicators including fault lights audio warnings etc.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2543	**Direct fault indicators** Where possible, direct fault indicators shall be designed in to equipment.	Accepted	SYS_REQ-2816	Inspection

16.3.7 Self-test

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2544	**Self-test.** Self-Test capability such that all faults can be identified down to LRU level shall be provided.	Accepted	SYS_REQ-2816	Analysis

16.3.8 Continuous performance monitoring

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2546	**Continuous performance monitoring.** Where possible, the system shall be designed to provide continuous performance monitoring.	Accepted	SYS_REQ-2816	Demonstration

16.3.9 Malfunction detection

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2552	**Malfunction detection.** All equipment malfunction shall be detected at the system level.	Accepted	SYS_REQ-2816	Demonstration

16.4 Accessibility

16.4.1 Access tools.

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2556	**Access tools.** Access requiring tools shall be minimised.	Accepted	SYS_REQ-2802	Analysis

16.5 Predictability - Design for manufacture

16.5.1 Design for economic production

Requirement needs further work to reflect the balance between manufacturing cost and RAM capability and its associated cost

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2559	**Design for economic production.** All designs for the SKA shall be designed for economic production. This is required to ensure that the SKA is buildable for a reasonable cost (Con Ops Section 1.2)	Accepted	Con Ops Section 1.2	Inspection

16.5.2 Design definition

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2560	**Design definition.** Design definition shall be in sufficient detail to allow one or more manufacturers to produce the same item within identified tolerances.	Accepted	SYS_REQ-2559	Inspection

16.5.3 Manufacturing facilities

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2561	**Manufacturing facilities.** Where possible, currently existing facilities shall be used for manufacturing.	Accepted	SYS_REQ-2559	Inspection

16.5.4 Standard manufacturing tools

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2562	**Standard manufacturing tools.** Where possible, standard manufacturing tools shall be used.	Accepted	SYS_REQ-2559	Inspection

17 Configuration Management

17.1 Product configuration information

Product configuration information comprises both product definition and product operational information. This typically includes requirements, specifications, design drawings, parts lists, software documents and listings, models, test specifications, maintenance and operating handbooks.

Product configuration information should be relevant and traceable. Numbering conventions should be established that are unique and ensure proper control of configuration items. These should take into consideration the existing numbering conventions of the organization and the change control information, such as revision status.

17.1.1 Materials

Use is to be made of adequate and (ecological) allowed permissible materials, deviations to be approved by the consortia leads (or their nominated authority), including management of applied materials.

The objectives are the following:

a) To ensure that all requirements of the program are met,

b) To verify the Materials, Parts and Processes activity of equipment suppliers,

c) To control and monitor the status of Materials, Parts and Processes in accordance with program milestones and regulations

17.1.1.1 Materials list

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2566	**Materials list.** Each sub-system supplier shall provide a Materials list for all items intended for use within SKA1.	Accepted	Configuration Management Plan	Inspection

17.1.1.2 Parts List

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2568	**Parts list.** Each Element supplier shall provide a parts list for all items intended for use in the SKA1.	Accepted	Configuration Management Plan	Inspection

17.1.1.3 Process list

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2569	**Process list.** Each element supplier shall provide a process list for all items intended for use in the SKA1.	Accepted	Configuration Management Plan	Inspection

17.1.2 Nameplates and Marking

Components, (sub) systems, instruments, equipment, and materials shall be marked for configuration control purposes and maintenance support purposes.

17.1.2.1 Serial numbers

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2573	**Serial number.** Each part shall be marked with a unique serial number in an easily visible location.	Accepted	Established Precedent	Inspection

17.1.2.2 Drawing numbers

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2574	**Drawing numbers.** Each LRU type shall be identified with a unique drawing number.	Accepted	Established Precedent	Inspection

17.1.2.3 Marking method

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2575	**Marking method.** Method of marking shall be compatible with the nature of the item, its environment and its use.	Accepted	Operational Concepts[3]	Inspection

17.1.2.4 Electronically readable or scannable ID

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2576	**Electronically readable or scannable ID.** Where possible line replaceable items shall be marked with an Electronically readable or scannable ID.	Accepted	Established Precedent	Inspection

17.1.2.5 Packaging part number marking

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2577	**Package part number marking.** All packaging shall be marked with the part number of the contents.	Accepted	Established Precedent	Inspection

17.1.2.6 Packaging serial number marking

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2578	**Package serial number marking.** All packaging shall be marked with the serial number of the contents.	Accepted	Established Precedent	Inspection

17.1.2.7 LRU electrostatic warnings

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2580	**LRU electrostatic warnings** All LRUs with electrostatic sensitive components shall be fitted with ESD warning labels.	Accepted	Established Precedent	Inspection

17.1.2.8 Packing electrostatic warnings

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2581	**Packaging electrostatic warnings.** All packaging containing static sensitive contents shall be marked with ESD warning labels.	Accepted	Established Precedent	Inspection

17.1.2.9 Cable identification

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2583	**Cable identification.** All cables ends shall carry a unique identifier.	Accepted	SKA Electrical Installation Standard SKA-TEL.OFF.SE-SKO-ST-001	Inspection

17.1.2.10 Connector plates

ID	Requirement	Status	Parent Requirement	Verification
SYS_REQ-2584	**Connector plates.** All connector plates shall carry identification labels for connectors.	Accepted	SKA Electrical Installation Standard SKA-TEL.OFF.SE-SKO-ST-001	Inspection

18 Verification Provisions

18.1 Methods

Demonstration (D): Operation of the system, subsystem or a part of the system that relies on observable, functional operation, not requiring use of instrumentation, special test equipment or subsequent analysis.

Test (T): Operation of the system, subsystem or a part of the system using instrumentation or other special test equipment to collect data for later analysis.

Analysis (A): Processing of accumulated data obtained from other qualification methods. Examples are reduction interpolation or extrapolation of test results.

Inspection (I): Visual examination of system components, documentation, etc.

Special Verification Methods: Special verification methods for the system or subsystem, for example, special tools, techniques, procedures, facilities, acceptance limits, use of standard samples, preproduction or periodic production samples, pilot models or pilot lots.

19 Appendix A: Requirements Traceability Matrices

This appendix contains tabularized requirements traceability to the source documentation and to the next lower tier documentation where known.

ID	Requirement	Parent ID	Parent Requirement
SYS_REQ-xxxx	Void	N/A	Void

Table 1Traceability Matrices

20 Appendix B: Verification Matrices

This appendix contains tabularized verification method for every system or subsystem requirement.

ID	Description	Priority	Verification
SYS_REQ-2113	**Global Headquarters** The SKA Global Headquarters (GHQ) will have overall responsibility for the SKA Observatory	Essential	Inspection
SYS_REQ-2114	**Site location.** The SKA1 Antenna systems and digital signal chain shall be located within radio quiet zones provided by the Host Countries of South Africa and Australia.	Essential	Inspection
SYS_REQ-2124	**SKA1_low array.** The SKA1_low array shall be located within the legal boundary of the Boolardy station.	Essential	Inspection
SYS_REQ-2713	**SKA1_low central frequency reference.** The SKA1_low central frequency reference shall be located in the SKA1_low Central Signal Processing facility	Essential	Inspection
SYS_REQ-2654	**SKA1_low CSP facility.** The facility housing the station beamformers for the inner area of the SKA1_Low and the central signal processing for SKA1_Low shall be at a distance of 2 km South West of the centre of the SKA1_Low array.	Essential	Inspection
SYS_REQ-2120	**Australian Science operations centre.** The Australian Science Operations Centre shall be in Perth.	Essential	Inspection
SYS_REQ-2121	**Australian Engineering Operations Centre** The Australian Engineering Operations Centre shall be in in Geraldton.	Essential	Inspection
SYS_REQ-2123	**Australian Science processing centre** The Australian Science Processing Centre shall make use of floor space, power, cooling, and other infrastructure at the Pawsey centre in Perth.	Essential	Inspection

SYS_REQ-2119	**SKA1_Mid array.** The SKA1_Mid dish array shall be located in the Karoo Central Astronomy Advantage Area.	**Essential**	**Inspection**
SYS_REQ-2656	**SKA1_mid CSP facility.** The CSP facility for SKA1_mid shall be located in the Karoo Array Processor Building.	**Essential**	**Inspection**
SYS_REQ-2714	**SKA1_mid central frequency reference.** The SKA1_mid central frequency reference shall be located in the SKA1_mid Central Signal Processing facility	**Essential**	**Inspection**
SYS_REQ-2115	**South African Science Operations.** The South African Science Operations Centre shall be located in Cape Town.	**Essential**	**Inspection**
SYS_REQ-2118	**South African Science Processing Centre** The South African Science Processing centre shall be located in Cape Town	**Essential**	**Inspection**
SYS_REQ-2116	**South African Engineering Operations Centre.** The South African Engineering Operations Centre shall be located at Klerefontein.	**Essential**	**Inspection**
SYS_REQ-2671	**Receptor type.** The SKA1_Low shall utilise dual, orthogonal, polarization log-periodic antennas.	**Essential**	**Analysis**
SYS_REQ-2673	**Array resolution (core).** The SKA1_Low shall have an array resolution of better than 5 arc minutes at 100 MHz (centre of the EoR frequency range).	**Essential**	**Analysis**
SYS_REQ-2134	**Electromagnetic frequency range.** SKA1_Low shall be able to measure electromagnetic radiation in a frequency range from 50 MHz to 350 MHz.	**Essential**	**Test**
SYS_REQ-2621	**Spectral stability:** The spectral stability, on a time scale of 600 sec.,of the station beam bandpass, post station calibration and RFI-mitigation, shall be within 1.3 %, 0.4 %, 0.6 % and 1.1 % at 50 MHz, 100 MHz, 160 MHz, and 220 MHz respectively compared to the full polarization, parameterized beam model.	**Essential**	**Test**
SYS_REQ-2135	**SKA1_Low array sensitivity at 50MHz**. The SKA1_Low array shall have sensitivity per polarization at zenith greater than 72 m^2K^{-1} at 50MHz when assuming a sky noise temperature following the law $60.lamda^{2.55}$	**Essential**	**Test**

SYS_REQ-2136	**SKA1_Low array sensitivity at 110MHz**. The SKA1_Low array shall have a sensitivity per polarization at zenith greater than 380 m^2K^{-1} at 100 MHz when assuming a sky noise temperature following the law 60.lambda^2.55	**Essential**	**Test**
SYS_REQ-2137	**SKA1_Low array sensitivity at 160MHz**. The SKA1_Low array shall have a sensitivity per polarization at zenith of greater than 535 m^2K^{-1} at 160 MHz when assuming a sky noise temperature following the law 60.lambda^2.55	**Essential**	**Test**
SYS_REQ-2138	**SKA1_Low array sensitivity at 220MHz**. The SKA1_Low array shall have a sensitivity per polarization at zenith of greater than 530 m^2K^{-1} at 220 MHz when assuming a sky noise temperature following the law 60.lambda^2.55.	**Essential**	**Test**
SYS_REQ-2814	**SKA1_Low array sensitivity per polarization at 280 MHz.** The SKA1_Low array shall have a sensitivity per polarization at zenith greater than 500 m^2/K at 280 MHz when assuming a sky noise temperature following the law 60.lambda^2.55	**Essential**	**Test**
SYS_REQ-2815	**SKA1_Low array sensitivity per polarization at 340 MHz.** The SKA1_Low array shall have a sensitivity per polarization at zenith greater than 453 m^2/K at 340 MHz when assuming a sky noise temperature following the law 60.lambda^2.55	**Essential**	**Test**
SYS_REQ-2622	**Sensitivity for off zenith angles.** The SKA1_low receptor has an off-zenith beam response defined by the receptor, a log-periodic dipole antenna,in the Baseline Design.	**Essential**	**Test**
SYS_REQ-2139	**SKA1_Low antennas per station.** The SKA1_Low shall comprise of stations each containing 256 antennas.	**Essential**	**Inspection**
SYS_REQ-2140	**SKA1_Low station diameter.** The station diameter will be 35 metres, which is consistent with being able to provide a single, circularly symmetric, beam of 5 degrees at the half-power points at 100 MHz (centre of the EoR frequency range) while meeting the sensitivity requirements with 256	**Essential**	**Inspection**

	antennas per station evenly distributed in an irregular-random configuration.		
SYS_REQ-2142	**SKA1_Low number of stations.** The SKA1_Low shall comprise of 512 stations.	**Essential**	**Inspection**
SYS_REQ-2143	**SKA1_Low configuration.** The SKA1_Low shall have a configuration as specified in TBD.	**Essential**	**Inspection**
SYS_REQ-2817	**SKA1_Low maximum baseline length between stations.** The maximum distance between station centres shall be approximately 80 km	**Essential**	**Inspection**
SYS_REQ-2147	**Instantaneous bandwidth.** The SKA1_Low shall be capable of simultaneously processing 300 MHz of bandwidth.	**Essential**	**Test**
SYS_REQ-2652	**SKA1_Low separation.** The SKA1_Low core shall be located at a minimum distance of 10km from the ASKAP core.	**Essential**	**Measurement**
SYS_REQ-2674	**Digitisation.** Digitisation of SKA1_antenna (SKA1_Low only) signals shall be to at least 8 bits.	**Essential**	**Demonstration**
SYS_REQ-2639	**Clipping.** The amplitude dynamic range of the SKA1_Low ADC's shall be such that no clipping will occur for 95% of the time	**Essential**	**Test**
SYS_REQ-2640	**Clipped data flagging.** Clipped data shall be flagged accordingly within the data stream.	**Essential**	**Demonstration**
SYS_REQ-2653	**Linearity.** At the finest frequency resolution in the processing chain, the level of spurious signals due to non-linearity shall be less than the noise level when no external input signal is present.	**Essential**	**Test**
SYS_REQ-2824	**Absolute flux scale**: The absolute flux scale shall be accurate to 5	**Essential**	**Test**
SYS_REQ-2676	**Dynamic range.** The SKA1_Low beams shall have a dynamic range of better than 40 dB	**Essential**	**Test**
SYS_REQ-2146	**SKA1_Low station beams** The antennas within each station shall be coherently beam-formed to provide one pair of station beams,one beam for each orthogonal polarization,for primary science.	**Essential**	**Demonstration**
SYS_REQ-2779	**Control of station beam properties:** It shall be possible to control specific properties of the station beam by setting the station beam weights appropriately	**Essential**	**Test**

SYS_REQ-2629	**Station beam stability.** The difference between the parameterized station beam model and the actual station beam shall remain smaller than 1.3 %, 0.4 %, 0.6 % and 1.1 % relative to the main beam peak power, after calibration, at 50 MHz, 100 MHz, 160 MHZ and 220 MHz respectively	**Essential**	**Test**
SYS_REQ-2634	**Calibration update rate.** Calibration measurements shall be necessary at a rate of no more than 10seconds.	**Essential**	**Demonstration**
SYS_REQ-2635	**Real-time calibration.** The LFAA reception system at station level shall provide on-line instrumental calibration functions with an update rate of 10 minutes	**Essential**	**Demonstration**
SYS_REQ-2636	**Beam products.** The SKA1_Low shall be capable of outputting beam products as voltage time series.	**Essential**	**Demonstration**
SYS_REQ-2773	**SKA1_Low correlator sub-array support**. The SKA1_Low correlator shall be able to correlate SKA1_low station beams from one to sixteen sub-arrays independently and concurrently	**Essential**	**Test**
SYS_REQ-2148	**SKA1_Low channelisation.** The SKA1_Low channelisation for each sub array shall provide up to 65,536 linearly spaced frequency channels across the available frequency range of each band.	**Essential**	**Test**
SYS_REQ-2149	**SKA1_Low channeliser maximum leakage power for adjacent frequency channels.** The SKA1_Low channeliser for each sub-array shall have a maximum noise leakage power from immediately adjacent frequency channels of < -30 dB.	**Essential**	**Test**
SYS_REQ-2810	**SKA1_Low channeliser maximum leakage power for non-adjacent frequency channels.** The SKA1_Low channeliser for each sub-array shall have a maximum noise leakage power from non adjacent frequency channels better than -60 dB.	**Essential**	**Test**
SYS_REQ-2811	**SKA1_Low fine frequency channel amplitude variation.** The fine frequency channels for the SKA1_Low channeliser shall have a total amplitude variation as a function of frequency of less than 0.01 dB.	**Essential**	**Test**
SYS_REQ-2812	**SKA1_Low fine frequency channel band edge**. The fine frequency cells for the SKA1_Low channeliser shall	**Essential**	**Test**

	have a -3dB transition band amplitude at the channel band edge.		
SYS_REQ-2678	**SKA1_Low correlatation signal to noise**. SKA1_Low correlation, for each sub array, shall not degrade the Signal to Noise ratio by more than 2 % compared to ideal analogue correlation.	**Essential**	**Analysis**
SYS_REQ-2150	**SKA1_Low correlator Integration rate. T**he SKA1_Low correlator for each sub array shall have independently configurable visibility integration periods in the range 9s to 0.9s.	**Essential**	**Test**
SYS_REQ-2153	**Diameter**. SKA1 dishes shall have a projected diameter of larger than 15m and smaller than 16.5m.	**Essential**	**Inspection**
SYS_REQ-2155	**Aperture Efficiency**. Aperture efficiency shall be within +/- 5 % of: • 60% at 350MHz with gradual degradation from 400 to 350 MHz • 65% at 400MHz • 78% from 600MHz to 8000MHz • 70% from 8 to 15 GHz • 65% from 15 to 20 GHz	**Useful**	**Test**
SYS_REQ-2158	**Pointing repeatability.** The pointing repeatability shall be better than 10 arc seconds rms for winds < 7 m/s at night time.	**Essential**	**Test**
SYS_REQ-2159	**Pointing repeatability**. The pointing repeatability shall be better than 17 arc seconds rms for an average wind speed of < 7 m/s in the day time	**Essential**	**Test**
SYS_REQ-2160	**Pointing repeatability.** The pointing repeatability shall be better than 180 arc seconds rms for an average wind speed between 7 and 20 m/s	**Essential**	**Test**
SYS_REQ-2162	**Number of feeds**. There shall be space at the Gregorian focus of SKA1 dishes for five single pixel feeds (SPF) or three Phased Array Feeds (PAF)	**Essential**	**Inspection**
SYS_REQ-2165	**Polarisation Purity.** The IXR shall be better than 15 dB over the whole observing bandwidth within the HPBW	**Essential**	**Test**
SYS_REQ-2170	**Elevation limit.** Reflector antennas shall be capable of operating at all elevations greater than 15 degrees	**Essential**	**Demonstration**
SYS_REQ-2171	**Azimuth range.** The Dish shall have a continuous useable azimuth	**Essential**	**Demonstration**

	observation range from -270° to +270°, inclusive measured relative to true North defined as 0° and with East defined as +90°		
SYS_REQ-2833	**SKA1_Mid inclusion of MeerKAT.** The SKA1_Mid shall incorporate the 64 antennas in both monitor and control and data collection functions.	**Essential**	**Demonstration**
SYS_REQ-2173	**MeerKAT array.** The monitor and control functions of MeerKAT shall be made available to SKA1_Mid via a Foreign Telescope interface consisting of a Local Monitor and Control system connected to the SKA1_Mid Telescope Manager.	**Essential**	**Demonstration**
SYS_REQ-2834	**SKA1_Mid-MeerKAT infrastructure reuse.** Where economically practicable, the existing MeerKAT infrastructure will be reused	**Essential**	**Analysis**
SYS_REQ-2825	**Absolute flux scale:** The absolute flux scale shall be accurate to 5% rms	**Essential**	**Test**
SYS_REQ-2826	**Absolute flux scale:** The absolute flux scale shall be accurate to 3% rms	**Useful**	**Test**
SYS_REQ-2174	**Combined SKA1 Mid Configuration.** The SKA1_Mid shall have the configuration defined in the TB	**Essential**	**Inspection**
SYS_REQ-2712	**SKA1_Mid antenna.** The SKA1_Mid array shall consist of 133 antennas centred in the same location as the MeerKAT array	**Essential**	**Inspection**
SYS_REQ-2179	**Antenna RF system.** The Dish Element shall make available only a single frequency band at any one time.	**Essential**	**Inspection**
SYS_REQ-2180	**RF system frequency range band 1** The array of SKA1_Mid dishes, when the band 1 capability is selected, shall operate over a frequency range from 0.35 to 1.050 GHz for each polarisation.	**Essential**	**Test**
SYS_REQ-2181	**RF system frequency range band 2.** The SKA1_Mid dishes, when the band 2 capability is selected, shall operate over a frequency range from 0.95 to 1.76 GHz for each polarisation.	**Essential**	**Test**
SYS_REQ-2182	RF system frequency range band 3. The SKA1_Mid dishes, when the band 3 capability is selected, shall operate over a frequency range from 1.65 to 3.05 GHz for each polarisation	**Essential**	**Test**
SYS_REQ-2183	**RF system frequency range band 4.** The SKA1_Mid dishes, when the band 4 capability is selected, shall operate	**Essential**	**Test**

	over a frequency range from 2.80 to 5.18 GHz for each polarisation		
SYS_REQ-2184	**RF system frequency range band 5.** The SKA1_Mid dishes, when the band 5 capability is selected, shall operate over a frequency range from 4.6 to 13.8 GHz for each polarisation.	**Essential**	**Test**
SYS_REQ-2185	**RF system sampled bandwidth band 1.** The instantaneous bandwidth for band 1 will be 700MHz and shall be sampled to at least 2.0 G samples per second for each polarisation	**Essential**	**Test**
SYS_REQ-2186	**RF system sampled bandwidth band 2.** The instantaneous bandwidth for band 2 will be 810 MHz and shall be sampled to at least 2.0 G sample per second for each polarisation.	**Essential**	**Test**
SYS_REQ-2187	**RF system sampled bandwidth band 3** The instantaneous bandwidth for band 3 will be 1,403 MHz and shall be sampled to at least 5.0 G samples per second for each polarisation	**Essential**	**Test**
SYS_REQ-2188	**RF system sampled bandwidth band 4** The instantaneous bandwidth for band 4 will be 2,380 MHz and shall be sampled at at least 5.0 G samples per second for each polarisation.	**Essential**	**Test**
SYS_REQ-2189	**RF system sampled bandwidth band 5** The SKA_Mid, for band 5, shall digitise two separate 2.5 GHz bands for each polarisation.	**Essential**	**Test**
SYS_REQ-2190	**RF digitisation.** Digitisation for each polarisation shall be: • band 1 8 bits • band 2 8 bits • band 3 6 bits • band 4 at least 4 bits • band 5 at least 2 streams of 3 bits	**Essential**	**Demonstration**
SYS_REQ-2774	**SKA1_Mid correlation sub-array support.** The SKA1_Mid shall be able to correlate SKA1_mid dishes as multiple sub-arrays independently and concurrently..	**Essential**	**Demonstration**
SYS_REQ-2195	**SKA1_Mid channelisation.** The SKA1_Mid channelisation for each sub array shall provide up to 65,536 linearly spaced frequency channels across the sampled bandwidth of each band.	**Essential**	**Test**
SYS_REQ-2196	**SKA1_Mid channelisation maximum leakage power for**	**Essential**	**Test**

	adjacent channels. The SKA1_Mid for each sub-array shall have a maximum noise leakage power from immediately adjacent frequency channels of < -30 dB		
SYS_REQ-2803	**SKA1_Mid maximum leakage power for non-adjacent frequency channels.** The SKA1_Mid, for each sub-array, shall have a maximum noise leakage power from non adjacent frequency channels better than -60 dB.	**Essential**	**Test**
SYS_REQ-2805	**SKA1_Mid fine frequency channel amplitude variation.** The fine frequency channels for the SKA1_Mid channeliser shall have a total amplitude variation as a function of frequency of less than 0.01 dB after bandpass calibratio	**Essential**	**Test**
SYS_REQ-2804	**SKA1_Mid fine frequency channel band edge**. The fine frequency cells for the SKA1_Mid channeliser shall have a -3dB transition band amplitude at the channel band edge.	**Essential**	**Test**
SYS_REQ-2679	**SKA1_Mid correlation signal to noise.** The SKA1_Mid correlation, for the same sub-array, shall not degrade the Signal to Noise ratio by more than 2% compared to ideal analogue correlation.	**Essential**	**Analysis**
SYS_REQ-2197	**SKA1_Mid correlation integration period.** The SKA1_Mid shall have independently configurable visibility integration period from a maximum integration time of 1.4s to a minimum of 0.14s for each subarray.	**Essential**	**Demonstration**
SYS_REQ-2616	**SKA1_Mid Pulsar phase binning.** The SKA1_Mid, for each subarray, shall allow for pulse phase-resolved observations supporting the product of the number of phase bins, channel and polarisation products up to 262,144 (i.e. 4 x 65,536).	**Essential**	**Demonstration**
SYS_REQ-2830	**SKA1_Mid Pulsar phase bin width.** The SKA1_Mid shall be capable of providing pulsar phase bin widths with a time resolution of better than 10us	**Essential**	**Test**
SYS_REQ-2831	**SKA1_Mid Pulsar phase bin synchronisation.** The SKA1_Mid shall be capable of synchronising phase bins to the ephemeris to limit drift to less than 10% of the selected bin width within the selected correlator integration period.	**Essential**	**Test**

SYS_REQ-2835	**SKA1_Mid Phase bin averaging time.** The SKA1_Mid phase bin averaging time shall be constrained to limit the output data rate to at most the single bin configuration output data rate.	**Essential**	**Demonstration**
SYS_REQ-2740	**Inclusion of MeerKAT into SKA1_mid correlator.** The SKA1_Mid correlator shall be capable of forming real time cross correlation products from all antenna within the SKA1_Mid combined array including those MeerKAT.	**Essential**	**Demonstration**
SYS_REQ-2201	**Beam-former sub-array support.** The SKA1_Mid central beam-former shall be able to form beams or more beams for one to sixteen sub-arrays independently and concurrently.	**Essential**	**Demonstration**
SYS_REQ-2751	**Pulsar search and timing within sub-arrays.** SKA1_Mid shall be capable of Pulsar search and timing processing within individual sub-arrays.	**Essential**	**Demonstration**
SYS_REQ-2202	**Pulsar search array diameter.** The central beam-former for pulsar search shall be capable of forming beams independently across all dishes (SKA1_Mid and MeerKAT) within each of the SKA1_Mid sub-arrays up to a distance of up to 10,000 metres from sub-array centres.	**Essential**	**Demonstration**
SYS_REQ-2755	**Pulsar search beamformer centre frequency**. The Pulsar search beamformer shall form beams for each of the search sub arrays with an independently selectable centre frequency for the sub-array in the range from the lowest frequency of SKA1_Mid band 1 through to the highest frequency of band 5.	**Essential**	**Demonstration**
SYS_REQ-2756	**Pulsar search beamforming bandwidth.** The SKA1_Mid Pulsar search shall have a contiguous processing bandwidth for beamforming of up to 300 MHz.	**Essential**	**Demonstration**
SYS_REQ-2203	**Number of beams: Pulsar search.** SKA1_Mid, when performing the Pulsar Search function, shall simultaneously form up to a total of 1111 beams per observation across all sub arrays.	**Essential**	**Demonstration**
SYS_REQ-2205	**Beamformer S/N pulsar search.** The SKA1_Mid central beam-forming for	**Essential**	**Analysis**

	each sub array shall have a Signal to Noise ratio greater or equal to 98% of ideal analogue beam forming for the same sub array:		
SYS_REQ-2753	**Pulsar search beamformer output.** For each SKA1_Mid Pulsar search sub-array the output shall be the power of summed polarisation beams.	**Essential**	**Demonstration**
SYS_REQ-2752	**Pulsar search beamforming output frequency resolution.** The frequency resolution for SKA1_Mid Pulsar search shall be independently configurable in frequency resolution with values in the 20 kHz and 75 kHz	**Essential**	**Demonstration**
SYS_REQ-2754	**Pulsar search beamforming output time resolution:** SKA1_Mid Pulsar search output beams shall have a minimum time resolution of 50us.	**Essential**	**Demonstration**
SYS_REQ-2206	**Pulsar timing array radius.** The central beam-former for pulsar timing shall be capable of forming beams across all dishes within the SKA1_Mid sub-arrays to a distance of up to 10,000 metres from their centres.	**Essential**	**Demonstration**
SYS_REQ-2757	**Pulsar timing beamformer centre frequency.** The Pulsar timing beamformer shall form beams for each of the timing sub-arrays with a selectable centre frequency for the sub-array in the range from the lowest frequency of SKA1_Mid band 1 through to the highest frequency of band 5.	**Essential**	**Demonstration**
SYS_REQ-2758	**Pulsar timing beamformer bandwidth.** The SKA1_Mid Pulsar timing beamformer for each timing sub-array shall have a contiguous processing bandwidth up to the full bandwidth of the selected band up to a bandwidth of 2.5 GHz.	**Essential**	**Test**
SYS_REQ-2207	**Number of beams: Pulsar timing.** The SKA1_Mid central beam-former for Pulsar timing shall be capable of forming up to 16 dual polarisation coherent beams in total across all timing sub-arrays.	**Essential**	**Demonstration**
SYS_REQ-2208	**Beamforming S/N ratio: Pulsar timing.** The SKA1_Mid for Pulsar timing shall have a Signal to Noise ratio greater or equal to 98% of an ideal analogue beam former.	**Essential**	**Analysis**

SYS_REQ-2689	**SKA1_Mid VLBI beam number.** SKA1_Mid shall be capable of producing up to four VLBI beams	**Essential**	**Analysis**
SYS_REQ-2759	**SKA1_Mid VLBI array diameter.** SKA1_Mid shall be able to generate VLBI beams from sub-arrays with receptors separated by up to 100km	**Useful**	**Analysis**
SYS_REQ-2760	**SKA1_Mid VLBI centre frequency.** SKA1_Mid shall be able to form a VLBI beam with a 0.01MHz step selectable centre frequency within the boundaries of the defined frequency bands for SKA1_Mid.	**Essential**	**Test**
SYS_REQ-2761	**SKA1_Mid VLBI beam bandwidth.** SKA1_Mid VLBI beamforming shall have a contiguous processing bandwidth up to the full bandwidth of the selected band	**Essential**	**Analysis**
SYS_REQ-2762	**SKA1_Mid VLBI beamformer S/N performance**. SKA1_Mid VLBI beamforming shall have the Signal to Noise ratio by more than 98% compared to an ideal analogue beam former.	**Essential**	**Test**
SYS_REQ-2847	**SKA1_Mid VLBI store the time-dependent antenna weights.** SKA1_Mid shall be able to store the time-dependent antenna weights used for each tied-array beam su	**Essential**	**Test**
SYS_REQ-2848	**SKA1_Mid VLBI timestamp accuracy.** SKA1_Mid shall be able to generate data from the VLBI beams with samples traceable to a timestamp with an accuracy of 1 nsec or better	**Essential**	**Test**
SYS_REQ-2849	**SKA1_Mid VLBI beams sampling rate.** SKA1_Mid shall be able to output VLBI beams with a sampling rate selectable between Nyquist and oversampled rates for the selected bandwidth	**Essential**	**Test**
SYS_REQ-2850	**SKA1_Mid VLBI beamforming**. SKA1_Mid shall be able to allocate antennas to be included in, or excluded from, individual tied-array beams	**Essential**	**Test**
SYS_REQ-2851	**SKA1_Mid VLBI relative sensitivity and coherence losses.** The SKA1_Mid beamformer shall be able to weight the antenna inputs into the tied-array sums based on relative sensitivity and coherence losses	**Essential**	**Test**
SYS_REQ-2852	**SKA1_Mid VLBI configurability.** SKA1_Mid shall be able to change the pointing, centre frequency, and	**Essential**	**Test**

	bandwidth of the individual tied-array beams within a single observing schedule		
SYS_REQ-2853	**SKA1_Mid VLBI configurability.** SKA1_Mid shall be capable of selecting, through configuration, 1, 2, 3, or 4 separate VLBI specific beams, each with independently selectable centre frequency, bandwidth, frequency resolution and pointing	**Essential**	**Test**
SYS_REQ-2854	**SKA1_Mid VLBI configurability.** SKA1_Mid shall be capable of reconfiguring the centre frequency, frequency band, and bandwidth for each tied-array beam, in less than 30 seconds	**Select One**	**Test**
SYS_REQ-2855	**SKA1_Mid VLBI spectral resolution.** SKA1_Mid shall be able to generate VLBI beams with a spectral resolutions different from the spectral resolution used for imaging within the same VLBI sub-arra	**Essential**	**Test**
SYS_REQ-2856	**SKA1_Mid VLBI channel width**. SKA1_Mid shall be able to generate VLBI beam data with a selectable channel width of: 512MHz, 256 MHz, 128MHz, 64MHz, 32MHz, 16MHz, 4MHz or 1MHz	**Essential**	**Test**
SYS_REQ-2857	**SKA1_Mid VLBI imaging and beamforming** SKA1_Mid shall be able to simultaneously generate imaging data using all antennas in a VLBI sub-array, as well as generating the VLBI beams	**Essential**	**Test**
SYS_REQ-2859	**SKA1_Mid VLBI spectral line and time domain observation** SKA1_Mid shall be able to generate VLBI beams optimised for either spectral line observations (to mitigate spectral leakage) or time domain observations (to mitigate time smearing	**Select One**	**Demonstration**
SYS_REQ-2860	**SKA1_Mid VLBI beams and sub-arrays.** SKA1_Mid shall be able to allocate individual VLBI beams to different sub-arrays	**Essential**	**Test**
SYS_REQ-2861	**SKA1_Mid VLBI array diameter.** SKA1_Mid shall be able to generate VLBI beams from sub-arrays with receptors separated by up to 20km	**Essential**	**Demonstration**
SYS_REQ-2765	**Pulsar search sub-array support**. The SKA1_Mid Pulsar search shall be able to independently process a total of up to 1111 beams from one to sixteen	**Essential**	**Demonstration**

	sub-arrays independently and concurrently.		
SYS_REQ-2767	**Pulsar search processing bandwidth**. The Pulsar search processing shall have a contiguous processing bandwidth up to 300 MHz for each search sub array.	**Essential**	**Test**
SYS_REQ-2212	**Dispersion Measure.** SKA1_Mid for pulsar search shall provide, for each sub array, trial dispersion corrections across the observation frequency range for dispersion measures from 0 up to 3000 pc cm^{-3}.	**Essential**	**Demonstration**
SYS_REQ-2216	**Time resolution.** The time resolution of the SKA1_Mid pulsar search processing for each sub-array shall be equivalent to the temporal smearing due to dispersion at the observation frequency and bandwidth of the observation with a quantisation of value in powers of 2 from 50 μs to 800 us	**Essential**	**Analysis**
SYS_REQ-2218	**Pulsar search observation time.** For each Pulsar search sub-array, the processing shall provide independently configurable observation times up to 1800 seconds duration.	**Essential**	**Demonstration**
SYS_REQ-2219	**Single pulse searches**. For each search sub-array within SKA1_Mid Pulsar search, the processing shall be capable of searching for single dispersed pulses over dispersion measure range up to 3000 pc cm^{-3} commensally with searches for periodic pulses with a S/N performance better than 7	**Essential**	**Analysis**
SYS_REQ-2220	**Binary search.** For each Pulsar search sub-array within SKA1_Mid the processing shall be capable of searching for binary systems with accelerations due to their orbital motion of up to 350 ms^{-2}.	**Essential**	**Analysis**
SYS_REQ-2763	**Pulsar timing sub-array support**. The SKA1_Mid Pulsar timing processing shall be able to independently process a total of up to 16 beams from one to sixteen sub-arrays independently and concurrently.	**Essential**	**Demonstration**
SYS_REQ-2768	**Pulsar timing processing bandwidth.** The Pulsar timing engine shall have a contiguous processing bandwidth up to the full bandwidth of	**Essential**	**Test**

	the selected band up to a bandwidth of 2.5 GHz for each timing sub-array		
SYS_REQ-2224	**Frequency agility.** The SKA1_Mid system shall, for each timing sub-array, be able to change from observing in any frequency band, to observing in any other frequency band in less than or equal to 30 seconds.	**Essential**	**Demonstration**
SYS_REQ-2766	**Pulsar timing observation time.** The observation period for each observation for each timing sub-array shall be independently configurable between 3 minutes and 300 minutes.	**Essential**	**Demonstration**
SYS_REQ-2764	**Time stamping.** For each individual Pulsar timing observation within a sub-array, each data sample shall be traceable to a time stamp derived from a clock accurate to 10ns on a time scale of 10 years referenced to a common delay centre at the centre of the SKA1_Mid array.	**Essential**	**Demonstration**
SYS_REQ-2230	**Multiple timings.** The SKA Phase 1 shall be capable of timing up to 16 pulsars simultaneously in total across all timing sub arrays .	**Essential**	**Demonstration**
SYS_REQ-2231	**Pulsar timing Dispersion Measure.** The SKA1_Mid shall be capable of timing pulsars with dispersion measures between 0 to 3000 pc cm^{-3} such that residual dispersive smearing is less than 500 ns.	**Essential**	**Analysis**
SYS_REQ-2128	**Continuum and spectral line imaging mode.** Both SKA1 telescopes shall be capable of operating in a Continuum and Spectral-line imaging mode concurrently.	**Essential**	**Demonstration**
SYS_REQ-2129	**Pulsar Search Mode.** The SKA1_mid telescope shall be capable of operating in a Pulsar search mode, concurrently with Continuum imaging mode.	**Essential**	**Demonstration**
SYS_REQ-2130	**Pulsar Timing Mode.** The SKA1_mid telescope shall be capable of operating in a Pulsar timing mode, concurrently with continuum imaging mode.	**Essential**	**Demonstration**
SYS_REQ-2126	**Simultaneous operation of telescopes.** Both SKA1 telescopes shall be capable of operating concurrently and independently.	**Essential**	**Demonstration**
SYS_REQ-2133	**Mode transition.** The switching time between telescope operating modes shall take less than 30 seconds (not including antenna slewing time)	**Essential**	**Test**

SYS_REQ-2681	**Specific epoch observations.** The observatory shall have the capability of scheduling observations at a specific epoch for time dependent phenomena.	**Essential**	**Demonstration**
SYS_REQ-2682	**Overriding normal processes.** There shall be a mechanism for requesting observing time outside the normal observing time allocation process for unpredicted phenomena or in cases of high current scientific interest.	**Essential**	**Inspection**
SYS_REQ-2683	**Overriding allocated time.** The Director-General or his/her delegate shall have the power to override allocation of time to other projects.	**Essential**	**Inspection**
SYS_REQ-2688	**Commensal Observing Data access rights.** There shall be a documented data access rights policy for commensal observing for data sets shared across projects.	**Essential**	**Inspection**
SYS_REQ-2127	**Sub-Arraying.** Both of the SKA1 telescopes shall be capable of operating independently with one to sixteen sub-arrays (i.e. collecting area is split and allocated to separate, concurrently observing programmes).	**Essential**	**Demonstration**
SYS_REQ-2736	**Authentication and Authorisation**. All SKA users shall require to be registered and authenticated for the purposes of proposal and project submission.	**Essential**	**Demonstration**
SYS_REQ-2278	**Scheduled maintenance logs**. A maintenance database shall be established that logs all the scheduled maintenance and unexpected repairs.	**Essential**	**Demonstration**
SYS_REQ-2279	**System error logs.** A failure database shall be established, which logs the errors of the system and its subsystems, including the corrective actions taken.	**Essential**	**Demonstration**
SYS_REQ-2280	**System status.** The system shall extract information about the current condition of the system from the science and calibration data streams, and log this information along with other relevant system and environmental status information. Based on this information, it shall be possible to monitor, save, and analyse the technical performance of the system.	**Essential**	**Demonstration**
SYS_REQ-2282	**Central location for data bases.** External sources of information used	**Essential**	**Demonstration**

	by the Elements shall be cached by Telescope Manager. No sources other than those cached by TM shall be used.		
SYS_REQ-2283	**Target of opportunity.** TOO observing shall be via Scheduling Blocks.	**Essential**	**Test**
SYS_REQ-2285	**Latency of TOO scheduling block initiation**. Scheduling intervention on TOO triggers shall be initiated within 1s of receiving the trigger.	**Essential**	**Test**
SYS_REQ-2286	**Discard previous scheduling block.** At the launching of a TOO Scheduling Block, the results from any active Scheduling Blocks shall be discarded.	**Essential**	**Test**
SYS_REQ-2289	**Proposal submission.** Program submission, assessment, and time allocation shall governed by an official policy document	**Essential**	**Inspection**
SYS_REQ-2723	**Proposal submission tool.** There shall be a tool to facilitate the assessment, review and ranking of proposals, guided by official SKA Policies.	**Essential**	**Test**
SYS_REQ-2647	**Tool for proposal submission.** There shall be a tool, either web or client, for the construction and submission of proposals, as necessary facilitating access to relevant sources of information such as Telescope characteristics, previous observations, SIMBAD, templates.	**Essential**	**Test**
SYS_REQ-2290	**Pre and post conditions.** Scheduling Blocks shall have computable pre- and post-conditions.	**Essential**	**Demonstration**
SYS_REQ-2291	**Semester queue**. A Semester Queue (SQ) shall be constructed by Operations following acceptance of proposals.	**Essential**	**Demonstration**
SYS_REQ-2292	**Operations: Operations** shall be responsible for constructing an executable schedule and Scheduling Blocks and submitting for execution.	**Essential**	**Inspection**
SYS_REQ-2293	**Short term schedule construction tool.** There shall be an interactive tool to aid the proposer in constructing Scheduling Blocks and an executable schedule.	**Essential**	**Demonstration**
SYS_REQ-2646	**API for construction of schedule.** There shall be a API or APIs for the construction of scheduling blocks from Python and Java.	**Essential**	**Test**
SYS_REQ-2294	**Simulated execution of scheduling blocks.** The scheduling tool shall offer	**Essential**	**Demonstration**

	the option to simulate execution of Scheduling Blocks in order to verify correctness and scientific performance at some limited level of accuracy.		
SYS_REQ-2735	**Operator control.** It shall be possible for the operator to take manual control of the telescope.	**Essential**	**Test**
SYS_REQ-2295	**Response policy.** The nature of the response to a transient event shall be controlled by policy administered by Telescope Manager.	**Essential**	**Inspection**
SYS_REQ-2296	**Responses to transients** Responses shall be one of the following (a) invoking a special mode on the telescope of origin, (b) issuing an VOEvent, (c) issuing a TOO announcement to SKA Telescopes, (d) no action.	**Essential**	**Demonstration**
SYS_REQ-2297	**Observing mode latency** The maximum allowed latency between event and detection shall be allowed to be Observing Mode dependent.	**Essential**	**Demonstrate**
SYS_REQ-2298	**Rules for issuing VOEvents** Proposals to search for transients shall include rules for issuing VOEvents.	**Essential**	**Demonstration**
SYS_REQ-2299	**Latency of initiating a response.** Response to an event shall be initiated within 1 second of notification.	**Essential**	**Test**
SYS_REQ-2300	**TOO VOStreams**. TOO proposals shall include specified VOEvent streams to be monitored.	**Essential**	**Test**
SYS_REQ-2301	**VOEvent issue latency**. A qualifying VOEvent shall lead to initiation of a response by the Telescope Manager within 1 second.	**Essential**	**Test**
SYS_REQ-2645	**Telescope model.** A dynamic computational model of the Telescope shall be used to answer all queries about the state of the Telescope. The telescope model shall consist of configuration information, numerical models, empirical parameters, and conventions.	**Essential**	**Demonstration**
SYS_REQ-2302	**Single geodetic model (Telescopes).** There shall be a single geodetic model for all telescopes, published as part of the Telescope Model.	**Essential**	**Demonstration**
SYS_REQ-2303	**Single geometric model.** There shall be a single geometric model for all receptor types, published by TM.	**Essential**	**Demonstration**
SYS_REQ-2304	**Dish pointing model.** The dish receptor system shall include a model for pointing including structural	**Essential**	**Demonstration**

	model, thermal model, reference pointing model, and refraction model, published by TM.		
SYS_REQ-2305	**AA element and station beam model.** The AA receptor system shall include a model for element and station beams as a function of azimuth and zenith angle, frequency, and polarisation, published by TM.	**Essential**	**Demonstration**
SYS_REQ-2306	**Forensic tool for telescope behaviour** There shall be an interactive forensic tool for evaluating and understanding the state and behaviour of the system at any one time.	**Essential**	**Demonstration**
SYS_REQ-2307	**Interfaces.** The interactive forensic tool shall have an Internet interface with availability on a range of platforms including desktop and mobile devices.	**Essential**	**Demonstration**
SYS_REQ-2308	**Replay of sequences**. The interactive forensic tool shall allow replay of selected sequences.	**Essential**	**Demonstration**
SYS_REQ-2309	**Active alarms.** Alarm notification shall be active (via SMS, email, etc.) rather than passive (requiring an Operator query)	**Essential**	**Demonstration**
SYS_REQ-2310	**Alarm filtering**. It shall be possible to filter alarms individually or by group.	**Essential**	**Demonstration**
SYS_REQ-2312	**Alarm latency.** Latency from event to alarm shall be no more than 5 seconds.	**Essential**	**Test**
SYS_REQ-2313	**Access to historical data.** All current and historic Site monitor data shall be as examinable as that from any telescope component.	**Essential**	**Demonstration**
SYS_REQ-2314	**Total electron content.** The SKA Phase 1 TM shall retrieve, persist and publish data on Total Electron Content (TEC) from dual frequency GPS as part of the Telescope Model.	**Essential**	**Inspection**
SYS_REQ-2315	**Ionospheric activity.** There shall be timely access to information from other relevant sources e.g. IPS concerning unusual ionospheric activity or alerts.	**Essential**	**Demonstration**
SYS_REQ-2316	**Weather station**. There shall be a data base for site weather station data.	**Essential**	**Demonstration**
SYS_REQ-2317	**Satellites.** There shall be a database of relevant satellite trajectories, including orbit information, emission characteristics and owner.	**Essential**	**Demonstration**

SYS_REQ-2318	**Commercial flights.** There shall be a data base of commercial flights in the neighbourhood of the site.	**Essential**	**Demonstration**
SYS_REQ-2734	**RFI database.** There shall be a database holding information about RFI.	**Essential**	**Demonstration**
SYS_REQ-2729	**Calibration and imaging formalism.** The Calibration and Imaging formalism shall be based upon the Rau framework [14].	**Essential**	**Demonstration**
SYS_REQ-2319	**Closed loop calibration.** The telescope calibration shall be solved by comparison of observed with GSM predictions with a time scale appropriate to the component and physical effect being calibrated and fed back to the telescope.	**Essential**	**Demonstration**
SYS_REQ-2322	**Global sky model.** Calibration and continuum subtraction shall use a Local Sky Model, derived from a Global Sky Model or previous Local Sky Model.	**Essential**	**Demonstration**
SYS_REQ-2324	**Multi-frequency synthesis imaging**. All imaging shall construct and make use of frequency dependent image models over the entire observed bandwidth.	**Essential**	**Demonstration**
SYS_REQ-2325	**Deconvolution of single channels** Scale sensitive two-dimensional (i.e. on the tangent plane) deconvolution shall be available.	**Essential**	**Demonstration**
SYS_REQ-2328	**Solution for pointing errors.** It shall be possible to solve for and correct time- and station-dependent pointing errors with accuracy and timescale limited by signal to noise ratio.	**Essential**	**Demonstration**
SYS_REQ-2330	**Peeling.** Peeling of bright sources (strength limited by signal to noise ratio) from the visibility data shall be possible.	**Essential**	**Demonstration**
SYS_REQ-2321	**Direction dependent effects.** Self-calibration and image reconstruction algorithms shall be capable of dealing with direction dependent effects	**Essential**	**Demonstration**
SYS_REQ-2724	**Aperture Array DDE**. There shall be a direction dependent model for the aperture array primary beam to be used in calibration and imaging.	**Essential**	**Test**
SYS_REQ-2727	**Dish DDE.** There shall be a direction dependent model for the dish primary beam to be used in calibration and imaging.	**Essential**	**Test**
SYS_REQ-2726	Delete	**Essential**	**Test**

SYS_REQ-2725	**Faraday rotation DDE.** There shall be a direction dependent Faraday Rotation model for use in calibration and imaging.	**Essential**	**Test**
SYS_REQ-2333	**Continuum source finding.** Where appropriate, continuum source finding shall be conducted on images generated by the Continuum Imaging pipeline. Polarization shall be fitted if available.	**Essential**	**Test**
SYS_REQ-2334	**Spectral line source finding.** Where appropriate, spectral line source finding shall be conducted on image cube generated by the Spectral Line pipeline.	**Essential**	**Test**
SYS_REQ-2335	**Stacking.** Where appropriate, spectral line stacking shall be conducted on image cubes generated by the pipelines using *a priori* known source lists.	**Essential**	**Test**
SYS_REQ-2336	**Standard pipeline products.** All pipelines shall include as data products the pipeline processing log, and Quality Assessment log.	**Essential**	**Test**
SYS_REQ-2338	**Calibration pipeline.** There shall be a Calibration pipeline that derives current telescope parameters using a recent observation and a Global Sky Model, either a known GSM or the most recent GSM.	**Essential**	**Test**
SYS_REQ-2339	**Continuum imaging pipeline.** There shall be a Continuum Imaging pipeline that shall have the goal of constructing noise-limited wide-band images for observations up to 1000h integration time. Polarisation shall be available if requested or necessary for calibration or quality assurance.	**Essential**	**Test**
SYS_REQ-2340	**Continuum imaging data products.** The Data Products shall include the first n moment images for multi-frequency synthesis, corresponding residual images (if deconvolved), sensitivity image and representative PSF image, where n is set by signal to noise ratio.	**Essential**	**Test**
SYS_REQ-2341	**Spectral line emission pipeline.** There shall be a Spectral Line Emission pipeline that is optimised for constructing noise-limited (up to 1000h integration) channel cubes of spectral line emission either with	**Essential**	**Test**

	continuum emission remaining or with continuum emission removed.		
SYS_REQ-2342	**Spectral line emission data products.** The data products shall include spectral line cube image, continuum model images, sensitivity image, and representative point spread function.	**Essential**	**Test**
SYS_REQ-2343	**Spectral line absorption pipeline.** There shall be a Spectral Line Absorption pipeline that is optimised for constructing noise-limited channel cubes of spectral line absorption with continuum sources removed.	**Essential**	**Test**
SYS_REQ-2344	**Spectral line absorption data products.** The data products shall include spectral line cube image, continuum model images, sensitivity image, and representative point spread function.	**Essential**	**Test**
SYS_REQ-2345	**Slow transient pipeline.** There shall be a Slow Transient imaging pipeline that shall be capable of constructing a continuum image after a GSM has been subtracted for every correlator integration time or slower, searching for transient sources, and producing a time-ordered catalogue.	**Essential**	**Test**
SYS_REQ-2346	**Slow transient data products.** The data products shall include a catalogue of found sources, a sensitivity image, and representative PSF image.	**Essential**	**Test**
SYS_REQ-2347	**Automated Quality Assessment.** All pipelines shall perform standardised, automated Quality Assessment of Images along the axes of astrometry, photometry, radiometry, polarimetry, and spectrometry.	**Essential**	**Test**
SYS_REQ-2742	**Performance assessment:** Performance assessment shall be based on multi-valued functions of an observed Image and optionally a template Image	**Essential**	**Test**
SYS_REQ-2743	**Performance Goals:** Performance goals shall be based on multi-valued functions of an observed Image and optionally a template Image	**Essential**	**Test**
SYS_REQ-2744	**Quality assessment:** Quality assessment shall be based on the comparison of a Performance Assessment and a Performance Goal	**Essential**	**Test**
SYS_REQ-2745	**Astrometric performance metric:** The Astrometric performance metric	**Essential**	**Test**

	(APM) shall measure deviation (rms, average offset, and med) of source positions from known standards		
SYS_REQ-2746	**Photometric performance metric:** The Photometric performance metric (PPM) shall measure deviation (rms, average offset, and med) of source fluxes from known standards	**Essential**	**Test**
SYS_REQ-2747	**Radiometric performance metric:** The Radiometric performance metric (RPM) shall measure noise fluctuations (rms, average offset, and med) in an Image	**Essential**	**Test**
SYS_REQ-2748	**Polarimetric performance metric:** The Polarimetric performance metric (OPM) shall measure deviation (rms, average offset, and med) of source polarisations (polarisation degree and angle) from known standards	**Essential**	**Test**
SYS_REQ-2749	**Spectrometric performance metric:** The Spectrometric performance metric (SPM) shall measure deviation (rms, average offset, and med) of source spectral lines from known standards	**Essential**	**Test**
SYS_REQ-2821	**Archive.** There shall be an archive for each telescope, located in the Science Processing Centre, for storing selected science data products for subsequent access by users according to science data access policy.	**Essential**	**Demonstration**
SYS_REQ-2348	**Role of science processing centres.** The science-processing centre will convert the output data from the CSP into science data products to be stored in the science data archive.	**Essential**	**Test**
SYS_REQ-2350	**Mirror sites.** All data within Science Archives shall have a secondary copy located offsite in a secure location.	**Essential**	**Test**
SYS_REQ-2352	**Web interface.** The science data archives shall be accessible from the internet via a standardised web interface.	**Essential**	**Demonstration**
SYS_REQ-2353	**Virtual Observatory interface.** The science data archives shall be accessible via a set of recommended IVOA services chosen to allow access to all approved data products.	**Essential**	**Test**
SYS_REQ-2354	**Archive API.** The science data archives shall publish a user accessible, open API in a small number of complementary languages such as Python, C++, and Java.	**Essential**	**Test**

SYS_REQ-2355	**Data product provenance.** An official data product shall have known, documented provenance, and shall have been produced via SKA observations and processing.	**Essential**	**Definition**
SYS_REQ-2357	**QA annotation.** The telescope shall facilitate the addition of QA annotations by Users.	**Essential**	**Test**
SYS_REQ-2358	**Third party data products.** Third party data products shall not be admitted to the archive.	**Essential**	**Inspection**
SYS_REQ-2360	**Science data product archive policy.** There shall be a policy, developed and administered by Operations, governing which types and sizes of data products will be retained in the archive and for how long.	**Essential**	**Inspection**
SYS_REQ-2361	**Archive access.** A telescope archive will be nominally open for access 24/7/365, with no more than 24 hrs planned downtime per year. Unplanned downtime shall be consistent with availability budget.	**Essential**	**Test**
SYS_REQ-2363	**Archive lifetime.** The science data archives shall be designed to provide an archived data lifetime of not less than 50 years from the start of archived observations.	**Essential**	**Inspection**
SYS_REQ-2728	**Data migration design.** The archive design shall support and facilitate migration from one medium to another.	**Essential**	**Demonstration**
SYS_REQ-2364	**Data migration plan.** Operations shall maintain at all times and update yearly a current data migration plan covering the contingency of moving from one archive platform to another.	**Essential**	**Inspection**
SYS_REQ-2366	**Distribution of data products.** As limited by resource constraints, it will be possible to deliver science data products to approved off-site facilities, which may be globally distributed	**Essential**	**Test**
SYS_REQ-2660	**Backup archive retrieval**. Backup archive items shall be retrievable to the full archive from an alternate source within 24 hours	**Essential**	**Demonstration**
SYS_REQ-2661	**Backup archive user access conversion.** Users shall have access to the data of the entire archive within one week following an incident.	**Essential**	**Demonstration**
SYS_REQ-2739	**Levels of access**. Access to the archive shall be either anonymous with correspondingly limited	**Essential**	**Test**

	capabilities or via SKA authentication and authorisation.		
SYS_REQ-2657	**Processing capability.** SDP processing per telescope at Early Science shall support processing rates 10% of that required for Full Observing (decimation being in any or all of time, frequency, field of view)	**Essential**	**Test**
SYS_REQ-2268	**Coherence losses 1s.** The SKA frequency reference system shall provide a 2% maximum coherence loss , equivalent to 0.2 radians, within a maximum integration period of 1s.	**Essential**	**Demonstration**
SYS_REQ-2692	**Coherence loss 1min**. The SKA frequency reference system shall provide a 2% maximum coherence loss , equivalent to 0.2 radians, within a maximum solution interval for in-beam calibration of 1 minute.	**Essential**	**Demonstration**
SYS_REQ-2693	**Frequency reference phase drift.** The SKA Frequency Reference System shall have a phase drift of less than 1 radian, over calibration intervals of up to 10 minutes, when using out of beam calibration sources.	**Essential**	**Demonstration**
SYS_REQ-2269	**Pulse per Second precision.** The SKA synchronisation and timing system shall provide a 1 pps heartbeat signal, precise to the sampling clock (the pulse-to-pulse scatter is less than one sampling time), derived from the distributed frequency reference	**Essential**	**Test**
SYS_REQ-2695	**Pulse per second phase relative to UTC.** The SKA synchronisation and timing system shall provide a 1PPS heartbeat signal with phase relative to UTC that over a 10 minute calibration interval shall survive synchronisation loss	**Essential**	**Demonstration**
SYS_REQ-2274	**UTC accuracy**. The SKA1 timescale shall be connected to UTC with an accuracy of 10 ns, on a timescale of 10 years	**Essential**	**Analysis**
SYS_REQ-2275	**Central frequency reference.** In order to avoid large offsets, the central frequency reference shall be steered to UTC to within at least 1 microsecond, with a frequency drift of less than 10 ns/day.	**Essential**	**Demonstration**
SYS_REQ-2276	**SKA1 UTC offsets.** The solution period for the calculation of offsets between SKA1 timescale and UTC shall be less than 1 day	**Essential**	**Demonstration**

SYS_REQ-2370	**Weather Monitoring**. Weather monitoring stations (2 No at each core and 2 No within each spiral arm) shall be provided as part of the infrastructure - wind, temperature and humidity.	**Essential**	**Inspection**
SYS_REQ-2371	**Visual monitoring.** The infrastructure shall provide day and night time capability for the operator(s) to visually monitor all antennas: for Dish antennas this shall be at every dish, for LFAA this shall be located at each station and also around the perimeter of the core area. Monitoring to deliver images at least one per minute for purposes of security and general telescope visual monitoring and shall be able to detect personnel at each dish and within each LFAA station.	**Essential**	**Inspection**
SYS_REQ-2730	**RFI Monitoring.** Permanent stations and mobile RFI monitoring units shall be provided as part of infrastructure	**Essential**	**Inspection**
SYS_REQ-2372	**Tropospheric Monitoring**. Existing Tropospheric monitoring stations shall be expanded as part of the SKA1 infrastructure to provide at least 3 No sensor units in each of the Australia and South Africa locations.	**Essential**	**Inspection**
SYS_REQ-2373	**Low RFI power delivery.** The power delivery infrastructure shall comply with the SKA1 RFI levels documentation.	**Essential**	**Test**
SYS_REQ-2374	**Site Access**. Roads and track-ways (including drainage) for the safe, secure and economic construction and operation of the SKA1 shall be provided	**Essential**	**Analysis and Inspection**
SYS_REQ-2375	**Air-strip**. There shall be access to an air strip on site.	**Essential**	**Inspection**
SYS_REQ-2376	**Construction.** Potable and non-potable water shall be available at SKA1 construction camps including foundation concrete plants.	**Essential**	**Inspection**
SYS_REQ-2377	**Steady state.** Sufficient water shall be continually available at SKA1 facilities in support of equipment cooling for each telescope.	**Essential**	**Inspection**
SYS_REQ-2378	**Standards and Regulations.** The delivery and disposal of water and all construction activity shall be compliant with local and national standards and regulations.	**Essential**	**Analysis**

SYS_REQ-2382	**Central Processing Facility RFI shielding**. Each Central Processing Facility shall provide RFI shielding greater than that derived from zoning specifications given in the SKA RFI levels documentation (to be published by T0 + 12w).	**Essential**	**Test**
SYS_REQ-2383	**Central Processing Facility RFI penetrations**. The Central Processing Facility shall provide RFI compliant penetrations for signal and power cables entering the facility and also for all other penetrations.	**Essential**	**Inspection**
SYS_REQ-2397	**Dish Antenna earthing**. For lightning protection of each dish antenna the earthing system shall conform to the requirements of IEC 62305 and also to national standards SANS 10142 and 10313. National standards shall take precedence.	**Essential**	**Test**
SYS_REQ-2398	**Telephone Network**. All populated facilities shall provide connectivity to the public telephone network.	**Essential**	**Test**
SYS_REQ-2400	**Communication.** All vehicles used on site shall be equipped with long range communication devices.	**Essential**	**Demonstration**
SYS_REQ-2401	**Training.** All drivers on or to the sites shall have appropriate awareness training.	**Essential**	**Inspection**
SYS_REQ-2402	**Site steady state power budget Africa.** The total steady state power budget for the African site shall be within the limits specified in SKA Power Budget SKA-SE-POW-TN-001 [21]	**Essential**	**Test**
SYS_REQ-2404	**Site steady state power budget Australia**. The total steady state power budget for the Australian site shall be within the limits specified in SKA Power Budget SKA-SE-POW-TN-001 Revision 1 [21].	**Essential**	**Test**
SYS_REQ-2769	**Time Reference:** SKA1 shall use a time reference derived from Global Positioning System (GPS).	**Essential**	**Inspection**
SYS_REQ-2838	**VLBI data sources.** The SKA1_Mid telescope shall be a data source for VLBI data acquisition system. The interface between the SAK1_Mid telescope and the external VLBI data acquisition system shall be compliant with the ICD SKA-TEL-SKO-0000116	**Essential**	**Demonstration**

SYS_REQ-2839	**Provision of equipment for recording**. Provision of equipment for recording or capturing VLBI data is outside the scope of SKA	**Essential**	**Demonstration**
SYS_REQ-2840	**VLBI equipment and eVLBI connectivity.** VLBI equipment and eVLBI connectivity beyond the interface boundary described in the ICD SKA-TEL-SKO-0000116 is outside the scope of supply of the SKA1 project	**Essential**	**Demonstration**
SYS_REQ-2841	**Infrastructure for VLBI equipment:.** The following infrastructure shall be provided to allow eventual outfitting of SKA1_Mid with VLBI equipment: 1. Adequate access for the potential fitment of VLBI equipment 2. Equipment space 3. Power 4. Cooling 5. Cable trays	**Essential**	**Demonstration**
SYS_REQ-2842	**Provision for VLBI terminal**. Provision for VLBI terminals or equivalent equipment shall be made in the Science Processing Centres for the associated telescopes	**Essential**	**Demonstration**
SYS_REQ-2843	**Compatibility with existing VLBI terminal.** SKA1 shall be able to output VLBI beam data with each individual stream limited to 512 MHz of signal bandwidth to ensure compatibility with existing VLBI terminal capabilit	**Select One**	**Demonstration**
SYS_REQ-2844	**VLBI Processing**. VLBI processing, with the exception of beam-forming and SKA1 imaging in support of VLBI. is outside the scope of the SKA	**Essential**	**Demonstration**
SYS_REQ-2845	**VLBI beam output data.** SKA1 shall be able to produce VLBI beam output data with either dual or single polarizatio	**Essential**	**Test**
SYS_REQ-2846	**Word length of VLBI beam output data**. SKA1 shall be able to output VLBI beam data with configurable word formats, the allowed values being 2, 4, 8, and 16-bit integer	**Essential**	**Test**
SYS_REQ-2410	**MeerKAT to SKA1_mid CSP interface**. The interface between MeerKAT and SKA1_mid CSP shall	**Essential**	**Test**

	be compliant with SKA-TEL.AIV.SE-TEL.CSP.SE-ICD-001 Interface Control Document		
SYS_REQ-2412	**MeerKAT to SKA1_mid SADT interface**. The interface between MeerKAT and SKA1_mid SADT shall be compliant with SKA-TEL.AIV.SE-TEL.SADT.SE-ICD-001 Interface Control Documen	**Essential**	**Test**
SYS_REQ-2414	**MeerKAT to SKA1_mid SADT interface**. The interface between MeerKAT and SKA1_mid SADT shall be compliant with SKA-TEL.AIV.SE-TEL.TM.SE-ICD-001 Interface Control Document.	**Essential**	**Test**
SYS_REQ-2775	**MeerKAT to SKA1_INFRA interface.** The interface between MeerKAT and SKA1_INFRA shall be compliant with SKA-TEL.AIV.SE-TEL.INFRA.SE-ICD-001 Interface Control Document	**Essential**	**Test**
SYS_REQ-2416	**CSP to Infra interface**. The interface between CSP and Infra shall be compliant with the SKA-TEL.CSP.SE-TEL.INFRA.SE-ICD-001 Interface Control Document.	**Essential**	**Test**
SYS_REQ-2738	**CSP to SDP interface**. The interface between CSP and SDP shall be compliant with the SKA-TEL.SDP.SE-TEL.CSP.SE-ICD-001 Interface Control Document	**Essential**	**Test**
SYS_REQ-2418	**Dish to CSP interface**. The interface between CSP and Dish shall be compliant with the SKA-TEL.DSH.SE-TEL.CSP.SE-ICD-001 Interface Control Document.	**Essential**	**Test**
SYS_REQ-2419	**Dish to Infra interface**. The interface between Dish and Infra shall be compliant with the SKA-TEL.DSH.SE-TEL.INFRA.SE-ICD-001 Interface Control Document.	**Essential**	**Test**
SYS_REQ-2420	**LFAA to CSP interface**. The interface between LFAA and CSP shall be compliant with the SKA-TEL.LFAA.SE-TEL.CSP.SE-ICD-001 Interface Control Document.	**Essential**	**Test**
SYS_REQ-2421	**LFAA to Infra interface**. The interface between LFAA and INFRA shall be compliant with the SKA-TEL.LFAA.SE-TEL.INFRA AUS.SE-ICD-001Interface Control Document.	**Essential**	**Test**
SYS_REQ-2422	**SADT to DSH interface**. The interface between SADT and DSH	**Essential**	**Test**

	shall be compliant with the SKA-TEL.SADT.SE-TEL.DSH.SE-ICD-001 Interface Control Document.		
SYS_REQ-2423	**SADT to LFAA interface**. The interface between SADT and LFAA shall be compliant with the SKA-TEL.SADT.SE-TEL.LFAA.SE-ICD-001 Interface Control Document.	**Essential**	**Test**
SYS_REQ-2424	**SADT to CSP interface**. The interface between SADT and CSP shall be compliant with the SKA-TEL.SADT.SE-TEL.CSP.SE-ICD-001 Interface Control Document.	**Essential**	**Test**
SYS_REQ-2425	**SADT to SDP interface**. The interface between SADT and SDP shall be compliant with the SKA-TEL.SADT.SE-TEL.SDP.SE-ICD-001 Interface Control Document.	**Essential**	**Test**
SYS_REQ-2426	**SADT to Infra interface**. The interface between SADT and Infra shall be compliant with the SKA.TEL.SADT.SE-TEL.INFRA.SE-ICD-001 Interface Control Document.	**Essential**	**Test**
SYS_REQ-2427	**TM to Dish interface**. The interface between TM and Dish shall be compliant with the SKA-TEL.TM.SE-TEL.DSH.SE-ICD-001. Interface Control Document.	**Essential**	**Test**
SYS_REQ-2428	**TM to LFAA interface**. The interface between TM and LFAA shall be compliant with the SKA-TEL.TM.SE-TEL.LFAA.SE-ICD-001 Interface Control Document.	**Essential**	**Test**
SYS_REQ-2429	**TM to SADT interface**. The interface between TM and SADT shall be compliant with the SKA-TEL.TM.SE-TEL.SADT.SE-ICD-001 Interface Control Document.	**Essential**	**Test**
SYS_REQ-2430	**TM to CSP interface**. The interface between CSP and TM shall be compliant with the SKA-TEL.CSP.SE-TEL.TM.SE-ICD-001. Interface Control Document.	**Essential**	**Test**
SYS_REQ-2737	**TM to INFRA Interface.** The interface between TM and INFRA shall be compliant with the SKA.TEL.TM.SE-TEL.INFRA.SE-ICD-001 Interface Control Document.	**Essential**	**Test**
SYS_REQ-2431	**SDP to TM interface**. The interface between SDP and TM shall be compliant with the SKA-TEL.SDP.SE-TEL.TM.SE-ICD-001 Interface Control Document.	**Essential**	**Test**

SYS_REQ-2432	**SDP to INFRA interface**. The interface between SDP and Infra shall be compliant with the SKA.TEL.SDP.SE-TEL.INFRA.SE-ICD-001 Interface Control Document.	**Essential**	**Test**
SYS_REQ-2462	**Electromagnetic Radiation.** Any component of the observatory shall not emit electromagnetic radiation, in any of the stated frequency intervals for broad band and narrow band cases, that exceeds the SKA RFI/EMI Threshold Levels[4]	**Essential**	**Test**
SYS_REQ-2463	**Self-induced RFI.** The SKA1 Telescope shall generate less self-induced RFI, within the Telescope's operating frequency bands, than the SKA RFI/EMI Protection Levels, for both broad band and narrow band cases, as specified in the "RFI/EMI Protection and Threshold Levels for the SKA" document. The SKA RFI/EMI Protection Levels are defined at the respective receiver input, and measured at the respective Telescope time series output.	**Essential**	**Test**
SYS_REQ-2464	**Electromagnetic Compatibility Standards.** The SKA1 Telescopes shall be compliant with one or more of the following standards for emissions and one or more for susceptibility/immunity:*BS EN 61000-6-2. Electromagnetic compatibility (EMC). Generic standards. Immunity standard for industrial environments. *BS EN 61000-6-4 AMD2. Electromagnetic compatibility (EMC). Part 6-4. Generic standards. Emission standard for industrial environments. *BS CISPR 14-1. Electromagnetic compatibility. Requirements for household appliances, electric tools and similar apparatus. Part 1. Emission. *MIL-STD-464C	**Essential**	**Inspection**
SYS_REQ-2465	**Electricity network Electromagnetic Compatibility.** The SKA1 telescopes shall follow the TBD code of practice for the application of Electromagnetic Compatibility (EMC) standards and guidelines in electricity utility networks.	**Essential**	**Analysis**

SYS_REQ-2466	**EMC compatibility marking.** All "off-the-shelf" equipment shall possess as a minimum the host country EMC marking.	**Essential**	**Inspection**
SYS_REQ-2467	**Electromagnetic susceptibility.** The observatory shall not be susceptible to terrestrial electromagnetic radiation at any frequency that significantly interferes with its normal operation.	**Essential**	**Test**
SYS_REQ-2472	**RFI flagging.** The SKA1 telescopes shall automatically flag frequency data with a resolution of one channel and time data to the resolution of the integration unit if the data is corrupted by RFI.	**Essential**	**Test**
SYS_REQ-2473	**RFI excision.** The SKA1 Telescopes shall automatically excise data that is corrupted by RFI.	**Essential**	**Test**
SYS_REQ-2474	**RFI masking.** The SKA1 Telescopes shall flag data according to a pre-selected RFI Mask.	**Essential**	**Demonstration**
SYS_REQ-2475	**RFI zones of avoidance**. The SKA1 telescopes shall allow spatial zones of avoidance to be defined.	**Essential**	**Demonstration**
SYS_REQ-2433	**Design for Extensibility**.Design trade studies for SKA1 shall include scenarios where design features are included which will allow 1. Increases in the number of receptors for SKA2 over SKA1 by a factor of 10 whilst re-using more than 90% of SKA1 hardware 2. The introduction of AIP technologies at SKA2 scales whilst re-using more than 90% of SKA1 hardware Such trade studies shall yield the incremental cost of such scenarios over those which do not include such design features.	**Essential**	**Inspection**
SYS_REQ-2484	**Environmental legislation and regulations.** The observatory shall be compliant with all local, State and national environmental protection legislation and regulations. NOTE: Legislation takes precedence over project/contract documentation and requirements. Omission of a law from this requirement does not affect its enforceability. Legislation is also subject to amendment and so the	**Essential**	**Analysis**

	Environmental Laws identified during the Request for Information (copied below) may be modified by the Hosting Agreements and subsequent Acts and Amendments.Legislation and regulations identified during the response to Request for Information include:South Africa: National Environmental Management Act, 1998 ("NEMA"); National Water Act, 1998; National Environmental Management: Air Quality Act, 2004; National Environmental Management Waste Act, 2008; National Environment Management: Biodiversity Act, 2004; National Heritage Resources Act, 1999.*Australia: The Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act 1999. The Western Australian Environmental Protection Act 1986 The Western Australian Land Administration Act 1997 In addition, approvals will be required under the Western Australia Mining Act 1978, Heritage of Western Australia Act 1990, the Western Australian Aboriginal Heritage Act 1972 and the MRO Indigenous Land Use Agreement 2009.* Other South African environmental statutes include the Environment Conservation Act, 1989, various air pollution statutes, the National Heritage Resources Act, 1999, the Hazardous Substances Act, 1973, the Health Act, 1977, the Nuclear Energy Act, 1999, the National Nuclear Regulatory Act, 1999, the National Environmental Management: Protected Areas Act, 2003, the Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947, the Marine Living Resources Act, 1998, and the National Environmental Management: Integrated Coastal Management Act, 2008.		
SYS_REQ-2790	**Environmental Impact Assessment**. The Observatory shall undertake an Environmental Impact Assessment	**Essential**	**Inspection**

	(EIA) in accordance with the local and national environmental legislation. NOTE: the EIA shall be undertaken in accordance with: South Africa - the National Environmental Management Act (NEMA); Australia - Western Australian EPA and Commonwealth EPBC		
SYS_REQ-2483	**Environment protection plan**. An Environmental protection plan shall be developed and maintained. This shall include the management of Environmental Impact Assessments (EIA) in accordance with SA NEMA, WA EPA and Commonwealth EPBC.	**Essential**	**Inspection**
SYS_REQ-2572	**Material environmental rule compliance.** All materials used in the SKA1 design shall be fully compliant to all environmental rules applicable to the SKA1 core and remote sites	**Essential**	**Inspection**
SYS_REQ-2819	**Safety of machinery risk assessment**. A risk assessment shall be conducted for each item of machinery in accordance with BS EN ISO 12100	**Essential**	**Inspection**
SYS_REQ-2450	**Safety information for use.** Where risks remain despite inherently safe design measures, safeguarding and the adoption of complementary protective measures, the residual risks shall be identified in the information for use in accordance with BS EN ISO 12100 (section 6).The information for use shall include, but not be limited to, the following: operating procedures for the use of the machinery consistent with the expected ability of personnel who use the machinery or other persons who can be exposed to the hazards associated with the machinery; the recommended safe working practices for the use of the machinery and the related training requirements adequately described; sufficient information, including warning of residual risks for the different phases of the life of the machinery; the description of any recommended personal protective equipment, including detail as to its need as well as to training needed for its	**Essential**	**Inspection**

	use.Information for use shall not be a substitute for the correct application of inherently safe design measures, safeguarding or complementary protective measures.		
SYS_REQ-2554	**Ergonomics.** The ergonomic design shall be compliant with ISO 6385.	**Essential**	**Inspection**
SYS_REQ-2820	**Safety of equipment with rated voltage not exceeding 600V**. Equipment shall comply with the safety requirements of BS EN IEC 60950. NOTE: This includes electric shock, energy related hazards, fire, heat related hazards, mechanical hazards, radiation and chemical hazards	**Essential**	**Inspection**
SYS_REQ-2437	**Design for hazard elimination.** Designs shall demonstrate the elimination, or mitigation to a risk level practically achievable, of all hazards by means of a subsystem hazard analysis (SSHA) report as described in EN 14738 and tailored by SKA Product Assurance and Safety Plan SKA-OFF.PAQA-SKO-QP-001.	**Essential**	**Analysis**
SYS_REQ-2435	**Hazard analysis**. A hazard analysis shall be performed at the system and element level in accordance with BS IEC 61882 and, where applicable, shall include a FMEA in accordance with EN 60812.	**Essential**	**Inspection**
SYS_REQ-2567	**Hazardous Materials list.** Each Element supplier shall provide a list of hazardous materials used for all items intended for use in the SKA1 detailing suggested handling precautions, disposal instructions and contra-indications.	**Essential**	**Inspection**
SYS_REQ-2579	**Hazard warning marking.** All items that present a potential hazard shall be labelled in accordance with BS EN ISO 7010	**Essential**	**Inspection**
SYS_REQ-2818	**Marking of machinery - safety.** In accordance with ISO 61310_2, machinery shall bear all markings which are necessary – for its unambiguous identification; – for its safe use; and supplementary information shall be given, as appropriate: – permanently on the machinery; – in accompanying documents such as	**Essential**	**Demonstration**

	instruction handbooks; – on the packagin		
SYS_REQ-2438	**Fail safe design.** Components and Equipment shall be designed to be locally fail-safe and not rely on external safety devices or measures to operate safely.	**Essential**	**Analysis**
SYS_REQ-2788	**Non-propagation of failures**. The equipment shall be designed such that hardware failures and software errors should not create a hazardous situation to interfacing systems	**Essential**	**Demonstration**
SYS_REQ-2439	**Emergency stop.** The SKA1 Elements shall have emergency stop switches or brakes for all electro-mechanical or mechanical systems that have been identified by safety analyses (required under SYS_REQ-2435) to pose a hazard.	**Essential**	**Demonstration**
SYS_REQ-2733	**Location of Emergency stop**. Emergency stop switches shall be located in such a way to minimize the risk of injury. (Verified by Analysis as 'minimisation' is unverifiable any other way.	**Essential**	**Analysis**
SYS_REQ-2786	**Safety documentation file**. Elements shall provide procedures for maintainers to recover from an unplanned shut-down, including safety checks to be conducted prior to start-up, as specified in SKA PRODUCT ASSURANCE & SAFETY PLAN SKA-OFF.PAQA-SKO-QP-001.	**Essential**	**Inspection**
SYS_REQ-2447	**Sharp metal edges.** If they cannot be eliminated from design, sharp edges, access openings and corners shall be protected with covers or coatings.	**Essential**	**Inspection**
SYS_REQ-2446	**Electrical safety.** Electrical risks and hazards shall be controlled in accordance with local, State and national legislation and Codes of Practice.NOTE: In South Africa, SANS 10142-1 and SANS 10142-2 shall apply.NOTE: In Australia, in addition to legislation, the following Codes of Practice shall be applied: AS/NZ 3000 Safe Work Australia 'Managing Electrical Risks at the Workplace'; Western Australia Director of Energy Safety 'Safe Low Voltage Work Practices by Electricians'	**Essential**	**Inspection**

SYS_REQ-2443	**Protection from high voltages.** High voltage cages or enclosures shall be used to protect personnel from inadvertent access to high voltages in accordance with AS/NZS3000 (Australia) and SANS10142 (South Africa).	**Essential**	**Inspection**
SYS_REQ-2444	**Safety grounding and bonding.** External conductive parts shall be grounded in compliance to:South Africa: National Building Regulations and Building Standards Act, 1977 Occupational Health and Safety act, 1993 SANS 10313Australia: AS/NZ 3000, AS/NZ 1768	**Essential**	**Test**
SYS_REQ-2445	**Electrical circuit interlocks.** Electrical circuit inter-locks shall be provided to prevent personnel coming into contact with hazards that cannot otherwise be eliminated from design.	**Essential**	**Inspection**
SYS_REQ-2481	**Emergency communication.** The observatory shall provide an independent system to communicate with outside locations in emergencies.	**Essential**	**Demonstration**
SYS_REQ-2449	**Construction and AIV Safety Plan.** A comprehensive safety plan, tailored to construction and AIV activities, shall be established and implemented before the construction starts at the observatory site.	**Essential**	**Inspection**
SYS_REQ-2436	**Safety incident recovery plan.** A safety incident recovery plan shall be produced in accordance with SKA PRODUCT ASSURANCE & SAFETY PLAN SKA-OFF.PAQA-SKO-QP-001.	**Essential**	**Inspection**
SYS_REQ-2451	**Safety training**. All personnel shall be provided with appropriate Health and Safety training in compliance with local regulations.	**Essential**	**Test**
SYS_REQ-2454	**Fire fighting equipment.** Fire fighting equipment shall be made available at all SKA premises and facilities.	**Essential**	**Inspection**
SYS_REQ-2453	**First aid stations.** First aid stations shall be provisioned.	**Essential**	**Inspection**
SYS_REQ-2452	**Protective clothing.** Protective Clothing for areas where environments detrimental to human safety shall be worn.	**Essential**	**Inspection**

SYS_REQ-2795	**Travel safety.** Personnel shall adhere to local safety procedures for travelling in remote areas. NOTE: Safety procedures should include the training and equipment required, such as driving instruction, vehicles appropriate for the environment and radio equipment	**Essential**	**Inspection**
SYS_REQ-2460	**Occupational health legislation and regulations.** The observatory shall comply with all applicable local, State and national occupational health regulations and standards in force at the time. Regulations include, but are not limited to: South Africa: Occupational Health and Safety Act, 1993, and all its regulations. Australia: Commonwealth Occupational Health and Safety Act 1991; OHS (Safety Arrangements) Regulations 1991; OHS (Safety Standards) Regulations 1994; OHS Codes of Practice 2008. Western Australia: Occupational Safety and Health Act 1984; Harmonised OHS legislation (as enacted).	**Essential**	**Analysis**
SYS_REQ-2455	**Noise level dosage.** Personnel shall not be exposed to noise level dosages exceeding local health and safety guideline levels. The maximum noise levels shall not exceed an 8-hour average exposure of 85 decibels as specified in the Australian National Standard for Occupational Noise NOHSC: 1007(2000) and South African Noise-Induce Hearing Loss Regulations (No R.307 2003) of the Occupational Health and Safety Act, 1993 (Act No 85 of 1993). The desirable maximum noise level is 75 decibels. Note: The National Code of Practice for Noise Management and Protection of Hearing at Work [NOHSC:2009(2004)] provides practical guidance on how NOHSC:1007(2000) can be achieved	**Essential**	**Test**

SYS_REQ-2456	**Transient noise level.** Noise levels exceeding 85dB shall be controlled or mitigated in accordance with NOHSC National Standard for Occupational Noise [NOHSC: 1007]	**Essential**	**Test**
SYS_REQ-2457	**Illumination.** Personnel shall be provided with a working illumination level which is compliant with local and national regulations including the current issue of SANS 10114-1 in South Africa and the AS/NZS 1680 series in Australia.	**Essential**	**Test**
SYS_REQ-2458	**Clean air.** Personnel shall be provided with air quality at least compliant with the current issue of SANS 10400-O (South Africa - The application of National Building Regulations Part O : Lighting and ventilation) and the AS 1668 series of codes (Australia - The use of mechanical ventilation and air conditioning in buildings).	**Essential**	**Test**
SYS_REQ-2649	**Humidity.** Working environments shall be designed, built and maintained to provide air quality that meets or exceeds the guidance provided in the Australian Code of Practice for Managing the Work Environment and Facilities, National Code of Australia and AS 1668. NOTE: Building humidity required for computing facilities is specified in Req 2367.	**Essential**	**Test**
SYS_REQ-2791	**Security Management System**. The SKA shall provide a security management system that includes : i. personnel security, ii. physical security (asset) iii. security of informatio	**Essential**	**Inspection**
SYS_REQ-2793	**Personnel security training**. All personnel shall receive the security training identified in the Security Management System necessary for their location. Additional specialist pre-deployment training shall be given prior to working in remote environments.	**Essential**	**Inspection**
SYS_REQ-2478	**Equipment security.** The observatory shall provide a secure environment for equipment. This shall include protection of generators, fuel, solar cells and inter-station assets such as copper cables.	**Essential**	**Analysis**

SYS_REQ-2822	**Information security risk assessment**. An information security risk assessment shall be conducted for each element in accordance with ISO/IEC 27005	**Essential**	**Inspection**
SYS_REQ-2823	**Information security management for inter-organizational communications.** Information transfer between organisations shall be controlled in accordance with ISO/IEC 27010 as tailored by SKA Organisation Security Policy	**Essential**	**Demonstration**
SYS_REQ-2482	**Accessibility.** It shall be possible to control on a per user basis which SKA1 facilities and resources (both hardware and software) may be accessed by the user.	**Essential**	**Demonstration**
SYS_REQ-2479	**Archive security.** The observatory shall provide a secure environment for all its data archives	**Essential**	**Test**
SYS_REQ-2798	**Protection of equipment in stationary use at non-weather protected locations**. Equipment in stationary use at non-weather protected locations shall be protected against environmental conditions 4K4H/ 4Z1/ 4Z5/ 4Z6/ 4B2/ 4C1/ 4S3/ 4M4 in accordance with BS EN IEC 60721-3-4. NOTE: 4Z5 refers to the survival, non-operational mode. The equipment shall be able to operate normally for air movement up to 11 m/s	**Essential**	**Inspection**
SYS_REQ-2488	**Allowable air temperature range.** SKA1 equipment located at the dishes or aperture arrays or outside the central processing and operating facilities shall be able to withstand (non-operating if necessary) an outside air temperature within the range of -15 ºC to +60 ºC. Note this takes precedence over IEC 60721-3-4 4K4H of parent requirement	**Essential**	**Test**
SYS_REQ-2489	**Air temperature operation range.** SKA1 equipment located at the dishes or aperture arrays or outside the central processing and operating facilities shall be able to operate within specification if the outside air temperature is within the range of -5 ºC to +50 ºC.	**Essential**	**Test**

	Note this takes precidence over IEC60721-3-4 4K4		
SYS_REQ-2490	**Wind velocities.** SKA1 equipment shall be able to survive wind velocities up to 160 km/hr, and shall operate within normal specification ranges for wind velocities up to 40 km/hr. Note: this takes precedence over IEC60721-3-4 4Z	**Essential**	**Test**
SYS_REQ-2799	**Protection of equipment in weather-protected locations.** Equipment in stationary use at weather protected locations shall be protected against environmental conditions 3K8H/ 3Z1/ 3Z11/ 3Z12/ 3B3/ 3C1R/ 3S3/ 3M4 in accordance with BS EN IEC 60721-3-3.	**Essential**	**Inspection**
SYS_REQ-2500	**Operating Humidity.** The operating humidity shall be between 40% and 60%	**Essential**	**Test**
SYS_REQ-2501	**Storage and transport Humidity.** The storage and transport humidity shall be between 40% and 95%.	**Essential**	**Analysis**
SYS_REQ-2502	**Condensation.** Appropriate measures shall be taken to prevent the formation of condensation on operating electronic components.	**Essential**	**Inspection**
SYS_REQ-2503	**Pressure.** Components shipped by air shall be capable of surviving pressures down to 11 kPa (equivalent altitude ~ 50,000 feet).	**Essential**	**Analysis**
SYS_REQ-2504	**Facilities and Equipment Intrusion.** Where appropriate, SKA1 equipment facilities shall be adequately protected against intrusion by insect and "larger" wandering animals.	**Essential**	**Inspection**
SYS_REQ-2505	**Sand and Dust.** SKA1 systems shall be adequately protected against sand and dust ingress.	**Essential**	**Inspection**
SYS_REQ-2506	**Fungus.** Equipment shall be protected against fungus growth.	**Essential**	**Inspection**
SYS_REQ-2801	**Storage of equipment**. Designs shall identify any requirements for equipment to be stored in environmental conditions less severe than 1K11/1B3/1C1/1S3/1M3 as specified inBS EN IEC 60721-3-1. Note: It may be assumed that equipment will be stored in its original packaging	**Essential**	**Inspection**
SYS_REQ-2800	**Transportation of equipment**. Equipment shall be designed to withstand transportation from an	**Essential**	**Inspection**

	engineering depot to a station exposed to environmental conditions 2K5H/2B3/2C1/2S3/2M3 as detailed in BS EN IEC 60721-3-2. NOTE: It may be assumed that the equipment will be transported in the original packaging that it was delivered to the engineering depot.		
SYS_REQ-2491	**Safety.** SKA1 equipment and buildings shall be designed and built in compliance with national and State regulations including AS 1170.4 (Importance level 3, design life 50 years) and SANS 10160-4 for earthquakes of magnitude up to Richter 3.8.	**Essential**	**Analysis**
SYS_REQ-2650	**Seismic resilience.** SKA1 structures and equipment shall survive and be fully operational after a seismic event of magnitude up to Richter 3.8. Note: Seismic event includes underground collapses in addition to earthquakes.	**Essential**	**Analysis**
SYS_REQ-2722	**Availability, reliability, and maintenance plans**. There shall be an availability, reliability and maintenance plan for each SKA1 telescope.	**Essential**	**Inspection**
SYS_REQ-2716	**Average annual availability.** Each SKA1 telescope shall have an operational availability of 95%	**Essential**	**Analysis**
SYS_REQ-2827	**System Availability**. System designs shall meet the system availability allocations specified in SKA-OFF.SE.ARC-SKAO-RAM-001	**Essential**	**Analysis**
SYS_REQ-2718	**Availability budgets.** Availability budgets shall be allocated at the system decomposition level, and shall be consistent with the system level requirements for reliability and maintainability of the system.	**Essential**	**Analysis**
SYS_REQ-2512	**Best practice.** Best available methods for reducing adverse effects of operational and maintenance environments on critical components shall be adopted.	**Essential**	**Analysis**
SYS_REQ-2513	**Critical-useful-life components.** Any critical-useful-life components shall be identified.	**Essential**	**Inspection**
SYS_REQ-2515	**Component selection.** Parts and components shall be selected to meet reliability requirements.	**Essential**	**Analysis**

SYS_REQ-2516	**Matching components.** Parts requiring select on test shall be eliminated by deign if possible.	**Essential**	**Inspection**
SYS_REQ-2517	**Known failure rate parts.** The failure rate of parts shall be known (e.g. through analysis or modelling) before inclusion in SKA design.	**Essential**	**Inspection**
SYS_REQ-2518	**High failure rate parts.** Parts with excessive failure rates shall be identified.	**Essential**	**Inspection**
SYS_REQ-2519	**Reliability testing.** A testing and evaluation master plan shall be generated for high-risk reliability components.	**Essential**	**Inspection**
SYS_REQ-2520	**Spares and repair parts testing.** Critical spare and repair line replaceable units shall be tested before deployment.	**Essential**	**Inspection**
SYS_REQ-2521	**Component derating.** Safety factors and margins shall be applied in the selection of modules and components	**Essential**	**Analysis**
SYS_REQ-2522	**Shelf life and wear out characteristics.** The shelf life and wear out characteristics of all components and parts shall be known before inclusion in SKA designs.	**Essential**	**Inspection**
SYS_REQ-2523	**Special procurement components.** Critical parts requiring special procurement methods, testing and handling provisions shall be identified.	**Essential**	**Inspection**
SYS_REQ-2525	**Fail safe provisions.** Designs shall implement fail-safe provisions to prevent secondary failures.	**Essential**	**Analysis**
SYS_REQ-2526	**Maintainability budgets.** Maintainability budgets shall be allocated at the system decomposition level, and shall be consistent with the system level requirements for reliability and maintainability of the system.	**Essential**	**Inspection**
SYS_REQ-2527	**Test and Repair Instructions.** Where end user repair is applicable Test and Repair Instructions shall be delivered with all equipment.	**Essential**	**Inspection**
SYS_REQ-2528	**Level of maintenance.** The level of maintenance shall be identified for each repairable item.	**Essential**	**Inspection**
SYS_REQ-2529	**Maintenance test and support equipment.** Equipment required for test and support shall be identified for each repairable item.	**Essential**	**Inspection**
SYS_REQ-2802	**Design for maintainability**. Designs shall incorporate maintainability	**Essential**	**Inspection**

	studies and analysis in accordance with BS EN IEC 60706-2 with emphasis on minimising the need for maintainers on sites. This activity should incorporate best practice such as described by B.S. Blanchard & W.J. Fabrycky 'Systems Engineering and Analysis', Pearson 2011		
SYS_REQ-2594	**Modular packaging.** The packaging of components shall be modular to limit maintenance to the removal of one module.	**Essential**	**Inspection**
SYS_REQ-2595	**Maintenance provisions.** Repairable items shall be designed to include maintenance provisions such as test points, accessibility, and plug-in components.	**Essential**	**Inspection**
SYS_REQ-2596	**Discard at failure items.** Discard at failure items shall be packed at low cost.	**Essential**	**Inspection**
SYS_REQ-2597	**Plug-in modules.** The design shall implement plug-in modules to the maximum extent possible.	**Essential**	**Inspection**
SYS_REQ-2598	**Module access.** Where applicable, access between modules shall be sufficient to facilitate hand grasping.	**Essential**	**Inspection**
SYS_REQ-2599	**Component removal.** Modules and components shall be mounted such that removal of any single item will not require the removal of other items (component stacking to be avoided where possible)	**Essential**	**Inspection**
SYS_REQ-2600	**Secure mounting of modules.** Modules shall be securely mounted (in compliance with the shock and vibration requirements) with the minimum number of fasteners.	**Essential**	**Inspection**
SYS_REQ-2601	**Shock mounting provision.** Shock mounting provisions shall be made where applicable.	**Essential**	**Inspection**
SYS_REQ-2602	**Mounting preclusion.** Provisions for the preclusion of mounting the wrong module shall be provided (key coding of connectors etc.).	**Essential**	**Inspection**
SYS_REQ-2448	**Stand-off and handles.** Stand-offs and handles shall be used to protect system components from damage during shop maintenance.	**Essential**	**Inspection**
SYS_REQ-2603	**Mounting guides.** Mounting guides and location pins shall be provided to facilitate module mounting.	**Essential**	**Inspection**

SYS_REQ-2604	**Module labelling.** Where possible, labelling of modules shall be on the top or adjacent in plain sight.	**Essential**	**Inspection**
SYS_REQ-2605	**Label robustness.** Labels shall be permanently affixed and unlikely to come off during maintenance or as a result of the environment.	**Essential**	**Inspection**
SYS_REQ-2606	**Disposable LRU labelling.** Disposable line replaceable units should be labelled as such.	**Essential**	**Inspection**
SYS_REQ-2711	**Component obsolescence plan.** There shall be a plan for the management of component obsolescence.	**Essential**	**Inspection**
SYS_REQ-2571	**Long lead time items.** Long lead time items shall be identified to the project management.	**Essential**	**Inspection**
SYS_REQ-2570	**Parts availability.** The estimated availability of the parts shall be compatible with the final system's life cycle.	**Essential**	**Analysis**
SYS_REQ-2806	**Product Assurance**. Product Assurance shall be managed following a process modelled on the SKA Product Assurance & Safety Plan SKA-OFF.PAQA-SKO-QP-00	**Essential**	**Inspection**
SYS_REQ-2509	**Scope of workmanship standards.** SKA1 dedicated workmanship standards shall cover all phases of production, assembly and integration, testing, handling, and include clear requirements for acceptance/rejection criteria.	**Essential**	**Inspection**
SYS_REQ-2816	**Design for testability.** Designs shall include an assessment of testability in accordance with BS EN IEC 60706-	**Essential**	**Inspection**
SYS_REQ-2538	**Test and support equipment** Test and support equipment shall be identified for each level of maintenance.	**Essential**	**Inspection**
SYS_REQ-2539	**Test and support equipment standardisation.** Any test equipment not included in the standard test equipment list required for the integration, commissioning and maintenance of equipment shall be declared.	**Essential**	**Inspection**
SYS_REQ-2540	**Test and support equipment lifecycle costs.** Life cycle costs shall be generated for all test and support equipment.	**Essential**	**Inspection**
SYS_REQ-2541	**Test equipment reliability** Test equipment reliability shall be	**Essential**	**Analysis**

	sufficient to meet the maintainability requirements.		
SYS_REQ-2542	**Training** A plan detailing the training required for maintenance, calibration and repair shall be generated.	**Essential**	**Inspection**
SYS_REQ-2543	**Direct fault indicators** Where possible, direct fault indicators shall be designed in to equipment.	**Essential**	**Inspection**
SYS_REQ-2544	**Self-test.** Self-Test capability such that all faults can be identified down to LRU level shall be provided.	**Essential**	**Analysis**
SYS_REQ-2546	**Continuous performance monitoring.** Where possible, the system shall be designed to provide continuous performance monitoring.	**Essential**	**Demonstration**
SYS_REQ-2552	**Malfunction detection.** All equipment malfunction shall be detected at the system level.	**Essential**	**Demonstration**
SYS_REQ-2556	**Access tools.** Access requiring tools shall be minimised.	**Essential**	**Analysis**
SYS_REQ-2559	**Design for economic production.** All designs for the SKA shall be designed for economic production. This is required to ensure that the SKA is buildable for a reasonable cost (Con Ops Section 1.2)	**Essential**	**Inspection**
SYS_REQ-2560	**Design definition.** Design definition shall be in sufficient detail to allow one or more manufacturers to produce the same item within identified tolerances.	**Essential**	**Inspection**
SYS_REQ-2561	**Manufacturing facilities.** Where possible, currently existing facilities shall be used for manufacturing.	**Essential**	**Inspection**
SYS_REQ-2562	**Standard manufacturing tools.** Where possible, standard manufacturing tools shall be used.	**Essential**	**Inspection**
SYS_REQ-2566	**Materials list.** Each sub-system supplier shall provide a Materials list for all items intended for use within SKA1.	**Essential**	**Inspection**
SYS_REQ-2568	**Parts list.** Each Element supplier shall provide a parts list for all items intended for use in the SKA1.	**Essential**	**Inspection**
SYS_REQ-2569	**Process list.** Each element supplier shall provide a process list for all items intended for use in the SKA1.	**Essential**	**Inspection**
SYS_REQ-2573	**Serial number.** Each part shall be marked with a unique serial number in an easily visible location.	**Essential**	**Inspection**
SYS_REQ-2574	**Drawing numbers.** Each LRU type shall be identified with a unique drawing number	**Essential**	**Inspection**

SYS_REQ-2575	**Marking method.** Method of marking shall be compatible with the nature of the item, its environment and its use.	**Essential**	**Inspection**
SYS_REQ-2576	**Electronically readable or scannable ID.** Where possible line replaceable items shall be marked with an Electronically readable or scannable ID	**Essential**	**Inspection**
SYS_REQ-2577	**Package part number marking.** All packaging shall be marked with the part number of the contents.	**Essential**	**Inspection**
SYS_REQ-2578	**Package serial number marking.** All packaging shall be marked with the serial number of the contents.	**Essential**	**Inspection**
SYS_REQ-2580	**LRU electrostatic warnings** All LRUs with electrostatic sensitive components shall be fitted with ESD warning labels.	**Essential**	**Inspection**
SYS_REQ-2581	**Packaging electrostatic warnings.** All packaging containing static sensitive contents shall be marked with ESD warning labels.	**Essential**	**Inspection**
SYS_REQ-2583	**Cable identification.** All cables ends shall carry a unique identifier.	**Essential**	**Inspection**
SYS_REQ-2584	**Connector plates.** All connector plates shall carry identification labels for connectors.	**Essential**	**Inspection**

Table 2 Verification Matrix

21 Appendix C: Requirement Allocation Matrices

ID	Description	Allocation
SYS_REQ-2113	**Global Headquarters** The SKA Global Headquarters (GHQ) will have overall responsibility for the SKA Observatory	**SPO**
SYS_REQ-2114	**Site location.** The SKA1 Antenna systems and digital signal chain shall be located within radio quiet zones provided by the Host Countries of South Africa and Australia.	**SKAO**
SYS_REQ-2124	**SKA1_low array.** The SKA1_low array shall be located within the legal boundary of the Boolardy station.	**LFAA, SADT, INFRA**
SYS_REQ-2713	**SKA1_low central frequency reference.** The SKA1_low central frequency reference shall be located in the SKA1_low Central Signal Processing facility	**SADT, INFRA,CSP**
SYS_REQ-2654	**SKA1_low CSP facility.** The facility housing the station beamformers for the inner area of the SKA1_Low and the central signal processing for SKA1_Low shall be at a distance of 2 km South West of the centre of the SKA1_Low array.	**SADT, CSP, INFRA, TM, LFAA**
SYS_REQ-2120	**Australian Science operations centre.** The Australian Science Operations Centre shall be in Perth.	**SADT, TM, INFRA**
SYS_REQ-2121	**Australian Engineering Operations Centre** The Australian Engineering Operations Centre shall be in in Geraldton.	**LFAA, CSP, SDP, TM, SADT**
SYS_REQ-2123	**Australian Science processing centre** The Australian Science Processing Centre shall make use of floor space, power, cooling, and other infrastructure at the Pawsey centre in Perth.	**SDP, TM, INFRA, SADT**
SYS_REQ-2119	**SKA1_Mid array.** The SKA1_Mid dish array shall be located in the Karoo Central Astronomy Advantage Area.	**SADT, INFRA, DSH**
SYS_REQ-2656	**SKA1_mid CSP facility.** The CSP facility for SKA1_mid shall be located in the Karoo Array Processor Building.	**SADT, CSP, INFRA, TM**
SYS_REQ-2714	**SKA1_mid central frequency reference.** The SKA1_mid central frequency reference shall be located in the SKA1_mid Central Signal Processing facility	**SADT, CSP, INFRA, TM**

SYS_REQ-2115	**South African Science Operations.** The South African Science Operations Centre shall be located in Cape Town.	**SADT, TM, INFRA**
SYS_REQ-2118	**South African Science Processing Centre** The South African Science Processing centre shall be located in Cape Town	**SDP, INFRA, TM, SADT**
SYS_REQ-2116	**South African Engineering Operations Centre.** The South African Engineering Operations Centre shall be located at Klerefontein.	**SADT, SDP, TM, INFRA, DSH, CSP**
SYS_REQ-2671	**Receptor type.** The SKA1_Low shall utilise dual, orthogonal, polarization log-periodic antennas.	**LFAA**
SYS_REQ-2673	**Array resolution (core).** The SKA1_Low shall have an array resolution of better than 5 arc minutes at 100 MHz (centre of the EoR frequency range).	**LFAA**
SYS_REQ-2134	**Electromagnetic frequency range.** SKA1_Low shall be able to measure electromagnetic radiation in a frequency range from 50 MHz to 350 MHz.	**LFAA, CSP, SDP**
SYS_REQ-2621	**Spectral stability:** The spectral stability, on a time scale of 600 sec.,of the station beam bandpass, post station calibration and RFI-mitigation, shall be within 1.3 %, 0.4 %, 0.6 % and 1.1 % at 50 MHz, 100 MHz, 160 MHz, and 220 MHz respectively compared to the full polarization, parameterized beam model.	**LFAA, CSP, SDP**
SYS_REQ-2135	**SKA1_Low array sensitivity at 50MHz**. The SKA1_Low array shall have sensitivity per polarization at zenith greater than 72 m^2K^{-1} at 50MHz when assuming a sky noise temperature following the law $60.lamda^{2.55}$	**LFAA**
SYS_REQ-2136	**SKA1_Low array sensitivity at 110MHz**. The SKA1_Low array shall have a sensitivity per polarization at zenith greater than 380 m^2K^{-1} at 100 MHz when assuming a sky noise temperature following the law 60.lambda^2.55	**LFAA**
SYS_REQ-2137	**SKA1_Low array sensitivity at 160MHz**. The SKA1_Low array shall have a sensitivity per	**LFAA**

	polarization at zenith of greater than 535 m^2K^{-1} at 160 MHz when assuming a sky noise temperature following the law 60.lambda^2.55	
SYS_REQ-2138	**SKA1_Low array sensitivity at 220MHz**. The SKA1_Low array shall have a sensitivity per polarization at zenith of greater than 530 m^2K^{-1} at 220 MHz when assuming a sky noise temperature following the law 60.lambda^2.55.	**LFAA**
SYS_REQ-2814	**SKA1_Low array sensitivity per polarization at 280 MHz.** The SKA1_Low array shall have a sensitivity per polarization at zenith greater than 500 m^2/K at 280 MHz when assuming a sky noise temperature following the law 60.lambda^2.55	**LFAA**
SYS_REQ-2815	**SKA1_Low array sensitivity per polarization at 340 MHz.** The SKA1_Low array shall have a sensitivity per polarization at zenith greater than 453 m^2/K at 340 MHz when assuming a sky noise temperature following the law 60.lambda^2.55	**LFAA**
SYS_REQ-2622	**Sensitivity for off zenith angles.** The SKA1_low receptor has an off-zenith beam response defined by the receptor, a log-periodic dipole antenna,in the Baseline Design.	**LFAA**
SYS_REQ-2139	**SKA1_Low antennas per station.** The SKA1_Low shall comprise of stations each containing 256 antennas.	**LFAA, SADT, INFRA**
SYS_REQ-2140	**SKA1_Low station diameter.** The station diameter will be 35 metres, which is consistent with being able to provide a single, circularly symmetric, beam of 5 degrees at the half-power points at 100 MHz (centre of the EoR frequency range) while meeting the sensitivity requirements with 256 antennas per station evenly distributed in an irregular-random configuration.	**LFAA, SADT, INFRA**
SYS_REQ-2142	**SKA1_Low number of stations.** The SKA1_Low shall comprise of 512 stations.	**LFAA, SADT, CSP, SDP, TM, INFRA**
SYS_REQ-2143	**SKA1_Low configuration.** The SKA1_Low shall have a configuration as specified in TBD.	**LFAA, SADT, INFRA**

SYS_REQ-2817	**SKA1_Low maximum baseline length between stations.** The maximum distance between station centres shall be approximately 80 km	**LFAA**
SYS_REQ-2147	**Instantaneous bandwidth.** The SKA1_Low shall be capable of simultaneously processing 300 MHz of bandwidth.	**LFAA, SADT, CSP, SDP**
SYS_REQ-2652	**SKA1_Low separation.** The SKA1_Low core shall be located at a minimum distance of 10km from the ASKAP core.	**LFAA, SADT, INFRA, DSH**
SYS_REQ-2674	**Digitisation.** Digitisation of SKA1_antenna (SKA1_Low only) signals shall be to at least 8 bits.	**LFAA**
SYS_REQ-2639	**Clipping.** The amplitude dynamic range of the SKA1_Low ADC's shall be such that no clipping will occur for 95% of the time	**LFAA, SADT**
SYS_REQ-2640	**Clipped data flagging.** Clipped data shall be flagged accordingly within the data stream.	**LFAA, CSP, Dish, SDP**
SYS_REQ-2653	**Linearity.** At the finest frequency resolution in the processing chain, the level of spurious signals due to non-linearity shall be less than the noise level when no external input signal is present.	**LFAA, SADT**
SYS_REQ-2824	**Absolute flux scale**: The absolute flux scale shall be accurate to 5	**LFAA, SDP**
SYS_REQ-2676	**Dynamic range.** The SKA1_Low beams shall have a dynamic range of better than 40 dB	**LFAA**
SYS_REQ-2146	**SKA1_Low station beams** The antennas within each station shall be coherently beam-formed to provide one pair of station beams,one beam for each orthogonal polarization,for primary science.	**LFAA**
SYS_REQ-2779	**Control of station beam properties:** It shall be possible to control specific properties of the station beam by setting the station beam weights appropriately	**LFAA, TM**
SYS_REQ-2629	**Station beam stability.** The difference between the parameterized station beam model and the actual station beam shall remain smaller than 1.3 %, 0.4 %, 0.6 % and 1.1 % relative to the main beam peak power, after calibration, at 50 MHz, 100 MHz, 160 MHZ and 220 MHz respectively	**LFAA, SDP**

SYS_REQ-2634	**Calibration update rate.** Calibration measurements shall be necessary at a rate of no more than 10seconds.	**LFAA, TM, SDP**
SYS_REQ-2635	**Real-time calibration.** The LFAA reception system at station level shall provide on-line instrumental calibration functions with an update rate of 10 minutes	**LFAA**
SYS_REQ-2636	**Beam products.** The SKA1_Low shall be capable of outputting beam products as voltage time series.	**LFAA**
SYS_REQ-2773	**SKA1_Low correlator sub-array support**. The SKA1_Low correlator shall be able to correlate SKA1_low station beams from one to sixteen sub-arrays independently and concurrently	**CSP**
SYS_REQ-2148	**SKA1_Low channelisation.** The SKA1_Low channelisation for each sub array shall provide up to 65,536 linearly spaced frequency channels across the available frequency range of each band.	**LFAA, CSP, SDP**
SYS_REQ-2149	**SKA1_Low channeliser maximum leakage power for adjacent frequency channels.** The SKA1_Low channeliser for each sub-array shall have a maximum noise leakage power from immediately adjacent frequency channels of < -30 dB.	**CSP, LFAA**
SYS_REQ-2810	**SKA1_Low channeliser maximum leakage power for non-adjacent frequency channels.** The SKA1_Low channeliser for each sub-array shall have a maximum noise leakage power from non adjacent frequency channels better than -60 dB.	**CSP, LFAA**
SYS_REQ-2811	**SKA1_Low fine frequency channel amplitude variation.** The fine frequency channels for the SKA1_Low channeliser shall have a total amplitude variation as a function of frequency of less than 0.01 dB.	**CSP**
SYS_REQ-2812	**SKA1_Low fine frequency channel band edge**. The fine frequency cells for the SKA1_Low channeliser shall have a -3dB transition band amplitude at the channel band edge.	**CSP**

SYS_REQ-2678	**SKA1_Low correlatation signal to noise**. SKA1_Low correlation, for each sub array, shall not degrade the Signal to Noise ratio by more than 2 % compared to ideal analogue correlation.	**CSP**
SYS_REQ-2150	**SKA1_Low correlator Integration rate. T**he SKA1_Low correlator for each sub array shall have independently configurable visibility integration periods in the range 9s to 0.9s.	**CSP, SDP**
SYS_REQ-2153	**Diameter**. SKA1 dishes shall have a projected diameter of larger than 15m and smaller than 16.5m.	**DSH**
SYS_REQ-2155	**Aperture Efficiency**. Aperture efficiency shall be within +/- 5 % of: • 60% at 350MHz with gradual degradation from 400 to 350 MHz • 65% at 400MHz • 78% from 600MHz to 8000MHz • 70% from 8 to 15 GHz • 65% from 15 to 20 GHz	**DSH**
SYS_REQ-2158	**Pointing repeatability.** The pointing repeatability shall be better than 10 arc seconds rms for winds < 7 m/s at night time.	**TM, DSH, SDP, SaDT**
SYS_REQ-2159	**Pointing repeatability**. The pointing repeatability shall be better than 17 arc seconds rms for an average wind speed of < 7 m/s in the day time	**TM, DSH, SDP, SaDT**
SYS_REQ-2160	**Pointing repeatability.** The pointing repeatability shall be better than 180 arc seconds rms for an average wind speed between 7 and 20 m/s	**TM, DSH, SDP, SaDT**
SYS_REQ-2162	**Number of feeds**. There shall be space at the Gregorian focus of SKA1 dishes for five single pixel feeds (SPF) or three Phased Array Feeds (PAF)	**DSH**
SYS_REQ-2165	**Polarisation Purity.** The IXR shall be better than 15 dB over the whole observing bandwidth within the HPBW	**DSH, SDP**
SYS_REQ-2170	**Elevation limit.** Reflector antennas shall be capable of operating at all elevations greater than 15 degrees	**DSH**
SYS_REQ-2171	**Azimuth range.** The Dish shall have a continuous useable azimuth observation range from -270° to	**DSH**

	+270°, inclusive measured relative to true North defined as 0° and with East defined as +90°	
SYS_REQ-2833	**SKA1_Mid inclusion of MeerKAT.** The SKA1_Mid shall incorporate the 64 antennas in both monitor and control and data collection functions.	**SADT, CSP, SDP, TM, INFRA, DSH, AIV**
SYS_REQ-2173	**MeerKAT array.** The monitor and control functions of MeerKAT shall be made available to SKA1_Mid via a Foreign Telescope interface consisting of a Local Monitor and Control system connected to the SKA1_Mid Telescope Manager.	**SADT, INFRA, DSH, TM**
SYS_REQ-2834	**SKA1_Mid-MeerKAT infrastructure reuse.** Where economically practicable, the existing MeerKAT infrastructure will be reused	**SADT, CSP, SDP, TM, INFRA, DSH, AIV**
SYS_REQ-2825	**Absolute flux scale:** The absolute flux scale shall be accurate to 5% rms	**DISH, CSP, SDP**
SYS_REQ-2826	**Absolute flux scale:** The absolute flux scale shall be accurate to 3% rms	**DSH, CSP, SDP**
SYS_REQ-2174	**Combined SKA1 Mid Configuration.** The SKA1_Mid shall have the configuration defined in the TB	**SADT, INFRA, DSH, SDP**
SYS_REQ-2712	**SKA1_Mid antenna.** The SKA1_Mid array shall consist of 133 antennas centred in the same location as the MeerKAT array	**SADT, INFRA, DSH**
SYS_REQ-2179	**Antenna RF system.** The Dish Element shall make available only a single frequency band at any one time.	**DSH**
SYS_REQ-2180	**RF system frequency range band 1** The array of SKA1_Mid dishes, when the band 1 capability is selected, shall operate over a frequency range from 0.35 to 1.050 GHz for each polarisation.	**DSH**
SYS_REQ-2181	**RF system frequency range band 2.** The SKA1_Mid dishes, when the band 2 capability is selected, shall operate over a frequency range from 0.95 to 1.76 GHz for each polarisation.	**DSH**
SYS_REQ-2182	RF system frequency range band 3. The SKA1_Mid dishes, when the band 3 capability is selected, shall operate over a frequency range from	**DSH**

	1.65 to 3.05 GHz for each polarisation	
SYS_REQ-2183	**RF system frequency range band 4.** The SKA1_Mid dishes, when the band 4 capability is selected, shall operate over a frequency range from 2.80 to 5.18 GHz for each polarisation	**DSH**
SYS_REQ-2184	**RF system frequency range band 5.** The SKA1_Mid dishes, when the band 5 capability is selected, shall operate over a frequency range from 4.6 to 13.8 GHz for each polarisation.	**DSH**
SYS_REQ-2185	**RF system sampled bandwidth band 1.** The instantaneous bandwidth for band 1 will be 700MHz and shall be sampled to at least 2.0 G samples per second for each polarisation	**SADT, CSP, SDP, DSH**
SYS_REQ-2186	**RF system sampled bandwidth band 2.** The instantaneous bandwidth for band 2 will be 810 MHz and shall be sampled to at least 2.0 G sample per second for each polarisation.	**SADT, CSP, SDP, DSH**
SYS_REQ-2187	**RF system sampled bandwidth band 3** The instantaneous bandwidth for band 3 will be 1,403 MHz and shall be sampled to at least 5.0 G samples per second for each polarisation	**SADT, CSP, SDP, DSH**
SYS_REQ-2188	**RF system sampled bandwidth band 4** The instantaneous bandwidth for band 4 will be 2,380 MHz and shall be sampled at at least 5.0 G samples per second for each polarisation.	**SADT, CSP, SDP, DSH**
SYS_REQ-2189	**RF system sampled bandwidth band 5** The SKA_Mid, for band 5, shall digitise two separate 2.5 GHz bands for each polarisation.	**SADT, CSP, SDP, DSH**
SYS_REQ-2190	**RF digitisation.** Digitisation for each polarisation shall be: • band 1 8 bits • band 2 8 bits • band 3 6 bits • band 4 at least 4 bits • band 5 at least 2 streams of 3 bits	**SADT, CSP, DSH**
SYS_REQ-2774	**SKA1_Mid correlation sub-array support.** The SKA1_Mid shall be	**CSP**

	able to correlate SKA1_mid dishes as multiple sub-arrays independently and concurrently..	
SYS_REQ-2195	**SKA1_Mid channelisation.** The SKA1_Mid channelisation for each sub array shall provide up to 65,536 linearly spaced frequency channels across the sampled bandwidth of each band.	**CSP, SDP**
SYS_REQ-2196	**SKA1_Mid channelisation maximum leakage power for adjacent channels.** The SKA1_Mid for each sub-array shall have a maximum noise leakage power from immediately adjacent frequency channels of < -30 dB	**CSP**
SYS_REQ-2803	**SKA1_Mid maximum leakage power for non-adjacent frequency channels.** The SKA1_Mid, for each sub-array, shall have a maximum noise leakage power from non adjacent frequency channels better than -60 dB.	**CSP**
SYS_REQ-2805	**SKA1_Mid fine frequency channel amplitude variation.** The fine frequency channels for the SKA1_Mid channeliser shall have a total amplitude variation as a function of frequency of less than 0.01 dB after bandpass calibratio	**CSP**
SYS_REQ-2804	**SKA1_Mid fine frequency channel band edge**. The fine frequency cells for the SKA1_Mid channeliser shall have a -3dB transition band amplitude at the channel band edge.	**CSP**
SYS_REQ-2679	**SKA1_Mid correlation signal to noise.** The SKA1_Mid correlation, for the same sub-array, shall not degrade the Signal to Noise ratio by more than 2% compared to ideal analogue correlation.	**CSP**
SYS_REQ-2197	**SKA1_Mid correlation integration period.** The SKA1_Mid shall have independently configurable visibility integration period from a maximum integration time of 1.4s to a minimum of 0.14s for each subarray.	**CSP, SDP**
SYS_REQ-2616	**SKA1_Mid Pulsar phase binning.** The SKA1_Mid, for each subarray, shall allow for pulse phase-resolved observations supporting the product of the number of phase bins, channel	**CSP, SDP**

	and polarisation products up to 262,144 (i.e. 4 x 65,536).	
SYS_REQ-2830	**SKA1_Mid Pulsar phase bin width.** The SKA1_Mid shall be capable of providing pulsar phase bin widths with a time resolution of better than 10us	**CSP, SDP**
SYS_REQ-2831	**SKA1_Mid Pulsar phase bin synchronisation.** The SKA1_Mid shall be capable of synchronising phase bins to the ephemeris to limit drift to less than 10% of the selected bin width within the selected correlator integration period.	**CSP**
SYS_REQ-2835	**SKA1_Mid Phase bin averaging time.** The SKA1_Mid phase bin averaging time shall be constrained to limit the output data rate to at most the single bin configuration output data rate.	**CSP**
SYS_REQ-2740	**Inclusion of MeerKAT into SKA1_mid correlator.** The SKA1_Mid correlator shall be capable of forming real time cross correlation products from all antenna within the SKA1_Mid combined array including those MeerKAT.	**AIV, CSP**
SYS_REQ-2201	**Beam-former sub-array support.** The SKA1_Mid central beam-former shall be able to form beams or more beams for one to sixteen sub-arrays independently and concurrently.	**CSP, SDP, TM**
SYS_REQ-2751	**Pulsar search and timing within sub-arrays.** SKA1_Mid shall be capable of Pulsar search and timing processing within individual sub-arrays.	**CSP**
SYS_REQ-2202	**Pulsar search array diameter.** The central beam-former for pulsar search shall be capable of forming beams independently across all dishes (SKA1_Mid and MeerKAT) within each of the SKA1_Mid sub-arrays up to a distance of up to 10,000 metres from sub-array centres.	**CSP**
SYS_REQ-2755	**Pulsar search beamformer centre frequency**. The Pulsar search beamformer shall form beams for each of the search sub arrays with an independently selectable centre frequency for the sub-array in the range from the lowest frequency of	**CSP**

	SKA1_Mid band 1 through to the highest frequency of band 5.	
SYS_REQ-2756	**Pulsar search beamforming bandwidth.** The SKA1_Mid Pulsar search shall have a contiguous processing bandwidth for beamforming of up to 300 MHz.	**CSP**
SYS_REQ-2203	**Number of beams: Pulsar search.** SKA1_Mid, when performing the Pulsar Search function, shall simultaneously form up to a total of 1111 beams per observation across all sub arrays.	**CSP**
SYS_REQ-2205	**Beamformer S/N pulsar search.** The SKA1_Mid central beam-forming for each sub array shall have a Signal to Noise ratio greater or equal to 98% of ideal analogue beam forming for the same sub array:	**CSP**
SYS_REQ-2753	**Pulsar search beamformer output.** For each SKA1_Mid Pulsar search sub-array the output shall be the power of summed polarisation beams.	**CSP**
SYS_REQ-2752	**Pulsar search beamforming output frequency resolution.** The frequency resolution for SKA1_Mid Pulsar search shall be independently configurable in frequency resolution with values in the 20 kHz and 75 kHz	**CSP**
SYS_REQ-2754	**Pulsar search beamforming output time resolution:** SKA1_Mid Pulsar search output beams shall have a minimum time resolution of 50us.	**CSP**
SYS_REQ-2206	**Pulsar timing array radius.** The central beam-former for pulsar timing shall be capable of forming beams across all dishes within the SKA1_Mid sub-arrays to a distance of up to 10,000 metres from their centres.	**CSP**
SYS_REQ-2757	**Pulsar timing beamformer centre frequency.** The Pulsar timing beamformer shall form beams for each of the timing sub-arrays with a selectable centre frequency for the sub-array in the range from the lowest frequency of SKA1_Mid band 1 through to the highest frequency of band 5.	**CSP**
SYS_REQ-2758	**Pulsar timing beamformer bandwidth.** The SKA1_Mid Pulsar	**CSP**

	timing beamformer for each timing sub-array shall have a contiguous processing bandwidth up to the full bandwidth of the selected band up to a bandwidth of 2.5 GHz.	
SYS_REQ-2207	**Number of beams: Pulsar timing.** The SKA1_Mid central beam-former for Pulsar timing shall be capable of forming up to 16 dual polarisation coherent beams in total across all timing sub-arrays.	**CSP, SDP**
SYS_REQ-2208	**Beamforming S/N ratio: Pulsar timing.** The SKA1_Mid for Pulsar timing shall have a Signal to Noise ratio greater or equal to 98% of an ideal analogue beam former.	**CSP**
SYS_REQ-2689	**SKA1_Mid VLBI beam number.** SKA1_Mid shall be capable of producing up to four VLBI beams	**CSP, TM, SADT**
SYS_REQ-2759	**SKA1_Mid VLBI array diameter.** SKA1_Mid shall be able to generate VLBI beams from sub-arrays with receptors separated by up to 100km	**CSP, TM**
SYS_REQ-2760	**SKA1_Mid VLBI centre frequency.** SKA1_Mid shall be able to form a VLBI beam with a 0.01MHz step selectable centre frequency within the boundaries of the defined frequency bands for SKA1_Mid.	**CSP, TM**
SYS_REQ-2761	**SKA1_Mid VLBI beam bandwidth.** SKA1_Mid VLBI beamforming shall have a contiguous processing bandwidth up to the full bandwidth of the selected band	**CSP, TM, SADT**
SYS_REQ-2762	**SKA1_Mid VLBI beamformer S/N performance**. SKA1_Mid VLBI beamforming shall have the Signal to Noise ratio by more than 98% compared to an ideal analogue beam former.	**CSP,SADT**
SYS_REQ-2847	**SKA1_Mid VLBI store the time-dependent antenna weights.** SKA1_Mid shall be able to store the time-dependent antenna weights used for each tied-array beam su	**CSP, TM, SADT,SDP**
SYS_REQ-2848	**SKA1_Mid VLBI timestamp accuracy.** SKA1_Mid shall be able to generate data from the VLBI beams with samples traceable to a timestamp with an accuracy of 1 nsec or better	**CSP, SADT**

SYS_REQ-2849	**SKA1_Mid VLBI beams sampling rate.** SKA1_Mid shall be able to output VLBI beams with a sampling rate selectable between Nyquist and oversampled rates for the selected bandwidth	**CSP, TM, SADT**
SYS_REQ-2850	**SKA1_Mid VLBI beamforming**. SKA1_Mid shall be able to allocate antennas to be included in, or excluded from, individual tied-array beams	**CSP, TM, SADT**
SYS_REQ-2851	**SKA1_Mid VLBI relative sensitivity and coherence losses.** The SKA1_Mid beamformer shall be able to weight the antenna inputs into the tied-array sums based on relative sensitivity and coherence losses	**CSP, SDP, TM, SADT**
SYS_REQ-2852	**SKA1_Mid VLBI configurability.** SKA1_Mid shall be able to change the pointing, centre frequency, and bandwidth of the individual tied-array beams within a single observing schedule	**CSP, TM, SADT**
SYS_REQ-2853	**SKA1_Mid VLBI configurability.** SKA1_Mid shall be capable of selecting, through configuration, 1, 2, 3, or 4 separate VLBI specific beams, each with independently selectable centre frequency, bandwidth, frequency resolution and pointing	**CSP, TM, SADT**
SYS_REQ-2854	**SKA1_Mid VLBI configurability.** SKA1_Mid shall be capable of reconfiguring the centre frequency, frequency band, and bandwidth for each tied-array beam, in less than 30 seconds	**CSP, TM, SADT**
SYS_REQ-2855	**SKA1_Mid VLBI spectral resolution.** SKA1_Mid shall be able to generate VLBI beams with a spectral resolutions different from the spectral resolution used for imaging within the same VLBI sub-arra	**CSP, TM, SDP**
SYS_REQ-2856	**SKA1_Mid VLBI channel width**. SKA1_Mid shall be able to generate VLBI beam data with a selectable channel width of: 512MHz, 256 MHz, 128MHz, 64MHz, 32MHz, 16MHz, 4MHz or 1MHz	**CSP, TM**
SYS_REQ-2857	**SKA1_Mid VLBI imaging and beamforming** SKA1_Mid shall be able to simultaneously generate	**CSP, TM, SADT, SDP**

	imaging data using all antennas in a VLBI sub-array, as well as generating the VLBI beams	
SYS_REQ-2859	**SKA1_Mid VLBI spectral line and time domain observation** SKA1_Mid shall be able to generate VLBI beams optimised for either spectral line observations (to mitigate spectral leakage) or time domain observations (to mitigate time smearing	**CSP, TM, SDP**
SYS_REQ-2860	**SKA1_Mid VLBI beams and sub-arrays.** SKA1_Mid shall be able to allocate individual VLBI beams to different sub-arrays	**CSP, TM**
SYS_REQ-2861	**SKA1_Mid VLBI array diameter.** SKA1_Mid shall be able to generate VLBI beams from sub-arrays with receptors separated by up to 20km	**CSP, TM**
SYS_REQ-2765	**Pulsar search sub-array support**. The SKA1_Mid Pulsar search shall be able to independently process a total of up to 1111 beams from one to sixteen sub-arrays independently and concurrently.	**CSP**
SYS_REQ-2767	**Pulsar search processing bandwidth**. The Pulsar search processing shall have a contiguous processing bandwidth up to 300 MHz for each search sub array.	**CSP**
SYS_REQ-2212	**Dispersion Measure.** SKA1_Mid for pulsar search shall provide, for each sub array, trial dispersion corrections across the observation frequency range for dispersion measures from 0 up to 3000 pc cm^{-3}.	**CSP**
SYS_REQ-2216	**Time resolution.** The time resolution of the SKA1_Mid pulsar search processing for each sub-array shall be equivalent to the temporal smearing due to dispersion at the observation frequency and bandwidth of the observation with a quantisation of value in powers of 2 from 50 μs to 800 us	**CSP**
SYS_REQ-2218	**Pulsar search observation time.** For each Pulsar search sub-array, the processing shall provide independently configurable observation times up to 1800 seconds duration.	**CSP, TM**
SYS_REQ-2219	**Single pulse searches**. For each search sub-array within SKA1_Mid	**CSP**

	Pulsar search, the processing shall be capable of searching for single dispersed pulses over dispersion measure range up to 3000 pc cm^{-3} commensally with searches for periodic pulses with a S/N performance better than 7	
SYS_REQ-2220	**Binary search.** For each Pulsar search sub-array within SKA1_Mid the processing shall be capable of searching for binary systems with accelerations due to their orbital motion of up to 350 ms^{-2}.	**CSP, SDP**
SYS_REQ-2763	**Pulsar timing sub-array support**. The SKA1_Mid Pulsar timing processing shall be able to independently process a total of up to 16 beams from one to sixteen sub-arrays independently and concurrently.	**CSP**
SYS_REQ-2768	**Pulsar timing processing bandwidth.** The Pulsar timing engine shall have a contiguous processing bandwidth up to the full bandwidth of the selected band up to a bandwidth of 2.5 GHz for each timing sub-array	**CSP**
SYS_REQ-2224	**Frequency agility.** The SKA1_Mid system shall, for each timing sub-array, be able to change from observing in any frequency band, to observing in any other frequency band in less than or equal to 30 seconds.	**CSP, SDP, TM, DSH**
SYS_REQ-2766	**Pulsar timing observation time.** The observation period for each observation for each timing sub-array shall be independently configurable between 3 minutes and 300 minutes.	**CSP**
SYS_REQ-2764	**Time stamping.** For each individual Pulsar timing observation within a sub-array, each data sample shall be traceable to a time stamp derived from a clock accurate to 10ns on a time scale of 10 years referenced to a common delay centre at the centre of the SKA1_Mid array.	**CSP, SADT, Dish, LFAA**
SYS_REQ-2230	**Multiple timings.** The SKA Phase 1 shall be capable of timing up to 16 pulsars simultaneously in total across all timing sub arrays .	**CSP, SDP, TM**

SYS_REQ-2231	**Pulsar timing Dispersion Measure.** The SKA1_Mid shall be capable of timing pulsars with dispersion measures between 0 to 3000 pc cm^{-3} such that residual dispersive smearing is less than 500 ns.	**CSP**
SYS_REQ-2128	**Continuum and spectral line imaging mode.** Both SKA1 telescopes shall be capable of operating in a Continuum and Spectral-line imaging mode concurrently.	**CSP, SDP, TM**
SYS_REQ-2129	**Pulsar Search Mode.** The SKA1_mid telescope shall be capable of operating in a Pulsar search mode, concurrently with Continuum imaging mode.	**CSP, SDP, TM**
SYS_REQ-2130	**Pulsar Timing Mode.** The SKA1_mid telescope shall be capable of operating in a Pulsar timing mode, concurrently with continuum imaging mode.	**CSP, SDP, TM**
SYS_REQ-2126	**Simultaneous operation of telescopes.** Both SKA1 telescopes shall be capable of operating concurrently and independently.	**SADT, CSP, SDP, TM, INFRA**
SYS_REQ-2133	**Mode transition.** The switching time between telescope operating modes shall take less than 30 seconds (not including antenna slewing time)	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2681	**Specific epoch observations.** The observatory shall have the capability of scheduling observations at a specific epoch for time dependent phenomena.	**TM**
SYS_REQ-2682	**Overriding normal processes.** There shall be a mechanism for requesting observing time outside the normal observing time allocation process for unpredicted phenomena or in cases of high current scientific interest.	**SPO**
SYS_REQ-2683	**Overriding allocated time.** The Director-General or his/her delegate shall have the power to override allocation of time to other projects.	**SPO**
SYS_REQ-2688	**Commensal Observing Data access rights.** There shall be a documented data access rights policy for commensal observing for data sets shared across projects.	**SPO**

SYS_REQ-2127	**Sub-Arraying.** Both of the SKA1 telescopes shall be capable of operating independently with one to sixteen sub-arrays (i.e. collecting area is split and allocated to separate, concurrently observing programmes).	**LFAA, CSP, SDP, TM, DSH**
SYS_REQ-2736	**Authentication and Authorisation**. All SKA users shall require to be registered and authenticated for the purposes of proposal and project submission.	**TM**
SYS_REQ-2278	**Scheduled maintenance logs**. A maintenance database shall be established that logs all the scheduled maintenance and unexpected repairs.	**TM, INFRA, AIV**
SYS_REQ-2279	**System error logs.** A failure database shall be established, which logs the errors of the system and its subsystems, including the corrective actions taken.	**TM, INFRA**
SYS_REQ-2280	**System status.** The system shall extract information about the current condition of the system from the science and calibration data streams, and log this information along with other relevant system and environmental status information. Based on this information, it shall be possible to monitor, save, and analyse the technical performance of the system.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2282	**Central location for data bases.** External sources of information used by the Elements shall be cached by Telescope Manager. No sources other than those cached by TM shall be used.	**TM**
SYS_REQ-2283	**Target of opportunity.** TOO observing shall be via Scheduling Blocks.	**TM**
SYS_REQ-2285	**Latency of TOO scheduling block initiation**. Scheduling intervention on TOO triggers shall be initiated within 1s of receiving the trigger.	**TM SDP CSP DSH LFAA**
SYS_REQ-2286	**Discard previous scheduling block.** At the launching of a TOO Scheduling Block, the results from any active Scheduling Blocks shall be discarded.	**TM SDP CSP**
SYS_REQ-2289	**Proposal submission.** Program submission, assessment, and time	**SPO TM**

	allocation shall governed by an official policy document	
SYS_REQ-2723	**Proposal submission tool.** There shall be a tool to facilitate the assessment, review and ranking of proposals, guided by official SKA Policies.	**TM**
SYS_REQ-2647	**Tool for proposal submission.** There shall be a tool, either web or client, for the construction and submission of proposals, as necessary facilitating access to relevant sources of information such as Telescope characteristics, previous observations, SIMBAD, templates.	**TM**
SYS_REQ-2290	**Pre and post conditions.** Scheduling Blocks shall have computable pre- and post-conditions.	**TM**
SYS_REQ-2291	**Semester queue**. A Semester Queue (SQ) shall be constructed by Operations following acceptance of proposals.	**TM**
SYS_REQ-2292	**Operations: Operations** shall be responsible for constructing an executable schedule and Scheduling Blocks and submitting for execution.	**SPO, TM**
SYS_REQ-2293	**Short term schedule construction tool.** There shall be an interactive tool to aid the proposer in constructing Scheduling Blocks and an executable schedule.	**SPO, TM**
SYS_REQ-2646	**API for construction of schedule.** There shall be a API or APIs for the construction of scheduling blocks from Python and Java.	**SPO, TM**
SYS_REQ-2294	**Simulated execution of scheduling blocks.** The scheduling tool shall offer the option to simulate execution of Scheduling Blocks in order to verify correctness and scientific performance at some limited level of accuracy.	**SPO, TM**
SYS_REQ-2735	**Operator control.** It shall be possible for the operator to take manual control of the telescope.	**TM**
SYS_REQ-2295	**Response policy.** The nature of the response to a transient event shall be controlled by policy administered by Telescope Manager.	**TM**
SYS_REQ-2296	**Responses to transients** Responses shall be one of the following (a) invoking a special mode on the	**TM**

	telescope of origin, (b) issuing an VOEvent, (c) issuing a TOO announcement to SKA Telescopes, (d) no action.	
SYS_REQ-2297	**Observing mode latency** The maximum allowed latency between event and detection shall be allowed to be Observing Mode dependent.	**TM**
SYS_REQ-2298	**Rules for issuing VOEvents** Proposals to search for transients shall include rules for issuing VOEvents.	**TM**
SYS_REQ-2299	**Latency of initiating a response.** Response to an event shall be initiated within 1 second of notification.	**TM**
SYS_REQ-2300	**TOO VOStreams**. TOO proposals shall include specified VOEvent streams to be monitored.	**TM**
SYS_REQ-2301	**VOEvent issue latency**. A qualifying VOEvent shall lead to initiation of a response by the Telescope Manager within 1 second.	**TM**
SYS_REQ-2645	**Telescope model.** A dynamic computational model of the Telescope shall be used to answer all queries about the state of the Telescope. The telescope model shall consist of configuration information, numerical models, empirical parameters, and conventions.	**TM, SDP**
SYS_REQ-2302	**Single geodetic model (Telescopes).** There shall be a single geodetic model for all telescopes, published as part of the Telescope Model.	**TM**
SYS_REQ-2303	**Single geometric model.** There shall be a single geometric model for all receptor types, published by TM.	**SPO, TM**
SYS_REQ-2304	**Dish pointing model.** The dish receptor system shall include a model for pointing including structural model, thermal model, reference pointing model, and refraction model, published by TM.	**SPO, TM, DSH**
SYS_REQ-2305	**AA element and station beam model.** The AA receptor system shall include a model for element and station beams as a function of azimuth and zenith angle, frequency, and polarisation, published by TM.	**SPO, LFAA, TM**
SYS_REQ-2306	**Forensic tool for telescope behaviour** There shall be an interactive forensic tool for	**TM**

	evaluating and understanding the state and behaviour of the system at any one time.	
SYS_REQ-2307	**Interfaces.** The interactive forensic tool shall have an Internet interface with availability on a range of platforms including desktop and mobile devices.	**TM**
SYS_REQ-2308	**Replay of sequences**. The interactive forensic tool shall allow replay of selected sequences.	**TM**
SYS_REQ-2309	**Active alarms.** Alarm notification shall be active (via SMS, email, etc.) rather than passive (requiring an Operator query)	**TM**
SYS_REQ-2310	**Alarm filtering**. It shall be possible to filter alarms individually or by group.	**TM**
SYS_REQ-2312	**Alarm latency.** Latency from event to alarm shall be no more than 5 seconds.	**LFAA, SADT, CSP, SDP, TM, DSH**
SYS_REQ-2313	**Access to historical data.** All current and historic Site monitor data shall be as examinable as that from any telescope component.	**TM**
SYS_REQ-2314	**Total electron content.** The SKA Phase 1 TM shall retrieve, persist and publish data on Total Electron Content (TEC) from dual frequency GPS as part of the Telescope Model.	**TM**
SYS_REQ-2315	**Ionospheric activity.** There shall be timely access to information from other relevant sources e.g. IPS concerning unusual ionospheric activity or alerts.	**TM**
SYS_REQ-2316	**Weather station**. There shall be a data base for site weather station data.	**TM**
SYS_REQ-2317	**Satellites.** There shall be a database of relevant satellite trajectories, including orbit information, emission characteristics and owner.	**TM**
SYS_REQ-2318	**Commercial flights.** There shall be a data base of commercial flights in the neighbourhood of the site.	**TM**
SYS_REQ-2734	**RFI database.** There shall be a database holding information about RFI.	**TM**
SYS_REQ-2729	**Calibration and imaging formalism.** The Calibration and Imaging formalism shall be based upon the Rau framework [14].	**SDP**

SYS_REQ-2319	**Closed loop calibration.** The telescope calibration shall be solved by comparison of observed with GSM predictions with a time scale appropriate to the component and physical effect being calibrated and fed back to the telescope.	**SDP, TM**
SYS_REQ-2322	**Global sky model.** Calibration and continuum subtraction shall use a Local Sky Model, derived from a Global Sky Model or previous Local Sky Model.	**SDP**
SYS_REQ-2324	**Multi-frequency synthesis imaging**. All imaging shall construct and make use of frequency dependent image models over the entire observed bandwidth.	**SDP**
SYS_REQ-2325	**Deconvolution of single channels** Scale sensitive two-dimensional (i.e. on the tangent plane) deconvolution shall be available.	**SDP**
SYS_REQ-2328	**Solution for pointing errors.** It shall be possible to solve for and correct time- and station-dependent pointing errors with accuracy and timescale limited by signal to noise ratio.	**SDP, DSH, LFAA, TM**
SYS_REQ-2330	**Peeling.** Peeling of bright sources (strength limited by signal to noise ratio) from the visibility data shall be possible.	**SDP**
SYS_REQ-2321	**Direction dependent effects.** Self-calibration and image reconstruction algorithms shall be capable of dealing with direction dependent effects	**SDP**
SYS_REQ-2724	**Aperture Array DDE**. There shall be a direction dependent model for the aperture array primary beam to be used in calibration and imaging.	**SDP, LFAA, TM**
SYS_REQ-2727	**Dish DDE.** There shall be a direction dependent model for the dish primary beam to be used in calibration and imaging.	**TM**
SYS_REQ-2726	Delete	**TM**
SYS_REQ-2725	**Faraday rotation DDE.** There shall be a direction dependent Faraday Rotation model for use in calibration and imaging.	**TM**
SYS_REQ-2333	**Continuum source finding.** Where appropriate, continuum source finding shall be conducted on images generated by the Continuum Imaging	**SDP**

	pipeline. Polarization shall be fitted if available.	
SYS_REQ-2334	**Spectral line source finding.** Where appropriate, spectral line source finding shall be conducted on image cube generated by the Spectral Line pipeline.	**SDP**
SYS_REQ-2335	**Stacking.** Where appropriate, spectral line stacking shall be conducted on image cubes generated by the pipelines using *a priori* known source lists.	**SDP**
SYS_REQ-2336	**Standard pipeline products.** All pipelines shall include as data products the pipeline processing log, and Quality Assessment log.	**SDP**
SYS_REQ-2338	**Calibration pipeline.** There shall be a Calibration pipeline that derives current telescope parameters using a recent observation and a Global Sky Model, either a known GSM or the most recent GSM.	**SDP**
SYS_REQ-2339	**Continuum imaging pipeline.** There shall be a Continuum Imaging pipeline that shall have the goal of constructing noise-limited wide-band images for observations up to 1000h integration time. Polarisation shall be available if requested or necessary for calibration or quality assurance.	**SDP**
SYS_REQ-2340	**Continuum imaging data products.** The Data Products shall include the first n moment images for multi-frequency synthesis, corresponding residual images (if deconvolved), sensitivity image and representative PSF image, where n is set by signal to noise ratio.	**SDP**
SYS_REQ-2341	**Spectral line emission pipeline.** There shall be a Spectral Line Emission pipeline that is optimised for constructing noise-limited (up to 1000h integration) channel cubes of spectral line emission either with continuum emission remaining or with continuum emission removed.	**SDP**
SYS_REQ-2342	**Spectral line emission data products.** The data products shall include spectral line cube image, continuum model images, sensitivity image, and representative point spread function.	**SDP**

SYS_REQ-2343	**Spectral line absorption pipeline.** There shall be a Spectral Line Absorption pipeline that is optimised for constructing noise-limited channel cubes of spectral line absorption with continuum sources removed.	**SDP**
SYS_REQ-2344	**Spectral line absorption data products.** The data products shall include spectral line cube image, continuum model images, sensitivity image, and representative point spread function.	**SDP**
SYS_REQ-2345	**Slow transient pipeline.** There shall be a Slow Transient imaging pipeline that shall be capable of constructing a continuum image after a GSM has been subtracted for every correlator integration time or slower, searching for transient sources, and producing a time-ordered catalogue.	**SDP**
SYS_REQ-2346	**Slow transient data products.** The data products shall include a catalogue of found sources, a sensitivity image, and representative PSF image.	**SDP**
SYS_REQ-2347	**Automated Quality Assessment.** All pipelines shall perform standardised, automated Quality Assessment of Images along the axes of astrometry, photometry, radiometry, polarimetry, and spectrometry.	**SDP, TM**
SYS_REQ-2742	**Performance assessment:** Performance assessment shall be based on multi-valued functions of an observed Image and optionally a template Image	**SDP, TM**
SYS_REQ-2743	**Performance Goals:** Performance goals shall be based on multi-valued functions of an observed Image and optionally a template Image	**SDP, TM**
SYS_REQ-2744	**Quality assessment:** Quality assessment shall be based on the comparison of a Performance Assessment and a Performance Goal	**SDP, TM**
SYS_REQ-2745	**Astrometric performance metric:** The Astrometric performance metric (APM) shall measure deviation (rms, average offset, and med) of source positions from known standards	**SDP, TM**
SYS_REQ-2746	**Photometric performance metric:** The Photometric performance metric	**SDP, TM**

	(PPM) shall measure deviation (rms, average offset, and med) of source fluxes from known standards	
SYS_REQ-2747	**Radiometric performance metric:** The Radiometric performance metric (RPM) shall measure noise fluctuations (rms, average offset, and med) in an Image	**SDP, TM**
SYS_REQ-2748	**Polarimetric performance metric:** The Polarimetric performance metric (OPM) shall measure deviation (rms, average offset, and med) of source polarisations (polarisation degree and angle) from known standards	**SDP, TM**
SYS_REQ-2749	**Spectrometric performance metric:** The Spectrometric performance metric (SPM) shall measure deviation (rms, average offset, and med) of source spectral lines from known standards	**SDP, TM**
SYS_REQ-2821	**Archive.** There shall be an archive for each telescope, located in the Science Processing Centre, for storing selected science data products for subsequent access by users according to science data access policy.	**SDP**
SYS_REQ-2348	**Role of science processing centres.** The science-processing centre will convert the output data from the CSP into science data products to be stored in the science data archive.	**SDP CSP**
SYS_REQ-2350	**Mirror sites.** All data within Science Archives shall have a secondary copy located offsite in a secure location.	**SADT, SDP, INFRA**
SYS_REQ-2352	**Web interface.** The science data archives shall be accessible from the internet via a standardised web interface.	**SADT, SDP**
SYS_REQ-2353	**Virtual Observatory interface.** The science data archives shall be accessible via a set of recommended IVOA services chosen to allow access to all approved data products.	**SDP**
SYS_REQ-2354	**Archive API.** The science data archives shall publish a user accessible, open API in a small number of complementary languages such as Python, C++, and Java.	**SDP**
SYS_REQ-2355	**Data product provenance.** An official data product shall have known, documented provenance, and	**SDP**

	shall have been produced via SKA observations and processing.	
SYS_REQ-2357	**QA annotation.** The telescope shall facilitate the addition of QA annotations by Users.	**SDP**
SYS_REQ-2358	**Third party data products.** Third party data products shall not be admitted to the archive.	**SDP**
SYS_REQ-2360	**Science data product archive policy.** There shall be a policy, developed and administered by Operations, governing which types and sizes of data products will be retained in the archive and for how long.	**SDP**
SYS_REQ-2361	**Archive access.** A telescope archive will be nominally open for access 24/7/365, with no more than 24 hrs planned downtime per year. Unplanned downtime shall be consistent with availability budget.	**SDP**
SYS_REQ-2363	**Archive lifetime.** The science data archives shall be designed to provide an archived data lifetime of not less than 50 years from the start of archived observations.	**SDP**
SYS_REQ-2728	**Data migration design.** The archive design shall support and facilitate migration from one medium to another.	**SDP**
SYS_REQ-2364	**Data migration plan.** Operations shall maintain at all times and update yearly a current data migration plan covering the contingency of moving from one archive platform to another.	**SDP**
SYS_REQ-2366	**Distribution of data products.** As limited by resource constraints, it will be possible to deliver science data products to approved off-site facilities, which may be globally distributed	**SDP**
SYS_REQ-2660	**Backup archive retrieval**. Backup archive items shall be retrievable to the full archive from an alternate source within 24 hours	**SDP**
SYS_REQ-2661	**Backup archive user access conversion.** Users shall have access to the data of the entire archive within one week following an incident.	**SDP**
SYS_REQ-2739	**Levels of access**. Access to the archive shall be either anonymous	**SDP**

	with correspondingly limited capabilities or via SKA authentication and authorisation.	
SYS_REQ-2657	**Processing capability.** SDP processing per telescope at Early Science shall support processing rates 10% of that required for Full Observing (decimation being in any or all of time, frequency, field of view)	**SADT, CSP, SDP**
SYS_REQ-2268	**Coherence losses 1s.** The SKA frequency reference system shall provide a 2% maximum coherence loss , equivalent to 0.2 radians, within a maximum integration period of 1s.	**SADT**
SYS_REQ-2692	**Coherence loss 1min**. The SKA frequency reference system shall provide a 2% maximum coherence loss , equivalent to 0.2 radians, within a maximum solution interval for in-beam calibration of 1 minute.	**SADT**
SYS_REQ-2693	**Frequency reference phase drift.** The SKA Frequency Reference System shall have a phase drift of less than 1 radian, over calibration intervals of up to 10 minutes, when using out of beam calibration sources.	**SADT**
SYS_REQ-2269	**Pulse per Second precision.** The SKA synchronisation and timing system shall provide a 1 pps heartbeat signal, precise to the sampling clock (the pulse-to-pulse scatter is less than one sampling time), derived from the distributed frequency reference	**SADT**
SYS_REQ-2695	**Pulse per second phase relative to UTC.** The SKA synchronisation and timing system shall provide a 1PPS heartbeat signal with phase relative to UTC that over a 10 minute calibration interval shall survive synchronisation loss	**SADT**
SYS_REQ-2274	**UTC accuracy**. The SKA1 timescale shall be connected to UTC with an accuracy of 10 ns, on a timescale of 10 years	**SADT**
SYS_REQ-2275	**Central frequency reference.** In order to avoid large offsets, the central frequency reference shall be steered to UTC to within at least 1	**SADT**

	microsecond, with a frequency drift of less than 10 ns/day.	
SYS_REQ-2276	**SKA1 UTC offsets.** The solution period for the calculation of offsets between SKA1 timescale and UTC shall be less than 1 day	**SADT**
SYS_REQ-2370	**Weather Monitoring**. Weather monitoring stations (2 No at each core and 2 No within each spiral arm) shall be provided as part of the infrastructure - wind, temperature and humidity.	**INFRA, SADT, AIV, TM**
SYS_REQ-2371	**Visual monitoring.** The infrastructure shall provide day and night time capability for the operator(s) to visually monitor all antennas: for Dish antennas this shall be at every dish, for LFAA this shall be located at each station and also around the perimeter of the core area. Monitoring to deliver images at least one per minute for purposes of security and general telescope visual monitoring and shall be able to detect personnel at each dish and within each LFAA station.	**INFRA, DSH, TM, SADT, AIV, LFAA**
SYS_REQ-2730	**RFI Monitoring.** Permanent stations and mobile RFI monitoring units shall be provided as part of infrastructure	**INFRA, AIV, TM, SADT**
SYS_REQ-2372	**Tropospheric Monitoring**. Existing Tropospheric monitoring stations shall be expanded as part of the SKA1 infrastructure to provide at least 3 No sensor units in each of the Australia and South Africa locations.	**INFRA, SADT, AIV, TM**
SYS_REQ-2373	**Low RFI power delivery.** The power delivery infrastructure shall comply with the SKA1 RFI levels documentation.	**INFRA**
SYS_REQ-2374	**Site Access**. Roads and track-ways (including drainage) for the safe, secure and economic construction and operation of the SKA1 shall be provided	**INFRA**
SYS_REQ-2375	**Air-strip**. There shall be access to an air strip on site.	**INFRA**
SYS_REQ-2376	**Construction.** Potable and non-potable water shall be available at SKA1 construction camps including foundation concrete plants.	**INFRA**
SYS_REQ-2377	**Steady state.** Sufficient water shall be continually available at SKA1	**INFRA**

	facilities in support of equipment cooling for each telescope.	
SYS_REQ-2378	**Standards and Regulations.** The delivery and disposal of water and all construction activity shall be compliant with local and national standards and regulations.	**INFRA**
SYS_REQ-2382	**Central Processing Facility RFI shielding**. Each Central Processing Facility shall provide RFI shielding greater than that derived from zoning specifications given in the SKA RFI levels documentation (to be published by T0 + 12w).	**INFRA**
SYS_REQ-2383	**Central Processing Facility RFI penetrations**. The Central Processing Facility shall provide RFI compliant penetrations for signal and power cables entering the facility and also for all other penetrations.	**INFRA**
SYS_REQ-2397	**Dish Antenna earthing**. For lightning protection of each dish antenna the earthing system shall conform to the requirements of IEC 62305 and also to national standards SANS 10142 and 10313. National standards shall take precedence.	**INFRA, DSH**
SYS_REQ-2398	**Telephone Network**. All populated facilities shall provide connectivity to the public telephone network.	**INFRA, AIV**
SYS_REQ-2400	**Communication.** All vehicles used on site shall be equipped with long range communication devices.	**INFRA, AIV, DSH, LFAA, SADT, CSP**
SYS_REQ-2401	**Training.** All drivers on or to the sites shall have appropriate awareness training.	**INFRA**
SYS_REQ-2402	**Site steady state power budget Africa.** The total steady state power budget for the African site shall be within the limits specified in SKA Power Budget SKA-SE-POW-TN-001 [21]	**INFRA**
SYS_REQ-2404	**Site steady state power budget Australia**. The total steady state power budget for the Australian site shall be within the limits specified in SKA Power Budget SKA-SE-POW-TN-001 Revision 1 [21].	**INFRA**
SYS_REQ-2769	**Time Reference:** SKA1 shall use a time reference derived from Global Positioning System (GPS).	**SADT**
SYS_REQ-2838	**VLBI data sources.** The SKA1_Mid telescope shall be a data source for	**INFRA,CSP,TM, SADT, SDP**

	VLBI data acquisition system. The interface between the SAK1_Mid telescope and the external VLBI data acquisition system shall be compliant with the ICD SKA-TEL-SKO-0000116	
SYS_REQ-2839	**Provision of equipment for recording**. Provision of equipment for recording or capturing VLBI data is outside the scope of SKA	**CSP,TM,SADT,SDP**
SYS_REQ-2840	**VLBI equipment and eVLBI connectivity.** VLBI equipment and eVLBI connectivity beyond the interface boundary described in the ICD SKA-TEL-SKO-0000116 is outside the scope of supply of the SKA1 project	**CSP,TM, SADT, SDP**
SYS_REQ-2841	**Infrastructure for VLBI equipment:.** The following infrastructure shall be provided to allow eventual outfitting of SKA1_Mid with VLBI equipment: 6. Adequate access for the potential fitment of VLBI equipment 7. Equipment space 8. Power 9. Cooling 10. Cable trays	**INFRA**
SYS_REQ-2842	**Provision for VLBI terminal**. Provision for VLBI terminals or equivalent equipment shall be made in the Science Processing Centres for the associated telescopes	**INFRA**
SYS_REQ-2843	**Compatibility with existing VLBI terminal.** SKA1 shall be able to output VLBI beam data with each individual stream limited to 512 MHz of signal bandwidth to ensure compatibility with existing VLBI terminal capabilit	**CSP,SADT**
SYS_REQ-2844	**VLBI Processing**. VLBI processing, with the exception of beam-forming and SKA1 imaging in support of VLBI. is outside the scope of the SKA	**CSP,TM, SADT, SDP**
SYS_REQ-2845	**VLBI beam output data.** SKA1 shall be able to produce VLBI beam output data with either dual or single polarizatio	**CSP, TM, SADT**

SYS_REQ-2846	**Word length of VLBI beam output data**. SKA1 shall be able to output VLBI beam data with configurable word formats, the allowed values being 2, 4, 8, and 16-bit integer	**CSP, TM, SADT**
SYS_REQ-2410	**MeerKAT to SKA1_mid CSP interface**. The interface between MeerKAT and SKA1_mid CSP shall be compliant with SKA-TEL.AIV.SE-TEL.CSP.SE-ICD-001 Interface Control Document	**CSP, DSH**
SYS_REQ-2412	**MeerKAT to SKA1_mid SADT interface**. The interface between MeerKAT and SKA1_mid SADT shall be compliant with SKA-TEL.AIV.SE-TEL.SADT.SE-ICD-001 Interface Control Documen	**SADT, DSH, AIV**
SYS_REQ-2414	**MeerKAT to SKA1_mid SADT interface**. The interface between MeerKAT and SKA1_mid SADT shall be compliant with SKA-TEL.AIV.SE-TEL.TM.SE-ICD-001 Interface Control Document.	**SADT, DSH**
SYS_REQ-2775	**MeerKAT to SKA1_INFRA interface.** The interface between MeerKAT and SKA1_INFRA shall be compliant with SKA-TEL.AIV.SE-TEL.INFRA.SE-ICD-001 Interface Control Document	**AIV, INFRA, SADT, TMGR**
SYS_REQ-2416	**CSP to Infra interface**. The interface between CSP and Infra shall be compliant with the SKA-TEL.CSP.SE-TEL.INFRA.SE-ICD-001 Interface Control Document.	**CSP, INFRA**
SYS_REQ-2738	**CSP to SDP interface**. The interface between CSP and SDP shall be compliant with the SKA-TEL.SDP.SE-TEL.CSP.SE-ICD-001 Interface Control Document	**CSP, SDP**
SYS_REQ-2418	**Dish to CSP interface**. The interface between CSP and Dish shall be compliant with the SKA-TEL.DSH.SE-TEL.CSP.SE-ICD-001 Interface Control Document.	**CSP, DSH**
SYS_REQ-2419	**Dish to Infra interface**. The interface between Dish and Infra shall be compliant with the SKA-TEL.DSH.SE-TEL.INFRA.SE-ICD-001 Interface Control Document.	**INFRA, DSH**
SYS_REQ-2420	**LFAA to CSP interface**. The interface between LFAA and CSP shall be compliant with the SKA-	**LFAA, CSP**

	TEL.LFAA.SE-TEL.CSP.SE-ICD-001 Interface Control Document.	
SYS_REQ-2421	**LFAA to Infra interface**. The interface between LFAA and INFRA shall be compliant with the SKA-TEL.LFAA.SE-TEL.INFRA AUS.SE-ICD-001Interface Control Document.	**LFAA, INFRA**
SYS_REQ-2422	**SADT to DSH interface**. The interface between SADT and DSH shall be compliant with the SKA-TEL.SADT.SE-TEL.DSH.SE-ICD-001 Interface Control Document.	**SADT, DSH**
SYS_REQ-2423	**SADT to LFAA interface**. The interface between SADT and LFAA shall be compliant with the SKA-TEL.SADT.SE-TEL.LFAA.SE-ICD-001 Interface Control Document.	**LFAA, SADT**
SYS_REQ-2424	**SADT to CSP interface**. The interface between SADT and CSP shall be compliant with the SKA-TEL.SADT.SE-TEL.CSP.SE-ICD-001 Interface Control Document.	**SADT, CSP**
SYS_REQ-2425	**SADT to SDP interface**. The interface between SADT and SDP shall be compliant with the SKA-TEL.SADT.SE-TEL.SDP.SE-ICD-001 Interface Control Document.	**SADT, SDP**
SYS_REQ-2426	**SADT to Infra interface**. The interface between SADT and Infra shall be compliant with the SKA.TEL.SADT.SE-TEL.INFRA.SE-ICD-001 Interface Control Document.	**SADT, INFRA**
SYS_REQ-2427	**TM to Dish interface**. The interface between TM and Dish shall be compliant with the SKA-TEL.TM.SE-TEL.DSH.SE-ICD-001. Interface Control Document.	**TM, DSH**
SYS_REQ-2428	**TM to LFAA interface**. The interface between TM and LFAA shall be compliant with the SKA-TEL.TM.SE-TEL.LFAA.SE-ICD-001 Interface Control Document.	**LFAA, TM**
SYS_REQ-2429	**TM to SADT interface**. The interface between TM and SADT shall be compliant with the SKA-TEL.TM.SE-TEL.SADT.SE-ICD-001 Interface Control Document.	**SADT, TM**
SYS_REQ-2430	**TM to CSP interface**. The interface between CSP and TM shall be compliant with the SKA-	**CSP, TM**

	TEL.CSP.SE-TEL.TM.SE-ICD-001. Interface Control Document.	
SYS_REQ-2737	**TM to INFRA Interface.** The interface between TM and INFRA shall be compliant with the SKA.TEL.TM.SE-TEL.INFRA.SE-ICD-001 Interface Control Document.	**TM, INFRA**
SYS_REQ-2431	**SDP to TM interface**. The interface between SDP and TM shall be compliant with the SKA-TEL.SDP.SE-TEL.TM.SE-ICD-001 Interface Control Document.	**SDP, TM**
SYS_REQ-2432	**SDP to INFRA interface**. The interface between SDP and Infra shall be compliant with the SKA.TEL.SDP.SE-TEL.INFRA.SE-ICD-001 Interface Control Document.	**SDP, INFRA**
SYS_REQ-2462	**Electromagnetic Radiation.** Any component of the observatory shall not emit electromagnetic radiation, in any of the stated frequency intervals for broad band and narrow band cases, that exceeds the SKA RFI/EMI Threshold Levels[4]	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2463	**Self-induced RFI.** The SKA1 Telescope shall generate less self-induced RFI, within the Telescope's operating frequency bands, than the SKA RFI/EMI Protection Levels, for both broad band and narrow band cases, as specified in the "RFI/EMI Protection and Threshold Levels for the SKA" document. The SKA RFI/EMI Protection Levels are defined at the respective receiver input, and measured at the respective Telescope time series output.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2464	**Electromagnetic Compatibility Standards.** The SKA1 Telescopes shall be compliant with one or more of the following standards for emissions and one or more for susceptibility/immunity:*BS EN 61000-6-2. Electromagnetic compatibility (EMC). Generic standards. Immunity standard for industrial environments. *BS EN 61000-6-4 AMD2. Electromagnetic compatibility (EMC). Part 6-4. Generic standards. Emission standard for industrial	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**

	environments. *BS CISPR 14-1. Electromagnetic compatibility. Requirements for household appliances, electric tools and similar apparatus. Part 1. Emission. *MIL-STD-464C	
SYS_REQ-2465	**Electricity network Electromagnetic Compatibility.** The SKA1 telescopes shall follow the TBD code of practice for the application of Electromagnetic Compatibility (EMC) standards and guidelines in electricity utility networks.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2466	**EMC compatibility marking.** All "off-the-shelf" equipment shall possess as a minimum the host country EMC marking.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2467	**Electromagnetic susceptibility.** The observatory shall not be susceptible to terrestrial electromagnetic radiation at any frequency that significantly interferes with its normal operation.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2472	**RFI flagging.** The SKA1 telescopes shall automatically flag frequency data with a resolution of one channel and time data to the resolution of the integration unit if the data is corrupted by RFI.	**LFAA, CSP, SDP, TM, DSH**
SYS_REQ-2473	**RFI excision.** The SKA1 Telescopes shall automatically excise data that is corrupted by RFI.	**CSP, SDP**
SYS_REQ-2474	**RFI masking.** The SKA1 Telescopes shall flag data according to a pre-selected RFI Mask.	**LFAA, CSP, SDP, TM, DSH**
SYS_REQ-2475	**RFI zones of avoidance**. The SKA1 telescopes shall allow spatial zones of avoidance to be defined.	**TM**
SYS_REQ-2433	**Design for Extensibility**.Design trade studies for SKA1 shall include scenarios where design features are included which will allow 3. Increases in the number of receptors for SKA2 over SKA1 by a factor of 10 whilst re-using more than 90% of SKA1 hardware 4. The introduction of AIP technologies at SKA2 scales	**SPO, LFAA, SADT, CSP, SDP, TM, INFRA, DSH**

	whilst re-using more than 90% of SKA1 hardware Such trade studies shall yield the incremental cost of such scenarios over those which do not include such design features.	
SYS_REQ-2484	**Environmental legislation and regulations.** The observatory shall be compliant with all local, State and national environmental protection legislation and regulations. NOTE: Legislation takes precedence over project/contract documentation and requirements. Omission of a law from this requirement does not affect its enforceability. Legislation is also subject to amendment and so the Environmental Laws identified during the Request for Information (copied below) may be modified by the Hosting Agreements and subsequent Acts and Amendments.Legislation and regulations identified during the response to Request for Information include:South Africa: National Environmental Management Act, 1998 ("NEMA"); National Water Act, 1998; National Environmental Management: Air Quality Act, 2004; National Environmental Management Waste Act, 2008; National Environment Management: Biodiversity Act, 2004; National Heritage Resources Act, 1999.*Australia: The Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act 1999. The Western Australian Environmental Protection Act 1986 The Western Australian Land Administration Act 1997 In addition, approvals will be required under the Western Australia Mining Act 1978, Heritage of Western Australia Act 1990, the Western Australian Aboriginal Heritage Act 1972 and the MRO Indigenous Land Use Agreement 2009.* Other South African	**SPO, LFAA, SADT, CSP, SDP, TM, INFRA, DSH**

	environmental statutes include the Environment Conservation Act, 1989, various air pollution statutes, the National Heritage Resources Act, 1999, the Hazardous Substances Act, 1973, the Health Act, 1977, the Nuclear Energy Act, 1999, the National Nuclear Regulatory Act, 1999, the National Environmental Management: Protected Areas Act, 2003, the Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947, the Marine Living Resources Act, 1998, and the National Environmental Management: Integrated Coastal Management Act, 2008.	
SYS_REQ-2790	**Environmental Impact Assessment**. The Observatory shall undertake an Environmental Impact Assessment (EIA) in accordance with the local and national environmental legislation. NOTE: the EIA shall be undertaken in accordance with: South Africa - the National Environmental Management Act (NEMA); Australia - Western Australian EPA and Commonwealth EPBC	**SPO, LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2483	**Environment protection plan**. An Environmental protection plan shall be developed and maintained. This shall include the management of Environmental Impact Assessments (EIA) in accordance with SA NEMA, WA EPA and Commonwealth EPBC.	**SPO, LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2572	**Material environmental rule compliance.** All materials used in the SKA1 design shall be fully compliant to all environmental rules applicable to the SKA1 core and remote sites	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2819	**Safety of machinery risk assessment**. A risk assessment shall be conducted for each item of machinery in accordance with BS EN ISO 12100	**SPO, LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2450	**Safety information for use.** Where risks remain despite inherently safe design measures, safeguarding and the adoption of complementary protective measures,	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**

	the residual risks shall be identified in the information for use in accordance with BS EN ISO 12100 (section 6).The information for use shall include, but not be limited to, the following: operating procedures for the use of the machinery consistent with the expected ability of personnel who use the machinery or other persons who can be exposed to the hazards associated with the machinery; the recommended safe working practices for the use of the machinery and the related training requirements adequately described; sufficient information, including warning of residual risks for the different phases of the life of the machinery; the description of any recommended personal protective equipment, including detail as to its need as well as to training needed for its use.Information for use shall not be a substitute for the correct application of inherently safe design measures, safeguarding or complementary protective measures.	
SYS_REQ-2554	**Ergonomics.** The ergonomic design shall be compliant with ISO 6385.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2820	**Safety of equipment with rated voltage not exceeding 600V**. Equipment shall comply with the safety requirements of BS EN IEC 60950. NOTE: This includes electric shock, energy related hazards, fire, heat related hazards, mechanical hazards, radiation and chemical hazards	**SPO, LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2437	**Design for hazard elimination.** Designs shall demonstrate the elimination, or mitigation to a risk level practically achievable, of all hazards by means of a subsystem hazard analysis (SSHA) report as described in EN 14738 and tailored by SKA Product Assurance and Safety Plan SKA-OFF.PAQA-SKO-QP-001.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2435	**Hazard analysis**. A hazard analysis shall be performed at the system and element level in accordance with BS	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**

	IEC 61882 and, where applicable, shall include a FMEA in accordance with EN 60812.	
SYS_REQ-2567	**Hazardous Materials list.** Each Element supplier shall provide a list of hazardous materials used for all items intended for use in the SKA1 detailing suggested handling precautions, disposal instructions and contra-indications.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2579	**Hazard warning marking.** All items that present a potential hazard shall be labelled in accordance with BS EN ISO 7010	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2818	**Marking of machinery - safety.** In accordance with ISO 61310_2, machinery shall bear all markings which are necessary – for its unambiguous identification; – for its safe use; and supplementary information shall be given, as appropriate: – permanently on the machinery; – in accompanying documents such as instruction handbooks; – on the packagin	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2438	**Fail safe design.** Components and Equipment shall be designed to be locally fail-safe and not rely on external safety devices or measures to operate safely.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2788	**Non-propagation of failures**. The equipment shall be designed such that hardware failures and software errors should not create a hazardous situation to interfacing systems	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2439	**Emergency stop.** The SKA1 Elements shall have emergency stop switches or brakes for all electro-mechanical or mechanical systems that have been identified by safety analyses (required under SYS_REQ-2435) to pose a hazard.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2733	**Location of Emergency stop**. Emergency stop switches shall be located in such a way to minimize the risk of injury. (Verified by Analysis as 'minimisation' is unverifiable any other way.	**DSH, LFAA, CSP, SDP, TM, INFRA, SADT**
SYS_REQ-2786	**Safety documentation file**. Elements shall provide procedures for maintainers to recover from an unplanned shut-down, including	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**

	safety checks to be conducted prior to start-up, as specified in SKA PRODUCT ASSURANCE & SAFETY PLAN SKA-OFF.PAQA-SKO-QP-001.	
SYS_REQ-2447	**Sharp metal edges.** If they cannot be eliminated from design, sharp edges, access openings and corners shall be protected with covers or coatings.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2446	**Electrical safety.** Electrical risks and hazards shall be controlled in accordance with local, State and national legislation and Codes of Practice.NOTE: In South Africa, SANS 10142-1 and SANS 10142-2 shall apply.NOTE: In Australia, in addition to legislation, the following Codes of Practice shall be applied: AS/NZ 3000 Safe Work Australia 'Managing Electrical Risks at the Workplace'; Western Australia Director of Energy Safety 'Safe Low Voltage Work Practices by Electricians'	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2443	**Protection from high voltages.** High voltage cages or enclosures shall be used to protect personnel from inadvertent access to high voltages in accordance with AS/NZS3000 (Australia) and SANS10142 (South Africa).	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2444	**Safety grounding and bonding.** External conductive parts shall be grounded in compliance to:South Africa: National Building Regulations and Building Standards Act, 1977 Occupational Health and Safety act, 1993 SANS 10313Australia: AS/NZ 3000, AS/NZ 1768	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2445	**Electrical circuit interlocks.** Electrical circuit inter-locks shall be provided to prevent personnel coming into contact with hazards that cannot otherwise be eliminated from design.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2481	**Emergency communication.** The observatory shall provide an independent system to communicate	**SPO, LFAA, SADT, CSP, SDP, TM, INFRA, DSH**

	with outside locations in emergencies.	
SYS_REQ-2449	**Construction and AIV Safety Plan.** A comprehensive safety plan, tailored to construction and AIV activities, shall be established and implemented before the construction starts at the observatory site.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH, AIV**
SYS_REQ-2436	**Safety incident recovery plan.** A safety incident recovery plan shall be produced in accordance with SKA PRODUCT ASSURANCE & SAFETY PLAN SKA-OFF.PAQA-SKO-QP-001.	**SPO**
SYS_REQ-2451	**Safety training**. All personnel shall be provided with appropriate Health and Safety training in compliance with local regulations.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2454	**Fire fighting equipment.** Fire fighting equipment shall be made available at all SKA premises and facilities.	**SPO, LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2453	**First aid stations.** First aid stations shall be provisioned.	**INFRA**
SYS_REQ-2452	**Protective clothing.** Protective Clothing for areas where environments detrimental to human safety shall be worn.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2795	**Travel safety.** Personnel shall adhere to local safety procedures for travelling in remote areas. NOTE: Safety procedures should include the training and equipment required, such as driving instruction, vehicles appropriate for the environment and radio equipment	**SPO, LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2460	**Occupational health legislation and regulations.** The observatory shall comply with all applicable local, State and national occupational health regulations and standards in force at the time. Regulations include, but are not limited to: South Africa: Occupational Health and Safety Act, 1993, and all its regulations. Australia: Commonwealth Occupational Health and Safety Act 1991; OHS (Safety Arrangements) Regulations 1991; OHS (Safety Standards) Regulations 1994;	**SPO, LFAA, SADT, CSP, SDP, TM, INFRA, DSH**

	OHS Codes of Practice 2008. Western Australia: Occupational Safety and Health Act 1984; Harmonised OHS legislation (as enacted).	
SYS_REQ-2455	**Noise level dosage.** Personnel shall not be exposed to noise level dosages exceeding local health and safety guideline levels. The maximum noise levels shall not exceed an 8-hour average exposure of 85 decibels as specified in the Australian National Standard for Occupational Noise NOHSC: 1007(2000) and South African Noise-Induce Hearing Loss Regulations (No R.307 2003) of the Occupational Health and Safety Act, 1993 (Act No 85 of 1993). The desirable maximum noise level is 75 decibels. Note: The National Code of Practice for Noise Management and Protection of Hearing at Work [NOHSC:2009(2004)] provides practical guidance on how NOHSC:1007(2000) can be achieved	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2456	**Transient noise level.** Noise levels exceeding 85dB shall be controlled or mitigated in accordance with NOHSC National Standard for Occupational Noise [NOHSC: 1007]	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2457	**Illumination.** Personnel shall be provided with a working illumination level which is compliant with local and national regulations including the current issue of SANS 10114-1 in South Africa and the AS/NZS 1680 series in Australia.	**SPO, LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2458	**Clean air.** Personnel shall be provided with air quality at least compliant with the current issue of SANS 10400-O (South Africa - The application of National Building Regulations Part O : Lighting and ventilation) and the AS 1668 series of codes (Australia - The use of mechanical ventilation and air conditioning in buildings).	**INFRA**
SYS_REQ-2649	**Humidity.** Working environments shall be designed, built and maintained to provide air quality that	**INFRA**

	meets or exceeds the guidance provided in the Australian Code of Practice for Managing the Work Environment and Facilities, National Code of Australia and AS 1668. NOTE: Building humidity required for computing facilities is specified in Req 2367.	
SYS_REQ-2791	**Security Management System**. The SKA shall provide a security management system that includes : i. personnel security, ii. physical security (asset) iii. security of informatio	**SPO, TM, INFRA**
SYS_REQ-2793	**Personnel security training**. All personnel shall receive the security training identified in the Security Management System necessary for their location. Additional specialist pre-deployment training shall be given prior to working in remote environments.	**SPO, LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2478	**Equipment security.** The observatory shall provide a secure environment for equipment. This shall include protection of generators, fuel, solar cells and inter-station assets such as copper cables.	**SPO, LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2822	**Information security risk assessment**. An information security risk assessment shall be conducted for each element in accordance with ISO/IEC 27005	**SPO, LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2823	**Information security management for inter-organizational communications.** Information transfer between organisations shall be controlled in accordance with ISO/IEC 27010 as tailored by SKA Organisation Security Policy	**SPO, LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2482	**Accessibility.** It shall be possible to control on a per user basis which SKA1 facilities and resources (both hardware and software) may be accessed by the user.	**SPO, LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2479	**Archive security.** The observatory shall provide a secure environment for all its data archives	**SPO, LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2798	**Protection of equipment in stationary use at non-weather protected locations**. Equipment in stationary use at non-weather protected locations shall be protected	**SPO, SADT, CSP, SDP, TM, INFRA, DSH, AIV**

	against environmental conditions 4K4H/ 4Z1/ 4Z5/ 4Z6/ 4B2/ 4C1/ 4S3/ 4M4 in accordance with BS EN IEC 60721-3-4. NOTE: 4Z5 refers to the survival, non-operational mode. The equipment shall be able to operate normally for air movement up to 11 m/s	
SYS_REQ-2488	**Allowable air temperature range.** SKA1 equipment located at the dishes or aperture arrays or outside the central processing and operating facilities shall be able to withstand (non-operating if necessary) an outside air temperature within the range of -15 ºC to +60 ºC. Note this takes precedence over IEC 60721-3-4 4K4H of parent requirement	**LFAA, SADT, TM, INFRA, DSH**
SYS_REQ-2489	**Air temperature operation range.** SKA1 equipment located at the dishes or aperture arrays or outside the central processing and operating facilities shall be able to operate within specification if the outside air temperature is within the range of -5 ºC to +50 ºC. Note this takes precidence over IEC60721-3-4 4K4	**LFAA, SADT, TM, INFRA, DSH**
SYS_REQ-2490	**Wind velocities.** SKA1 equipment shall be able to survive wind velocities up to 160 km/hr, and shall operate within normal specification ranges for wind velocities up to 40 km/hr. Note: this takes precedence over IEC60721-3-4 4Z	**LFAA, SADT, TM, INFRA, DSH**
SYS_REQ-2799	**Protection of equipment in weather-protected locations.** Equipment in stationary use at weather protected locations shall be protected against environmental conditions 3K8H/ 3Z1/ 3Z11/ 3Z12/ 3B3/ 3C1R/ 3S3/ 3M4 in accordance with BS EN IEC 60721-3-3.	**SPO, LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2500	**Operating Humidity.** The operating humidity shall be between 40% and 60%	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2501	**Storage and transport Humidity.** The storage and transport humidity shall be between 40% and 95%.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**

SYS_REQ-2502	**Condensation.** Appropriate measures shall be taken to prevent the formation of condensation on operating electronic components.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2503	**Pressure.** Components shipped by air shall be capable of surviving pressures down to 11 kPa (equivalent altitude ~ 50,000 feet).	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2504	**Facilities and Equipment Intrusion.** Where appropriate, SKA1 equipment facilities shall be adequately protected against intrusion by insect and "larger" wandering animals.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2505	**Sand and Dust.** SKA1 systems shall be adequately protected against sand and dust ingress.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2506	**Fungus.** Equipment shall be protected against fungus growth.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2801	**Storage of equipment**. Designs shall identify any requirements for equipment to be stored in environmental conditions less severe than 1K11/1B3/1C1/1S3/1M3 as specified inBS EN IEC 60721-3-1. Note: It may be assumed that equipment will be stored in its original packaging	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2800	**Transportation of equipment**. Equipment shall be designed to withstand transportation from an engineering depot to a station exposed to environmental conditions 2K5H/2B3/2C1/2S3/2M3 as detailed in BS EN IEC 60721-3-2. NOTE: It may be assumed that the equipment will be transported in the original packaging that it was delivered to the engineering depot.	**SPO, LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2491	**Safety.** SKA1 equipment and buildings shall be designed and built in compliance with national and State regulations including AS 1170.4 (Importance level 3, design life 50 years) and SANS 10160-4 for earthquakes of magnitude up to Richter 3.8.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2650	**Seismic resilience.** SKA1 structures and equipment shall survive and be fully operational after a seismic event of magnitude up to Richter 3.8. Note: Seismic event includes	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**

	underground collapses in addition to earthquakes.	
SYS_REQ-2722	**Availability, reliability, and maintenance plans**. There shall be an availability, reliability and maintenance plan for each SKA1 telescope.	**SPO**
SYS_REQ-2716	**Average annual availability.** Each SKA1 telescope shall have an operational availability of 95%	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2827	**System Availability**. System designs shall meet the system availability allocations specified in SKA-OFF.SE.ARC-SKAO-RAM-001	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2718	**Availability budgets.** Availability budgets shall be allocated at the system decomposition level, and shall be consistent with the system level requirements for reliability and maintainability of the system.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2512	**Best practice.** Best available methods for reducing adverse effects of operational and maintenance environments on critical components shall be adopted.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2513	**Critical-useful-life components.** Any critical-useful-life components shall be identified.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2515	**Component selection.** Parts and components shall be selected to meet reliability requirements.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2516	**Matching components.** Parts requiring select on test shall be eliminated by deign if possible.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2517	**Known failure rate parts.** The failure rate of parts shall be known (e.g. through analysis or modelling) before inclusion in SKA design.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2518	**High failure rate parts.** Parts with excessive failure rates shall be identified.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2519	**Reliability testing.** A testing and evaluation master plan shall be generated for high-risk reliability components.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2520	**Spares and repair parts testing.** Critical spare and repair line replaceable units shall be tested before deployment.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2521	**Component derating.** Safety factors and margins shall be applied in the selection of modules and components	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**

SYS_REQ-2522	**Shelf life and wear out characteristics.** The shelf life and wear out characteristics of all components and parts shall be known before inclusion in SKA designs.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2523	**Special procurement components.** Critical parts requiring special procurement methods, testing and handling provisions shall be identified.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2525	**Fail safe provisions.** Designs shall implement fail-safe provisions to prevent secondary failures.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2526	**Maintainability budgets.** Maintainability budgets shall be allocated at the system decomposition level, and shall be consistent with the system level requirements for reliability and maintainability of the system.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2527	**Test and Repair Instructions.** Where end user repair is applicable Test and Repair Instructions shall be delivered with all equipment.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2528	**Level of maintenance.** The level of maintenance shall be identified for each repairable item.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2529	**Maintenance test and support equipment.** Equipment required for test and support shall be identified for each repairable item.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2802	**Design for maintainability**. Designs shall incorporate maintainability studies and analysis in accordance with BS EN IEC 60706-2 with emphasis on minimising the need for maintainers on sites. This activity should incorporate best practice such as described by B.S. Blanchard & W.J. Fabrycky 'Systems Engineering and Analysis', Pearson 2011	**SPO, SADT, SDP, TM, INFRA, DSH, CSP, LFAA**
SYS_REQ-2594	**Modular packaging.** The packaging of components shall be modular to limit maintenance to the removal of one module.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2595	**Maintenance provisions.** Repairable items shall be designed to include maintenance provisions such as test points, accessibility, and plug-in components.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**

SYS_REQ-2596	**Discard at failure items.** Discard at failure items shall be packed at low cost.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2597	**Plug-in modules.** The design shall implement plug-in modules to the maximum extent possible.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2598	**Module access.** Where applicable, access between modules shall be sufficient to facilitate hand grasping.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2599	**Component removal.** Modules and components shall be mounted such that removal of any single item will not require the removal of other items (component stacking to be avoided where possible)	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2600	**Secure mounting of modules.** Modules shall be securely mounted (in compliance with the shock and vibration requirements) with the minimum number of fasteners.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2601	**Shock mounting provision.** Shock mounting provisions shall be made where applicable.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2602	**Mounting preclusion.** Provisions for the preclusion of mounting the wrong module shall be provided (key coding of connectors etc.).	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2448	**Stand-off and handles.** Stand-offs and handles shall be used to protect system components from damage during shop maintenance.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2603	**Mounting guides.** Mounting guides and location pins shall be provided to facilitate module mounting.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2604	**Module labelling.** Where possible, labelling of modules shall be on the top or adjacent in plain sight.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2605	**Label robustness.** Labels shall be permanently affixed and unlikely to come off during maintenance or as a result of the environment.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2606	**Disposable LRU labelling.** Disposable line replaceable units should be labelled as such.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2711	**Component obsolescence plan.** There shall be a plan for the management of component obsolescence.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2571	**Long lead time items.** Long lead time items shall be identified to the project management.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2570	**Parts availability.** The estimated availability of the parts shall be	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**

	compatible with the final system's life cycle.	
SYS_REQ-2806	**Product Assurance**. Product Assurance shall be managed following a process modelled on the SKA Product Assurance & Safety Plan SKA-OFF.PAQA-SKO-QP-00	**SPO, SADT, SDP, TM, INFRA, DSH, CSP, LFAA**
SYS_REQ-2509	**Scope of workmanship standards.** SKA1 dedicated workmanship standards shall cover all phases of production, assembly and integration, testing, handling, and include clear requirements for acceptance/rejection criteria.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2816	**Design for testability.** Designs shall include an assessment of testability in accordance with BS EN IEC 60706-	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2538	**Test and support equipment** Test and support equipment shall be identified for each level of maintenance.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2539	**Test and support equipment standardisation.** Any test equipment not included in the standard test equipment list required for the integration, commissioning and maintenance of equipment shall be declared.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2540	**Test and support equipment lifecycle costs.** Life cycle costs shall be generated for all test and support equipment.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2541	**Test equipment reliability** Test equipment reliability shall be sufficient to meet the maintainability requirements.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2542	**Training** A plan detailing the training required for maintenance, calibration and repair shall be generated.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2543	**Direct fault indicators** Where possible, direct fault indicators shall be designed in to equipment.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2544	**Self-test.** Self-Test capability such that all faults can be identified down to LRU level shall be provided.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2546	**Continuous performance monitoring.** Where possible, the system shall be designed to provide continuous performance monitoring.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**

SYS_REQ-2552	**Malfunction detection.** All equipment malfunction shall be detected at the system level.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2556	**Access tools.** Access requiring tools shall be minimised.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2559	**Design for economic production.** All designs for the SKA shall be designed for economic production. This is required to ensure that the SKA is buildable for a reasonable cost (Con Ops Section 1.2)	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2560	**Design definition.** Design definition shall be in sufficient detail to allow one or more manufacturers to produce the same item within identified tolerances.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2561	**Manufacturing facilities.** Where possible, currently existing facilities shall be used for manufacturing.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2562	**Standard manufacturing tools.** Where possible, standard manufacturing tools shall be used.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2566	**Materials list.** Each sub-system supplier shall provide a Materials list for all items intended for use within SKA1.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2568	**Parts list.** Each Element supplier shall provide a parts list for all items intended for use in the SKA1.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2569	**Process list.** Each element supplier shall provide a process list for all items intended for use in the SKA1.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2573	**Serial number.** Each part shall be marked with a unique serial number in an easily visible location.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2574	**Drawing numbers.** Each LRU type shall be identified with a unique drawing number	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2575	**Marking method.** Method of marking shall be compatible with the nature of the item, its environment and its use.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2576	**Electronically readable or scannable ID.** Where possible line replaceable items shall be marked with an Electronically readable or scannable ID	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2577	**Package part number marking.** All packaging shall be marked with the part number of the contents.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2578	**Package serial number marking.** All packaging shall be marked with the serial number of the contents.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**

SYS_REQ-2580	**LRU electrostatic warnings** All LRUs with electrostatic sensitive components shall be fitted with ESD warning labels.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2581	**Packaging electrostatic warnings.** All packaging containing static sensitive contents shall be marked with ESD warning labels.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2583	**Cable identification.** All cables ends shall carry a unique identifier.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**
SYS_REQ-2584	**Connector plates.** All connector plates shall carry identification labels for connectors.	**LFAA, SADT, CSP, SDP, TM, INFRA, DSH**

Table 3 Allocation Matrix

22 Appendix D: Power Budget Allocation

22.1 Power Budget allocation Africa

Values are to be informed in by the Power Allocation Process.

22.2 Power Budget Allocation Australia

Values are to be informed by the Power Allocation Process.

23 Appendix E: Availability, Reliability Maintainability Allocations

23.1 SKA1_low availability allocations

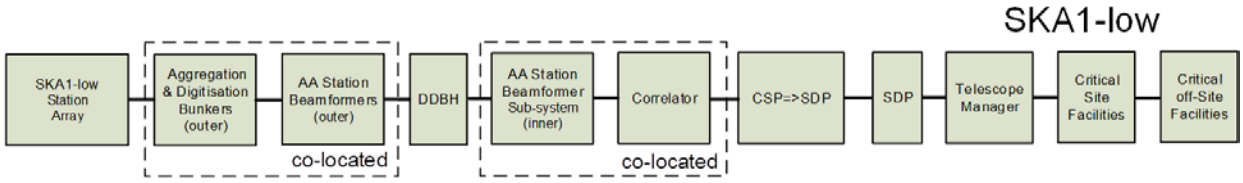

Figure 3 The availability block diagram for SKA1-low

Availability Requirements for Sub-systems of SKA1-low			
Block	Availability Requirement		Notes
	Available	Available or Degraded	
SKA1-low Outer Station Array	> 0.9969	>0.9937	MTBF margin of 1.5
Signal Aggregation & Digitisation Beamformers	"	"	"
AA Station Beamformers	"	"	"
DDBH	"	"	"
SKA1-low Inner Station Array	"	"	"

AA Station Beamformer Sub-system	"	"	"
Correlator	"	"	"
CSP=>SDP	"	"	"
SDP	"	"	"
Telescope Manager	"	"	"
Critical Site Facilities	"	"	"
Critical Off-site Facilities	"	"	"

Table 4 Availability Requirements for Sub-systems of SKA1_Low

23.2 SKA1_mid availability allocations

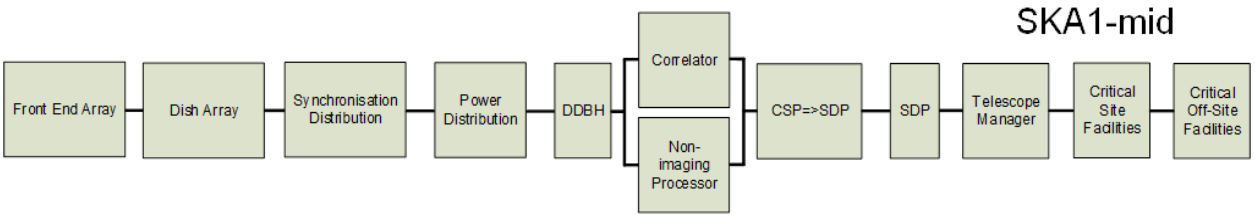

Figure 4 The availability block diagram for SKA1-Mid

Availability Requirements for Sub-systems of SKA1-mid			
Block	Availability Requirement		Notes
	Available	Available or Degraded	
Front End Array	>0.9969	> 0.9937	MTBF margin of 1.5
Dish Array	"	"	"
Synchronisation Dist'n	"	"	"
Power Dist'n	"	"	"
DDBH	"	"	"
Correlator	>0.9969	"	"
Non-Imaging Processor	>0.90	>0.85	Lower requirement
CSP=>SDP	"	"	"
SDP	"	"	"
Telescope Manager	"	"	"
Site Facilities	"	"	"
Critical Off-site Facilities	"	"	"

Table 5 Availability Requirements for Sub-systems of SKA1_Mid

23.3 Reliability, Availability and Maintainability analysis process

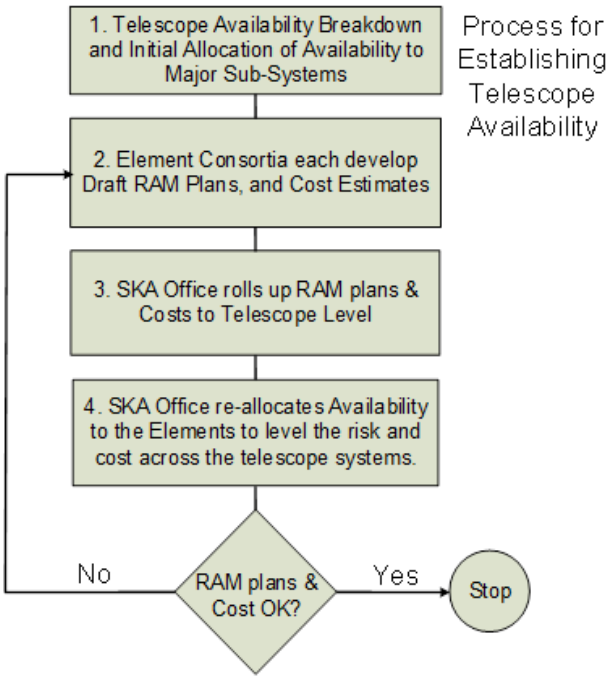

Figure 5 RAM analysis process

Figure 5 illustrates the procedure for each telescope. The initial allocation of availability requirements (Step 1) is provided in Appendix E, based on simplified availability block diagrams.These are subject to refinement and change as the design matures.

RAM plans, provided at the Element level (Step 2), will be rolled up to the system level (Step 3), leading to the introduction of new allocations (Step 4).

Capital and operating cost estimates shall be provided in Step 2 for the Elements and Step 4 for the telescope system. In the final iteration, the costs shall fall within allocated capital and operating costs.

- The first pass through Figure 14 shall be complete at the mid-point of the preliminary design phase.
- The second pass shall be complete before the Preliminary Design Review.
- During the detailed design phase, iterations shall be as frequent as necessary to keep up with changes at the Element level. These will be merely 'adjustment passes'. Significant changes will require a formal change control procedure.
- At the conclusion of each iteration of Figure 10, the Elements will deliver a draft RAM plan. The preliminary version will be reviewed at the Preliminary Design Review (PDR), and the final version will be reviewed at the Critical Design Review (CDR).

24 Appendix F Requirement Changes this Issue

The table below identifies the requirements and supportive text that have changed from Revision 5 to this rebase-lining Revision. The changes are traceable to the documents submitted to the SKA board: **SKA-BD-17-13a and SKA-BD-17-13c**. No changes other than those traceable to rbs are included as there are further updates planned:

6 RBS Board decision ECP150001
6A Remove Process documents from requirements ECP150002
6B Align L1 requirements at Telescope level ECP150003
6C Outstanding and well developed ECP
6D Address comments from Revision 5
6E Inclusion of missing comments from comments
6F PDR outcomes that impact L1 requirements
7 New Architecture Pack release
7A Outstanding ECPs that require further development
7B Issues that require further development from missing requirements, PDR comments and Rev 5 comments
8

There are rbs updates that are postponed or require further work beyond Revision 6:

- The requirement document context diagram Figure 1
- Requirements relating to the potential fitment of PAFs to SKA1 _Mid dishes needs further analysis

The cells in the table present the item identifier (supportive text or requirement) with the content at Revision 6 and the immediately preceding Revision 5. The change list is provided as an aid and the main body of the document takes precedence.

Item	Revision 5 content	Revision 6 Content
Purpose of the Document	This document serves as a vehicle to communicate the high-level quantitative and qualitative characteristics of the SKA Phase 1 Observatory in the form of formal requirements that are to be allocated to each of its constituent elements.	This document serves as a vehicle to communicate the high-level quantitative and qualitative characteristics of the SKA Phase 1 Observatory in the form of formal requirements that are to be allocated to each of its constituent elements.

	Figure 6 SKA Phase 1 System Requirements Specification Context Figure 1 provides an initial simplified context assumed for this document in relation to other SKA documentation. There may be changes to the figure as the system engineering process progresses. This figure should be studied carefully since the SKA development process may not be as expected. In particular, the root document is the Baseline Design, not the Level 0 requirements; There are no security, intellectual property, or privacy considerations attached to the use or distribution of this document.	**New diagram to be inserted** **Figure 1 SKA Phase 1 System Requirements Specification Context** Figure 1 provides an initial simplified context assumed for this document in relation to other SKA documentation.There may be changes to the figure as the system engineering process progresses. This figure should be studied carefully since the SKA development process may not be as expected. In particular, the root document is not the Level 0 requirements; There are no security, intellectual property, or privacy considerations attached to the use or distribution of this document.
Approach	This document will reside within a requirements capture tool (Jama Contour) and for each requirement statement will include relational links back to the following source documents: • Baseline Design • Design Reference Mission/ Science Requirements • Operations Concept Guidance This document is a living document that will converge on the requirements for the SKA1 system. The convergence process is an iterative one between the SKA Office and the consortia involved with the Element design work. At present, some requirement statements have no traceability link available back to higher level source documents. These will usually be	This document will reside within a requirements capture tool (Jama Contour) and for each requirement statement will include relational links back to the following source documents: • Baseline Design + SKA-BD-17-13a and SKA-BD-17-13c rebase-lining documents presented to the SKA board. • Science Priority Outcome • Operations Concept Guidance This document is a living document that will converge on the requirements for the SKA1 system. The convergence process is an iterative one between the SKA Office and the consortia involved with the Element design work.

	identified as TBJ (to be justified). However, if no link is identified then it is to be assumed that this is the case. If the requirement cannot be justified it will be removed. Each requirement identified within this document will have a unique four digit identifier preceded by a prefix of "SYS_REQ_". The identifier will be generated by the requirements capture tool. It provides a useful reference tag and indicates where in the system hierarchy the requirement resides. Each requirement will identify the type of verification method. The status of each requirement will be identified. The allocation of requirements to Elements is provided in Appendix C of this document The latest issued document will take precedence over the contents of the requirements capture tool. However, an issued Level 1 Requirement document represents a requirements capture tool baseline. The data base baseline identifier will be referenced in the document history. Amendments to the document will be via change control. If accepted, amendments will be via the requirements capture tool. Up 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.	At present, some requirement statements have no traceability link available back to higher level source documents. These will usually be identified as TBJ (to be justified). However, if no link is identified then it is to be assumed that this is the case. If the requirement cannot be justified it will be removed. Each requirement identified within this document will have a unique four digit identifier preceded by a short hand prefix of "SYS_REQ_". The identifier is a truncation of the "SKA1-SYS_REQ_" that is generated be generated by the requirements capture tool. It provides a useful reference tag and indicates where in the system hierarchy the requirement resides. Each requirement will identify the type of verification method. The status of each requirement will be identified. The allocation of requirements to Elements is provided in Appendix C of this document The latest issued document will take precedence over the contents of the requirements capture tool. However, an issued Level 1 Requirement document represents a requirements capture tool baseline. The data-base baseline identifier will be referenced in the document history. Amendments to the document will be via change control. If accepted, amendments will be via the requirements capture tool. Up 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.
Applicable documents	In the event of conflict between the contents of the applicable documents and this SKA1 System Requirement	In the event of conflict between the contents of the applicable documents and this SKA1 System Requirement

	Specification (SRS) document, the applicable documents shall take precedence; [1] SKA1 System Baseline Design SKA-TEL-SKO-DD-001 Rev 1 [2] Concept of Operations for the SKA Observatory SKA.TEL.SE.OPS-SKO-COO-001-0-A [3] Operational Concepts [in prep] [4] EMI/EMC standards [in prep]	Specification (SRS) document, the applicable documents shall take precedence; [1] SKA1 System Baseline Design SKA-TEL-SKO-DD-001 Rev 1 [2] Concept of Operations for the SKA Observatory SKA.TEL.SE.OPS-SKO-COO-001-0-A [3] Operational Concepts [in prep] [4] SKA EMI/EMC standards SKA EMI/EMC Standards and Procedures SKA-TEL-SKO-0000202-AG-RFI-ST-01 [5] SKA1_Low Configuration Coordinates (*in preparation*) [6] SKA1_Mid Configuration Coordinates (*in preparation*) [7] SKA1 Rebaselining outcome summary (in preparation)
Reference Documents	The following documents are referenced in this document. In the event of conflict between the contents of the referenced documents and this document, this document shall take precedence. [5]SKA Science Working Group, "*The Square Kilometre Array Design Reference Mission: SKA Phase 1*", report, v.1.3, January 2011. [6]SKA Science Working Group, "*The Square Kilometre Array Design reference Mission: SKA-mid and SKA-lo*", report, v.0.4, October 2009 [7]SKA Memo 125: '*Concept Design for SKA Phase 1 (SKA$_1$)*', M.A. Garrett, J.M. Cordes, D. De Boer, J.L. Jonas, S. Rawlings, and R. T. Schilizzi (SSEC SKA Phase 1 Sub-committee), 30 May 2010. [8]SKA Memo 130: '*SKA Phase 1: Preliminary System Description*', P.E. Dewdney et al, dated November 2010.	The following documents are referenced in this document. In the event of conflict between the contents of the referenced documents and this document, this document shall take precedence. [8]SKA Memo 130: '*SKA Phase 1: Preliminary System Description*', P.E. Dewdney et al, dated November 2010. [9]Logistics Engineering and Management B.S. Blanchard Sixth Edition Prentice Hall [10] Reliability-Centred Maintenance John Moubray Second Edition Butterworth-Heinemann [11] Practical Reliability Engineering Patrick D.T. O'Connor Fourth Edition Wiley [12] System Engineering Management B.S Blanchard Third Edition Wiley [13] The Basics of FMEA R.E. McDermott, R.J. Mikulak

	[9]Logistics Engineering and Management B.S. Blanchard Sixth Edition Prentice Hall [10] Reliability-Centred Maintenance John Moubray Second Edition Butterworth-Heinemann [11] Practical Reliability Engineering Patrick D.T. O'Connor Fourth Edition Wiley [12] System Engineering Management B.S Blanchard Third Edition Wiley [13] The Basics of FMEA R.E. McDermott, R.J. Mikulak [14] M.R. Beauregard Second Edition CRC Press [15] RFI Protection and Threshold Levels for the SKA SKA.TEL.OFF.PAQA.RFI-SK0-TN-001 (available T0 + 12 weeks) [16] Rau, U., Bhatnagar, S., Voronkov, M.A., and Cornwell, T.J., "Advances in Calibration and Imaging Techniques in Radio Interferometry", Proc IEEEE, 97, 1472-1481, (2008) [17] U. Rau and T. J. Cornwell, A multi-scale multi-frequency deconvolution algorithm for synthesis imaging in radio interferometry A&A 532, A71 (2011) [18] S.J. Wijnholds, J.D. Bregman and A.van Ardenne, Calibratability and its inmpact on configuration design for LOFAR and SKA phased array radio telescopes, Radio Science, vol. 46, No. RS0F07, 8 November 2011 [19] C.J. Lonsdale, D. Oberoi, A.J Coster and P.J Erickson, The Effects of Variable Ionospheric and Plasmaspheric Faraday Rotation on Low Frequency Radio Arrays, Proceedings of the XXXth General Assembly and Scientific Symposium of the Interation Union of Radio Science (URSI GASS), Istanbul (Turkey), 13 - 20 August 2011 [20] R. Braun SKA1 Array Configurations SKA1 ARRAY CONFIGURATIONS Rev1 2014-05-16.	[14] M.R. Beauregard Second Edition CRC Press [15] RFI Protection and Threshold Levels for the SKA SKA.TEL.OFF.PAQA.RFI-SK0-TN-001 (available T0 + 12 weeks) [16] Rau, U., Bhatnagar, S., Voronkov, M.A., and Cornwell, T.J., "Advances in Calibration and Imaging Techniques in Radio Interferometry", Proc IEEEE, 97, 1472-1481, (2008) [17] U. Rau and T. J. Cornwell, A multi-scale multi-frequency deconvolution algorithm for synthesis imaging in radio interferometry A&A 532, A71 (2011) [18] S.J. Wijnholds, J.D. Bregman and A.van Ardenne, Calibratability and its inmpact on configuration design for LOFAR and SKA phased array radio telescopes, Radio Science, vol. 46, No. RS0F07, 8 November 2011 [19] C.J. Lonsdale, D. Oberoi, A.J Coster and P.J Erickson, The Effects of Variable Ionospheric and Plasmaspheric Faraday Rotation on Low Frequency Radio Arrays, Proceedings of the XXXth General Assembly and Scientific Symposium of the Interation Union of Radio Science (URSI GASS), Istanbul (Turkey), 13 - 20 August 2011 [21] A. Schutte SKA1 Power Budget SKA-SE-POW-TN-001 Rev2

	[21] A. Schutte SKA1 Power Budget SKA-SE-POW-TN-001 Rev2	
Observatory Structure	The product trees shown in this section are extracted from a SysML model of the baseline design, and are included primarily to establish product names.	**Deleted**
Observatory Product Tree	The top level observatory product tree is shown below. Figure 3 Telescope Product Tree	**Deleted**
Murchison Radio Observatory Product Tree	Figure 4 Murchison Radio Observatory Product Tree	**Deleted**
Survey Array	**Heading 3.5.1.5**	**Deleted**
SYS_REQ-2125	**SKA1_survey array.** The SKA1 survey array shall be located within the legal boundary of the Boolardy station.	**Deleted**
SKA1_survey CSP Facility	**Heading 3.5.1.6**	**Deleted**
SYS_REQ-2655	**SKA1_survey CSP facility**. The CSP facility for SKA1_survey shall be the ASKAP processing facility**.**	**Deleted**
Australian Engineering Operations Centre	Allocation: LFAA, CSP, SDP, TM, SADT, DSH	**Allocation:** LFAA, CSP, SDP, TM, SADT
Observatory locations	**Section 3.6**	**Deleted**
SKA1_Low	**Figure 7 SKA1_low Functional Context** Figure 7 provides the functional context model for SKA1_low. This is an export from the hierarchical model for the SKA1 system created in Magic Draw system modelling tool utilising the formalism of the graphical SysML language. It is for information only as the model isn't currently under configuration control.	**Deleted**
SKA1_Low telescope product tree	**Section 4.1.1**	**Deleted**
SYS_REQ-2135	**SKA1_Low array sensitivity at 50MHz**. The SKA1_Low array shall have sensitivity per polarization at zenith greater than 144 m^2K^{-1} at 50MHz when assuming a sky noise temperature following the law $60.lamda^{2.55}$	**SKA1_Low array sensitivity at 50MHz**. The SKA1_Low array shall have sensitivity per polarization at zenith greater than 72 m^2K^{-1} at 50MHz when assuming a sky noise temperature following the law $60.lamda^{2.55}$
SYS_REQ-2136	**SKA1_Low array sensitivity at 110MHz**. The SKA1_Low array shall have a sensitivity per polarization at zenith greater than 760 m^2K^{-1} at 100	**SKA1_Low array sensitivity at 110MHz**. The SKA1_Low array shall have a sensitivity per polarization at zenith greater than 380 m^2K^{-1} at 100

	MHz when assuming a sky noise temperature following the law 60.lambda^2.55	MHz when assuming a sky noise temperature following the law 60.lambda^2.55
SYS_REQ-2137	**SKA1_Low array sensitivity at 160MHz**. The SKA1_Low array shall have a sensitivity per polarization at zenith of greater than 1070 m^2K^{-1} at 160 MHz when assuming a sky noise temperature following the law 60.lambda^2.55	**SKA1_Low array sensitivity at 160MHz**. The SKA1_Low array shall have a sensitivity per polarization at zenith of greater than 535 m^2K^{-1} at 160 MHz when assuming a sky noise temperature following the law 60.lambda^2.55
SYS_REQ-2138	**SKA1_Low array sensitivity at 220MHz**. The SKA1_Low array shall have a sensitivity per polarization at zenith of greater than 1060 m^2K^{-1} at 220 MHz when assuming a sky noise temperature following the law 60.lambda^2.55.	**SKA1_Low array sensitivity at 220MHz**. The SKA1_Low array shall have a sensitivity per polarization at zenith of greater than 530 m^2K^{-1} at 220 MHz when assuming a sky noise temperature following the law 60.lambda^2.55.
SYS_REQ-2814	**SKA1_Low array sensitivity per polarization at 280 MHz.** The SKA1_Low array shall have a sensitivity per polarization at zenith greater than 1000 m^2/K at 280 MHz when assuming a sky noise temperature following the law 60.lambda^2.55	**SKA1_Low array sensitivity per polarization at 280 MHz.** The SKA1_Low array shall have a sensitivity per polarization at zenith greater than 500 m^2/K at 280 MHz when assuming a sky noise temperature following the law 60.lambda^2.55
SYS_REQ-2142	**SKA1_Low number of stations.** The SKA1_Low shall comprise of 1024 stations.	**SKA1_Low number of stations.** The SKA1_Low shall comprise of 512 stations.
SKA1_Low 600m configuration	SKA1_Low 600m configuration	SKA1_Low configuration
SYS_REQ-2143	**SKA1_Low 600m configuration.** The SKA1_Low shall have 50% of its antennas within a 600 metre radius.	**SKA1_Low configuration.** The SKA1_Low shall have a configuration as specified in TBD.
SKA1_Low 1000m core configuration	**SKA1_Low maximum baseline length between stations.** The maximum distance between stations shall be approximately100 km	**SKA1_Low maximum baseline length between stations.** The maximum distance between station centres shall be approximately 80 km
SYS_REQ-2144	**SKA1_Low core configuration.** The SKA1_low shall have 75% of its antennas within a 1000 metre radius.	**Deleted**
SKA1_Low spiral arm configuration	**Heading 4.1.2.17**	**Deleted**
SYS_REQ-2145	**SKA1_low spiral arm configuration.** The SKA1_Low shall have a configuration of 3 spiral arms beyond a radius of 1,000 metres.	**Deleted**
SYS_REQ-2817	**SKA1_Low maximum baseline length between stations.** The	**SKA1_Low maximum baseline length between stations.** The

	maximum distance between stations shall be approximately100 km	maximum distance between stations shall be approximately 80 km
SYS_REQ-2652	**SKA1_Low separation.** The SKA1_Low core shall be located at a minimum distance of 10km from the ASKAP core.	**SKA1_Low separation.** The SKA1_Low core shall be located at a minimum distance of 10km from the ASKAP core.
SYS_REQ-2148	**SKA1_Low channelisation.** The SKA1_Low channelisation for each sub array shall provide up to 256,000 linearly spaced frequency channels across the available frequency range of each band.	**SKA1_Low channelisation.** The SKA1_Low channelisation for each sub array shall provide up to 65,536 linearly spaced frequency channels across the available frequency range of each band.
SKA1-SYS_REQ-2150	**SKA1_Low correlator Integration rate. T**he SKA1_Low correlator for each sub array shall have independently configurable visibility integration periods in the range 6s to 0.6s.	**SKA1_Low correlator Integration rate .** T he SKA1_Low correlator for each sub array shall have independently configurable visibility integration periods in the range 9s to 0.9s.
SYS_REQ-2162	**Number of receivers**. There shall be space at the Gregorian focus of SKA1 dishes for five single pixel feeds (SPF) or three Phased Array Feeds (PAF)	**Number of feeds**. There shall be space at the Gregorian focus of SKA1 dishes for five single pixel feeds (SPF) or three Phased Array Feeds (PAF)
SKA1_Mid	**Figure 9 SKA1_Mid Functional Context** Figure 9 provides the functional context model for SKA1_Mid. This is an export from the hierarchical model for the SKA1 system created in Magic Draw system modelling tool utilising the formalism of the graphical SysML language.	**Deleted**
SKA1_Mid Telescope product tree	**Section 4.3.1**	**Deleted**
SYS_REQ-2174	**Combined SKA1 Mid Configuration.** 42 % of the Combined SKA1_Midshall be within a radius of 400 m of the array centre.	**Combined SKA1 Mid Configuration.** The SKA1_Mid shall have the configuration defined in the TBD
Combined SKA1_Mid configuration 1,000m	**Heading 4.3.2.4**	**Deleted**
SYS_REQ-2175	**Combined SKA1_Mid configuration** . 17 % of the combined SKA1_Mid array shall be within a radius of between 400 and 1,000 m of the array centre**.**	**Deleted**
Combined SKA1_Mid configuration 2,500m	**Heading 4.3.2.5**	**Deleted**
SYS_REQ-2176	**Combined SKA1_Mid configuration** . 16 % of the combined SKA1_Mid array shall be within a radius between 1,000m and 2,500 m of the array centre**.**	**Deleted**

Combined SKA1_Mid configuration 4,000m	**Heading 4.3.2.6**	**Deleted**
SKA1-SYS_REQ-2177	**Combined SKA1_Mid configuration .** 11 % of the combined SKA1_Mid array shall be within a radius between 2,500m and 4,000 m of the array centre**.**	**Deleted**
Combined SKA1_Mid configuration 100,000m	**Heading 4.3.2.7**	**Deleted**
SYS_REQ-2178	**Combined SKA1_Mid configuration.** 14 % of the combined SKA1_Mid array shall be within a radius between 4,000m and 100,000 m of the array centre.	**Deleted**
SYS_REQ-2712	**SKA1_Mid antenna.** The SKA1_Mid array shall consist of 190 antennas centred in the same location as the MeerKAT array	**SKA1_Mid antenna.** The SKA1_Mid array shall consist of 133 antennas centred in the same location as the MeerKAT array
SYS_REQ-2195	**SKA1_Mid channelisation.** The SKA1_Mid channelisation for each sub array shall provide up to 256, 000 linearly spaced frequency channels across the sampled bandwidth of each band.	**SKA1_Mid channelisation.** The SKA1_Mid channelisation for each sub array shall provide up to 65,536 linearly spaced frequency channels across the sampled bandwidth of each band.
SKA1_Mid correlation integration time	**SKA1_Mid correlation integration period.** The SKA1_Mid shall have independently configurable visibility integration period from a maximum integration time of 0.8s to a minimum of 0.08s for each subarray.	**SKA1_Mid correlation integration period.** The SKA1_Mid shall have independently configurable visibility integration period from a maximum integration time of 1.4s to a minimum of 0.14s for each subarray.
SYS_REQ-2616	**SKA1_Mid Pulsar phase binning.** The SKA1_Mid, for each subarray, shall allow for pulse phase-resolved observations supporting the product of the number of phase bins, channel and polarisation products up to 1,000,000 (i.e. 4 x 256,000).	**SKA1_Mid Pulsar phase binning.** The SKA1_Mid, for each subarray, shall allow for pulse phase-resolved observations supporting the product of the number of phase bins, channel and polarisation products up to 262,144 (i.e. 4 x 65,536).
SYS_REQ-2203	**Number of beams: Pulsar search.** SKA1_Mid, when performing the Pulsar Search function, shall simultaneously form up to a total of 2222 beams per observation across all sub arrays.	**Number of beams: Pulsar search.** SKA1_Mid, when performing the Pulsar Search function, shall simultaneously form up to a total of 1111 beams per observation across all sub arrays.
SYS_REQ-2765	**Pulsar search sub-array support**. The SKA1_Mid Pulsar search shall be able to independently process a total of up to 2222 beams from one to sixteen sub-arrays independently and concurrently.	**Pulsar search sub-array support**. The SKA1_Mid Pulsar search shall be able to independently process a total of up to 1111 beams from one to sixteen sub-arrays independently and concurrently.
SKA1_Survey	**Figure 7** SKA1_Survey Context diagram	**Deleted**

	Figure 11 provides the functional context model for SKA1_survey. This is an export from the hierarchical model for the SKA1 system created in Magic Draw system modelling tool utilising the formalism of the graphical SysML language.	
SKA1_Survey Telescope product tree	**Section 4.4.1**	**Deleted**
SKA1_Survey array	**Heading 4.4.2**	**Deleted**
SYS_REQ-2732	**SKA1_survey array**. The SKA1_Survey array shall consist of 60 antennas centred in the same location as the ASKAP array.	**Deleted**
SKA1_Survey configuration and performance	**Heading 4.4.3**	**Deleted**
SKA1_survey inclusion of ASKAP	**Heading 4.4.3.1**	**Deleted**
SYS_REQ-2262	**SKA1_Survey inclusion of ASKAP.** The SKA1_Survey shall incorporate the 36 ASKAP antennas in both monitor and control and data collection functions.	**Deleted**
SYS_REQ-2832	**Monitor and Control of ASKAP .** The monitor and control functions of ASKAP shall be made available to SKA1_Survey via a Foreign Telescope interface consisting of a Local Monitor and Control system connected to the SKA1_Survey Telescope Manager.	**Deleted**
SYS_REQ-2265	**SKA1_Survey**- ASKAP infrastructure reuse. Where economically practicable, the existing ASKAP infrastructure will be reused.	**Deleted**
SKA1_Survey configuration < 400m	**Heading 4.4.3.2** Filling factor 0.25%	**Deleted**
SYS_REQ-2232	**SKA1_Survey configuration.** 12% of the SKA1_Survey dishes shall be within a radius of 400 m of the array centre.	**Deleted**
SKA1_Survey configuration 400m to 1000m	**Heading 4.4.3.3** Filling factor 0.082%	**Deleted**
SYS_REQ-2233	**SKA1_Survey configuration.** 20% of the SKA1_Survey Dishes shall be located in an area with a radius of	**Deleted**

	less than 1000m and greater than 400m from the array centre.	
SKA1_Survey configuration 1,000m to 2,500	**Heading 4.4.3.4** Filling factor 0.031%	**Deleted**
SYS_REQ-2234	**SKA1_Survey configuration.** 30% of the SKA1_Survey Dishes shall be located in an area with a radius of less than 2500m and greater than 1000m from the array centre	**Deleted**
SKA1_Survey configuration 2,500 to 4,000m	**Heading 4.4.3.5** Filling factor 0.008%	**Deleted**
SYS_REQ-2235	**SKA1_survey configuration .** 16% of the SKA1_Survey array shall be within a radius of 2,500 m and 4,000 m of the array centre.	**Deleted**
SKA1_Survey configuration 4,000m to 25,000	**Heading 4.4.3.6** Filling factor 1.2×10^{-5} %	**Deleted**
SYS_REQ-2236	**SKA1_Survey configuration** . 22% of the SKA1_Survey array shall be within a radius of 4,000 m and 25,000 m of the array centre.	**Deleted**
Antenna RF system	**Heading 4.4.3.7**	**Deleted**
SYS_REQ-2237	**Antenna RF system.** For all SKA1_Survey antennas, only one PAF system shall be available at any one time	**Deleted**
RF system frequency range PAF band 1	**Heading 4.4.3.8**	**Deleted**
SYS_REQ-2238	**RF system frequency range PAF band 1** The SKA1_Survey PAF for band 1 shall have a frequency range from 350 to 900 MHz for each polarisation.	**Deleted**
RF system frequency range PAF band 2	**Heading 4.4.3.9**	**Deleted**
SYS_REQ-2239	**RF system frequency range PAF band 2** The SKA1_Survey PAF for band 2 shall have a frequency range from 0.650 to 1.670 GHz for each polarisation.	**Deleted**
RF system frequency range PAF band 3	**Heading 4.4.3.10**	**Deleted**
SYS_REQ-2240	**RF system frequency range PAF band 3** The SKA1_Survey PAF for band 3 shall have a frequency range from 1.500 to 4.000 GHz for each polarisation.	**Deleted**

Maximum available bandwidth	**Heading 4.4.3.11**	**Deleted**
SYS_REQ-2241	**Maximum available bandwidth** The SKA1_Survey shall have a PAF bandwidth of at least 500 MHz for each polarisation and beam	**Deleted**
SKA1_Survey digitised bandwidth	**Heading 4.4.3.12**	**Deleted**
SYS_REQ-2242	**SKA1_Survey digitised bandwidth** The SKA1_Survey digitised bandwidth for each PAF shall be greater than 500 MHz for each polarisation.	**Deleted**
SKA1_Survey - superimposed beams	**Heading 4.4.3.13**	**Deleted**
SYS_REQ-2260	**SKA1_Survey – coincident beams** ASKAP PAF and SKA1 PAF beamforming chains shall be capable of locating beams with identical phase and delay centres to within an accuracy set by the signal to noise ratio.	**Deleted**
SKA1_Survey PAF1 diameter	**Heading 4.4.3.14**	**Deleted**
SYS_REQ-2243	**SKA1_Survey PAF1 diameter** The SKA1_Survey PAF diameter shall be equal to or less than 1.82 m.	**Deleted**
SKA1_Survey PAF2 diameter	**Heading 4.4.3.15**	**Deleted**
SYS_REQ-2244	**SKA1_Survey PAF2 diameter** The SKA1_Survey PAF2 diameter shall be 1.0 m.	**Deleted**
SKA1_Survey PAF3 diameter	**Heading 4.4.3.16**	**Deleted**
SYS_REQ-2245	**SKA1_Survey PAF3 diameter** The SKA1_Survey PAF3 diameter shall be 0.41 m.	**Deleted**
SKA1_Survey number of PAF elements	**Heading 4.4.3.17**	**Deleted**
SYS_REQ-2246	**SKA1_Survey number of PAF elements**. The SKA1_Survey PAF arrays shall have 94 dual polarisation elements.	**Deleted**
SKA1_Survey array sensitivity	**Heading 4.4.3.18**	**Deleted**
SYS_REQ-2253	**SKA1_Survey array sensitivity.** The SKA1_Survey array shall have a net sensitivity of better than: 235 m 2 K -1 for PAF band 1 for but not with 391 m 2 K -1 for PAF band 2	**Deleted**

	293 m 2 K -1 for PAF band 3 for but not with These array sensitivities are based on the total collecting area, of the SKA1 Survey Array, including the 36 ASKAP antennas, and a 80 % aperture efficiency resulting in an effective collecting area of 11.740 m 2 .	
SKA1_Survey imaging dynamic range	**Heading 4.4.3.19**	**Deleted**
SYS_REQ-2256	**SKA1_Survey imaging dynamic range – band 1.** The SKA1_Survey array shall have an imaging dynamic range of greater than: band 1: 55dB for a 1000 hour single-field integration band 2: 56dB for a 1000 hour single-field integration band 3: 54dB for a 1000 hour single-field integration	**Deleted**
SKA1_Survey derotation	**Heading 4.4.3.20**	**Deleted**
SYS_REQ-2266	**SKA1_Survey derotation**. SKA1_Survey shall provide PAF rotation capability sufficient to orient Phased Array Feed beams on a sky coordinate frame independent of parallactic angle**.**	**Deleted**
SKA1-Survey single array operation	**Heading 4.4.3.21**	**Deleted**
SYS_REQ-2263	**SKA1_Survey single array operation** . SKA1-Survey shall be capable of operating ASKAP and SKA1 dishes as single array for frequency band 2.	**Deleted**
SKA1_Survey sub-arraying	**Heading 4.4.3.22**	**Deleted**
SYS_REQ-2264	**SKA1_Survey sub-arraying.** It shall be possible to split the SKA1_Survey array into independent operable ASKAP and SKA1 dish sub-arrays.	**Deleted**
Absolute flux scale	**Heading 4.4.3.23**	**Deleted**
SYS_REQ-2828	**Absolute flux scale:** The absolute flux scale shall be accurate to 5% rms	**Deleted**

SYS_REQ-2829	**Absolute flux scale:** The absolute flux scale shall be accurate to 3% rms	**Deleted**
SKA1_Survey beamformer	**Heading 4.4.4**	**Deleted**
SKA1_Survey number of beams	**Heading 4.4.4.1**	**Deleted**
SYS_REQ-2247	**SKA1_Survey number of beams.** The SKA1_Survey shall beam-form the element signals in each band to provide 36 full bandwidth, dual polarisation beams per antenna**.**	**Deleted**
SKA1_Survey beam quantisation	**Heading 4.4.4.2**	**Deleted**
SYS_REQ-2248	**SKA1_Survey beam quantisation.** The SKA1_Survey processing shall quantise beams passed to the correlator to 8 effective bits.	**Deleted**
PAF beam properties	**Heading 4.4.4.3**	**Deleted**
SYS_REQ-2780	**Control of PAF beam properties:** It shall be possible to control specific properties of the PAF beam by setting the PAF weights appropriately **.**	**Deleted**
SKA1_Survey correlator	**Heading 4.4.5**	**Deleted**
SKA1_Survey correlator sub-array support	**Heading 4.4.5.1**	**Deleted**
SYS_REQ-2781	**SKA1_Survey correlator sub-array support.** The SKA1_Survey correlator shall be able to correlate SKA1_Survey station beams from one to sixteen sub-arrays independently and concurrently.	**Deleted**
SKA1_Survey channelisation	**Heading 4.4.5.2**	**Deleted**
SYS_REQ-2250	**SKA1_Survey correlator sub-array support .** The SKA1_Survey correlator shall be able to correlate SKA1_Survey station beams from one to sixteen sub-arrays independently and concurrently.	**Deleted**
SYS_REQ-2782	**SKA1_Survey channeliser maximum leakage power for adjacent channels.** The SKA1_Survey channeliser for each sub-array shall have a maximum noise leakage power from immediately adjacent channels of < -30 dB.	**Deleted**
SYS_REQ-2807	**SKA1_Survey channelisation maximum leakage power for non-adjacent channels.** The	**Deleted**

	SKA1_Survey channelisation shall have a maximum noise leakage power from non adjacent frequency channels better than -60 dB.	
SYS_REQ-2808	**SKA1_Survey fine frequency channel amplitude variation.** The fine frequency channels for the SKA1_Survey channeliser shall have a total amplitude variation as a function of frequency of less than 0.01 dB.	**Deleted**
SYS_REQ-2809	**SKA1_Survey fine frequency channel band edge .** The fine frequency cells for the SKA1_Survey channeliser shall have a -3dB transition band amplitude at the channel band edge.	**Deleted**
SKA1_Survey correlation signal to noise	**Heading 4.4.5.3**	**Deleted**
SYS_REQ-2680	**SKA1_Survey correlation signal to noise.** The SKA1_Survey correlation, for each sub array, shall not degrade the Signal to Noise ratio by more than 2 % compared to ideal analogue correlation.	**Deleted**
SKA1_Survey correlator integration time	**Heading 4.4.5.3** The base line design suggests two separate ranges of baselines with associated dump rates. This is problematic for Imaging processing and not included in the SKA1 requirements	**Deleted**
SYS_REQ-2252	**SKA1_Survey correlator dump period.** The SKA1_Survey correlator shall have a programmable dump period in the range 3 seconds to 0.3 seconds	**Deleted**
SKA1_Survey spectral dynamic range	**Heading 4.4.5.5**	**Deleted**
SYS_REQ-2259	**SKA1_Survey spectral dynamic range.** The spectral dynamic range for SKA1_Survey shall be better than 30dB between adjacent channels and 60dB globally**.**	**Deleted**
SKA1_Survey VLBI	**Heading 4.4.5.6**	**Deleted**
SYS_REQ-2690	**SKA1_Survey VLBI beam number.** SKA1_Survey shall be capable of producing up to four VLBI beams	**Deleted**
SYS_REQ-2784	**SKA1_Survey VLBI array diameter .** SKA1_Survey shall be able to	**Deleted**

	generate VLBI beams from sub-arrays with receptors separated by up to 25km	
SYS_REQ-2785	**SKA1_Survey VLBI beam centre frequency**. SKA1_Survey shall be able to form a VLBI beam with a 0.01MHz step selectable centre frequency within the boundaries of the defined frequency bands for SKA1_Survey.	**Deleted**
SYS_REQ-2778	**SKA1_Survey VLBI beam bandwidth. SKA1_Survey** VLBI beamforming shall have a contiguous processing bandwidth up to the full bandwidth of the selected band	**Deleted**
SYS_REQ-2813	**SKA1_Survey VLBI beamformer S/N performance.** SKA1_Survey VLBI beamforming shall have the Signal to Noise ratio by more than 98% compared to an ideal analogue beam former.	**Deleted**
SYS_REQ-2862	**SKA1_Survey VLBI store the time-dependent antenna weight.** SKA1_Survey shall be able to store the time-dependent antenna weights used for each tied-array beam sum.	**Deleted**
SYS_REQ-2863	**SKA1_Survey VLBI timestamp accuracy**. SKA1_Survey shall be able to generate data from the VLBI beams with samples traceable to a timestamp with an accuracy of 1 nsec or better.	**Deleted**
SYS_REQ-2864	**SKA1_Survey VLBI beams sampling rate.** SKA1_Survey shall be able to output VLBI beams with a sampling rate selectable between Nyquist and oversampled rates for the selected bandwidth.	**Deleted**
SYS_REQ-2865	**SKA1_Survey VLBI beamforming.** SKA1_Survey shall be able to allocate antennas to be included in, or excluded from, individual tied-array beams**.**	**Deleted**
SYS_REQ-2866	**SKA1_Survey VLBI relative sensitivity and coherence.** The SKA1_Survey beamformer shall be able to weight the antenna inputs into the tied-array sums based on relative sensitivity and coherence losses.	**Deleted**

SYS_REQ-2867	**SKA1_Survey VLBI configurability.** SKA1_Survey shall be able to change the pointing, centre frequency, and bandwidth of the individual tied-array beams within a single observing schedule.	**Deleted**
SYS_REQ-2868	**SKA1_Survey VLBI configurability .** SKA1_Survey shall be capable of selecting, through configuration, 1, 2, 3, or 4 separate VLBI specific beams, each with independently selectable centre frequency, bandwidth, frequency resolution and pointing**.**	**Deleted**
SYS_REQ-2869	**SKA1_Survey VLBI configurability.** SKA1_Survey shall be capable of reconfiguring the centre frequency, frequency band, and bandwidth for each tied-array beam, in less than 30 seconds.	**Deleted**
SYS_REQ-2870	**SKA1_Survey VLBI spectral resolution.** SKA1_Survey shall be able to generate VLBI beams with a spectral resolutions different from the spectral resolution used for imaging within the same VLBI sub-array	**Deleted**
SYS_REQ-2871	**SKA1_Survey VLBI channel width.** SKA1_Survey shall be able to generate VLBI beam data with a selectable channel width of: 512MHz, 256 MHz, 128MHz, 64MHz, 32MHz, 16MHz, 4MHz or 1MHz	**Deleted**
SYS_REQ-2872	**SKA1_Survey VLBI imaging and beamforming.** SKA1_Survey shall be able to simultaneously generate imaging data using all antennas in a VLBI sub-array, as well as generating the VLBI beams.	**Deleted**
SYS_REQ-2873	**SKA1_Survey VLBI spectral line and time domain observation.** SKA1_Survey shall be able to generate VLBI beams optimised for either spectral line observations (to mitigate spectral leakage) or time domain observations (to mitigate time smearing).	**Deleted**
SYS_REQ-2874	**SKA1_Survey VLBI beams and sub-array.** SKA1_Survey shall be able to allocate individual VLBI beams to different sub-arrays.	**Deleted**

SYS_REQ-2875	**SKA1_Survey VLBI array diameter.** SKA1_Survey shall be able to generate VLBI beams from sub-arrays with receptors separated by up to 20km	**Deleted**
SYS_REQ-2128	**Continuum and spectral line imaging mode.** All three SKA1 telescopes shall be capable of operating in a Continuum and Spectral-line imaging mode concurrently.	**Deleted**
SYS_REQ-2126	**Simultaneous operation of telescopes.** All three telescopes shall be capable of operating concurrently and independently.	**Deleted**
SYS_REQ-2127	**Sub-Arraying.** All of the SKA1 telescopes shall be capable of operating independently with one to sixteen sub-arrays (i.e. collecting area is split and allocated to separate, concurrently observing programmes).	**Deleted**
SYS_REQ-2726	**PAF DDE.** There shall be a direction dependent model for the dish phased array feed sensitivity pattern to be used in calibration and imaging.	**Deleted**
SYS_REQ-2371	**Visual monitoring.** The infrastructure shall provide day and night time capability for the operator(s) to visually monitor all antennas: for Dish antennas this shall be at every dish, for LFAA this shall be located at each station in the spiral arms and also around the perimeter of the core area. Monitoring to deliver images at least one per minute for purposes of security and general telescope visual monitoring and shall be able to detect personnel at each dish and within each LFAA station.	**Deleted**
SYS_REQ-2397	**Dish Antenna earthing .** For lightning protection of each dish antenna the earthing system shall conform to the requirements of IEC 62305 and also to national standards AS/NZS 3000 and AS/NZS 1768 or SANS 10142 and 10313. National standards shall take precedence.	**Deleted**
SYS_REQ-2838	**VLBI data sources.** The SKA1_Mid and SKA1_Survey telescopes shall be data sources for	**Deleted**

	VLBI data acquisition system. The interface between the telescopes SAK1_Mid and SkA1_Survey and the external VLBI data acquisition system shall be compliant with the ICD SKA-TEL-SKO-0000116	
SYS_REQ-2841	**Infrastructure for VLBI equipment:.** The following infrastructure shall be provided to allow eventual outfitting of SKA1_Mid and SKA1_Survey with VLBI equipment: Adequate access for the potential fitment of VLBI equipment Equipment space Power Cooling Cable trays	**Deleted**
ASKAP to SKA1_survey CSP	**Heading 9.1.2**	**Deleted**
SYS_REQ-2411	**ASKAP to SKA1_survey CSP interface .** The interface between ASKAP and SKA1_survey CSP shall be compliant with SKA-TEL.AIV.SE-TEL.CSP.SE-ICD-002 Interface Control Document.	**Deleted**
ASKAP to SKA1_survey SADT	**Heading 9.1.4**	**Deleted**
SYS_REQ-2413	**ASKAP to SKA1_survey SADT interface .** The interface between ASKAP and SKA1_survey SADT shall be compliant with SKA-TEL.AIV.SE-TEL.SADT.SE-ICD-002 Interface Control Document**.**	**Deleted**
ASKAP to SKA1_survey TM	**Heading 9.1.6**	**Deleted**
SYS_REQ-2415	**ASKAP to SKA1_survey TM interface .** The interface between ASKAP and SKA1_survey TM shall be compliant with SKA-TEL.AIV.SE-TEL.TM.SE-ICD-002 Interface Control Document.	**Deleted**
ASKAP to SKA1_INFRA	**Heading 9.1.7**	**Deleted**
SYS_REQ-2776	**ASKAP to SKA1_INFRA interface.** The interface between ASKAP/MRO and SKA1_INFRA shall be compliant with the SKA-TEL.AIV.INFRA.SE-ICD-002 Interface Control Document.	**Deleted**
Availability	The following applies to each of SKA1-low, SKA1-survey, and SKA1-mid telescopes separately. In general available means that the	The following applies to each of SKA1-low and SKA1-mid telescopes separately. In general available means that the telescope or a fraction

	telescope or a fraction thereof as defined below is available to an operator to be scheduled for science or other operations. Availability is defined as A=MTBF' / (MTBF' + MTTR'), where MTBF' is the mean time between failures (based on the conditional probability of failure), given that regular inspection or preventative maintenance is done, and MTTR' is the total time spent on these two activities plus any repair time. • Availability Fraction is defined as (N Ae) / (Nmax Ae_max), where N is the number of schedulable major modes and Ae is the effective area available; Nmax is the number of major modes in the full set of defined modes; Ae_max is the maximum effective area of the telescope. • Major modes correspond to the main categories of observations that the telescope is designed to carry out. For each frequency band defined for the telescope they are: o Spectral line observations. o Pulsar search observations. o Pulsar timing observations.	thereof as defined below is available to an operator to be scheduled for science or other operations. Availability is defined as A=MTBF' / (MTBF' + MTTR'), where MTBF' is the mean time between failures (based on the conditional probability of failure), given that regular inspection or preventative maintenance is done, and MTTR' is the total time spent on these two activities plus any repair time. • Availability Fraction is defined as (N Ae) / (Nmax Ae_max), where N is the number of schedulable major modes and Ae is the effective area available; Nmax is the number of major modes in the full set of defined modes; Ae_max is the maximum effective area of the telescope. • Major modes correspond to the main categories of observations that the telescope is designed to carry out. For each frequency band defined for the telescope they are: o Spectral line observations. o Pulsar search observations. o Pulsar timing observations.

	o Continuum observations. o Transient detection. The telescope system will have three availability states: 1. Available: The availability fraction is 95% 2. Degraded: The availability fraction is between 50 and 95%. 3. Unavailable: The availability fraction is less than 50%. In a running average over a year, the design requirement is: o Unavailable for <5% of the time, corresponding to ~18 days per year. o Degraded for <5% of the time, corresponding to ~18 days per year. o Available >90% of the time, corresponding to ~329 days per year. Natural disturbances of severity outside design boundaries are not counted against availability, unless the system does not behave according to design. The availability state depends only on the telescope, itself. The operational state of all sub-systems shall be defined as 'failed', 'degraded' or 'available'. It shall be possible to sense and log the operational state (failed, degraded, or available) of every sub-system at the system level.	o Continuum observations. o Transient detection. The telescope system will have three availability states: 1. Available: The availability fraction is 95% 2. Degraded: The availability fraction is between 50 and 95%. 3. Unavailable: The availability fraction is less than 50%. In a running average over a year, the design requirement is: o Unavailable for <5% of the time, corresponding to ~18 days per year. o Degraded for <5% of the time, corresponding to ~18 days per year. o Available >90% of the time, corresponding to ~329 days per year. Natural disturbances of severity outside design boundaries are not counted against availability, unless the system does not behave according to design. The availability state depends only on the telescope, itself. The operational state of all sub-systems shall be defined as 'failed', 'degraded' or 'available'. It shall be possible to sense and log the operational state (failed, degraded, or available) of every sub-system at the system level.

SKA1_survey availability allocations	**Section 23.3**	**Deleted**

25 Glossary

A selected glossary extracted from IEEE Std 1233:
baseline: A specification or system that has been formally reviewed and agreed upon, that thereafter serves as the basis for further development and can be changed only through formal change control procedures. (IEEE Std 610.12-1990)
constraint: A statement that expresses measurable bounds for an element or function of the system. That is, a constraint is a factor that is imposed on the solution by force or compulsion and may limit or modify the design changes.
derived requirement: A requirement deduced or inferred from the collection and organization of requirements into a particular system configuration and solution.
customer(s): The entity or entities for whom the requirements are to be satisfied in the system being *de*fined and developed. This can be an end-user of the completed system, an organization within the same company as the developing organization (e.g., System Management), a company or entity external to the developing company, or some combination of all of these. This is the entity to which the system developer must provide proof that the system developed satisfies the system requirements specified.
end user: The person or persons who will ultimately be using the system for its intended purpose.
environment: The circumstances, objects, and conditions that will influence the completed system; they include political, market, cultural, organizational, and physical influences as well as standards and policies that govern what the system must do or how it must do it.
function: A task, action, or activity that must be accomplished to achieve a desired outcome.
model: A representation of a real world process, device, or concept.
prototype: An experimental model, either functional or non-functional, of the system or part of the system. A prototype is used to get feedback from users for improving and specifying a complex human interface, for feasibility studies, or for identifying requirements.
raw requirement : An environmental or customer requirement that has not been analysed and formulated as a well-formed requirement.
representation: A likeness, picture, drawing, block diagram, description, or symbol that logically portrays a physical, operational, or conceptual image or situation.
requirement:

> (A)A condition or capability needed by a user to solve a problem or achieve an objective.
> (B)A condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed document.
> (C)A documented representation of a condition or capability as in definition (A) or (B). (IEEE Std 610.12-1990)

system: An interdependent group of people, objects, and procedures constituted to achieve defined objectives or some operational role by performing specified functions. A complete system includes all of the associated equipment, facilities, material, computer programs, Firmware, technical documentation, services, and personnel required for operations and support to the degree necessary for self-sufficient use in its intended environment.
System Requirement Specification (SyRS): A structured collection of information that embodies the requirements of the system.
testability: The degree to which a requirement is stated in terms that permit establishment of test criteria and performance of tests to determine whether those criteria have been met. (IEEE Std 610.12-1990)
traceability: The degree to which a relationship can be established between two or more products of the development process, especially products having a predecessor-successor or master-subordinate

relationship to one another; e.g., the degree to which the requirements and design of a given system element match.(IEEE Std 610.12-1990)

validation: The process of evaluating a system or component during or at the end of the development process to determine whether a system or component satisfies specified requirements. (IEEE Std 610.12-1990)

verification: The process of evaluating a system or component to determine whether the system of a given development phase satisfies the conditions imposed at the start of that phase. (IEEE Std 610.12-1990)

well-formed requirement: A statement of system functionality (a capability) that can be validated, and that must be met or possessed by a system to solve a customer problem or to achieve a customer objective, and is qualified by measurable conditions and bounded by constraints.